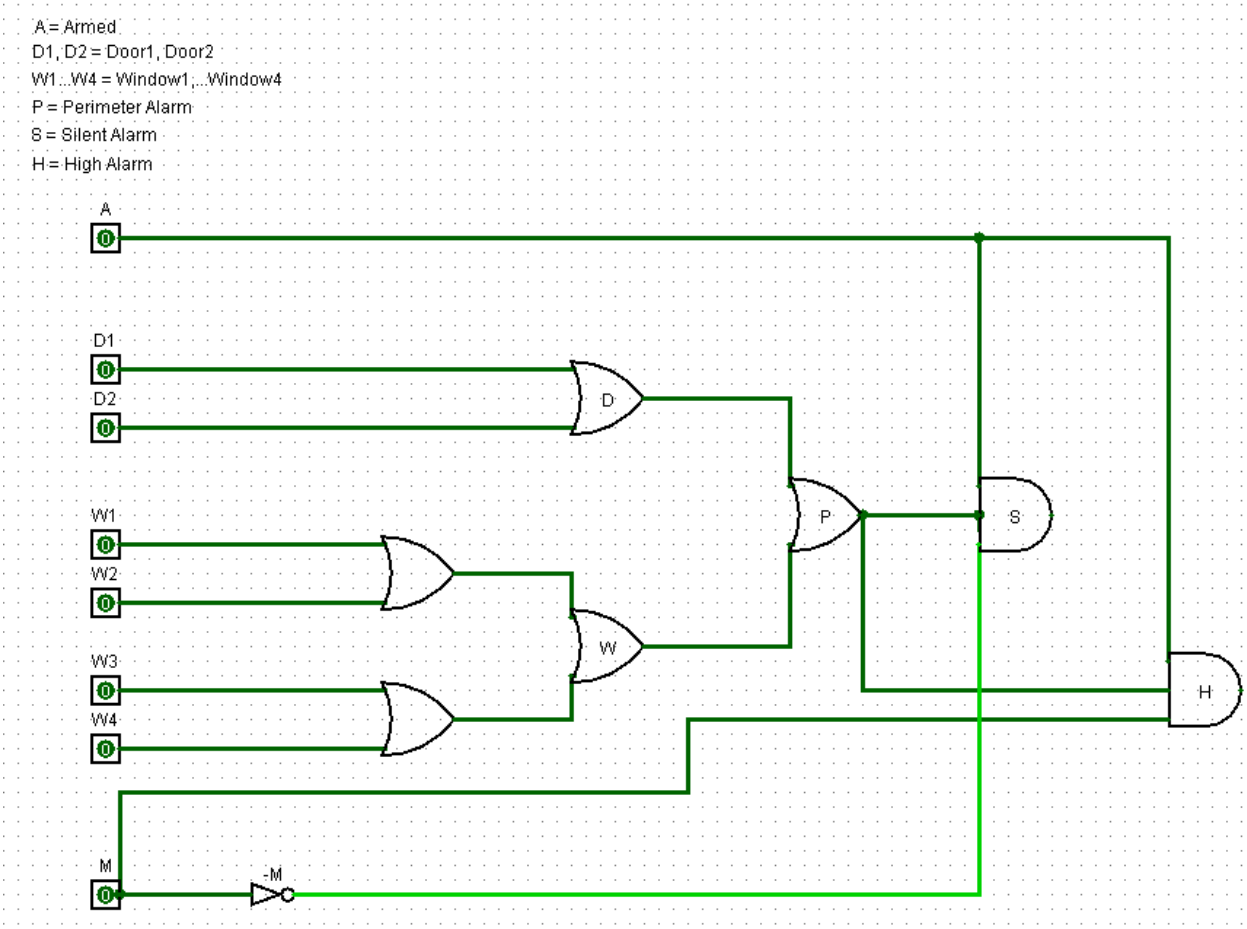
Logic Circuit Design – Simple Alarm System

The circuit implements a simple alarm system performing basic control functions using Boolean logic principles. The system has three main inputs: A (armed), P (perimeter breach), and M (motion detection). It has two outputs: S (silent alarm) and H (high alarm). The P signal is generated by two doors and four windows sensors combined with OR gates, triggering when any of the sensors is active. The silent alarm is triggered when the system is armed and the perimeter is breached without motion detection, represented by the Boolean expression: S = A AND P AND NOT M. A high alarm is triggered when the system is armed and both a perimeter breach and motion detection occur. This I represented by: H = A AND P AND M.

The circuit was designed and simulated in Logisim, and Truth tables for both outputs were generated using the dCode Boolean Truth Table Generator. Each truth table row was tested in Logisim, with LEDs on P, S, and H confirming correct operation. This process demonstrated how Boolean logic can be effectively applied to implement a functional control system. The result shows that theory and practice worked together 100%.



(*Circuit diagram of the simple alarm system implemented in Logisim*)

Truth Tables

(Truth table for Silent alarm (S))

a	m	p	X
0	0	0	**0**
0	0	1	**0**
0	1	0	**0**
0	1	1	**0**
1	0	0	**0**
1	0	1	**1**
1	1	0	**0**
1	1	1	**0**

(Truth table for High alarm (H))

a	m	p	X
0	0	0	**0**
0	0	1	**0**
0	1	0	**0**
0	1	1	**0**
1	0	0	**0**
1	0	1	**0**
1	1	0	**0**
1	1	1	**1**

Testing

Sensor labels (D1, D2, W1…W4) are shown in the diagram above.

Each test case corresponds to a specific row in the truth table.

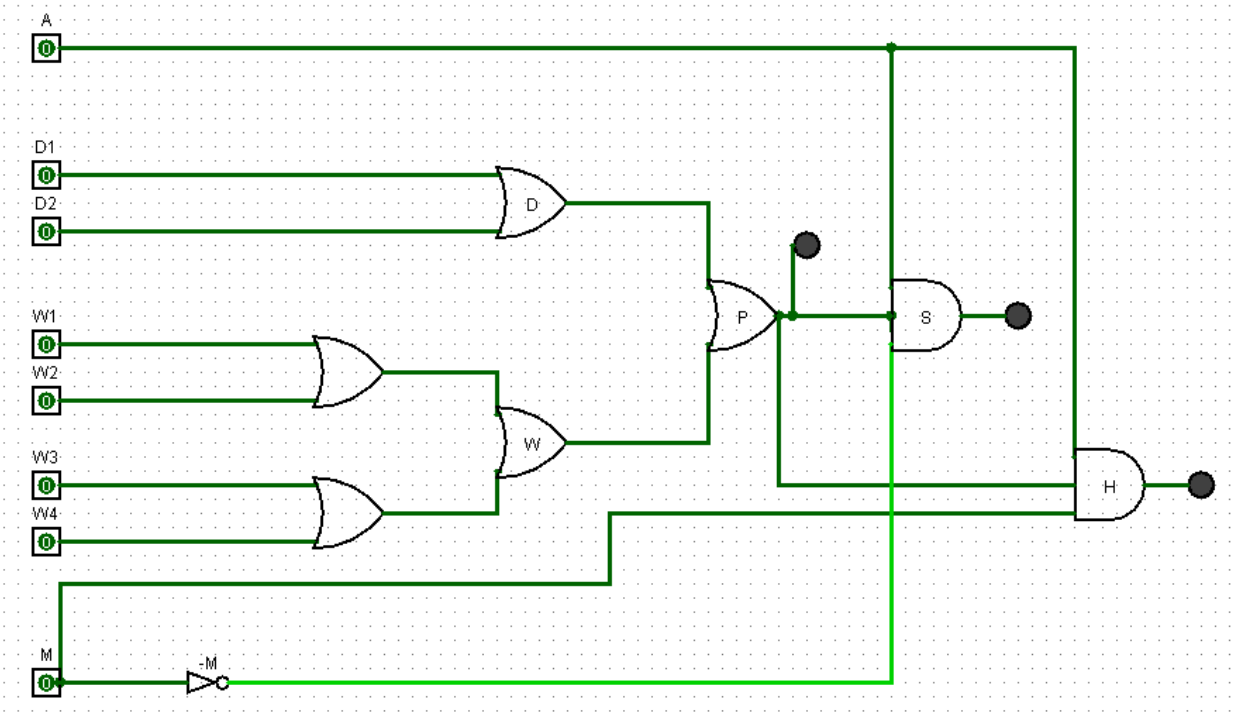
Cases:

Case 1 (truth table row 1)

Inputs: A=0, P=0, M=0

Expected: S=0, H=0

Description: System disarmed, no perimeter breach, no motion.



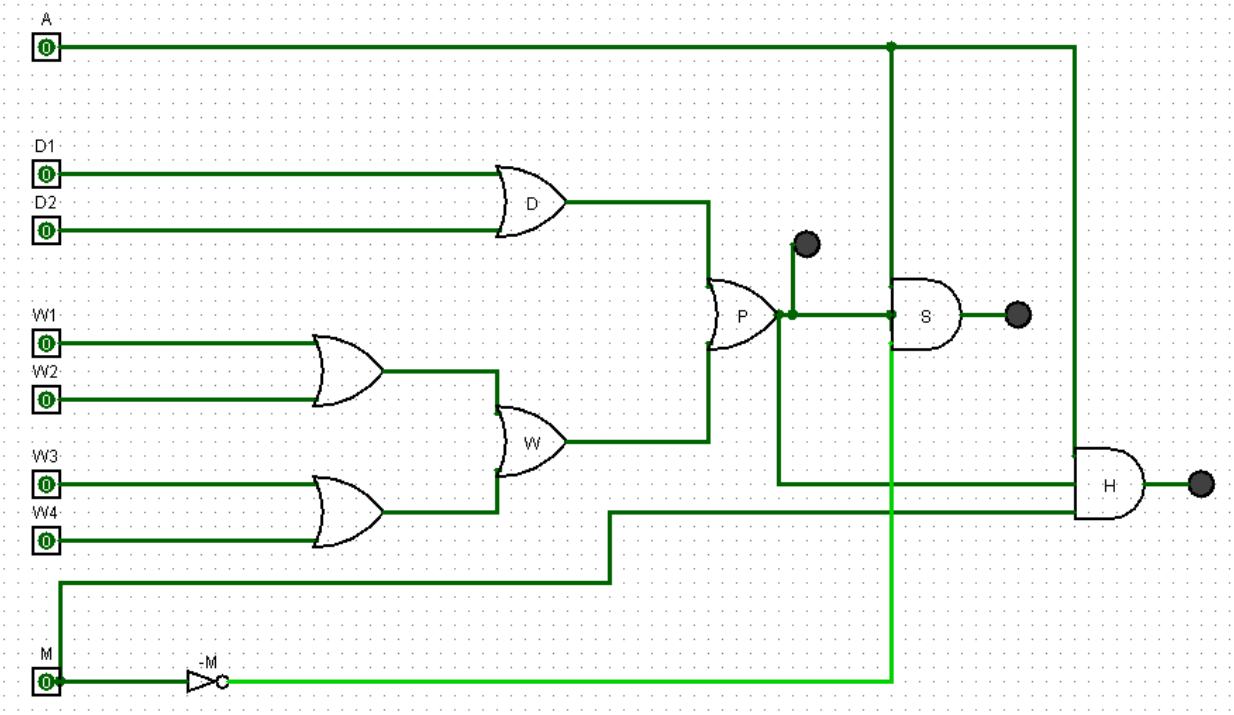
Result: Test successful

Case 2 (truth table row 2)

Inputs: A=0, P=0, M=1

Expected: S=0, H=0

Description: System disarmed, no perimeter breach, motion detected.



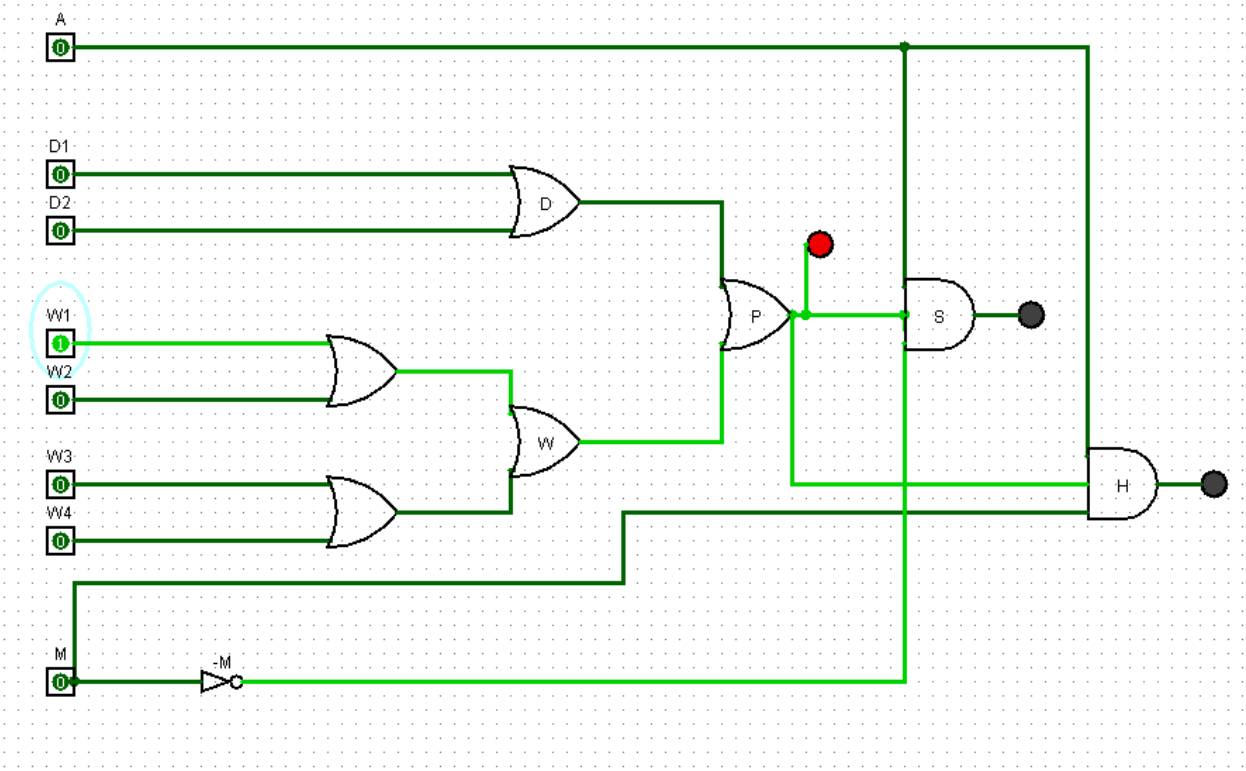
Result: Test successful

Case 3 (truth table row 3)

Inputs: A=0, P=1, M=0

Expected: S=0, H=0

Description: System disarmed, perimeter breach, no motion.



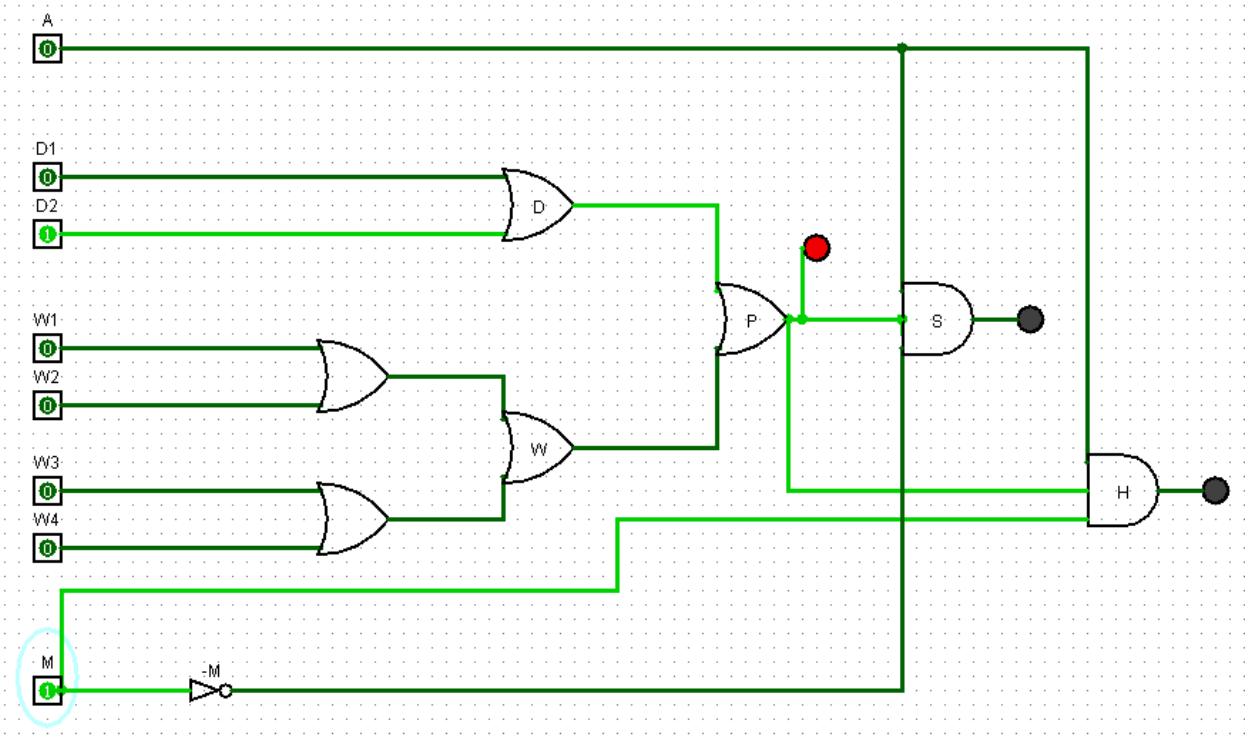
Result: Test successful

Case 4 (truth table row 4)

Inputs: A=0, P=1, M=1

Expected: S=0, H=0

Description: System disarmed, perimeter breach, motion detected.



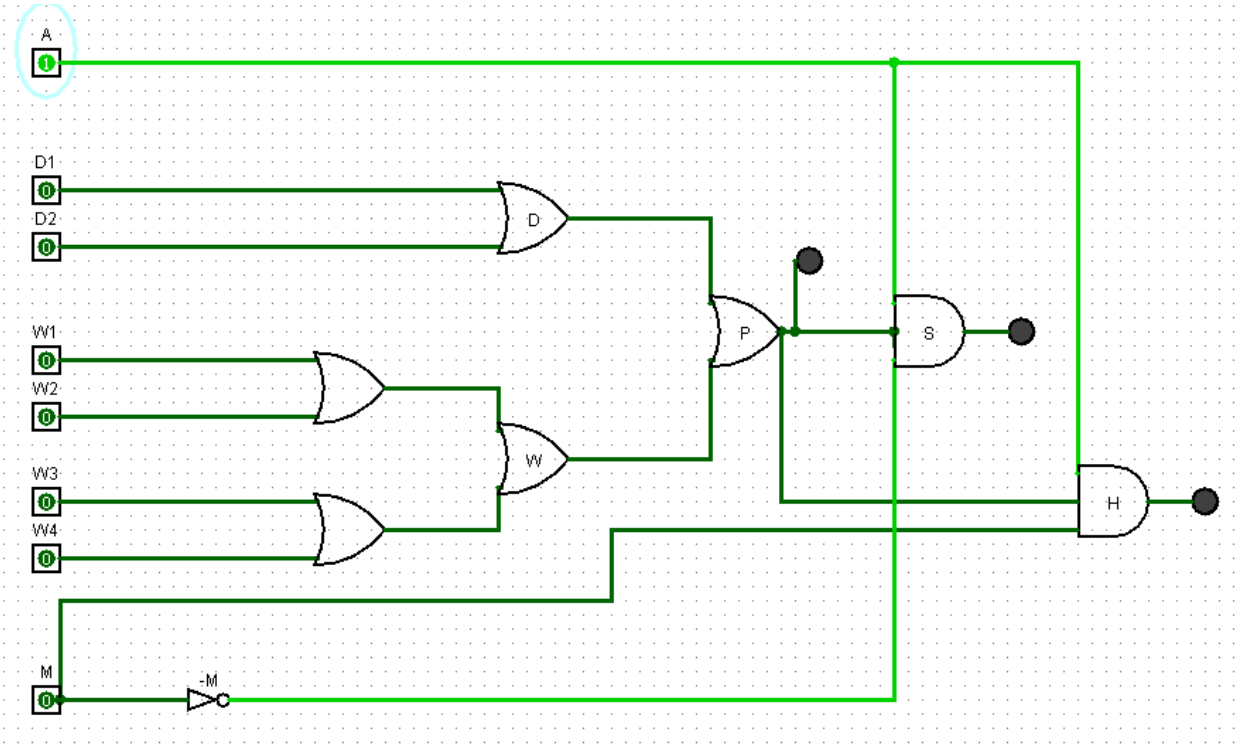
Result: Test successful

Case 5 (truth table row 5)

Inputs: A=1, P=0, M=0

Expected: S=0, H=0

Description: Armed, no perimeter breach, no motion.



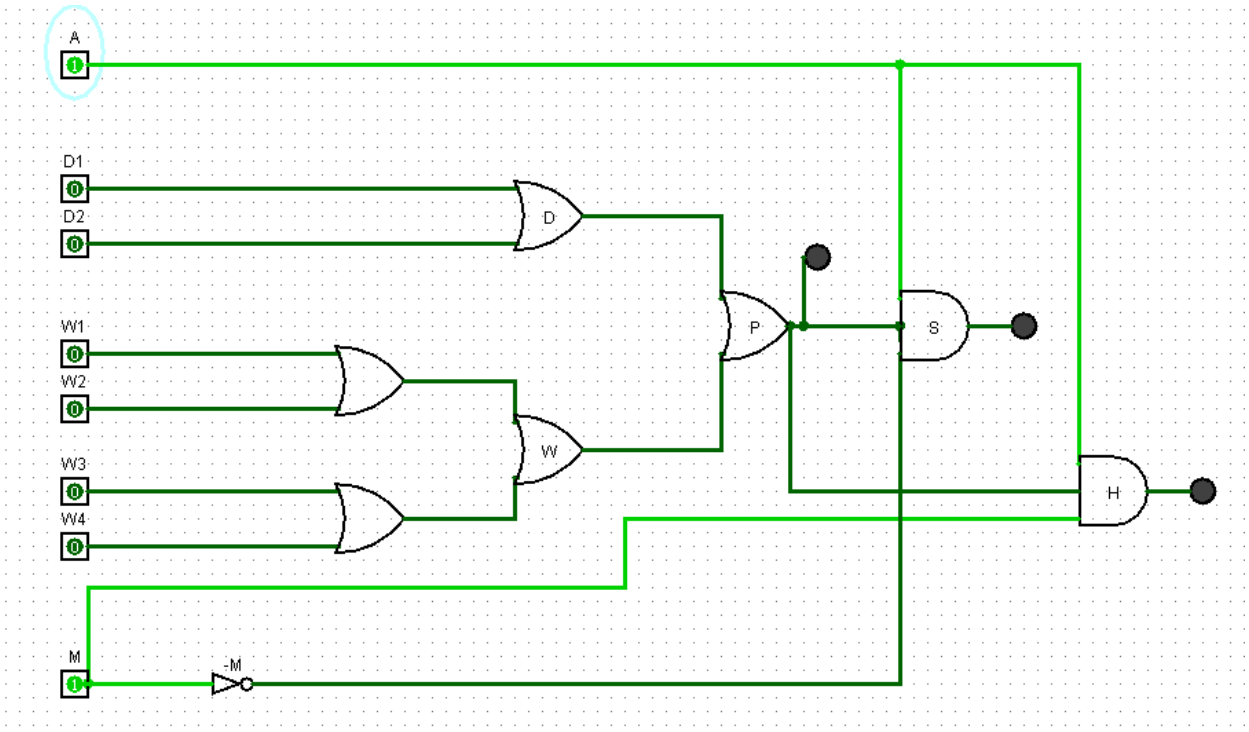
Result: Test successful

Case 6 (truth table row 6)

Inputs: A=1, P=0, M=1

Expected: S=0, H=0

Description: Armed, no perimeter breach, motion detected.



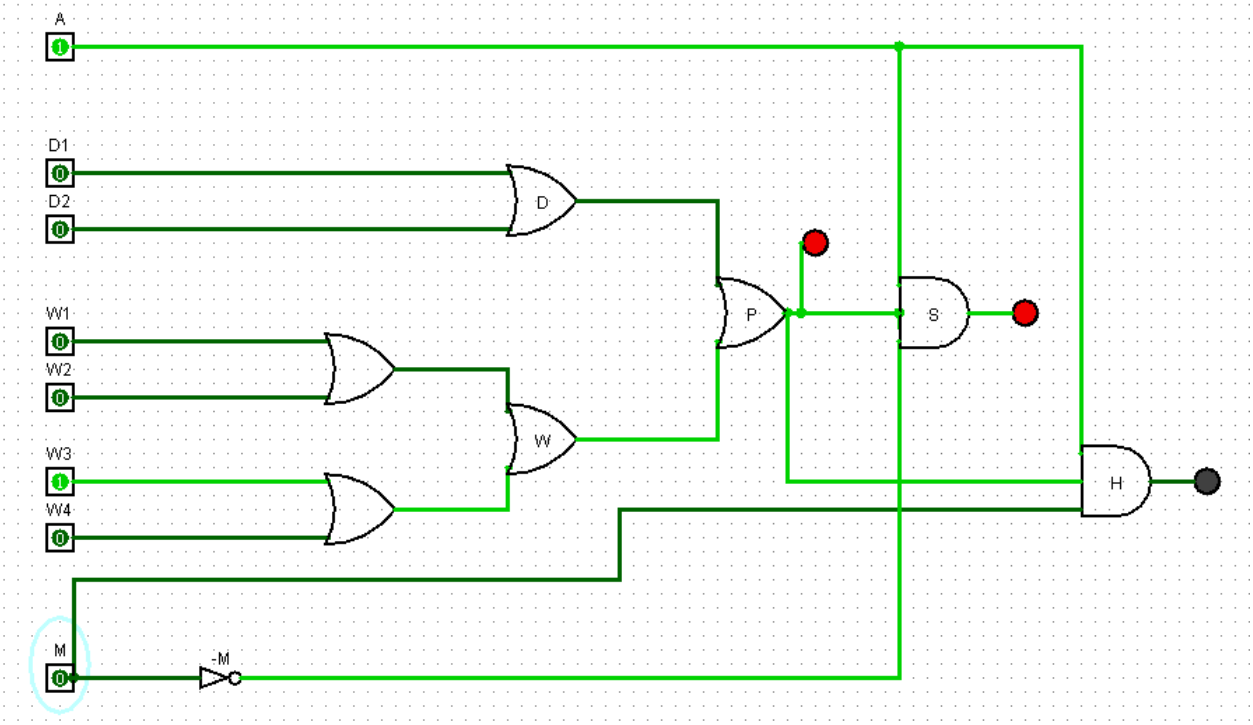
Result: Test successful

Case 7 (truth table row 7)

Inputs: A=1, P=1, M=0

Expected: S=1, H=0

Description: Silent alarm, armed, perimeter breach, no motion.



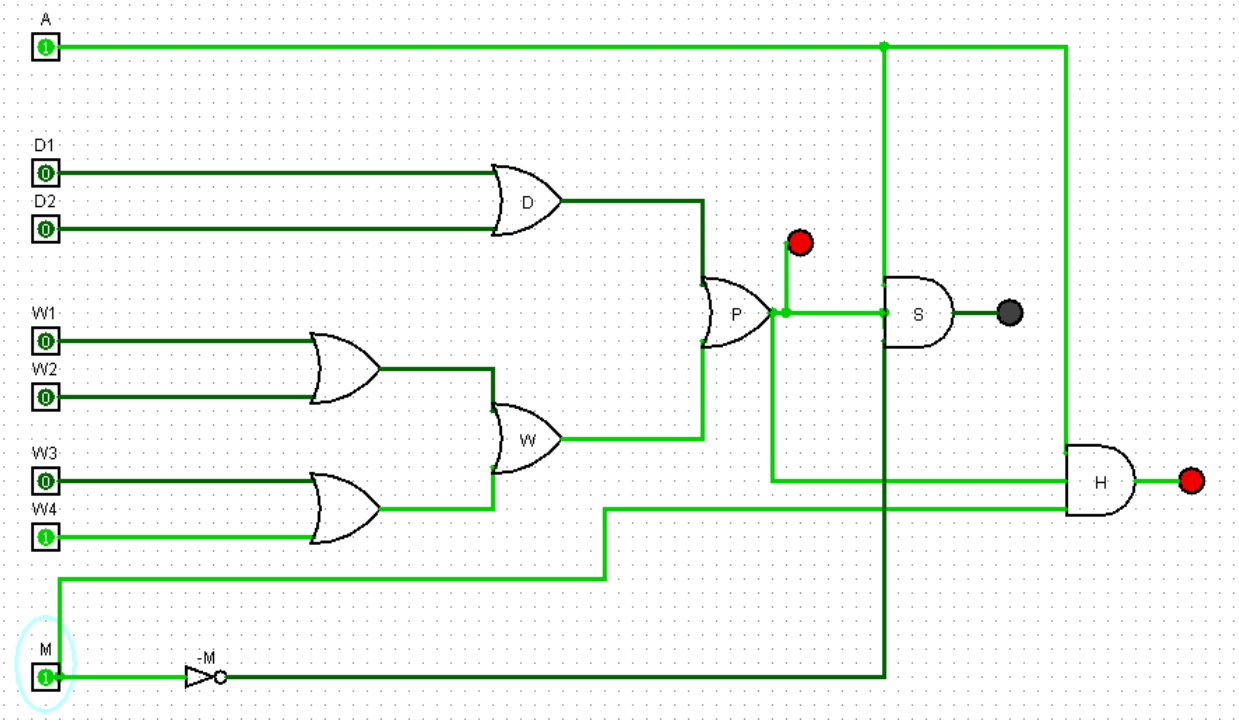
Result: Test successful

Case 8 (truth table row 8)

Inputs: A=1, P=1, M=1

Expected: S=0, H=1

Description: High alarm, armed, perimeter breach, motion detected.



Result: Test successful