

Supplementary Information

I. 4 control lines

Case 1) all 4 control lines are 50 kPa

All four control lines are selected as P_{50kPa} . The number of control pressure combination is ${}_4C_4 = 1$. The unique combination in this case is (C₁:50kPa, C₂:50kPa, C₃:50kPa, C₄:50kPa).

Case 2) 1 line is 100 kPa and 2 control lines are 50kPa

Due to the dependency of control pressure as we explained above, P_{100kPa} in a control line requires the choice of P_{low} in the same control line. Once we choose one among four control lines for P_{100kPa} , P_{50kPa} is automatically selected and we lose one option. So cases are to choose two control lines among the four control lines for P_{50kPa} (${}_4C_2$) and choose one control lines among the remaining two (${}_2C_1$). Therefore, overall number of pressure combinations is ${}_4C_2 \times {}_2C_1 = 12$. The pressure combinations are (C₁:100kPa, C₁:50kPa, C₂:50kPa, C₃:50kPa), (C₁:100kPa, C₁:50kPa, C₂:50kPa, C₄:50kPa), (C₁:100kPa, C₁:50kPa, C₃:50kPa, C₄:50kPa), (C₂:100kPa, C₂:50kPa, C₁:50kPa, C₃:50kPa), (C₂:100kPa, C₂:50kPa, C₁:50kPa, C₄:50kPa), (C₂:100kPa, C₂:50kPa, C₃:50kPa, C₄:50kPa), (C₃:100kPa, C₃:50kPa, C₁:50kPa, C₂:50kPa), (C₃:100kPa, C₃:50kPa, C₁:50kPa, C₄:50kPa), (C₃:100kPa, C₃:50kPa, C₂:50kPa, C₄:50kPa), (C₄:100kPa, C₄:50kPa, C₁:50kPa, C₂:50kPa), (C₄:100kPa, C₄:50kPa, C₁:50kPa, C₃:50kPa), (C₄:100kPa, C₄:50kPa, C₂:50kPa, C₃:50kPa).

Case 4) 2 line are 100 kPa

In this case, we need two control lines with P_{100kPa} . Each P_{100kPa} require P_{50kPa} in the same control line and no other options are left. The pressure combination is to choose two among four control lines, ${}_4C_2 = 6$. The detailed pressure combinations are (C₁:100kPa, C₁:50kPa, C₂:100kPa, C₂:50kPa), (C₁:100kPa, C₁:50kPa, C₃:100kPa, C₃:50kPa), (C₁:100kPa, C₁:50kPa, C₄:100kPa, C₄:50kPa), (C₂:100kPa, C₂:50kPa, C₃:100kPa, C₃:50kPa), (C₂:100kPa, C₂:50kPa, C₄:100kPa, C₄:50kPa), (C₃:100kPa, C₃:50kPa, C₄:100kPa, C₄:50kPa).

$$F_{Total} = 1 + 12 + 6 = 19$$

II. 6 control lines

In case for 6 control lines ($n=6, m=2$), equation 3 and 4 are,

$$a_1 + 2a_2 = 6, \quad a_1 + a_2 \leq 6$$

(a_1, a_2) satisfying these equations are $(a_1=6, a_2=0)$, $(a_1=4, a_2=1)$, $(a_1=2, a_2=2)$, $(a_1=0, a_2=3)$.

In each case, the number of controllable fluidic channels is,

Case 1) All 6 control lines are 50kPa, $F_{a_1=6, a_2=0} = {}_6C_6 = 1$

Case 2) 1 control line is 100kPa and 4 control lines are 50kPa, $F_{a_1=4, a_2=1} = {}_6C_4 \cdot {}_2C_1 = 30$

Case 3) 2 control lines are 100kPa and 2 control lines are 50kPa, $F_{a_1=2, a_2=2} = {}_6C_2 \cdot {}_4C_2 = 90$

Case 4) 3 control lines are 100kPa, $F_{a_1=0, a_2=3} = {}_6C_3 = 20$

$$F_{Total} = 1 + 30 + 90 + 20 = 141$$

III. 8 control lines

In case for 8 control lines ($n=8, m=2$), equation 3 and 4 are,

$$a_1 + 2a_2 = 8, \quad a_1 + a_2 \leq 8$$

(a_1, a_2) cases satisfying these equations are $(a_1=8, a_2=0)$, $(a_1=6, a_2=1)$, $(a_1=4, a_2=2)$, $(a_1=2, a_2=3)$, $(a_1=0, a_2=4)$. In each case, the number of controllable fluidic channels is,

Case 1) All 8 control lines are 50 kPa, $F_{a_1=8, a_2=0} = {}_8C_8 = 1$

Case 2) 1 control line is 100kPa and 6 control lines are 50kPa, $F_{a_1=6, a_2=1} = {}_8C_6 \cdot {}_2C_1 = 56$

Case 3) 2 control lines are 100kPa and 4 control lines are 50kPa, $F_{a_1=4, a_2=2} = {}_8C_4 \cdot {}_4C_2 = 420$

Case 4) 3 control lines are 100kPa and 2 control lines are 50kPa, $F_{a_1=2, a_2=3} = {}_8C_2 \cdot {}_6C_3 = 560$

Case 5) 4 control lines are 100kPa, $F_{a_1=0, a_2=4} = {}_8C_4 = 70$

$$F_{Total} = 1 + 56 + 420 + 560 + 70 = 1,107$$

IV. 10 control lines

In case for 10 control line($n=10, m=2$), equation 3 and 4 are,

$$a_1 + 2a_2 = 10, \quad a_1 + a_2 \leq 10$$

(a_1, a_2) cases satisfying these equations are $(a_1=10, a_2=0)$, $(a_1=8, a_2=1)$, $(a_1=6, a_2=2)$, $(a_1=4, a_2=3)$, $(a_1=2, a_2=4)$, $(a_1=0, a_2=5)$. In each case, the number of controllable fluidic channels is,

Case 1) All 10 control lines are 50kPa, $F_{a_1=10, a_2=0} = {}_{10}C_{10} = 1$

Case 2) 1 control line is 100kPa and 8 control lines are 50kPa, $F_{a_1=8, a_2=1} = {}_{10}C_8 \cdot {}_2C_1 = 90$

Case 3) 2 control lines are 100kPa and 6 control lines are 50kPa, $F_{a_1=6, a_2=2} = {}_{10}C_6 \cdot {}_4C_2 = 1260$

Case 4) 3 control lines are 100kPa and 4 control lines are 50kPa, $F_{a_1=4, a_2=3} = {}_{10}C_4 \cdot {}_6C_3 = 4200$

Case 5) 4 control lines are 100kPa and 2 control lines are 50kPa, $F_{a_1=2, a_2=4} = {}_{10}C_2 \cdot {}_8C_4 = 3150$

Case 6) 5 control lines are 100kPa, $F_{a_1=0, a_2=5} = {}_{10}C_5 = 252$

$$F_{Total} = 1 + 90 + 1260 + 4200 + 3150 + 252 = 8,953$$