User Guide

Caterpillar microfluidic system

Microfluidics Innovation Center

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Introduction

Instrument description

Caterpillar microfluidic system is made of a mother module (copper color in the image) with up to twelve pump modules (green in the image). The USB and power supply connection ports can be found on the back of the mother module, and the power button is found on its front. On each pump module, there is a holder on the back for a reservoir, and a space on top for a flow sensor (connected either magnetically or through USB-C).

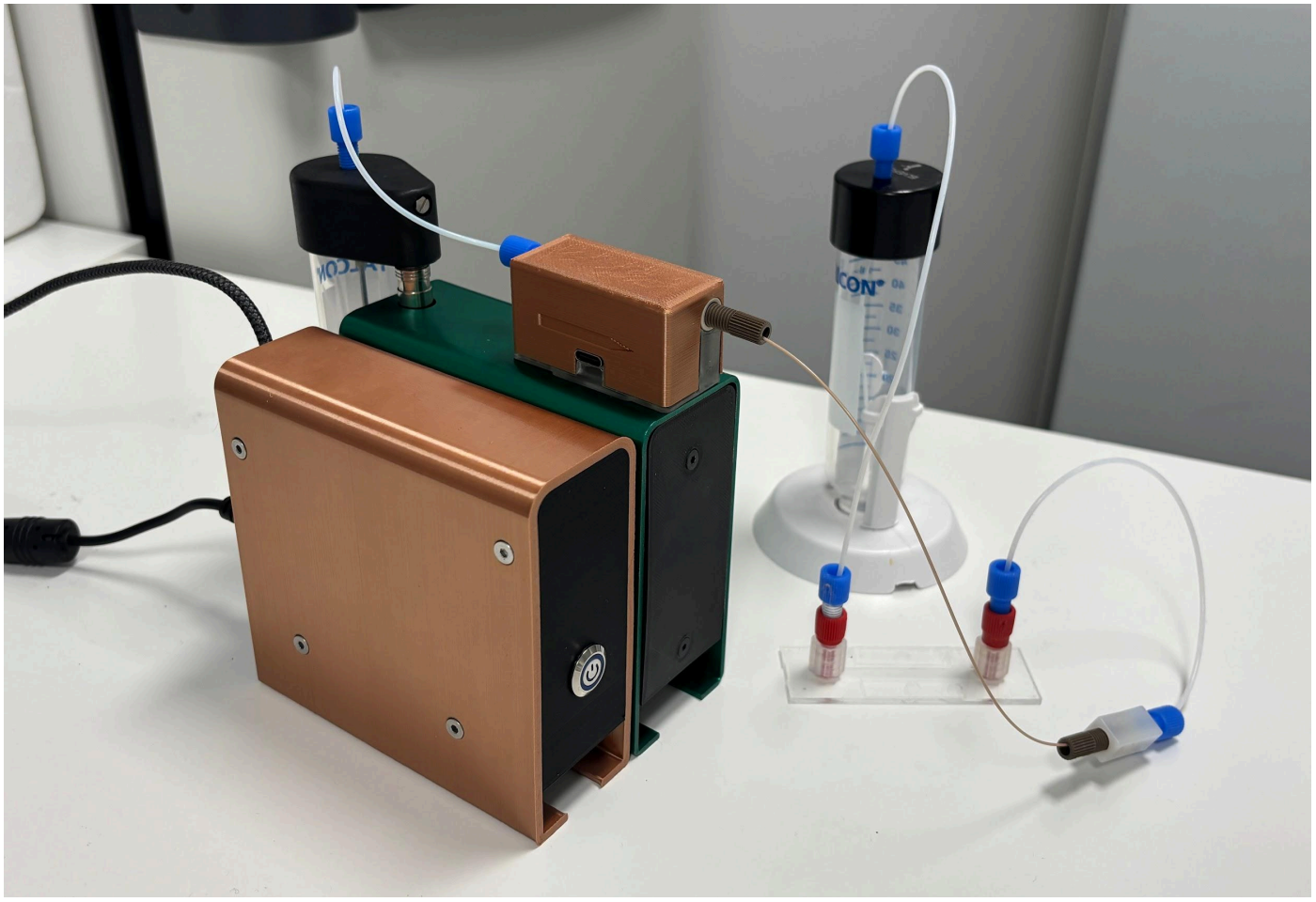


Figure 1. *A caterpillar with one pump module connected to a chip and a waste.*

Technical Specifications

Performances	Pressure range	0 - 500 mbar
	Pressure stability	0.2 mbar
	Air flow rate	0.1 L/min (possibility to work with higher air flow rates by reducing the pressure range)
Electrical	Input voltage range	100V to 240V
	AC supply frequency	50 Hz to 60Hz
	Power supply voltage	18-24V DC
	Max current consumption	2A peak
	Power consumption (max)	36W
	Connection type	USB-C to USB-A
Mechanical specifications	Fluidic connectors	Reservoir cap: Standard 1/4-28 UNF, flat-bottom SLF3S-0600F or LG16-0431: Standard 1/4-28 UNF, flat-bottom LG16-0150: UNF 6-40 coned port
	Operating temperature	5-40°C
	Operating Humidity	0-100%
	Dimensions (of 1 module without connectors)	4 cm x 10 cm x 11 cm

	Weight (of 1 module without connectors)	322 g
Software	Computer specifications	USB 2.0 port, Intel Pentium II 500 MHz, 1 Go Hard Disk space, Windows 10 and newer, 32/64 bit.
	Provided software	Dedicated Software Interface

Product package contents

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

1. One Caterpillar mother module

2. **n** Caterpillar pump modules. Each pump module is supplied with a quick connect reservoir cap, a needle, an integrated flow sensor, a USB-C to USB-C cable and a certain length of resistance tubing.

3. One 24V power supply

4. One USB-A to USB-C cable

The fluidic accessories, tubings and fittings to connect the inlets/outlets and the microfluidic chip are not included and should be purchased separately..

Installation & use

In order to use the CATERPILLAR MICROFLUIDIC SYSTEM, the device must be connected to the fluidic setup and to the computer.

Fluidic connections

For fluidic connections, you need these accessories:

- A quick connect reservoir cap
- A needle
- A reservoir adapted to the quick connect cap
- Two 1/4-28 threaded connectors with two conical ferules
- 10cm of PTFE tubing (1/16” outer diameter)
- x cm of PEEK resistance tubing (1/32” outer diameter – inner diameter depending on the desired flow range)
- Two 1/4-28 threaded connectors with two flat ferules
- A 1/4-28 tubing union

All these connections are for one pump module, and they are not included with the pump modules.

Connect each port as described in the following illustrations:

A. Connect the needle to the quick connect cap. Also, make sure that the black silicone gasket of the cap is correctly positioned.

B. Screw cap to reservoir.

C. Assemble the 10cm 1/16” PTFE tubing with the 1/4-28 threaded connector and the two conical ferules (see Figures 2 and 3 for reference), and connect it on the cap and on the flow sensor. Then, connect the quick connect cap to the pump module. You should hear a click once a connection has been made. If you have difficulty taking off the cap, see section tips and tricks.

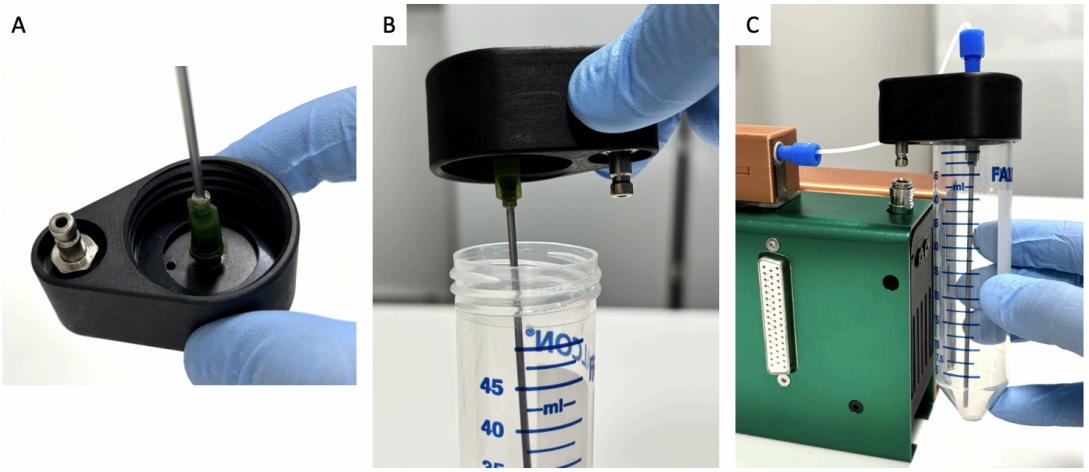


Figure 2. *A. Needle connected to base of cap. B. Screw cap to reservoir. C. Click the cap onto the Caterpillar microfluidic system.*

D. Connect the outlet of the Caterpillar flow sensor to the resistance tubing.

E. Connect the outlet of the resistance tubing with the rest of your system under study – for example using a union with a piece of PTFE tubing connected to a microfluidic chip.

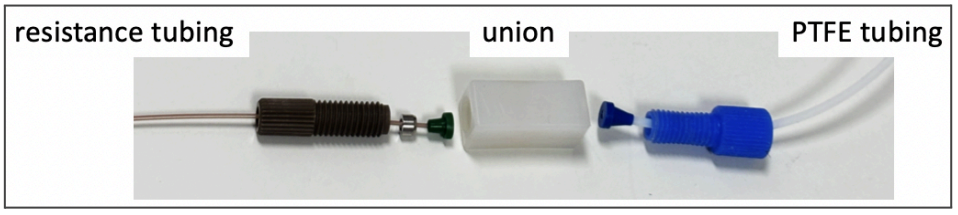
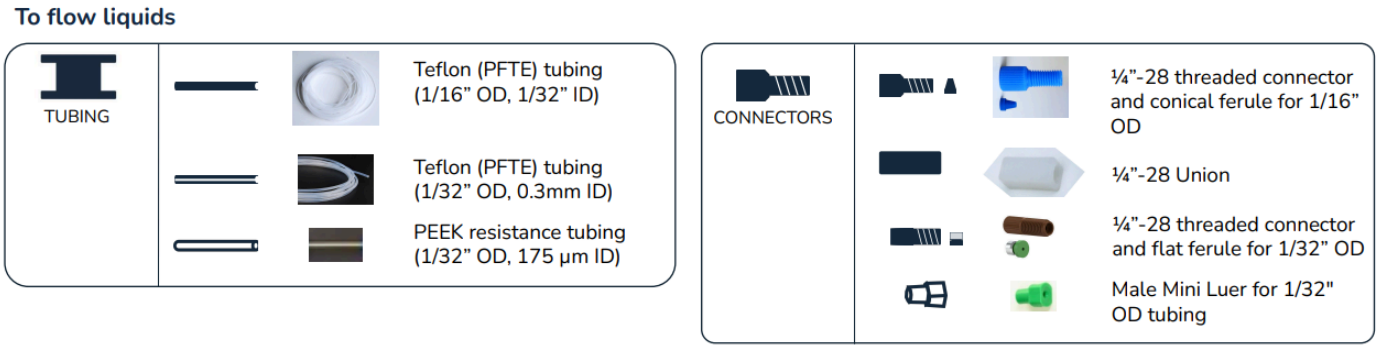


Figure 3. Example of 1/32" PEEK resistance tubing with flat ferule connector, linked by a tubing union to PTFE 1/16" tubing with conical ferule connector.

Please find below the dedicated schematics illustrating an example of set-up to connect a mini-luer connection chip (here Fluidic 845 Rhombic Chamber from Chipshop for reference):



Electrical connections

1. Connect the power supplies (24V) to the mother module.

2. Connect the USB-C to USB-A cable between the mother module (USB-C) and the computer running the dedicated software (USB-A).

3. Use the power button to turn on the instrument.

Software

The following section details, in instructional format, the use of the Caterpillar custom Software.

The Caterpillar Software is compatible with Windows 10 and Windows 11. Open the software by double-clicking on the icon. You will see the window below open.

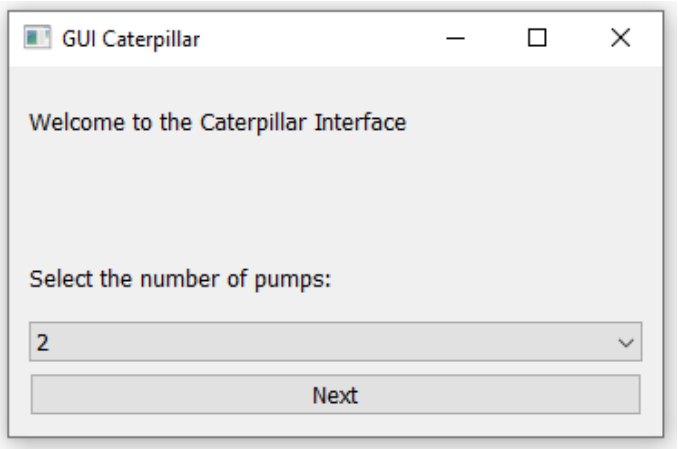


Figure 3. *Pop-up window to select the number of pump modules in the Caterpillar software*

Select the number of pump modules you have, and click “Next”. The control window will appear. It has all the control features on the left panel (connection, control of pressure and flow, data acquisition, sequence creation) and a graph on the right panel.

Ensure the Caterpillar is connected via the provided USB cable to your PC. Once the physical connections are made, you may click the “Select port” button on the interface. You will be asked to select the USB com port of the Caterpillar. Once you selected the USB com port, click the “Connect Caterpillar” button to establish communication.
Once communication is established, the interface will appear as below (if it is not the case, refer to section Tips and tricks). Here is the description of the different features of the software, corresponding to the labels on the below image:

1. This button terminates communication.
2. This controls and monitors the first pump module. You can select the control mode (between pressure and flow rate control) and the target value, and visualize the pressure of the pump and the flow rate measured by the flow sensor. The flow direction button “→” can be used if you have the recirculation module.
3. This button allows you to create a sequence of operations. Can only be found in v2.2.1.
4. This central display is a live-updated graph of the measure over time.
5. This section allows the control of the graph parameters. Changes are effective after clicking on the reset button. The minimum sampling time is 0.1s.
6. This section allows the acquisition and saving of data at the user defined data acquisition sampling time. The minimum sampling time is 0.01s and can not be changed once the acquisition has started.

When clicking the “Start acquisition” button in the interface, you will be prompted to select a location and name of the log file. Once a location and name are chosen and saved, you will find a CSV format file in the designated location, which will be logged with data constantly until you stop it. In order to finish data logging, you must click the “Stop acquisition” button found in place of the “Start acquisition” button in the interface. The CSV format file created may be opened in the preferred method of the user.

NOTE: your computer entering sleep mode may interrupt data acquisition. Please disable your computer’s sleep mode if long term data acquisition is required.

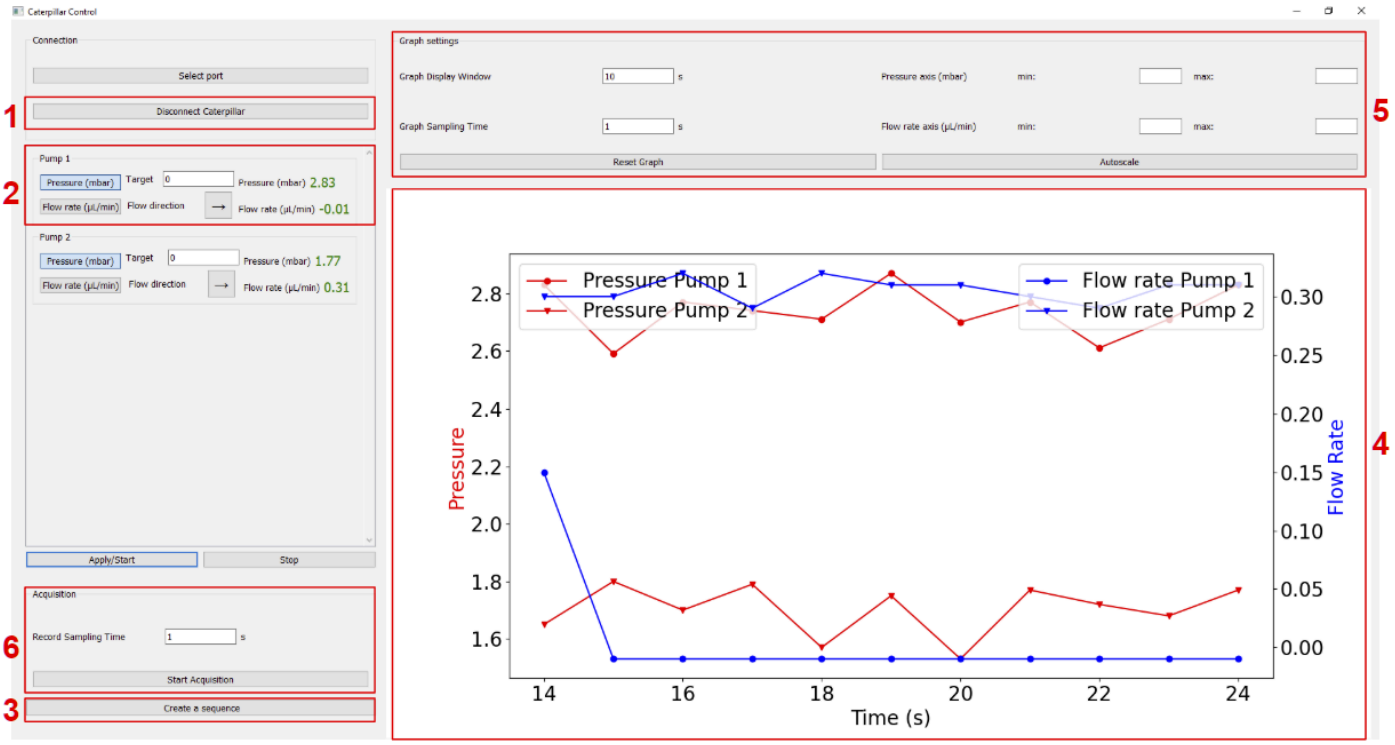


Figure 4. *Caterpillar software with two pump modules. The numbered elements allow for 1. Connection / disconnection, 2. Control and monitoring of one pump module, 3. Sequence creation, 4. Live visualization, 5. Changing graph parameters and 6. Data acquisition.*

Tips & tricks - Recommendations

Cleaning Procedure

It is recommended that the Caterpillar is cleaned after each use, especially if being placed in storage for a significant amount of time after a flow experiment. Depending on the working fluid being used, the Caterpillar may be cleaned by flushing one or a combination of the following liquids:

- Pure, deionized water
- Pure isopropanol
- Pure ethanol
- Hellmanex® III 2% v/v in water solution (especially if working with biological media)

Regardless of the cleaning liquids applied, the Caterpillar should be stored dry. Thus flushing the Caterpillar with air should be done after any liquid cleaning step.

Troubleshooting

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

- The software does not properly establish communication with the Caterpillar:
  Try turning off the power button, disconnecting the USB cable, disconnecting the power cable, waiting 5 seconds, reconnecting the power cable, reconnecting the USB cable, and turning on the power button. If the software does not establish communication after 3 tries, contact us.
- Pressure is not able to reach the specifications level (close to 600mbar), or goes down after some time:
  Unclick the quick connect cap. The pneumatic circuit should be now closed, and pressure should reach the specifications. If it does, search for a leak between the reservoir and the cap, or after. If it does not solve the problem, contact us.
- It is difficult to remove the quick connect cap from the pump module:
  There is a ring that goes down to free the quick connect cap. Try pinching the base of the holder between the quick connect cap and the pump module (where the ring is located), and push it down (see figure).

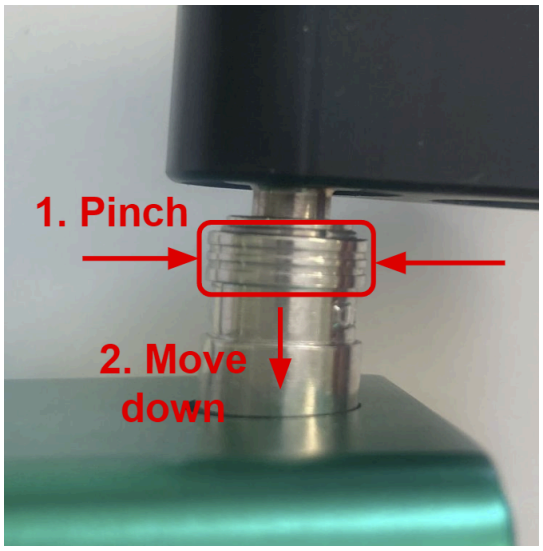


Figure 5. *Quick connect cap connected to a pump module. To remove it, you can 1. Pinch the highlighted metallic ring and 2. Move it down.*

Customer Support

In case there are still some questions and you would like further clarification, please don't hesitate to let us know by email at innovation@microfluidic.fr. We are always happy to help.

Acknowledgements

Thor and Edaphos projects helped develop this instrument. These projects are funded by European Union's HORIZON-EIC-2022-PATHFINDEROPEN-01-01 grant agreement No. 101099719 (Thor) and HORIZON-MISS-2022-SOIL-01, grant agreement No. 101036702 (Edaphos).