

User manual: Utilization, reparation and upgrade of the pneumatic FlowIO silicone hand

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1 - Introduction

Before learning how to use, repair or upgrade the FlowIO module and the silicone hand, we need to explain what is it and what is the objective behind it. The FlowIO module [Sht21] is a miniaturize toolkit created by Ali Shtarbanov to facilitate the use of pneumatic systems [Bea07]. It is composed of 2 main parts, The air pumps and their own controller and power supply integrated and the core part which contain 7 valves, a pressure sensor, a battery, a Bluetooth system and other components and sensors. I created a silicone soft robotic [ASEG+08] hand which work with FlowIO, to understand the use of soft robotics and soft materials [MSL17] in the biomedical domain [CLMD18] and specifically in the process of fabrication of prosthesis.

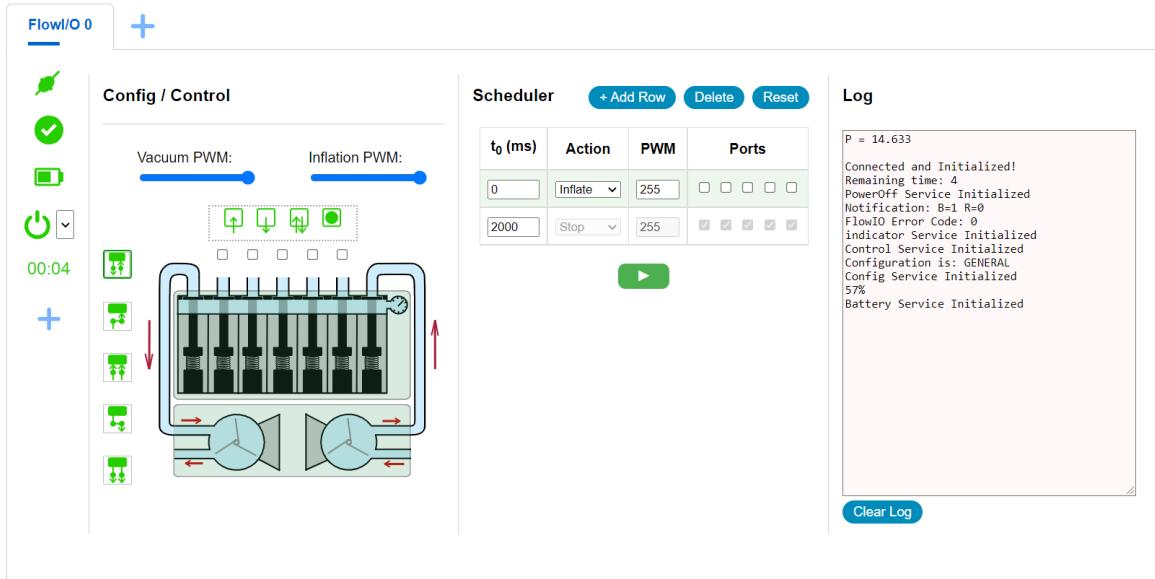


2 - Utilization

1. Choose the pumps you want to use. There are 3 types of pumps modules with different pumps sizes. each pumps modules used different voltage to operate. If you decide to used the large module, you will have to link the power source part to the pumps.
2. Connected the hand or the pneumatic element you want to use to the Inputs/Outputs ports of the FlowIO.
3. Go to the FlowIO web page click on documentation and find the GUI section (Graphical User Interface). It is possibly that there are several version of the GUI. Choose the one which match the current firmware of the FlowIO. (<https://www.softrobotics.io/gui>)
4. Enable your Bluetooth on your device and find the flowIO module on the web page. You are now able to use the FlowIO device.

Graphical User Interface details :

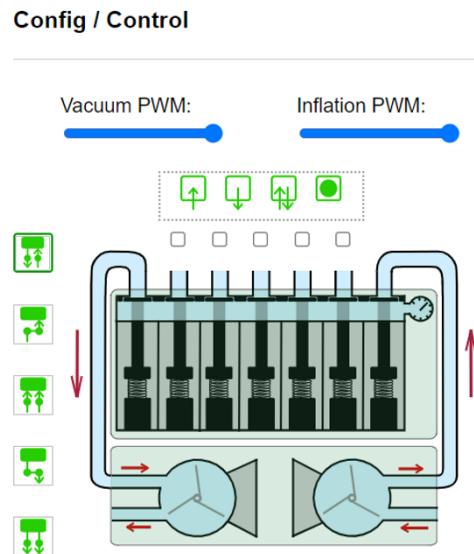
This section describe the functionalities on the FlowIO GUI web page :



There are 3 main parts on the web site :

- The configuration / control panel
- The scheduler
- The console log

The Configuration / control panel :



The Vacuum PWM and the Inflation PWM allow the user to control respectively the power of the vacuum pump(s) and the power of the inflation pump(s) with Pulse-Width Modulation (PWM).

The green icons at the top allow the user to choose the action of the module (Inflation, vacuum, release or stop all current actions).

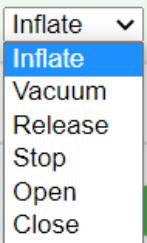
The check-boxes below define the ports on which the actions will be performed. If a box is checked, the valve on this specific port can be opened.

The green icons at the left indicate the configuration of the module. There are 5 types of configurations possible (General (inflation and vacuum), vacuum parallel, vacuum series, inflation parallel, inflation series).

The picture show the states of the valves and the actions perform by the module. The different configurations of the pumps are also shown.

The scheduler :

Scheduler		+ Add Row	Delete	Reset
t ₀ (ms)	Action	PWM	Ports	
0	Inflate	255	<input type="checkbox"/>	<input type="checkbox"/>
2000	Inflate	255	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>




The scheduler allow the user to create a list of action to perform at a specific time after the program began. This system is similar as block programming. The scheduler accepted various parameters like the ports used, the power of the vacuum/inflation, the action to perform and the delay before the action occurred. each action below must have a time t0 superior to the previous action.

The console log :

Log

```

P = 14.634
Connected and Initialized!
Remaining time: 5
PowerOff Service Initialized
FlowIO Error Code: 0
Notification: B=1 R=0
Indicator Service Initialized
Control Service Initialized
Configuration is: GENERAL
Config Service Initialized
59%
Battery Service Initialized

```

Clear Log

The console log allow you to monitor all the resources of the FlowIO module. Furthermore the sensors data like the pressure, or the battery level will be printed here.

3 - Reparation / Upgrade

I made several 3D printed parts and 3D modelizations on fusion 360 for the fingers and the hand. if you need to build your own pneumatic system with these components or repaired the original system you can use them.

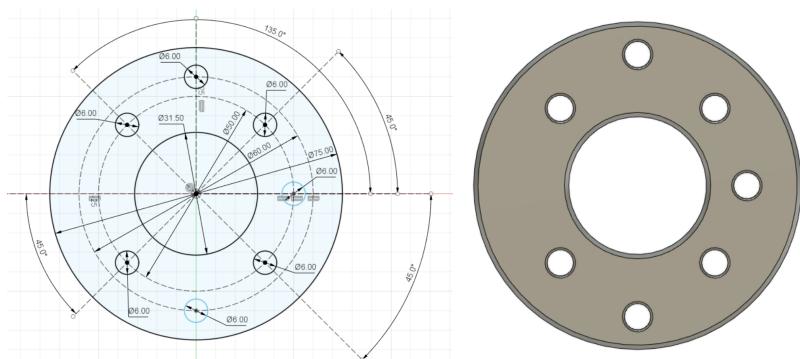


To fabricate a silicone finger you will need a mold of it. You can build your own mold with the STL files I made (available here: https://github.com/09TT09/FlowIO_documentation).

The pneumatic hand also work with the robotic arm but you will need another part to link the hand to the arm.



To fabricate your own fastening system, you can use the images below to have the correct dimensions to attach your module to the arm or directly get the file on my Github (https://github.com/09TT09/FlowIO_documentation).



References

- [ASEG⁺08] Alin Albu-Schaffer, Oliver Eiberger, Markus Grebenstein, Sami Haddadin, Christian Ott, Thomas Wimbock, Sebastian Wolf, and Gerd Hirzinger. Soft robotics. *IEEE Robotics & Automation Magazine*, 15(3):20–30, 2008.
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- [CLMD18] Matteo Cianchetti, Cecilia Laschi, Arianna Menciassi, and Paolo Dario. Biomedical applications of soft robotics. *Nature Reviews Materials*, 3(6):143–153, 2018.
- [MSL17] Aslan Miriyev, Kenneth Stack, and Hod Lipson. Soft material for soft actuators. *Nature communications*, 8(1):1–8, 2017.
- [Sht21] Ali Shtarbanov. Flowio development platform—the pneumatic “raspberry pi” for soft robotics. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, pages 1–6, 2021.