

Logic Gate Simulation for Fluidic Computers

N. Mehendale¹, R. Patil², D. Chakroborty¹, V. Sharma²

1. Indian Institute of Technology Bombay, Mumbai, Maharashtra, India

2. Lord Krishna College Of Technology, Indore, Madhya Pradesh, India

Introduction: Fluidic computers work on fluids such as air, water etc. and do not depend on electrical power like traditional semi-conductor electronics based computers. The major aim of fluidic computing [1-2] is to enhance the functionality of different applications, by integrating a computing capability with the microfluidics. We present, simulations on the operation of basic fluidic logic gates are performed in COMSOL Multiphysics platform and all the possible combinations for the logic operations are tested and are compared with the corresponding truth table.

Working principal: A fluid is pressurized from the inlet of a microfluidic channel and the valves perpendicular to the channel are pressurized to control the flow operations as per the required logic operations.

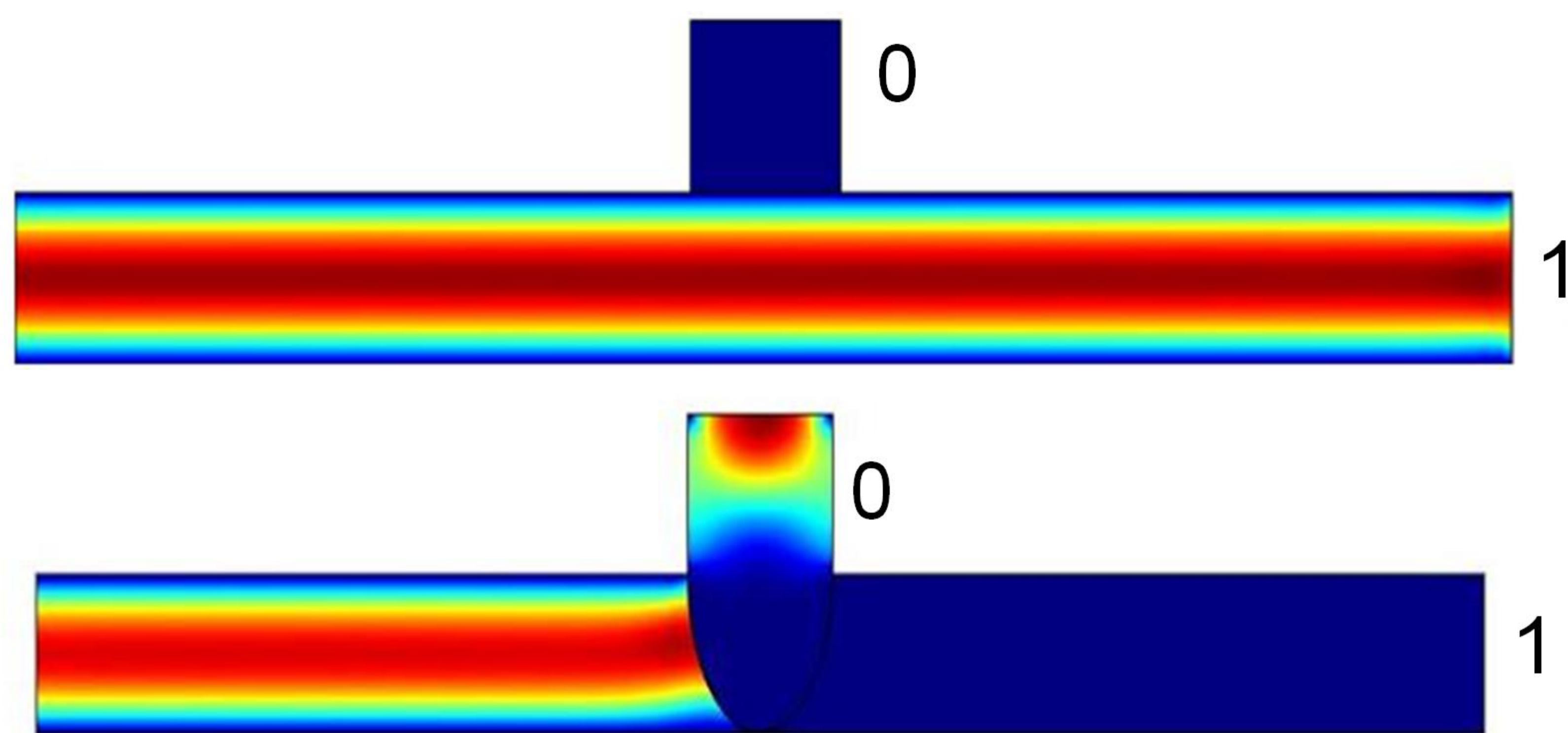


Figure 1. Fluidic NOT gate showing when valve is pressurized no flow at the output and logic gets inverted

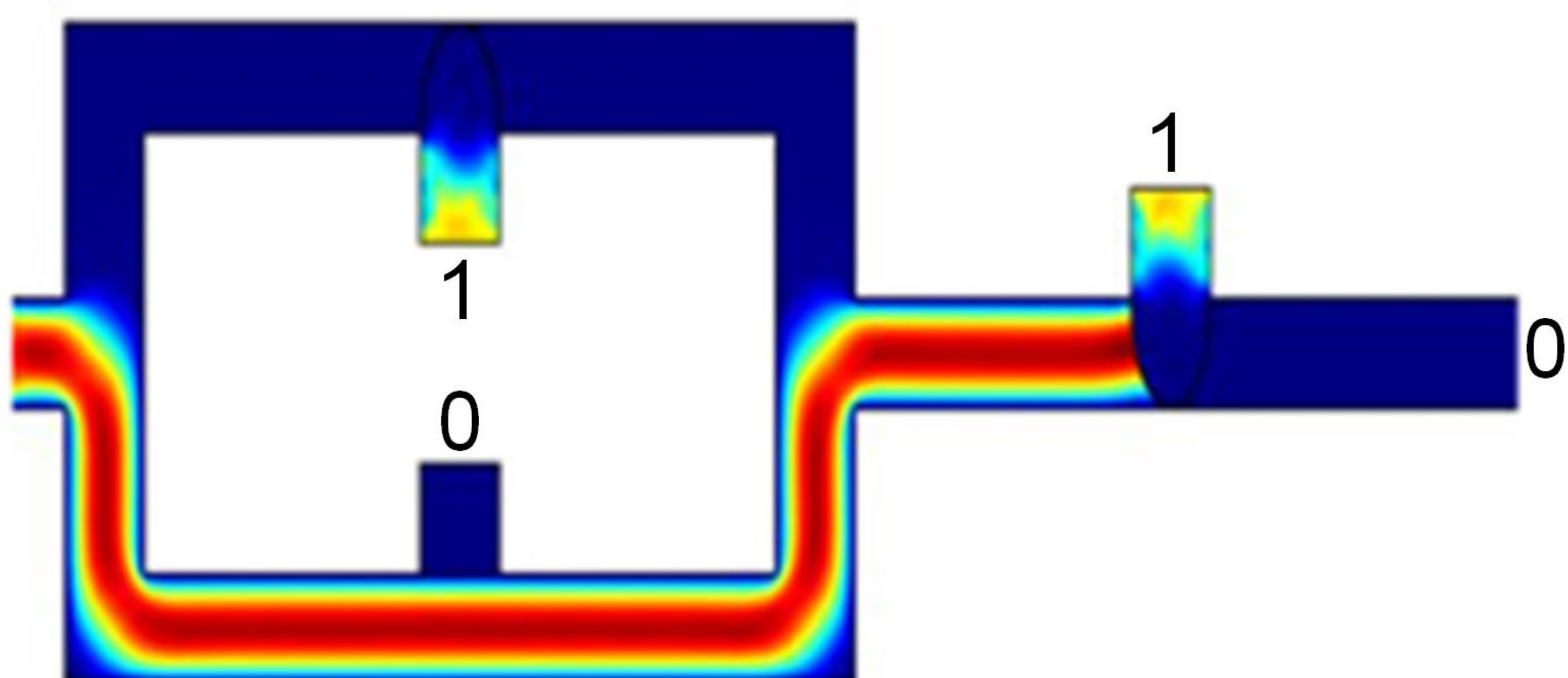


Figure 2. Fluidic AND gate achieved by adding NOT gate to the output of NAND gate

Results: The deflection of the diaphragm of the valve closes the pathway of the fluid flowing and thus provides 'logic 0' whereas the flow of fluid is considered as 'logic 1'.

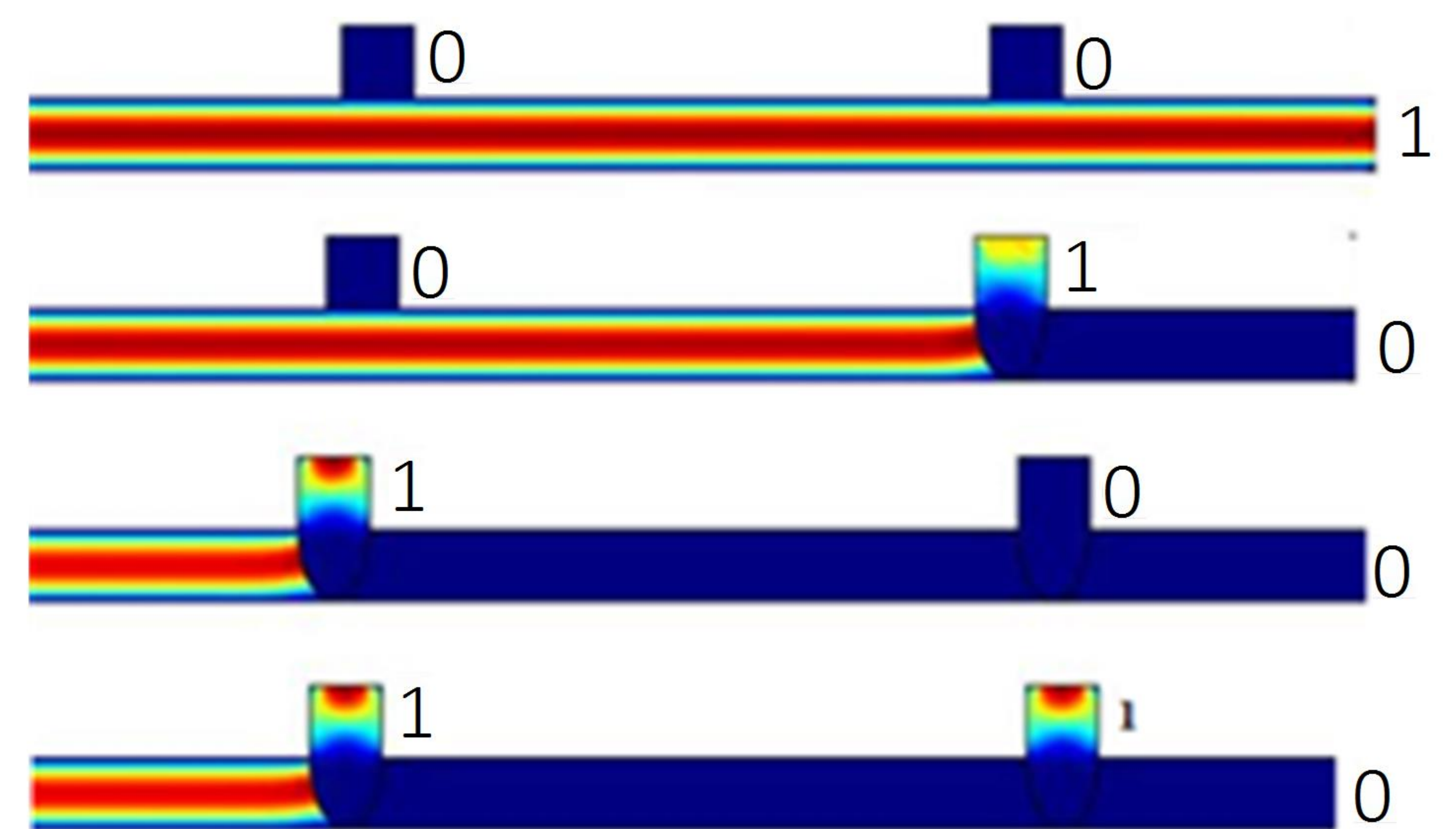


Figure 3. Fluidic NOR gate showing all possible inputs and corresponding outputs

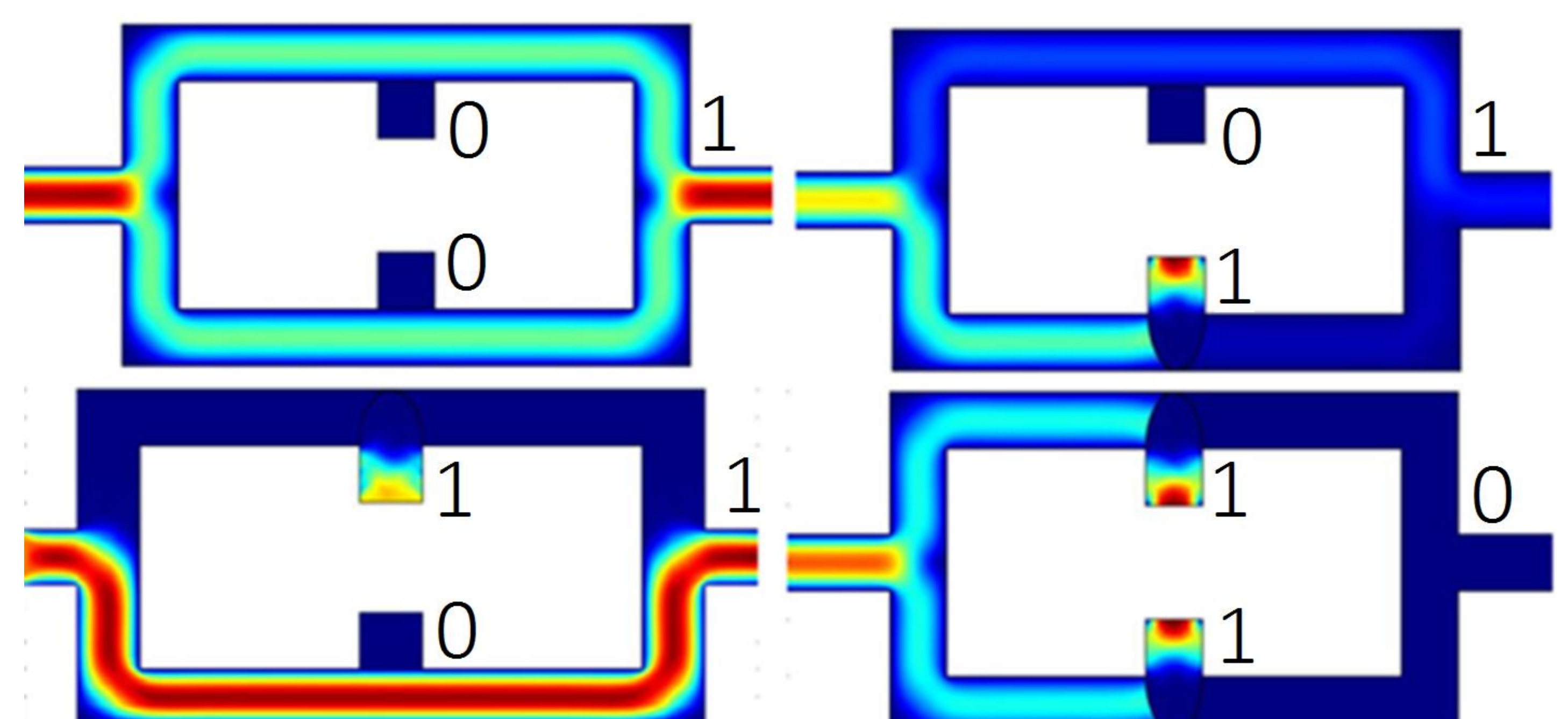


Figure 4. Simulation results for fluidic NAND gate with all input cases

Conclusions: These independent logic gates can be assembled to form fluidic computer. Though fluid-based computing does not aim to replace traditional silicon-based technology, computing elements, but will serve to the communities in the remote areas providing them the digitized computation capability without electrical power.

References:

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2. Thies, W. B., Urbanski, J. P., Cooper, M., Wentzloff, D., Thorsen, T., & Amarasinghe, S., "Programmable microfluidics", 2007.