# Software-Programmable Lab-on-a-Chip Report

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The following is a brief summary of relevant information and device parameters from the paper [Amin, A.M., Thakur, R., Madren, S. *et al.* Software-programmable continuous-flow multi-purpose lab-on-a-chip. *Microfluid Nanofluid* **15,** 647–659 (2013). https://doi.org/10.1007/s10404-013-1180-2]. In this paper, the researchers develop a programmable, multi-use lab on a chip microfluidic device with novel functionality , as well as looking into the novel GP valve as written about in [Han-Sheng Chuang et al 2012 J. Micromech. Microeng. 22 085023]

## Overview

The device we chose to model is a software programmable lab on a chip (spLOC) that is a variable-volume mixing microfluidic chip which is able to automate mixing protocols. This device aims to be a versatile chip which is able to perform a variety of protocols and address the custom-build limitations of other microfluidic devices.

## Device Dimensions

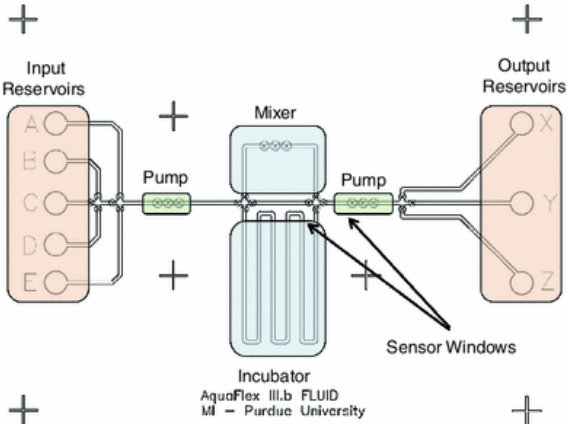
For the device described in [2], The dimensions of the GP valve is 600 µm in diameter, 48 µm in depth and 150 µm across the valve seat. The liquid channel and the gas channel were 300 and 100µm in width, respectively. The final thickness of the membrane added to the PDMS layers is 100 µm.

## Device Parameters

The spLOC is 5-input reservoir device with a central mixer-incubator complex that then leads to three output reservoirs. The device has a total of 17 valves, although our 3Duf design only has 15 (more info in the activity two on this challenge). There are also a total of three pumps, two on both sides of the mixer-incubator complex and one within the complex itself. Each peristaltic pump is controlled by a triple valve system that can also act as a vacuum. The mixer portion of the complex consists of a 1 bend mixing turn with a channel width of 20um. The incubator portion of the complex consists of a 3-bend mixing turn. After the liquid exits that complex, it can be routed to any of the three output reservoirs.

The input and output reservoirs of the spLOC consists of 700um ports. The channel width of the all the connectors on the chip are 20um. All channels within the mixer-incubator complex are also 20um.

The dimensions of the parameters of the chip can be scaled up/down if needed, however current dimensions support a wide range of protocols including, but not limited to glucose assays, enzyme kinetics, particle sorting assays, and bacteria culturing/automated synchronization. The device can also be tiled and cascaded to expand the complexities of mixing procedures. The output reservoir X could me mapped to the input reservoir of A, for example. This output->input method can be replicated in any number of combinations to expand the microfluidic platform.

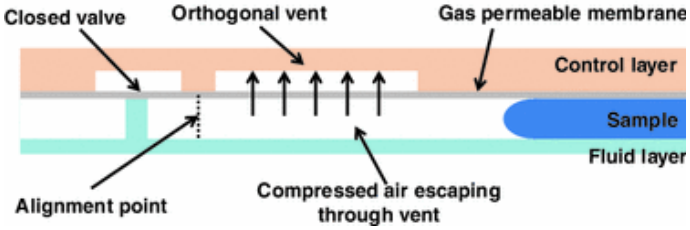



## Fabrication

The spLOC is a three-layer device which is fabricated in polydimethylsiloxane (PDMS). The reservoirs, channels, and valve ports were created using a soft lithography method. Initially an SU8 mold is created by cleaning glass wafers and spinning them 4,000rpm. It is then heated at 65 degrees Celsius for 4 minutes followed by 7-8 minutes of heating at 95 degrees Celsius. The PDMS layers are then prepped by in petri dish with a 10:1 ratio of Sylgard 184 curing agent. The mold is then baked for 3 hours at 70 degrees Celsius in a convection style oven. Then the PDMS layers are peeled from the mold leaving 20um channels. Again the membrane is spun at 1,200 rpm onto a clean glass wafer. The membrane layers are then plasma treated and bonded. Lastly the control valves are punched with a 22 gauge needle.

## VALVE CONTROL

Movement of fluids on the spLOC is achieved through the opening and closing of gate valves in conjunction with on-chip perstaltic pumps. Since the consists of three layers—a fluidic layer, a flexible membrane layer and a gas control layer—the opening and closing of valves is done through the application of vacuum or pressure source to the gas layer. Consequently, this causes a deflection of the membrane layer out of or onto the fluid channel thus holding open or closing the valves. Each control channel is connected to an external, of-chip solenoid valve acting as the source. One of the novelties of the spLOC is that using this same off-chip source system, the researchers incorporated orthogonal vents with gas-only permeable membranes that are used to purge air within the device (i.e. following mixing or between fluid slugs).




## Conflicts of interest

"There are no conflicts to declare".

## Notes and references

[1] Amin, A.M., Thakur, R., Madren, S. *et al.* Software-programmable continuous-flow multi-purpose lab-on-a-chip. *Microfluid Nanofluid* **15,** 647–659 (2013). https://doi.org/10.1007/s10404-013-1180-2

[2] Han-Sheng Chuang et al 2012 J. Micromech. Microeng. 22 085023