

# ESS™ PLATFORM

## Easy Switch Solutions™



## User Manual

ESS™ platform: SWITCHBOARD, M-SWITCH™, L-SWITCH™ and 2-SWITCH™

Version 10A



<b>1. INTRODUCTION</b>	<b>6</b>
<b>2. FLUIDIC CIRCUITS EXAMPLES</b>	<b>7</b>
<b>3. USING A 2-SWITCH™ VALVE</b>	<b>8</b>
<b>3.1 Fluidic principle</b>	<b>8</b>
<b>3.2 Description</b>	<b>9</b>
3.2.1 2-SWITCH™ Front	9
3.2.2 2-SWITCH™ Back	10
3.2.3 2-SWITCH™ Top and Bottom faces	11
<b>3.3 Connection</b>	<b>12</b>
3.3.1 Fluidic connection	12
3.3.2 Electric connection	15
<b>3.4 Positioning</b>	<b>16</b>
<b>4. USING AN M-SWITCH™ VALVE</b>	<b>19</b>
<b>4.1 Fluidic principle</b>	<b>19</b>
<b>4.2 Description</b>	<b>20</b>
4.2.1 M-SWITCH™ Front and top	20
4.2.2 M-SWITCH™ Back	21
4.2.3 M-SWITCH™ Bottom face	21
4.2.4 M-SWITCH™ Side face	21
<b>4.3 Connection</b>	<b>22</b>
4.3.1 Fluidic connection	22
4.3.2 Electric connection	25
<b>4.4 Positioning</b>	<b>26</b>
<b>5. USING AN L-SWITCH™ VALVE</b>	<b>28</b>
<b>5.1 Fluidic principle</b>	<b>28</b>
<b>5.2 Description</b>	<b>29</b>
5.2.1 L-SWITCH™ Front and top	29
5.2.2 L-SWITCH™ Back	30
5.2.3 L-SWITCH™ Bottom face	30
5.2.4 L-SWITCH™ Side face	30
<b>5.3 Connection</b>	<b>31</b>
5.3.1 Fluidic connection	31
5.3.2 Electric connection	37
<b>5.4 Positioning</b>	<b>38</b>
<b>6. USING THE SWITCHBOARD</b>	<b>40</b>
<b>6.1 Description</b>	<b>40</b>

<b>6.2</b>	<b>Connection</b>	<b>41</b>
<b>7.</b>	<b>HOW TO USE THE 2-SWITCH™, M-SWITCH™ AND L-SWITCH™ WITH GAS</b>	<b>43</b>
<b>8.</b>	<b>HOW TO START WORKING WITH THE ESS™</b>	<b>46</b>
<b>9.</b>	<b>FREQUENTLY ASKED QUESTIONS</b>	<b>47</b>
<b>10.</b>	<b>SPECIFICATIONS</b>	<b>48</b>

## **WARRANTY 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 SWITCHBOARD, 2-SWITCH™, L-SWITCH™ and M-SWITCH™ devices.
- Do not use other cables than cables provided by Fluigent.
- Prevent foreign objects or liquids from entering the SWITCHBOARD.
- Prevent foreign objects from entering the 2-SWITCH™, L-SWITCH™ and M-SWITCH™ devices.
- Connect the power cord to an AC outlet of the correct voltage.
- Use the right RJ45 port on the SWITCHBOARD with the right device.
- 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.
- If you are using the ESS™ platform with other flow control systems, please check that the pressure in your fluidic system does not exceed 100 psi.
- Respect the temperature compatibility (from 5°C to 50 °C).
- Use the specific connectors provided by Fluigent (Teflon fittings and nuts for the 2-Switch™).
- Only use 1/16'' OD tubings with the valves (each type).

For specific use, please contact our Support team at [support@fluigent.com](mailto:support@fluigent.com)

### WARNINGS:



- Do never open SWITCHBOARD, 2-SWITCH™, L-SWITCH™ and M-SWITCH™ devices. Refer all servicing to after-sales service department (support@fluigent.com).



- Prevent any objects or liquids from entering the SWITCHBOARD, 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.
- **Do not use other power supply than the one provided with the ESS™.** The power supply provided with the ESS™ has been carefully selected to meet the power requirements of the ESS™ in all configurations and to comply with all safety standards.
- If you are using the ESS™ platform with other flow control systems, please check that the pressure in your fluidic system does not exceed 100 psi

## 1. Introduction

The **Easy Switch Solutions™ platform (or ESS™)** provides solutions for path selection in microfluidics. The Easy Switch Solutions™ platform enables you to implement three (3) different kinds of valves in your microfluidic circuit.

- ⇒ The **2-SWITCH™** is a 3-port / 2-position solenoid valve: two (2) ports can alternatively be connected to a third one. The 2-SWITCH™ is fully described in §3.
- ⇒ The **M-SWITCH™** is an 11-port / 10-position rotary valve: ten (10) peripheral ports can alternatively be connected to a central one. The M-SWITCH™ is fully described in §4.
- ⇒ The **L-SWITCH™** is a 6-port/ 2-position valve for injecting precise volume of fluid or for switching the fluid to different channels. The L-SWITCH™ is fully described in §5.
- ⇒ The fourth element of the Easy Switch Solutions™ platform is the **SWITCHBOARD**: this device hosts up to four (4) M-SWITCH™ or L-SWITCH™ and eight (8) 2-SWITCH™ and provides them power supply. The SWITCHBOARD is also the link between the connected 2-SWITCH™, M-SWITCH™ and L-SWITCH™ and the controlling software ESS™ Control (cf. ESS™ Control User Manual). The SWITCHBOARD is fully described in §6.

Combining the 2-SWITCH™, M-SWITCH™ and L-SWITCH™ valves thanks to the SWITCHBOARD will give you new possibilities to easily design and build even the most complex microfluidic circuits. It is also a powerful tool to simplify your chip design and automate your experiments.

The **ESS™ platform has been designed to work at its best performances with FLUIGENT flow control solutions** (MFCS™ and Flow-Rate Platform). It is however possible to use the ESS™ platform with other flow control systems provided that the pressure applied to the ESS™ devices **does not exceed 100 psi**.

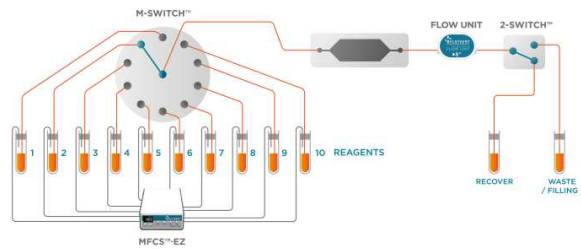
The ESS™ user manual will show you how to use the ESS™ elements for your daily work. It will describe all the ESS™ functionalities that will help you to rationalize your microfluidic circuits and automate your experiments. You will also find examples of applications using the ESS™ and answers to the frequently asked questions about the ESS™. With these elements you will be able to exploit the full performances of the Easy Switch Solutions™ platform for your application.

## 2. Fluidic circuits examples

### SEQUENTIAL INJECTIONS

Up to 10 liquids are selected sequentially inside the 1-channel chip by the M-SWITCH™. The samples at the outlet are then sorted by the 2-SWITCH™. All steps can be automated by the ESS™ control software.

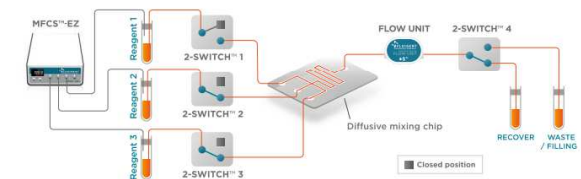
- Cell analysis
- Cell lysis and DNA extraction for PCR or NGS (Next Generation Sequencing) analysis
- Drug testing
- Calibration curve, etc



### SAMPLE PREPARATION

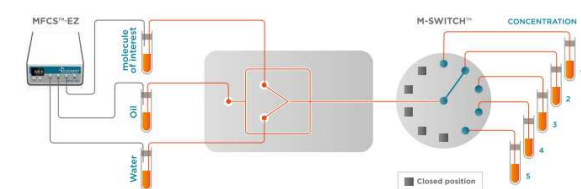
Several samples are injected simultaneously or separately within a Y-shape chip by changing the position of the 2-SWITCH™. The samples at the outlet are then sorted by the 2-SWITCH™. All steps can be automated by the ESS™ control software or controlled manually.

- Chemical mixing reactions
- Stoichiometry study, etc



### SAMPLE SEPARATION AND COLLECTION

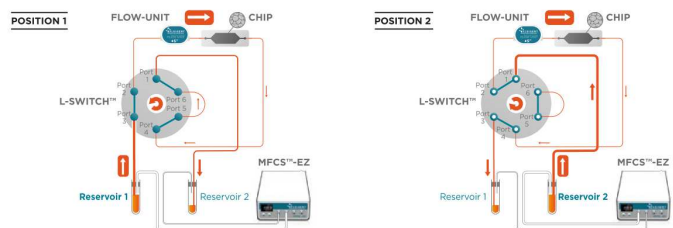
Different proportions of the molecule of interest are injected in the chip, generating droplets of different concentrations. These droplets are then sorted at the outlet by the M-SWITCH™ depending on their concentrations. All steps can be automated by the ESS™ control software.



### FLUID RECIRCULATION

A small volume of buffer is recirculated within a close loop into the chip for several days via the L-SWITCH™ from the first reservoir to the second and the other way round, keeping the same direction in the chip by changing the position of the L-SWITCH™.

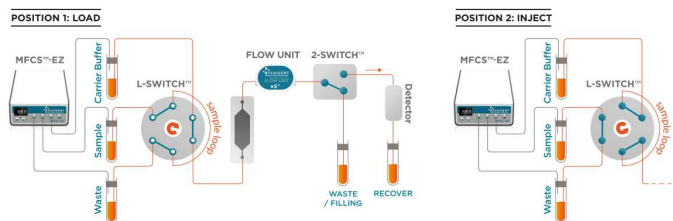
- ➔ Cell Culture
- ➔ Shear-stress Control



### CONTROLLED VOLUME INJECTION

The sample is "loaded" into the sample loop with the L-SWITCH™ while the carrier buffer is injected directly into the chip. When the L-SWITCH™ is switched the controlled sample loop volume is "injected" into the chip with the carrier buffer. The sample is then sorted by the 2-SWITCH™ at the outlet. All steps can be automated by the ESS™ Control software.

- ➔ Cell culture
- ➔ PCR

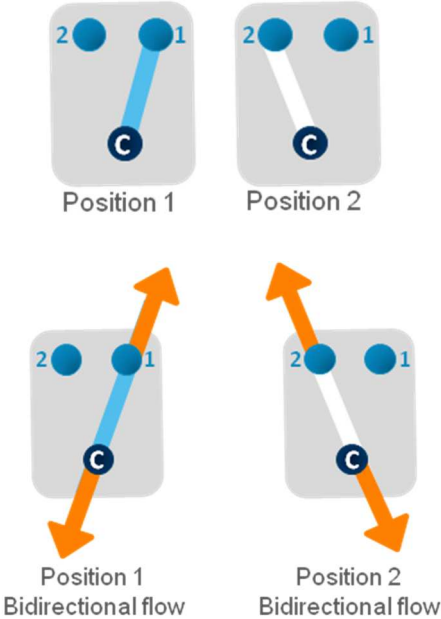


### 3. Using a 2-SWITCH™ valve

#### 3.1 Fluidic principle

The 2-SWITCH™ is a 3-port / 2-position valve. This means that three (3) ports can be connected with fittings and tubings to your application, and that it is possible to choose between two (2) positions linking the ports in two (2) different manners.

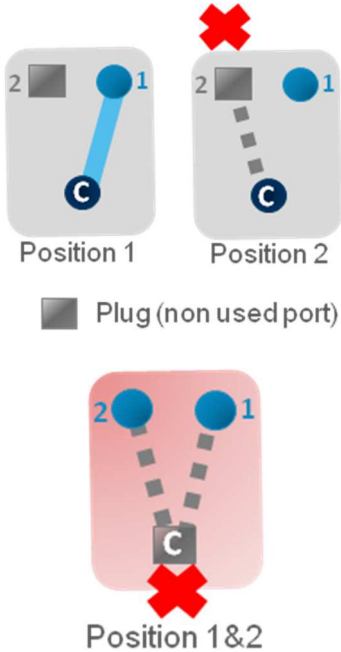
##### Fluidic 2-way switch



Here is the fluidic diagram of a 2-SWITCH™. The dark blue “C” port at the bottom of the 2-SWITCH™ is the **common port**: it can be either connected to port #1 or to port #2 depending on the chosen position.

- ▶ **Position 1** connects the common port to port #1 and **Position 2** connects the common port to port #2. The 2-SWITCH™ enables you to switch between these two positions.
- ▶ The **Default position of the 2-SWITCH™** when the 2-SWITCH™ is not powered is **Position 1**.
- ▶ The 2-SWITCH™ is a **bidirectional valve**: the fluid can flow in both directions inside the 2-SWITCH™ i.e. from the common port to port #1 / port #2 **AND** from port #1 / port #2 to the common port.

##### Fluidic on/off switch



Another possibility for using the 2-SWITCH™ is to connect a plug to either port #1 or port #2. This way, one of the positions of the 2-SWITCH™ (Position 1 for port #1 or Position 2 for port #2) becomes a closed position, and the 2-SWITCH™ acts as a fluidic “on/off” switch.

- ▶ *Example:* A plug (gray square) is connected to port #2. Position 2 is thus closed. In Position 1 fluids can flow through the valve between the common port and port #1, whereas in Position 2 the fluidic path is closed between the common port and port #2.

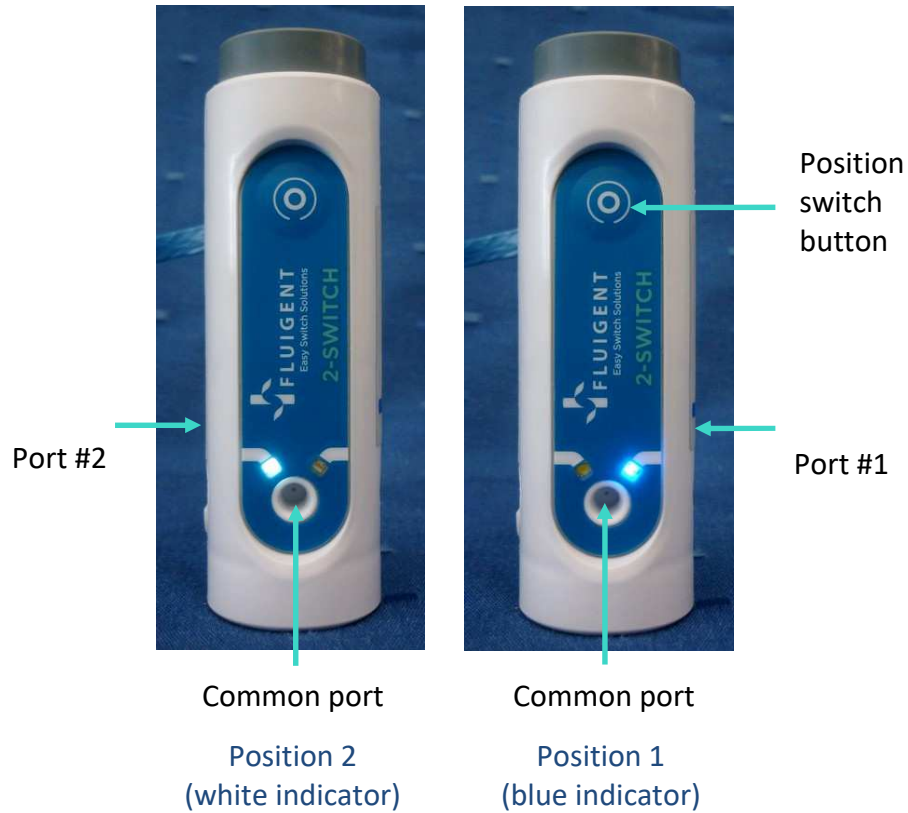
**Warning:** The fluidic “on/off” switch configuration only works if port #1 or port #2 is connected with a plug. **If the common port is plugged then no flow can circulate through the 2-SWITCH™** (bottom diagram).

FAQ: Should I fill with liquid the plugged path inside the 2-SWITCH™ before screwing the plug? (cf. §9)



## 3.2 Description

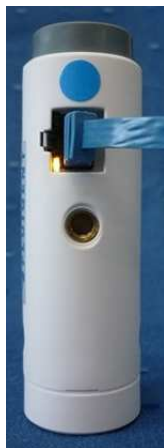
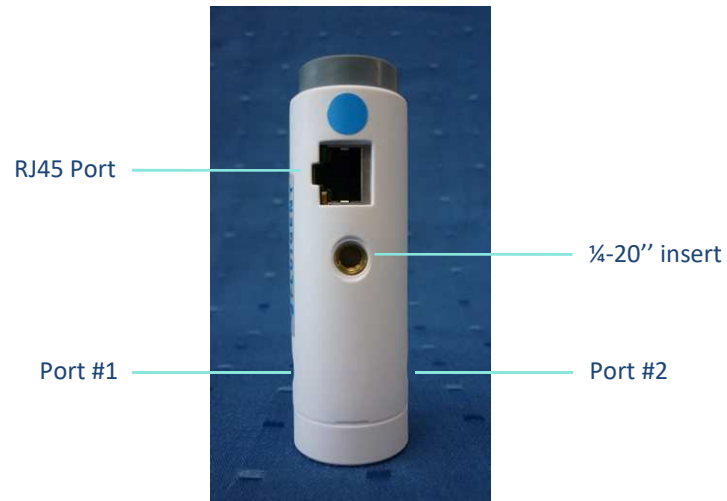
### 3.2.1 2-SWITCH™ Front



Here is a picture of the front of a 2-SWITCH™.

- ▶ The 3 fluidic ports are at the bottom part of the device. The **common port** is the **central port**, included in the device front. When looking at the front of the 2-SWITCH™, **port #1** is the **right port** and **port #2** is the **left one**.
- ▶ Two light indicators on the front show the current activated position of the 2-SWITCH™:
  - A **blue indicator** (right) for Position 1 linking the common port to port #1 (right).
  - A **white indicator** (left) for Position 2 linking the common port to port #2 (left).
- ▶ The front of the 2-SWITCH™ also includes a push button at the top to manually switch between Position 1 and Position 2.

### 3.2.2 2-SWITCH™ Back



Orange indicator  
(Power OK)



Orange indicator + green indicator  
(Power OK + Check connection)

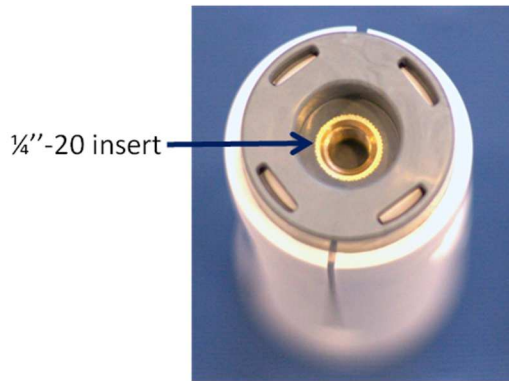
Here is a picture of the back of a 2-SWITCH™.

- ▶ Port #1 is now at the left and port #2 is at the right.
- ▶ At the centre of the back, a **UNC 1/4-20" thread is inserted** to enable the user to fasten the 2-SWITCH™ to the provided base or to any 1/4-20" screw-mounted device (as further explained in §3.4).
- ▶ At the top of the device we can see the RJ45 port to connect electrically the 2-SWITCH™ to the SWITCHBOARD. Two light indicators are associated with the RJ45 port.
  - The **orange indicator** lights up when the 2-SWITCH™ is powered.
  - The **green indicator** lights up if a "Check connection" identification has been requested for the 2-SWITCH™ from the SWITCHBOARD (cf. §6.2) or from the ESS™ Control software (cf. ESS™ Control User Manual).

**Warning:** Please note that **only straight-through wired RJ45 cables are compatible with the ESS™** (to connect the 2-SWITCH™ with the SWITCHBOARD). Other types of cable can damage the ESS™, and reciprocally, the cables provided with the ESS™ should not be used for other applications. FLUIGENT advises to only use the cables provided with the ESS™ for ESS™ operation.

### 3.2.3 2-SWITCH™ Top and Bottom faces

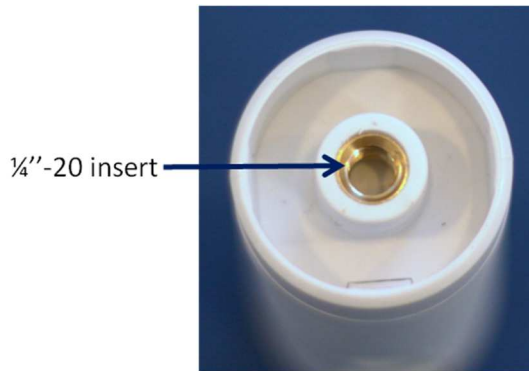
#### Top face



2-SWITCH™ top

Here is a picture of the top face of a 2-SWITCH™. A **UNC 1/4-20'' thread is inserted** in the centre of the top face so that the 2-SWITCH™ can be fastened to the provided base or to any 1/4-20'' screw-mounted device (as further explained in §3.4).

#### Bottom face



2-SWITCH™ bottom

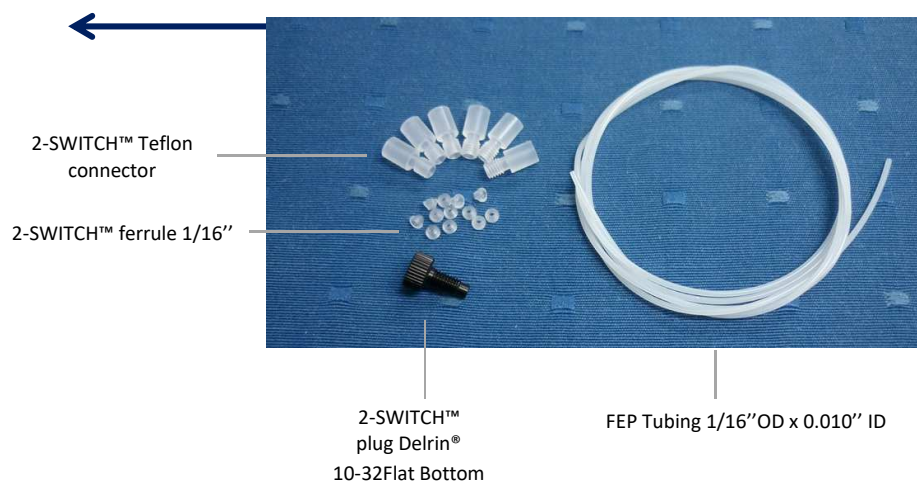
Here is a picture of the bottom face of a 2-SWITCH™. A **UNC 1/4-20'' thread is inserted** in the centre of the bottom face so that the 2-SWITCH™ can be fastened to the provided base or to any 1/4-20'' screw-mounted device (as further explained in §3.4).

The **bottom face and the top face of the 2-SWITCH™ are complementary**: two 2-SWITCH™ can be assembled together by inserting the top face of one 2-SWITCH™ in the bottom of another 2-SWITCH™. Please see §3.4 for more details.

### 3.3 Connection

#### 3.3.1 Fluidic connection

##### Description of the fittings and tubings



A 2-SWITCH™ has three (3) fluidic ports, described in §3.1 as “Common port”, “Port #1” and “Port #2”.

- ▶ The characteristics of those three (3) ports are:
  - Thread-size: 10-32.
  - Flat-bottom type (FB).
  - Compatible with tubings of 1/16" external diameter (1/16" OD).
- ▶ To get started, FLUIGENT provides you, into the “KIT ESS 2-SWITCH “ :
  - Six (6) 2-SWITCH™ Teflon connectors.
  - Twelve (12) 2-SWITCH™ ferrules 1/16"
  - One (1) plug Delrin® - 10-32 Flat Bottom.
  - One (1) meter of FEP tubing: 1/16" OD (external diameter) and 0.010" ID (internal diameter). **NB:** There is a wide variety of materials and internal diameters available with 1/16" tubing from fittings suppliers to suit your application.

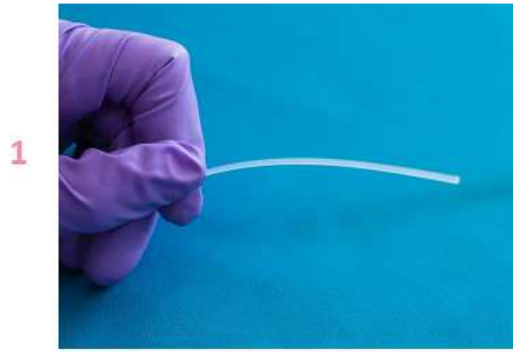
**Warning:** These fittings have been **specifically selected by FLUIGENT to ensure good 2-SWITCH™ operation**. FLUIGENT advises you to **use only these fittings** on the 2-SWITCH™.

**Warning:** Please note that **only tubings of 1/16" external diameter should be used with the 2-SWITCH™**. FLUIGENT does not recommend the use of other tubings sizes with or without tubing sleeves, as it can damage the 2-SWITCH™ and give non-tight fluidic connection.

**NB:** When the 2-SWITCH™ is not used or stored, FLUIGENT advises you to **connect plugs to all ports** to protect the fluidic ports from dust.

FAQ: How can I make a junction between a 2-SWITCH™ and tubings with external diameters different from 1/16"? (cf. §9)

## Connecting a 1/16" OD tubing to the 2-SWITCH™



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



5. To check the tightness of your connection, you may pull gently on the tubing: it must stay fitted in the ferrule and nut.

### Connecting a plug to the 2-SWITCH™



1. Simply screw the plug in port #1 or port #2 finger-tight.



Fully connected 2-SWITCH™ in fluidic on/off configuration. Position 1 is plugged and Position 2 is opened.

### 3.3.2 Electric connection



- ▶ Simply plug one connector of the RJ45 **blue** cable provided with the 2-SWITCH™ in the female RJ45 plug at the back of the 2-SWITCH™. The other connector should be connected to a port in the **blue** cables section of the SWITCHBOARD (See §6.2 for more details)
- ▶ If the 2-SWITCH™ is connected to a powered SWITCHBOARD, the orange indicator on the female RJ45 connector lights up.

**Warning:** Please note that **only straight-through wired RJ45 cables are compatible with the ESS™** (to connect the 2-SWITCH™ with the SWITCHBOARD). Other types of cable can damage the ESS™, and reciprocally, the cables provided with the ESS™ should not be used for other applications. FLUIGENT advises to only use the cables provided with the ESS™ for the ESS™.

### 3.4 Positioning

There are several possibilities to set the 2-SWITCH™ up. Please note that the 2-SWITCH™ device does not have any imposed mounting orientation. The 2-SWITCH™ can be used in any spatial configuration.

#### Setting-up with the provided base



Vertical positioning  
with base



Horizontal positioning  
with base

- ▶ The base provided with the 2-SWITCH™ can be screwed to any of its ¼-20" inserts.
- ▶ Mainly, the 2-SWITCH™ can be set-up **vertically** on the base by fastening the base into the ¼-20" insert of the bottom face or **horizontally** when fastening the base into the ¼-20" insert of the back.

**NB:** It is easier to first connect the RJ45 cable on the 2-SWITCH™ before screwing the base on the back face for horizontal positioning.



## Assembling several 2-SWITCH™ together using the complementary faces



- ▶ The top and bottom faces of the 2-SWITCH™ devices are complementary: you can assemble them together by inserting the top face of one 2-SWITCH™ into the bottom face of another 2-SWITCH™.



- ▶ As many 2-SWITCH™ as you need can be assembled together horizontally, and meanwhile can be set-up on their base fastened into their back insert.

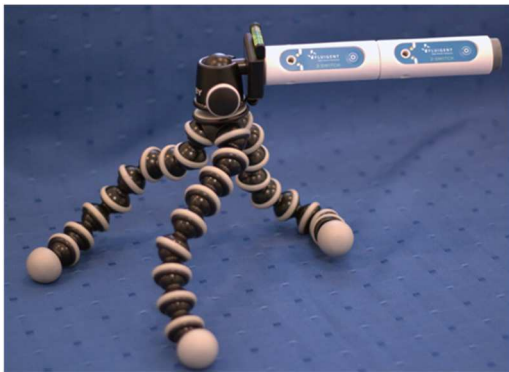


- ▶ 2-SWITCH™ devices can also be assembled vertically. FLUIGENT advises not to assemble more than two 2-SWITCH™ together vertically.

## Other possible setting-up



- ▶ The three ¼-20" inserts of the 2-SWITCH™ can be used to mount the 2-SWITCH™ on any frame or support equipped with ¼-20" pins such as a flexible rod as shown here (not provided with the 2-SWITCH™).

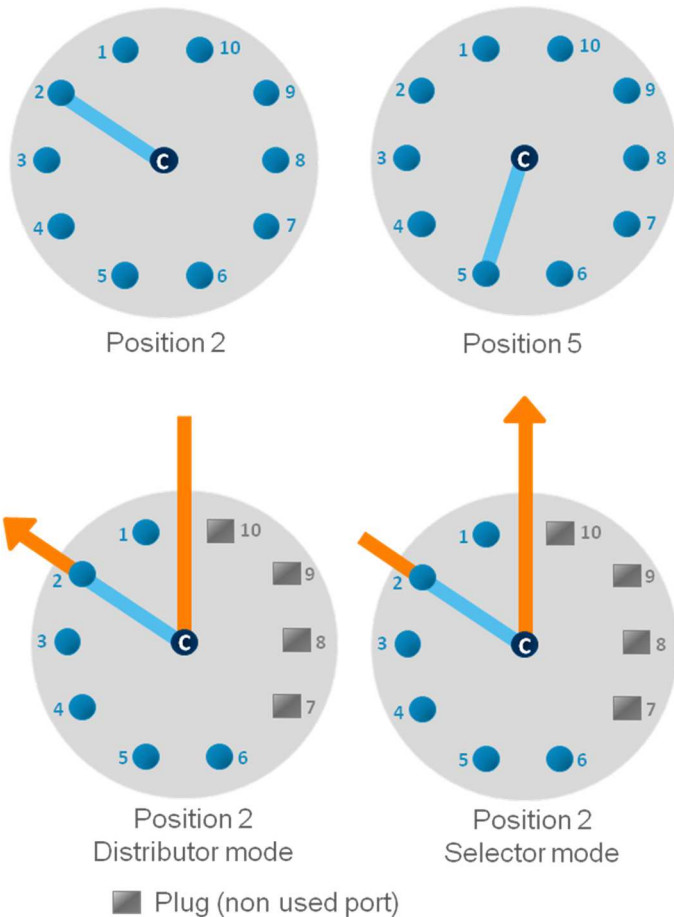


- ▶ ¼-20" thread is also the standard for all photographic equipment. You can use for example a tripod for cameras and screw a 2-SWITCH™ on it (not provided with the 2-SWITCH™).

## 4. Using an M-SWITCH™ valve

### 4.1 Fluidic principle

The M-SWITCH™ is an 11-port / 10-position valve. This means that eleven (11) ports can be connected with tubings, and that it is possible to choose between ten (10) positions linking one of the ten (10) external ports to the central port of the valve.

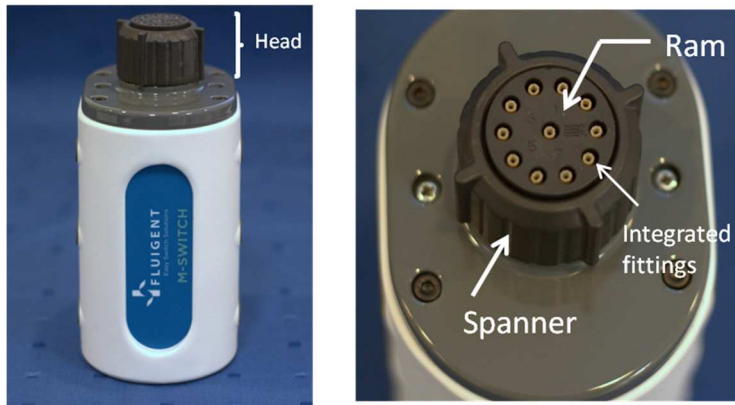


Here is the fluidic diagram of an M-SWITCH™. The dark blue port at the centre of the M-SWITCH™ is the **central port**. The light blue ports are the **external ports**. The central port can be connected in turns to each external port, from port #1 to port #10 depending on the chosen position (respectively from Position 1 to Position 10).

- ▶ The **Default position of the M-SWITCH™** when the M-SWITCH™ is not powered is **the last actuated position**.
- ▶ The M-SWITCH™ is a **bidirectional valve**, meaning that the fluid can flow inside the M-SWITCH™ in both directions:
  - **Distributor mode**: fluid flows from the central port to one external port (according to the selected position).
  - **Selector mode**: fluid flows from one of the external ports (according to the selected position) to the central port.
  - The **non used ports must be closed with plugs** (gray squares on the diagram) to preserve the M-SWITCH™ good operation. In the same way as the 2-SWITCH™, it is possible to use a plugged position to close a fluidic path.

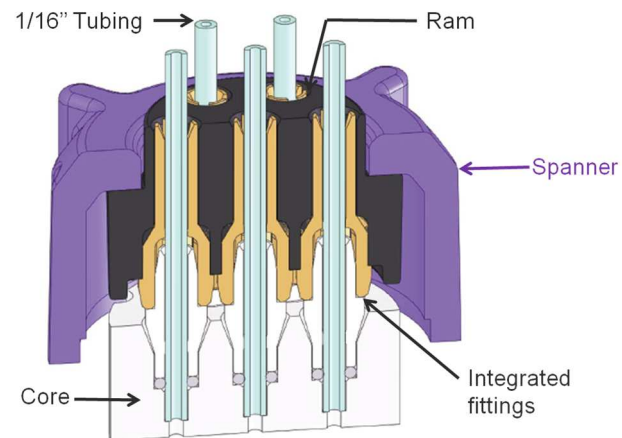
## 4.2 Description

### 4.2.1 M-SWITCH™ Front and top



Here is a picture of the front of an M-SWITCH™.

- ▶ At the top of the picture, the fluidic head of the device can be seen. The head holds the fluidic ports.
- ▶ The head of the M-SWITCH™ is made up of the **Ram** which holds the integrated fittings and the **Spanner**, which is tightened around the Ram to clench the integrated fittings and make tight fluidic connections. The method to connect tubings to the M-SWITCH™ is detailed in §4.3.1.



## 4.2.2 M-SWITCH™ Back



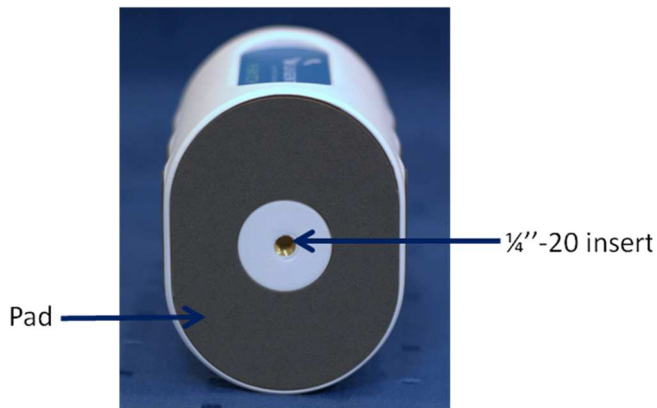
Orange indicator  
(Power OK)

Orange + green indicator  
(Power OK + Check connection)

Here are pictures of the back of an M-SWITCH™.

- ▶ At the bottom of the device we can see the RJ45 port to connect electrically the M-SWITCH™ to the SWITCHBOARD. Two light indicators are associated with the RJ45 port.
  - The **orange indicator** lights up when the M-SWITCH™ is powered.
  - The **green indicator** lights up if a “Check connection” identification has been requested for the M-SWITCH™ from the SWITCHBOARD (cf. §6.2) or from the ESS™ Control software (cf. ESS™ Control User Manual).

## 4.2.3 M-SWITCH™ Bottom face



Here is a picture of the bottom face of an M-SWITCH™.

- ▶ A pad covers the bottom face to ensure a good gripping of the M-SWITCH™ to the surface where it is placed in vertical position.
- ▶ A **UNC 1/4-20" thread is inserted** in the centre of the bottom face so that the M-SWITCH™ can be fastened to any 1/4-20" screw-mounted device (as further explained in §4.4).

## 4.2.4 M-SWITCH™ Side face



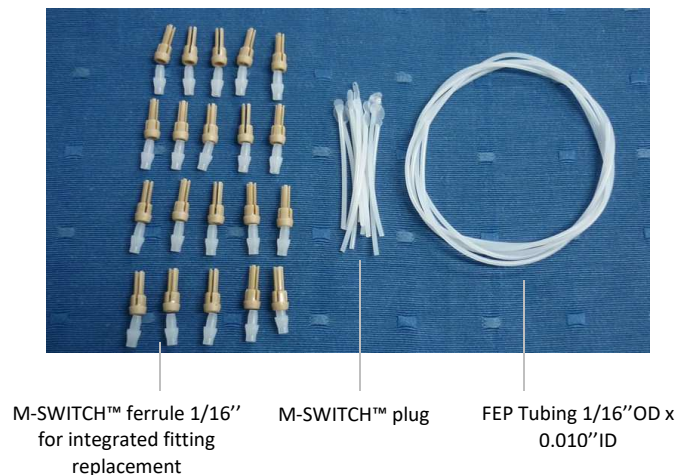
Here is a picture of the side face of an M-SWITCH™.

- ▶ Several pads are integrated on each side of the M-SWITCH™ to ensure a good gripping to the surface where it is placed in horizontal position.

## 4.3 Connection

### 4.3.1 Fluidic connection

#### Description of the fittings and tubings



An M-SWITCH™ has eleven (11) fluidic ports, described in §4.1 as one (1) “Central port”, and ten (10) “External ports”.

- ▶ The M-SWITCH™ has **integrated fittings**, whose ferrules are visible at the surface of the Ram. These ferrules are **compatible with tubings of 1/16" external diameter** (1/16" OD).
- ▶ **Warning: All ports should have a piece of 1/16" OD tubing or a plug inserted during operation.**
- ▶ To get started, FLUIGENT provides you into the “KIT ESS M-SWITCH”:
  - Twenty (20) M-SWITCH™ ferrules for integrated fittings replacement additionally to the ten already fitted in the M-SWITCH™.
  - Ten (10) M-SWITCH™ plugs: 1/16" OD.
  - One (1) meter of FEP tubing: 1/16"OD (external diameter) and 0.010" ID (internal diameter). **NB:** There is a wide variety of materials and internal diameters available with 1/16" tubing from fittings suppliers to suit your application.

**Warning:** These fittings have been **specifically selected by FLUIGENT to ensure good M-SWITCH™ operation**. FLUIGENT advises you to **use only these fittings** on the M-SWITCH™.

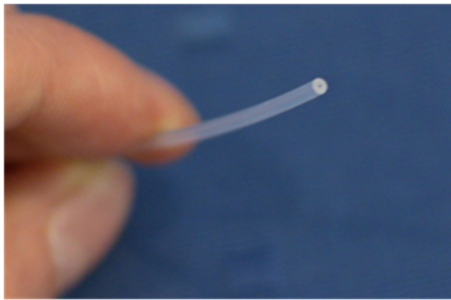
**Warning:** Please note that **only tubings of 1/16" external diameter should be used with the M-SWITCH™**. FLUIGENT does not recommend the use of other tubings sizes with or without tubing sleeves, as it can damage the M-SWITCH™ and give non-tight fluidic connection.

**NB:** When the M-SWITCH™ is not used or stored, FLUIGENT advises you to **cover** the M-SWITCH™ with the red cap to protect the fluidic ports from dust..

FAQ: How can I make a junction between an M-SWITCH™ and tubings with external diameters different from 1/16"? (cf. §9)

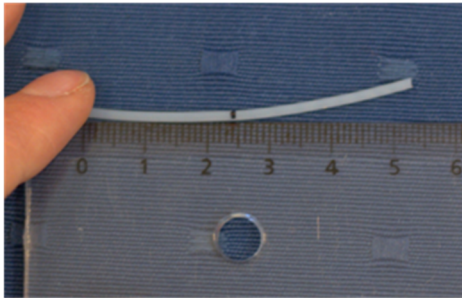
## Connecting a 1/16" OD tubing or plug to the M-SWITCH™

1



1. Cut the 1/16" OD tubing to the desired length, leaving a square-cut face. For connecting a plug, take one of the plugs provided by Fluigent.

2



2. **Mark each piece of tubing or plug 24mm from the end** (it will be an indicator to ensure that the tubing is fully seated).

3



Tightened spanner



Loosened spanner

3. Loosen the Spanner adequately to release the ferrules of the integrated fittings. **NB:** it is better to do the fluidic connections with the M-SWITCH™ in vertical position (see §4.4).

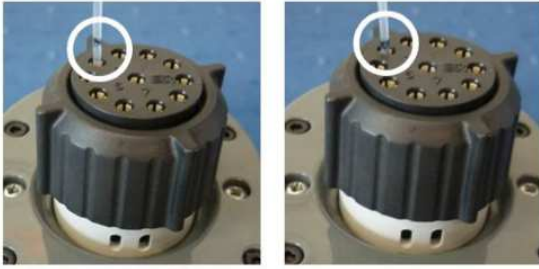


Tightened fittings



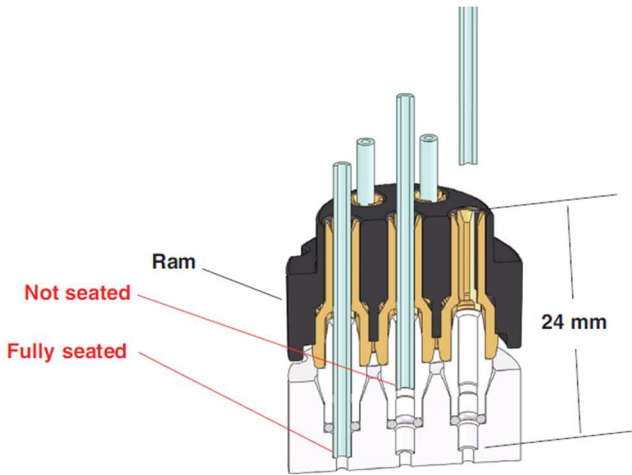
Loosened fittings

4



Insertion not sufficient

Correct insertion



5

Tightened spanner



Leakage

4. Insert the piece of tubing or plug in one port and push it all the way to the bottom of the port. The mark made at step 2 should be approximately flush with the top of the Ram when tubing is fully seated.

5. Once tubing or plugs have been inserted in every ports, tighten the spanner to clench the fittings around tubing and plugs and have a tight connection. To check the tightness of you connection, you may pull gently on the tubings and plugs: they must stay fitted in the integrated fittings.

6. If leakage occurs at the side of the switch, it means something is wrong. Proceed as follows:

- Immediately stop the experiment and gently remove the liquid that spilled out of the valve with a piece of sorbent tissue.
- Check that all the tubing is correctly seated in the valve following steps 1-4. Do not forget that all the ports must be plugged either with tubing or with plugs.
- Do not hesitate to tighten the spanner very firmly.



### 4.3.2 Electric connection



- ▶ Simply plug one connector of the RJ45 **white** cable provided with the M-SWITCH™ in the female RJ45 plug at the back of the M-SWITCH™. The other connector should be connected to a port in the **white** cables section of the SWITCHBOARD (See §6.2 for more details)
- ▶ If the M-SWITCH™ is connected to a powered SWITCHBOARD, the orange indicator on the female RJ45 connector lights up.

**Warning:** Please note that **only straight-through wired RJ45 cables are compatible with the ESS™** (to connect the M-SWITCH™ with the SWITCHBOARD). Other types of cable can damage the ESS™, and reciprocally, the cables provided with the ESS™ should not be used for other applications. FLUIGENT advises to only use the cables provided with the ESS™ for the ESS™.

## 4.4 Positioning

There are several possibilities to set the M-SWITCH™ up. Please note that the M-SWITCH™ device does not have any imposed mounting orientation. The M-SWITCH™ can be used in any spatial configuration.

### Vertical position



- ▶ The M-SWITCH™ can be set up vertically. As explained in §4.2.3, a pad covers the bottom face to ensure a good gripping of the M-SWITCH™ to the surface where it is placed in vertical position.

### Horizontal position



- ▶ The M-SWITCH™ can also be set up horizontally. As explained in §4.2.4, several pads are integrated on each side of the M-SWITCH™ to ensure a good gripping to the surface where it is placed in horizontal position.

### Other possible setting-up



- ▶ The ¼-20" insert on the bottom face of the M-SWITCH™ can be used to mount the M-SWITCH™ on any frame or support equipped with ¼-20" pins such as a flexible rod as shown here opposite (not provided with the M-SWITCH™).



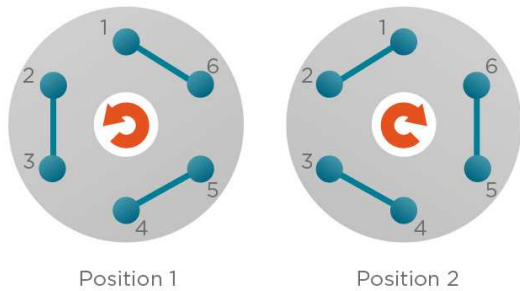
- ▶ ¼-20" thread is also the standard for all photographic equipment. You can use for example a tripod for cameras and screw an M-SWITCH™ on it (not provided with the M-SWITCH™).

## 5. Using an L-SWITCH™ valve

### 5.1 Fluidic principle

The L-SWITCH™ is a 6-port / 2-position valve for injection or switching different fluids controlled by our ESS™ Control software.

#### Fluidic switching mode



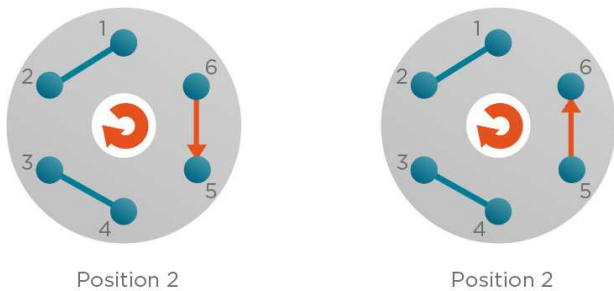
Here is the fluidic diagram of an L-SWITCH™. The L-SWITCH™ can be in position 1 or position 2.

- ▶ **Position 1** connects port #1 with port #6, port #5 with port #4, and port #3 with port #2. **Position 2** connects port #1 with port #2, port #3 with port #4, and port #5 with port #6. The L-SWITCH™ enables you to switch between these two positions.

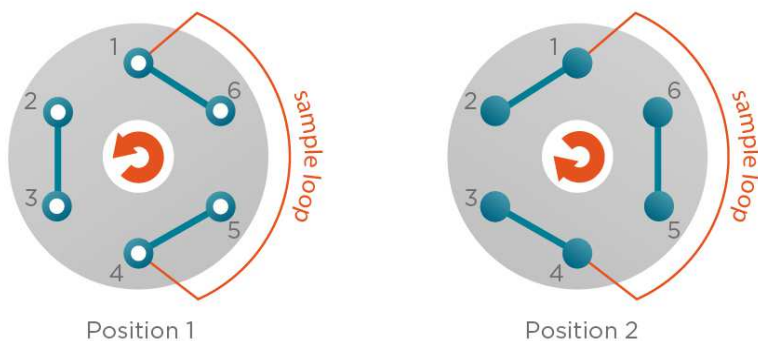
- ▶ The **Default position of the L-SWITCH™** when the L-SWITCH™ is not powered is **the last actuated position**.

- ▶ The L-SWITCH™ is a **bidirectional valve**, meaning that the fluid can flow inside the L-SWITCH™ in both directions.

- ▶ The **non used ports must be closed with plugs** to preserve the L-SWITCH™ good operation. In the same way as the 2-SWITCH™ and the M-SWITCH™, it is possible to use a plugged position to close a fluidic path.



#### Fluidic injection mode

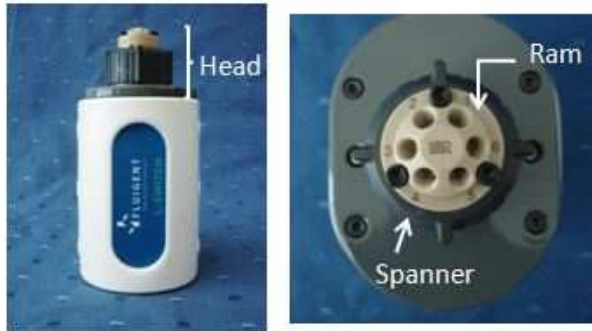


- ▶ Another possibility for using the L-SWITCH™ is to use it with a sample loop (**more details in §4.3.1**). This way, position 1 of the L-SWITCH™ becomes a load position, and the second position is an inject position. In this mode, the L-Switch™ enables to inject a precise volume of fluid, depending of the sample loop size.

**Example:** In Position 1 fluid can flow through the valve between port #6 and port #4, whereas in Position 2 the fluidic path is between the port #2 and port #3.

## 5.2 Description

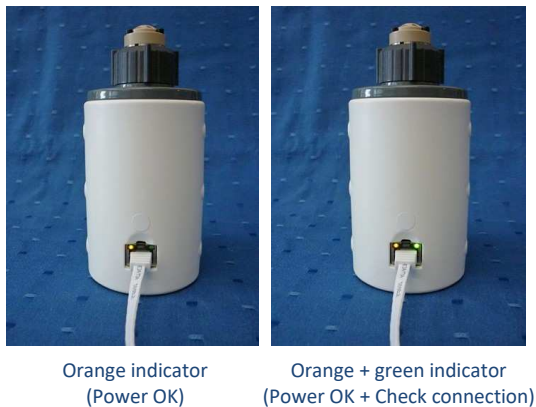
### 5.2.1 L-SWITCH™ Front and top



Here is a picture of the front of an L-SWITCH™.

- ▶ At the top of the picture, the fluidic head of the device can be seen. The head holds the fluidic ports.
- ▶ The head of the L-SWITCH™ is made up of the **Ram** which holds the fluidics ports and a **Spanner**. Fluigent provides you external fittings to make tight fluidic connections. The method to connect tubings to the L-SWITCH™ is detailed in §5.3.1.

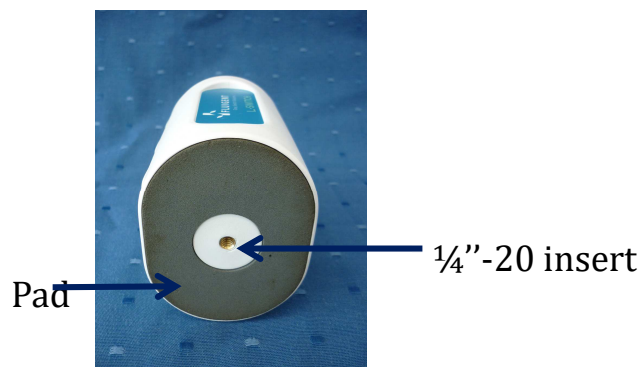
## 5.2.2 L-SWITCH™ Back



Here are pictures of the back of an L-SWITCH™.

- ▶ At the bottom of the device we can see the white RJ45 port to connect electrically the L-SWITCH™ to the SWITCHBOARD. Two light indicators are associated with the RJ45 port.
  - The **orange indicator** lights up when the L-SWITCH™ is powered.
  - The **green indicator** lights up if a “Check connection” identification has been requested for the L-SWITCH™ from the SWITCHBOARD (cf. §6.2) or from the ESS™ Control software (cf. ESS™ Control User Manual).

## 5.2.3 L-SWITCH™ Bottom face



Here is a picture of the bottom face of an L-SWITCH™.

- ▶ A pad covers the bottom face to ensure a good gripping of the L-SWITCH™ to the surface where it is placed in vertical position.
- ▶ A **UNC 1/4-20" thread is inserted** in the centre of the bottom face so that the L-SWITCH™ can be fastened to any 1/4-20" screw-mounted device (as further explained in §5.4).

## 5.2.4 L-SWITCH™ Side face



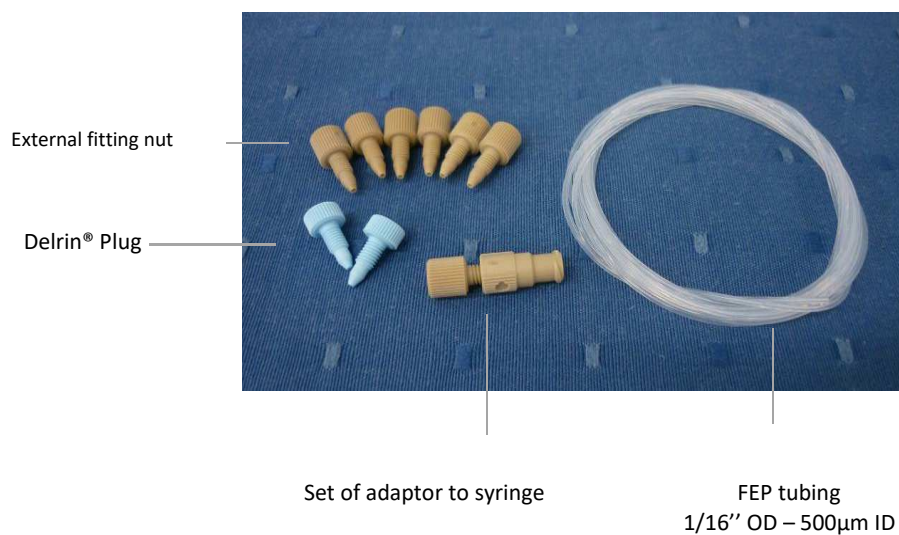
Here is a picture of the side face of an L-SWITCH™.

- ▶ Several pads are integrated on each side of the L-SWITCH™ to ensure a good gripping to the surface where it is placed in horizontal position.

## 5.3 Connection

### 5.3.1 Fluidic connection

#### Description of the fittings and tubings



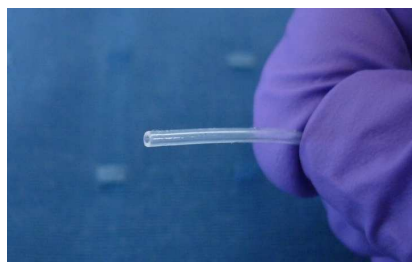
An L-SWITCH™ has six (6) fluidic ports, described in §5.1 and has 2 positions.

- ▶ The L-SWITCH™ has **external fittings, compatible with tubings of 1/16'' external diameter (1/16'' OD)**.
- ▶ **Warning: All ports should have a piece of 1/16'' OD tubing or a plug inserted during operation.**
- ▶ To get started, FLUIGENT provides you the "KIT ESS L-SWITCH", including:
  - Six (6) external fitting nuts (yellow, PEEK).
  - Two (2) Delrin® plugs (blue, PEEK).
  - One (1) set of adaptor to syringe (one adaptor + one nut).
  - Two (2) meters of FEP tubing: 1/16''OD (external diameter) and 500µm ID (internal diameter). **NB:** There is a wide variety of materials and internal diameters available with 1/16'' tubing from fittings suppliers to suit your application.

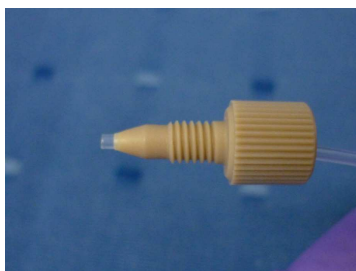
**Warning:** These fittings have been **specifically selected by FLUIGENT to ensure good L-SWITCH™ operation**. FLUIGENT advises you to **use only these fittings** on the L-SWITCH™.

**NB:** When the L-SWITCH™ is not used or stored, FLUIGENT advises you to **cover** the L-SWITCH™ with the red cap to protect the fluidic ports from dust.

## Connecting a 1/16" OD tubing to the L-SWITCH™



Cut the 1/16" OD tubing to the desired length, leaving a square-cut face.



Insert the tubing into a nut until it passes 1.5 - 3mm



Insert into a port of L-SWITCH™, twist until it is tightened. You can pull gently the tubing to verify that it is securely connected to the port.



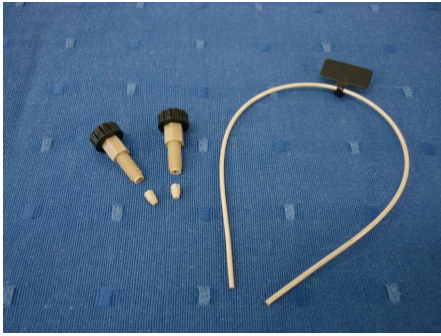
### Connecting a plug to the L-SWITCH™

Before using the L-SWITCH™ in your fluidic circuit, if there are still unclosed ports after connecting all your tubing, you need to close them with blue plugs.



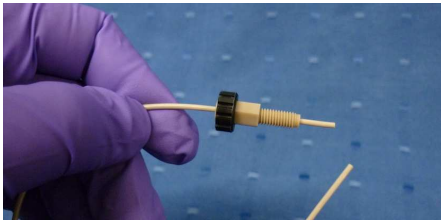
Twist the blue plug until it is tightened

## Connecting a sample loop to the L-SWITCH™

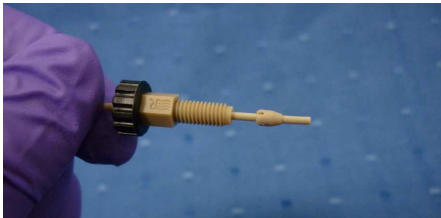


In order to connect a sample loop to the L-SWITCH™, you will need two nuts and two ferrules, in addition to the sample loop itself (nuts and ferrules are provided with the sample loop).

You have a large selection of sample loops of different volumes. Please contact Fluigent for more information.



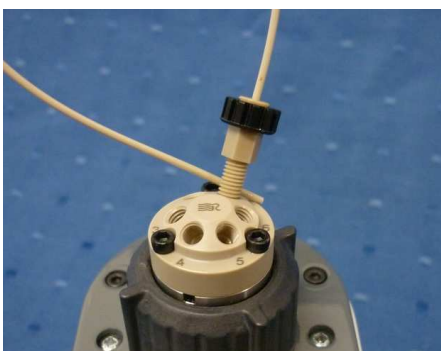
Pass one end of the sample loop through a nut



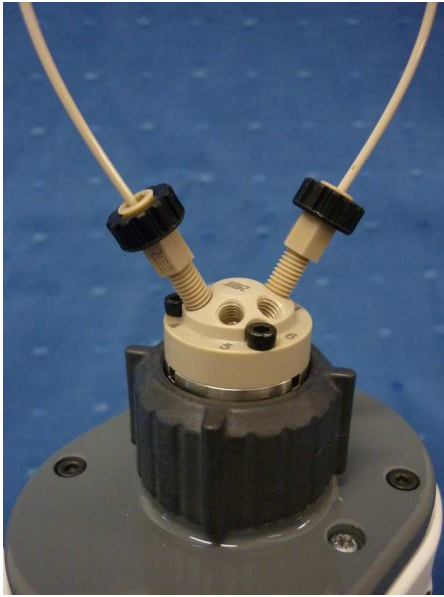
Add a ferrule



Hold the set together and insert it into a port of the L-SWITCH™ (for example port 1 here)



Twist until the set is tightened. You can pull gently the sample loop to verify that it is securely connected

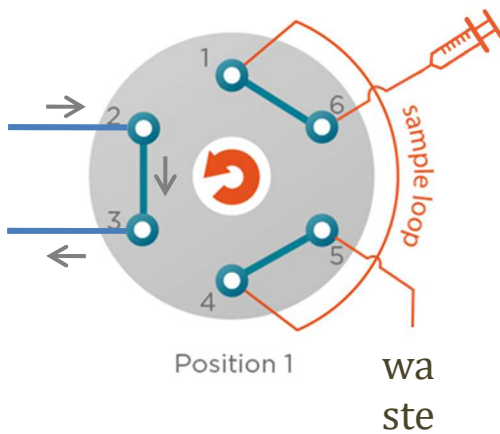


Repeat these steps for the other end of the sample loop to connect it to another port of the L-SWITCH™ (for example port 4 here)

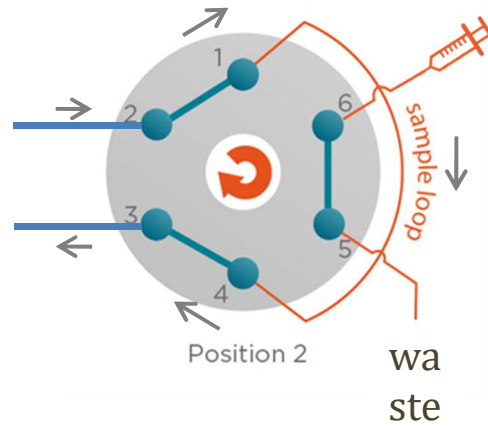
### Example of using the sample loop with a syringe injector

The objective of using sample loop is to introduce a precise volume of liquid into a fluidic circuit.

In this example, the fluid circuit enters from the port 2 and exits from the port 3.



When the L-SWITCH™ is in position 1, push the syringe to fill up the sample loop until the liquid comes out from the port 5.

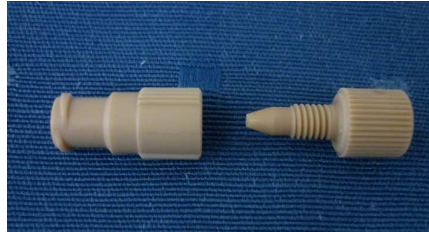


Turn the L-SWITCH™ to position 2; the liquid in the sample loop enters into the fluidic circuit

## Connecting a syringe injector to the L-SWITCH™

The syringe is often used with a sample loop in order to fill up the sample loop. (See the example above)

You need to use the provided adaptor to connect a syringe injector to the L-SWITCH™



Unscrew the adaptor set to separate the nut from the adaptor



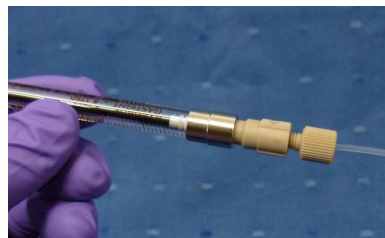
Insert the 1/16" OD tubing into the nut and screw together the nut and adaptor



Insert the adaptor set into the syringe and twist to tighten securely



BD Plastipak 5mL



Hamilton 500µL

Here are two examples of connected syringe



Connect the other end of the tubing to the L-SWITCH™ with a nut

### 5.3.2 Electric connection



- ▶ Simply plug one connector of the white RJ45 **white** cable provided with the L-SWITCH™ in the female RJ45 plug at the back of the L-SWITCH™. The other connector should be connected to a port in the **white** cables section of the SWITCHBOARD (See §6.2 for more details)
- ▶ If the L-SWITCH™ is connected to a powered SWITCHBOARD, the orange indicator on the female RJ45 connector lights up.

**Warning:** Please note that **only straight-through wired RJ45 cables are compatible with the ESS™** (to connect the L-SWITCH™ with the SWITCHBOARD). Other types of cable can damage the ESS™, and reciprocally, the cables provided with the ESS™ should not be used for other applications. FLUIGENT advises to only use the cables provided with the ESS™ for the ESS™.

## 5.4 Positioning

There are several possibilities to set the L-SWITCH™ up. Please note that the L-SWITCH™ device does not have any imposed mounting orientation. The L-SWITCH™ can be used in any spatial configuration.

### Vertical position



- ▶ The L-SWITCH™ can be set up vertically. As explained in §5.2.3, a pad covers the bottom face to ensure a good gripping of the L-SWITCH™ to the surface where it is placed in vertical position.

### Horizontal position



- ▶ The L-SWITCH™ can also be set up horizontally. As explained in §5.2.4, several pads are integrated on each side of the L-SWITCH™ to ensure a good gripping to the surface where it is placed in horizontal position.

### Other possible setting-up



- ▶ The ¼-20" insert on the bottom face of the L-SWITCH™ can be used to mount the L-SWITCH™ on any frame or support equipped with ¼-20" pins such as a flexible rod as shown here opposite (not provided with the L-SWITCH™).

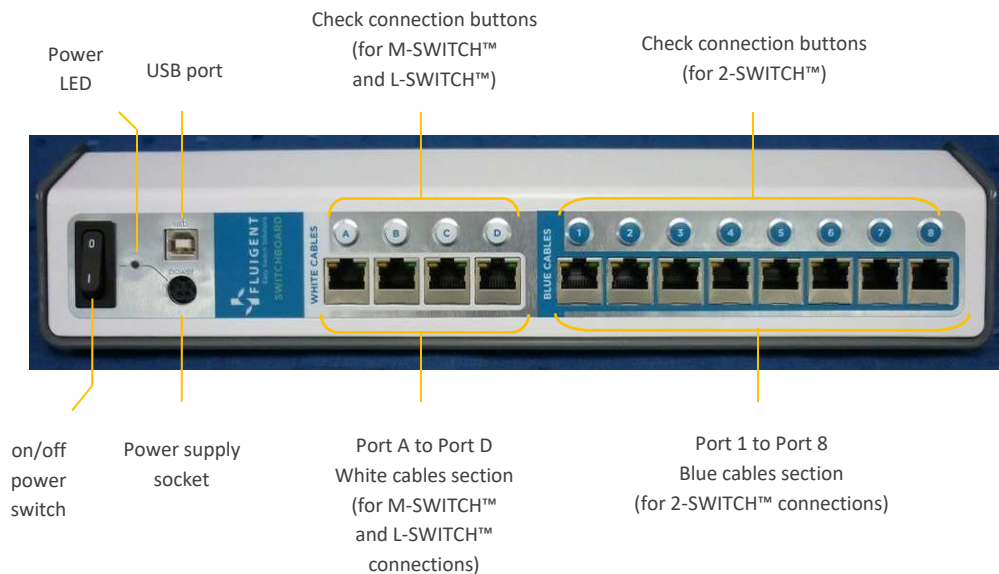


- ▶ ¼-20" thread is also the standard for all photographic equipment. You can use for example a tripod for cameras and screw an L-SWITCH™ on it (not provided with the L-SWITCH™).

## 6. Using the SWITCHBOARD

The **SWITCHBOARD** is absolutely necessary to operate the ESS™. This device hosts up to four (4) M-SWITCH™ or L-SWITCH™ and eight (8) 2-SWITCH™ and provides them power supply. The SWITCHBOARD is also the link between the connected 2-SWITCH™, M-SWITCH™, L-SWITCH™ and the controlling software ESS™ Control (cf. ESS™ Control User Manual).

### 6.1 Description



- ▶ An **on/off power switch** enables to choose to power the SWITCHBOARD (and consequently all the connected M-SWITCH™, L-SWITCH™ and 2-SWITCH™) or not while leaving the power supply plugged to the SWITCHBOARD.
  - Power switch on the “O” position: power off.
  - Power switch on the “I” position: power on.
- ▶ A **green indicator (power LED)** lights up when the SWITCHBOARD is powered.
- ▶ A **USB port (type B)** links the SWITCHBOARD to a computer for software control. It is labeled “usb” on the front panel of the SWITCHBOARD.
- ▶ Below the USB port is the **power supply socket** to power the SWITCHBOARD and all connected 2-SWITCH™, M-SWITCH™ and L-SWITCH™. It is labeled “power” on the front panel of the SWITCHBOARD.
- ▶ Then there are two groups of RJ45 ports:
  - A first group of four RJ45 ports (Port A to Port D), called “**White cables**” to connect up to four (4) M-SWITCH™ or L-SWITCH™.
  - A second group of eight RJ45 ports (Port 1 to Port 8), called “**Blue cables**” to connect up to eight (8) 2-SWITCH™.
- ▶ Two light indicators are associated with each RJ45 ports:
  - The **orange indicator** lights up when an M-SWITCH™, an L-SWITCH™ or a 2-SWITCH™ is connected to the port.
  - The **green indicator** lights up if a “Check connection” identification has been requested for the device connected to the port from the corresponding **Check connection push button** on the SWITCHBOARD or from the ESS™ Control software (cf. ESS™ Control User Manual).



## 6.2 Connection

### Power supply connection

1



2



3



- ▶ The on/off power switch is on position O (off).

- ▶ Connect the plug of the power supply provided with the ESS™ into the socket on the front of the SWITCHBOARD labeled “power”. The flat side of the power supply plug must face upwards to enter the socket on the SWITCHBOARD.

- ▶ You can now actuate the on/off power switch to turn the SWITCHBOARD on and off.

**Warning:** Please note that the power supply provided with the ESS™ has been carefully selected to meet the power requirements of the ESS™ in all configurations and to comply with all safety standards. FLUIGENT advises to only use the power supply provided with the ESS™ for the ESS™.

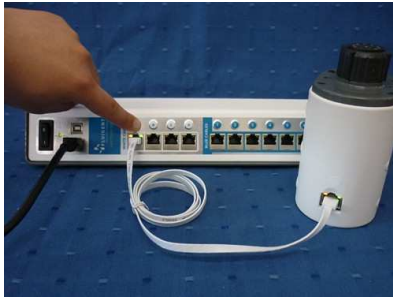
### USB connection



- ▶ Connect the type B plug of the USB cable provided with the ESS™ into the type B USB port on the front of the SWITCHBOARD labeled “usb”.

- ▶ Connect the other end of the USB cable (type A standard plug) to the computer where the ESS™ Control software is installed (cf. ESS™ Control User Manual).

### M-SWITCH™ and L-SWITCH™ connection



▶ To connect an M/L-SWITCH™ to the SWITCHBOARD, plug one end of a **white** RJ45 cable provided with the ESS™ to one of the four (4) M/L-SWITCH™ RJ45 ports on the SWITCHBOARD, and the other end to the RJ45 port of the M/L-SWITCH™ (cf. §4.3.2 and §5.3.2). When the SWITCHBOARD is powered on (cf. §6.2) the orange indicators of the linked RJ45 ports on the SWITCHBOARD and the M/L-SWITCH™ light up, indicating a good electric connection.

▶ **Check connection feature:** To check the communication between the M/L-SWITCH™ and the SWITCHBOARD, push the button located above the used RJ45 port on the SWITCHBOARD. If the communication is good, the green indicators of the linked RJ45 ports on the SWITCHBOARD and the M/L-SWITCH™ light up while the push button is pressed. **This is also a tool to identify RJ45 ports that are linked on the SWITCHBOARD and an M/L-SWITCH™.**

## 2-SWITCH™ connection



▶ To connect a 2-SWITCH™ to the SWITCHBOARD, plug one end of a **blue** RJ45 cable provided with the ESS™ to one of the eight (8) 2-SWITCH™ RJ45 ports on the SWITCHBOARD, and the other end to the RJ45 port of the 2-SWITCH™ (cf. §3.3.2). When the SWITCHBOARD is powered on (cf. §6.2) the orange indicators of the linked RJ45 ports on the SWITCHBOARD and the 2-SWITCH™ light up, indicating a good connection.

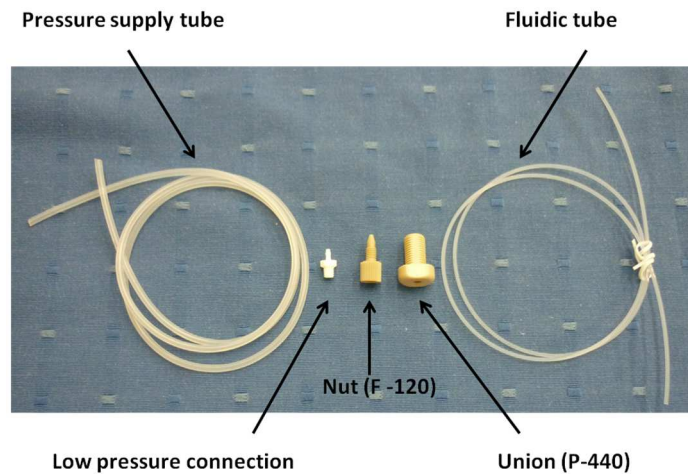
▶ **Check connection feature:** To check the communication between the 2-SWITCH™ and the SWITCHBOARD, push the button located above the used RJ45 port on the SWITCHBOARD. If the communication is good, the green indicators of the linked RJ45 ports on the SWITCHBOARD and the 2-SWITCH™ light up while the push button is pressed. **This is also a tool to identify RJ45 ports that are linked on the SWITCHBOARD and a 2-SWITCH™.**

**Warning:** Please be sure to connect the M-SWITCH™ and the L-SWITCH™ to RJ 45 to ports located in the 'White cable' SWITCHBOARD section (A to D) and to connect the 2-SWITCH™ RJ 45 to ports located in the 'Blue cable' SWITCHBOARD section (1 to 8) on the SWITCHBOARD. If you connect the Switch to a wrong port, it can damage the ESS™.

## 7. How to use the 2-SWITCH™, M-SWITCH™ and L-SWITCH™ with gas

Here is an example of how you can use the 2-SWITCH™, M-SWITCH™ or L-SWITCH™ with gas. We present the fittings and tubes and describe how to use it to connect in air the MFCS™-EZ to the 2-SWITCH™/M-SWITCH™/L-SWITCH™.

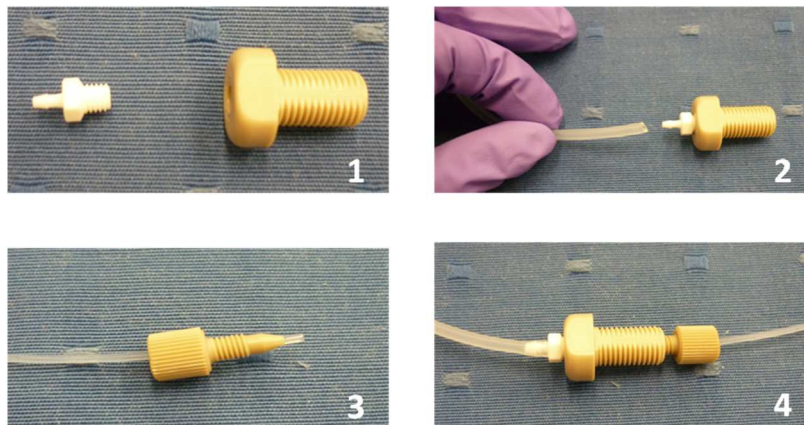
### Description of the fittings and tubes



In this example we use:

- A pressure supply tube provided with the MFCS™-EZ and its pressure connection (X210-1 from Promepla)
- A fluidic tube OD 1/16" and its fluidic connection: a nut (F-120 from Idex Health and Science)
- A union (P-440 from Idex Health and Science) to connect fluidic tube to pressure tube

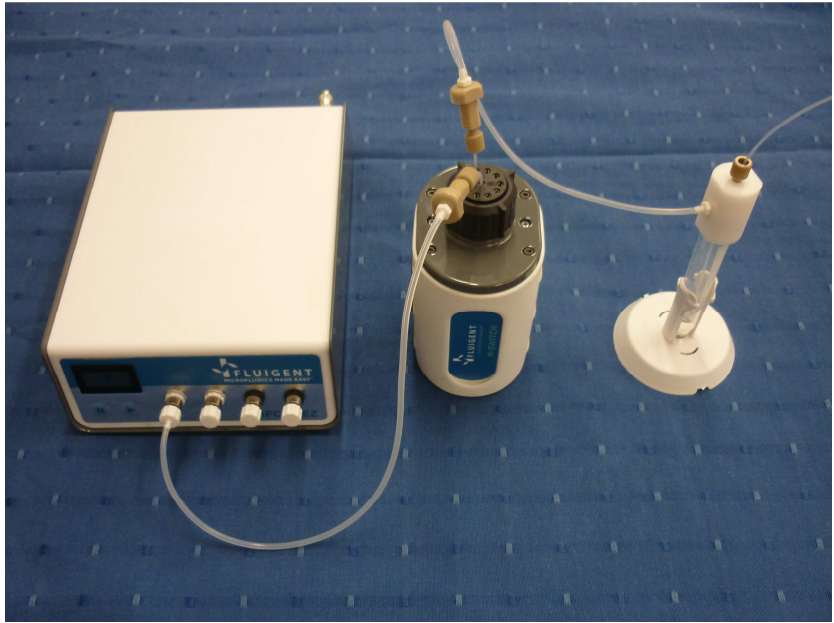
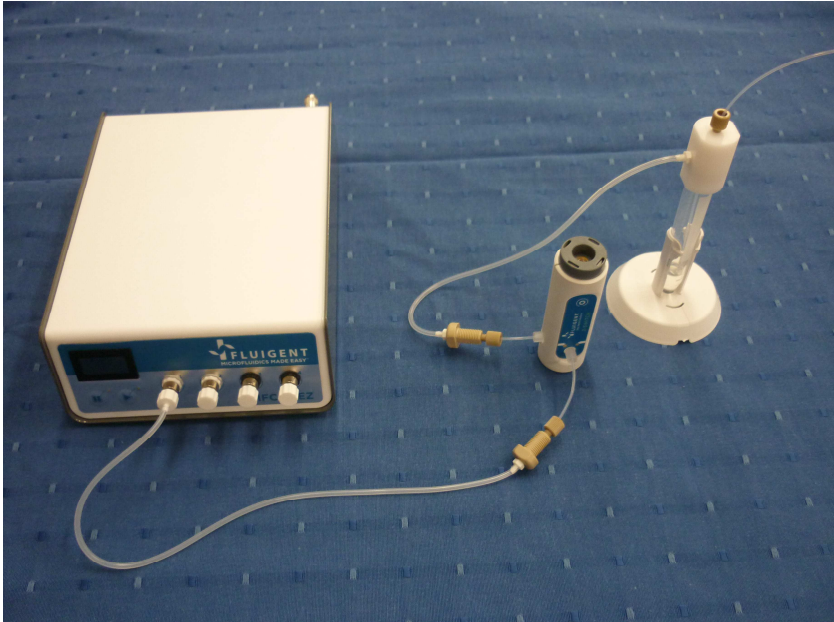
### Connecting pressure tube to fluidic tube

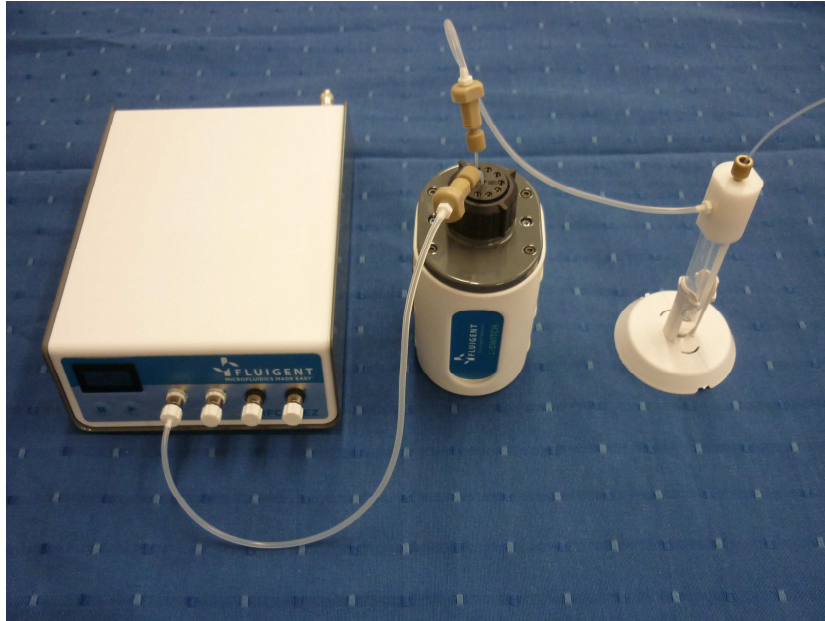


1. Insert the low pressure connection into the union (P-440)
2. Insert the assembly in the pressure tube
3. Slide the **nut** over the fluidic tube
4. Insert the assembly into the union (P-440)

**Connecting the reservoir to the MFCS™-EZ via the 2-SWITCH™, the M-SWITCH™ and the L-SWITCH™**

Once the connection has been done between the fluidic tube and the pressure tube, you can use the assembly to connect the 2-SWITCH™/M-SWITCH™/ L-SWITCH™ to the MFCS™-EZ and the 2-SWITCH™/M-SWITCH™/ L-SWITCH™ to the reservoir, as described on the images below.





**Warning:**

- After your experiment, do not forget to wash your M-SWITCH™, L-SWITCH™ or 2-SWITCH™ with distilled water and then isopropanol, to avoid any clogging in the fluidic parts that could damage the device and cause malfunction.
- The use of 2-SWITCH™ and/or M-SWITCH™ and /or L-SWITCH™ with gas reduces the lifetime of the valves and can lead to a premature aging.

## 8. How to start working with the ESS™

Here is a quick-setup guide to remind you of the main steps to get your ESS™ platform up and running:

1. Firstly, you may want to do the required fluidic connections on the 2-SWITCH™ , M-SWITCH™ and L-SWITCH™ that you want to use:
    - See §3.3.1 for the 2-SWITCH™ fluidic connection how-to.
    - See §4.3.1 for the M-SWITCH™ fluidic connection how-to.
    - See §5.3.1 for the L-SWITCH™ fluidic connection how-to.
  2. Then, position your devices as you reckon the most practical for your application.
    - See §3.4 for the different 2-SWITCH™ mounting options.
    - See §4.4 for the different M-SWITCH™ positioning options.
    - See §5.4 for the different L-SWITCH™ positioning options.
  3. Connect your devices RJ45 ports with the provided flat RJ45 cables.
  4. Connect your SWITCHBOARD to the power supply as explained in §6.2 and then connect your devices RJ45 cables on appropriate SWITCHBOARD RJ45 ports (white RJ45 cables for M-SWITCH™ and L-SWITCH™ and blue RJ45 cables for 2-SWITCH™).
  5. If you wish to use the ESS™ Control software provided with your devices, do not forget to connect a USB cable from the SWITCHBOARD to the computer where ESS™ Control is installed (cf. §6.2 and the ESS™ Control User Manual).
- ⇒ You can now use your ESS™ platform for your application.
- ⇒ **Warning:** After your experiment, do not forget to rinse your 2-SWITCH™, M-SWITCH™ and L-SWITCH™ with distilled water and then isopropanol, to avoid any clogging in the fluidic parts that could damage the device and cause malfunction.

FAQ: I do not remember which device is connected to a SWITCHBOARD RJ45 port (cf. §9)

## 9. Frequently Asked Questions

### §3.1 With a fluidic “on/off” switch configuration, should I fill with liquid the plugged path inside the 2-SWITCH™ before screwing the plug?

If you are planning to use a 2-SWITCH™ as a fluidic on/off switch, you will need to plug either port #1 or port #2 on the 2-SWITCH™.

For example if you plug port #2, when in Position 2 the common port will be connected to the plug inside the 2-SWITCH™. As there is still some internal volume inside the 2-SWITCH™ (12µL per position), it is better to fill the 2-SWITCH™ in Position 2 with distilled water before connecting the plug to close the position. This way, during the experiment when the valve is actuated in Position 2 to close a path, there will be minimal liquid displacement in the Position 2 internal volume, as it will have already been filled with liquid.

### §3.3.1 How can I make a junction between a 2-SWITCH™ and tubings with external diameters different from 1/16”?

The 2-SWITCH™ device can only be connected with **1/16” OD tubing and the provided fittings**, as explained in §3.3.1. There is a wide variety of materials and internal diameters available with 1/16” tubing to suit your application. However, if you have constraints on your fluidic setup that force you to use tubings of other external diameters than 1/16”, a wide range of **adaptors and unions** are available from the fittings suppliers, to make a junction between your specific tubing and the 2-SWITCH™ tubing.

**Warning:** Please note that **sleeves cannot be used directly in the 2-SWITCH™ fluidic ports** (risks of trapping the smaller tubing and possible non-tight connection).

### §4.3.1 How can I make a junction between an M-SWITCH™ and tubings with external diameters different from 1/16”?

The M-SWITCH™ can only be connected with 1/16” OD tubing, as explained in §4.3.1. The same strategy as for the 2-SWITCH™ can be followed if it is needed to use tubing with other external diameters on the fluidic setup (read above).


**Warning:** Please note that **sleeves cannot be used directly in the M-SWITCH™ fluidic ports** (risks of trapping the smaller tubing and possible non-tight connection).

### §8 I do not remember which device is connected to a SWITCHBOARD RJ45 port.

To identify the linked SWITCHBOARD RJ45 ports and devices, you can use the **Check connection feature** by pushing the corresponding Check connection buttons on the SWITCHBOARD (one for each RJ45 port, see §6.2). This will light up the green RJ45 indicators on the associated SWITCHBOARD RJ45 port and on the RJ45 port of the device connected to it.

Other methods are applicable if using the ESS™ Control software (see the ESS™ Control User Manual).

## 10. Specifications

<b>2-SWITCH™</b>		
Pressure rating	100 psi	Please note that the ESS™ platform have been optimized to work with FLUIGENT flow control devices. <b>If you are using the ESS™ platform with other flow control systems, please check that the pressure in your fluidic system does not exceed 100 psi.</b>
Internal volume	12 µL for each position	
Wetted materials	PTFE	
Mechanical response time	20 ms	
Size	30.44 x 96.37 mm 60 x 42.5 mm (base)	Diameter x height Diameter x height
Weight	70 g 18 g (base)	
<b>M-SWITCH™</b>		
Pressure rating	100 psi	Please note that the ESS™ platform have been optimized to work with FLUIGENT flow control devices. <b>If you are using the ESS™ platform with other flow control systems, please check that the pressure in your fluidic system does not exceed 100 psi.</b>
Internal volume	11.6 µL for each position	
Wetted material	RPC-7 polymer	
Mechanical response time	280 ms port-to-port	
Size	92 x 71.2 x 138.4 mm	Length x width x height
Weight	419 g	
<b>L-SWITCH™</b>		
Pressure rating	100 psi	Please note that the ESS™ platform have been optimized to work with FLUIGENT flow control devices. <b>If you are using the ESS™ platform with other flow control systems, please check that the pressure in your fluidic system does not exceed 100 psi.</b>
Internal volume	660 nL port to port	
Wetted material	PEEK	
Mechanical response time	100 ms	
Size	92 x 71.2 x 138.4 mm	Length x width x height
Weight	419 g	
<b>SWITCHBOARD</b>		
Input	24V  6.67A 160W max	
Size	343 x 99.4 x 58.35 mm	Length x width x height
Weight	1228 g	





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