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Automated venting technique used in microfluidic digital logic lab-on-a-chip device

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Microfluidic digital logic is an emerging technology which can be useful to automate a variety of lab processes in order to bring lab tests and diagnostics to low resource settings where it can be difficult to establish expensive and advanced labs. Microfluidic digital logic derives its concept from the digital logic in electronics and aids to automate complex liquid handling processes. The basic logic circuits are designed using valves and pneumatic resistors in a way that can be used to pump fluid around in the chip in order to transport the fluid or to mix it or store it. Automation of such basic aspects of a microfluidic device can help to eliminate the wieldy machinery that is required to drive a microfluidic chip. For example, the computer program, mechanical/ electrical pumps and syringe pumps can be replaced by on-chip pneumatic logic circuits. The heart of this work is a serial dilution circuit which has been previously reported in detail. The logic blocks designed around the dilution ladder do the job of selecting the program, pumping the diluent and making sure all the logic signals are routed correctly without any leakage or impeding attenuation. The circuit that receives and routes all other signals incorporates a feature to check the quality of dilution, the feature is called the venting network. This network uses the logic of its host circuit to vent appropriate valves during the corresponding cycle of dilution in order to avoid leakage and maintain optimal speed of dilution. This work demonstrates engineering of solutions around the challenges associated with large scale integration of complex microfluidic technologies. This technique can prove to be useful for many other challenges involved in design as well as application of microfluidic lab-on-a-chip devices.

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