Supplementary Material (ESI) for Lab on a Chip



# Electronic Supplementary Information

# Three-dimensional surface microfluidics enabled by spatiotemporal control of elastic fluidic interface

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**Equation 2.** Derivation of the capacitance of circular micro-reservoirs in surface microfluidic networks:

$$C = \frac{dV}{dP} = \frac{\pi\left(4h^2 + d^2\right)^3}{128\gamma\left(d^2 - 4h^2\right)}$$

Analogous to the capacitance defination in electronic circuits, the microfluidic capacitance can be obtained by the volume change over the pressure change. In the circular micro-reservoir, the liquid volume is $V=\pi h(d^2/8+h^2/6)$, while the pressure can be calculated from Laplace equation, $P=16\gamma h/(d^2+4h^2)$, where $\gamma$ is the liquid surface tension, $d$ indicates the diameter of the reservoir and the fluidic height is shown as $h$. During the liquid accumulation and release processes, the fluidic height in the reservoir varies along the time. However, since the wetting boundary is clamped along the peripheral of the reservoir, the volume and pressure can be differentiated respectively as follow:

$$\frac{dV}{dt} = \frac{\pi}{8}\left(4h^2 + d^2\right)\frac{dh}{dt}$$

$$\frac{dP}{dt} = \frac{16\gamma\left(d^2 - 4h^2\right)}{\left(4h^2 + d^2\right)^2}\frac{dh}{dt}$$

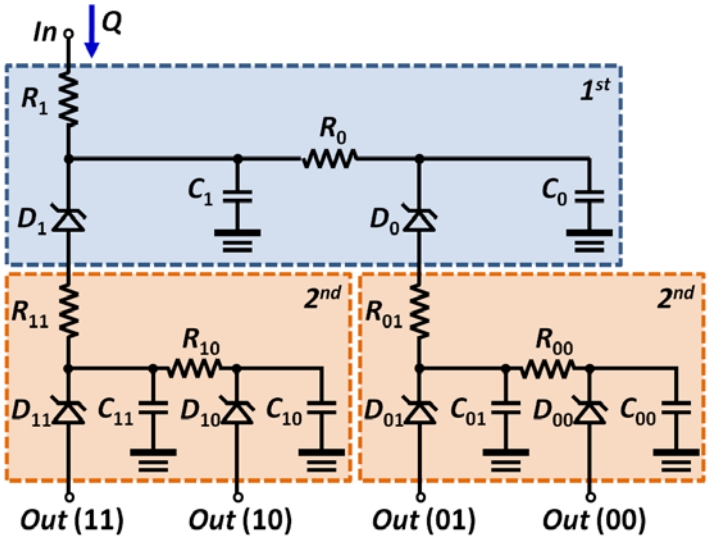


**Figure S1.** The equivalent circuit model for the two-stage analog-to-digital flow activation. It shows the extendability of the simulation of multistage analog-to-digital flow activations.

**Movie 1.** The maximal outflow is solely determined by the geometrical design of the circular reservoir. When the influx is smaller than or equal to the maximal flow rate, the liquid dome formed in the reservoir is stable.

Otherwise, the accumulated liquid will exceed the hemispherical shape, and becomes unstable (The video is played at 2 times faster than the real-time recording).

**Movie 2.** By altering the input flow rate, the capillary bridge on the two reservoirs can be switched ON individually (The video is played at 2 times faster than the real-time recording).

**Movie 3.** The two-stage switching can be operated by controlling the input flow rates, acting as an analog-to-digital flow activation. Under programmed influx, the output channels can be selected individually (The videos for activation of channel 00 and 01 are played at 4 times faster than the real-time recording, while the videos for activation of channel 10 and 11 are played at 2 times faster than the real-time recording).