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Objectives

- To design and Construct a half Adder
- To design and Construct a Full Adder
- To design and Construct a half Subtractor
- To design and Construct a Full Subtractor
- Verification of Truth Table using Logic Gates.

Apparatus

- Power Supply
- Breadboard

Components

- 7430 or 7408 Quad 2-Inout AND Gate
- 7432 Quad 2-Input OR Gate
- 7404 Hex Inverter
- 7486 Quad 2-Input XOR Gate
- 520 Ω / 1k Ω resistors
- DIP Switches
- LEDs

Theory

A digital adder circuit adds binary signals & a subtractor subtracts binary signals. Half Adder/Subtractor is a basic circuit that adds / subtracts 2 bits and generates Sum or Difference along with Carry / Borrow. Unlike Half Adder or Subtractor a Full Adder / Subtractor has the provision to take consideration of previous Carry / Borrow also.

Half Adder

Half adder is a combinational circuit that performs simple addition of two binary numbers. If we assume A and B as the two bits whose addition is to be performed, the block diagram and a truth table for half adder with A, B as inputs and Sum, carry as outputs can be tabulated.

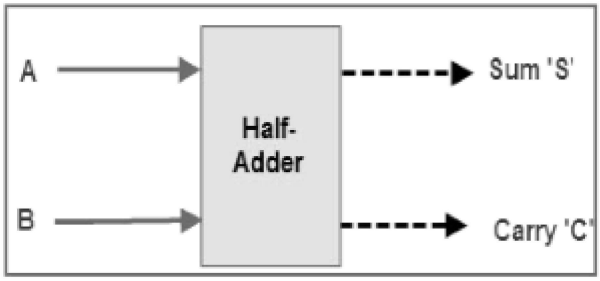


Figure 1: Half Adder Logic Symbol

Full adder

Full adder is a digital circuit used to calculate the sum of three binary bits. Full adders are complex and difficult to implement when compared to half adders. Two of the three bits are same as before which are A, the augend bit and B, the addend bit. The additional third bit is carry bit from the previous stage and is called 'Carry' – in generally represented by CIN. It calculates the sum of three bits along with the carry. The output carry is called Carry – out and is represented by Carry OUT.

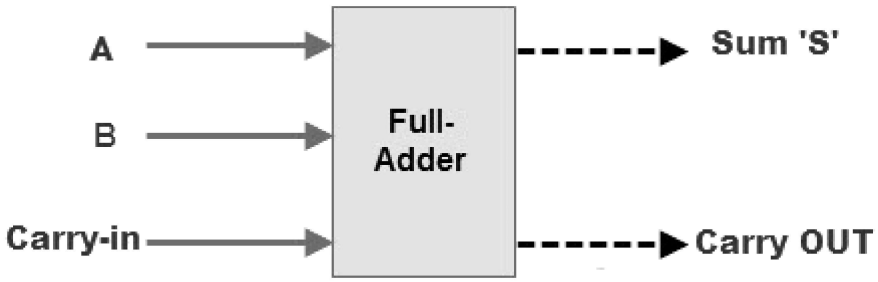


Figure 2: Full Adder Logic Symbol

Half Subtractor

The half-subtractor is a combinational circuit which is used to perform subtraction of two bits. It has two inputs, A (minuend) and B (subtrahend) and two outputs Difference and Borrow. The logic symbol is shown below.

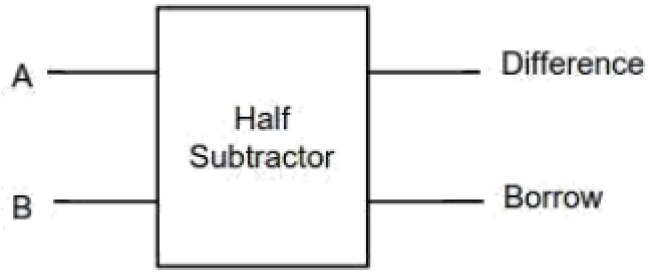


Figure 3: Half Subtractor Logic Symbol

Full Subtractor

A full subtractor is a combinational circuit that performs subtraction involving three bits, namely A (minuend), B (subtrahend), and Bin (borrow-in). It accepts three inputs: A (minuend), B (subtrahend) and a Bin (borrow bit) and it produces two outputs: D (difference) and Bout (borrow out). The logic symbol is shown below.

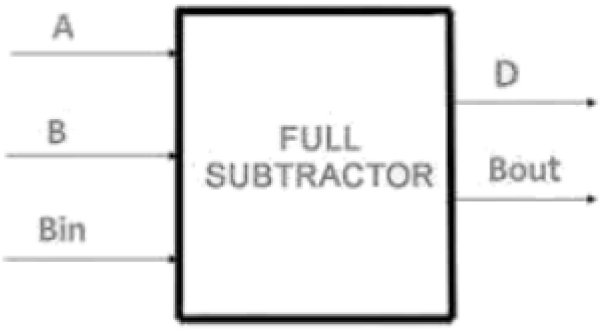


Figure 4: Full Subtractor

Procedure

1. Connections are given as per circuit diagram.
2. Logical inputs are given as per circuit diagram.
3. Observe the output and verify the truth table.

Half Adder

- Logic Diagram

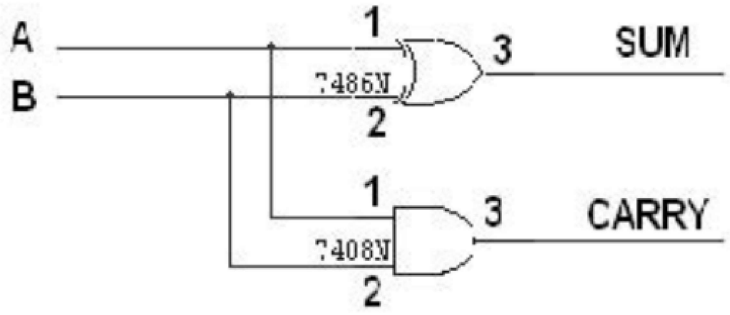
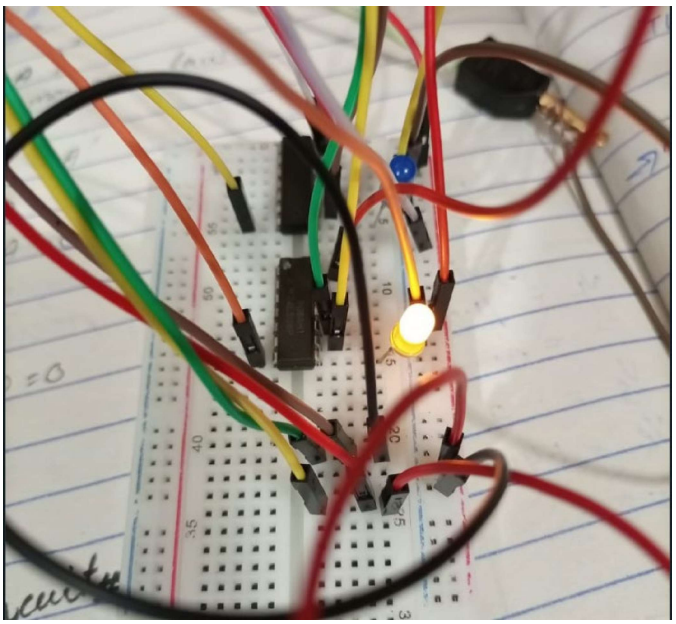


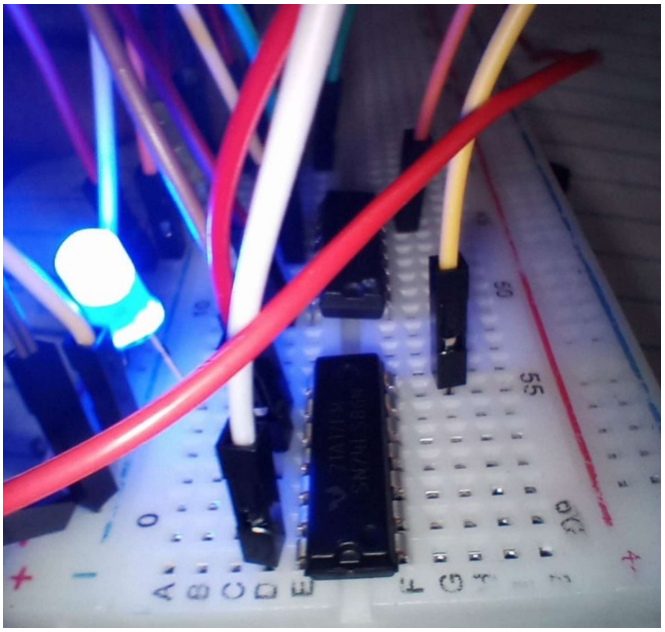
Figure 5: Half Adder

- Truth Table

A	B	CARRY	SUM
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

- Implementation on Breadboard





Full Adder

- Logic Diagram

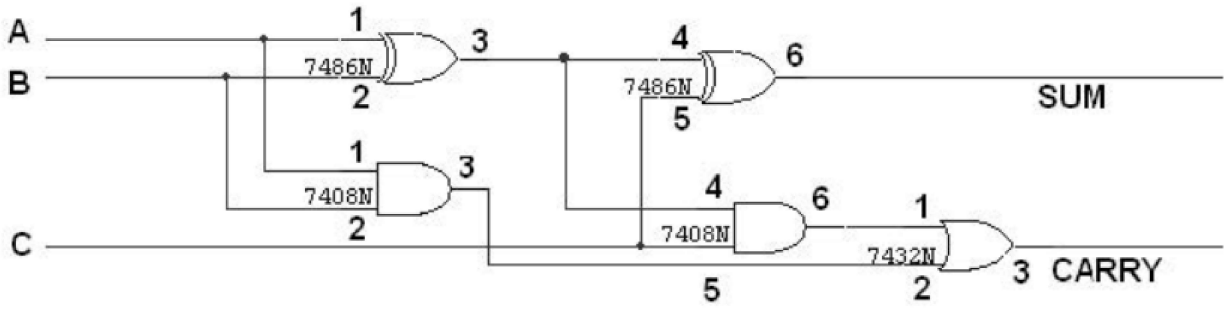
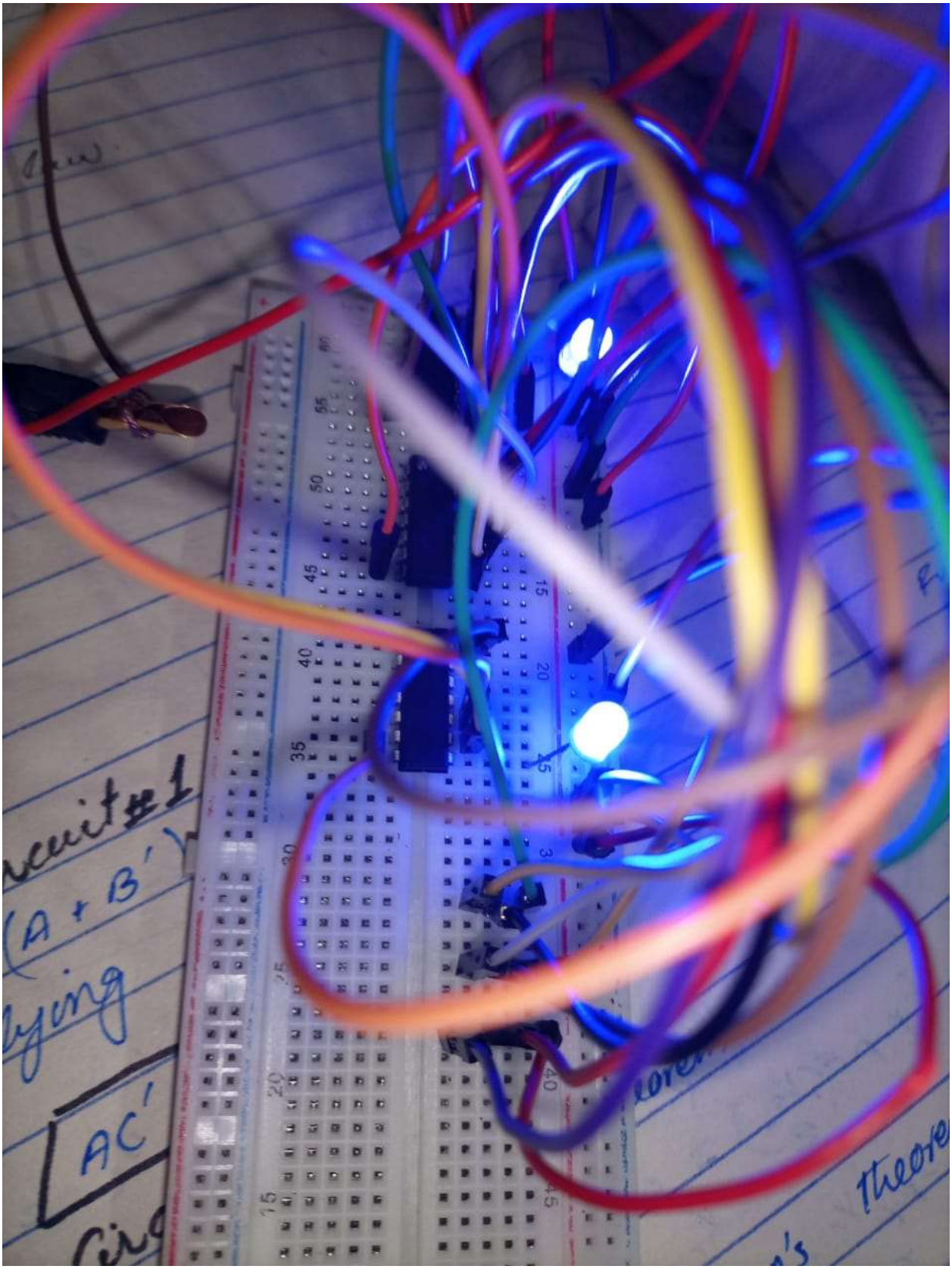


Figure 6: Full Adder

- Truth Table

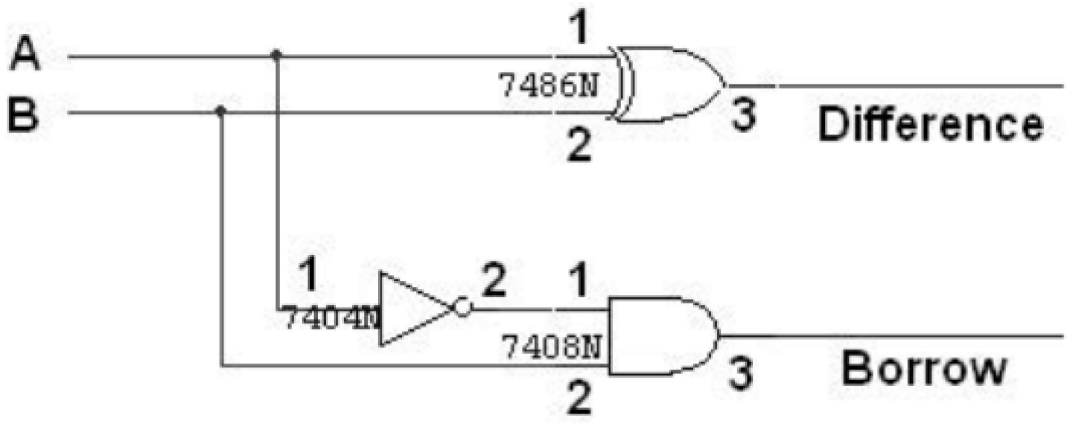
A	B	C	CARRY	SUM
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

- Implementation on Breadboard



Half Subtractor

- Logic Diagram



- Truth Table

A	B	BORROW	DIFFERENCE
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0

- Implementation in Logisim

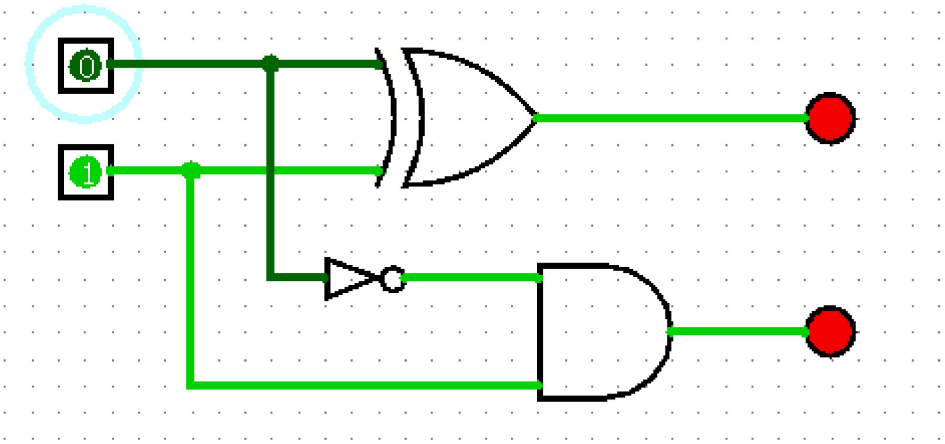
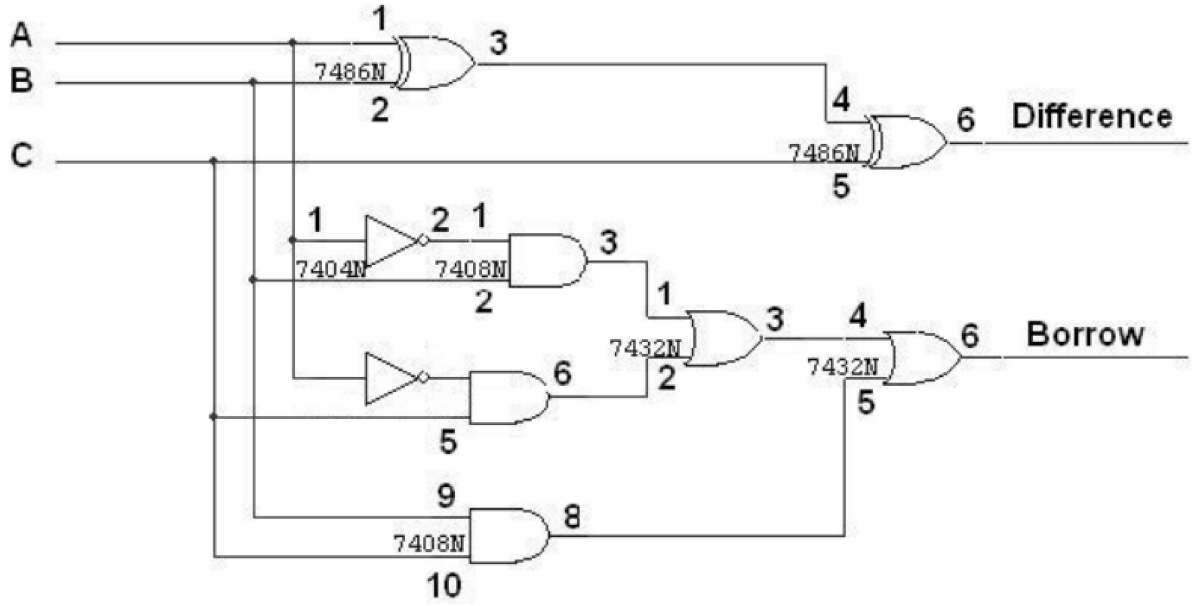


Figure 7:Half Subtractor

Full Subtractor

- Logic Diagram



- Truth Table

A	B	C	BORROW	DIFFERNCE
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

- Implementation in Logisim

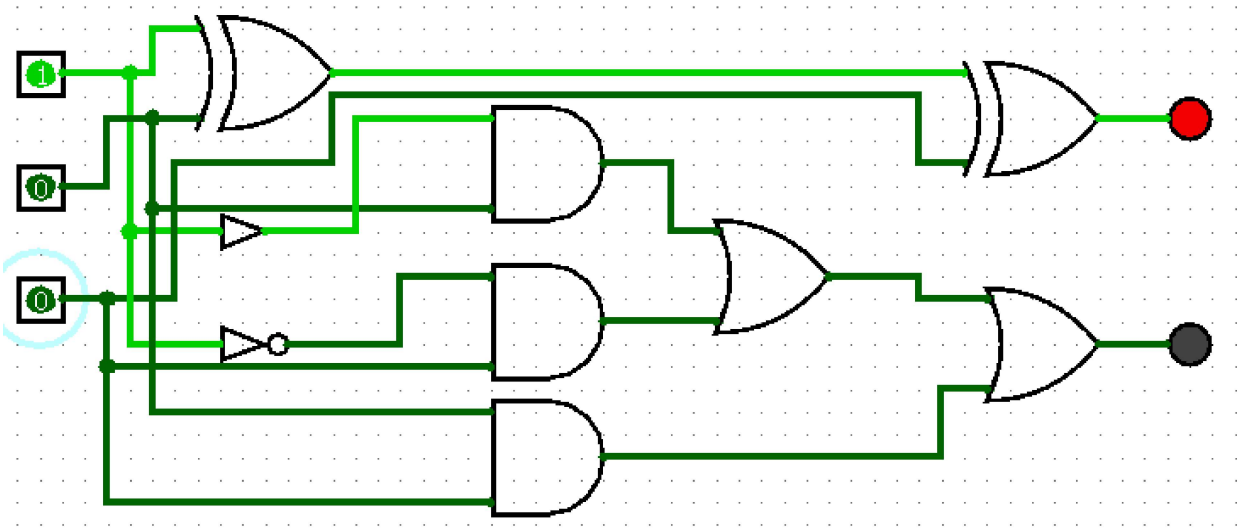
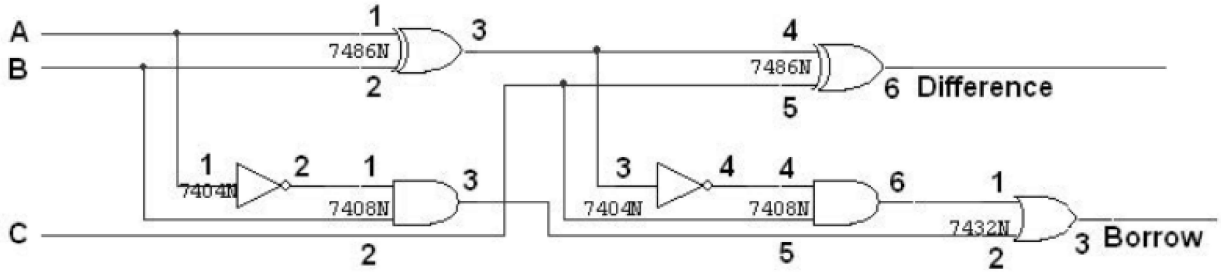


Figure 8: Full Subtractor

Full Subtractor using two Half Subtractor

- Logic Diagram



- Truth Table

A	B	C	BORROW	DIFFERNCE
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

- Implementation in Logisim

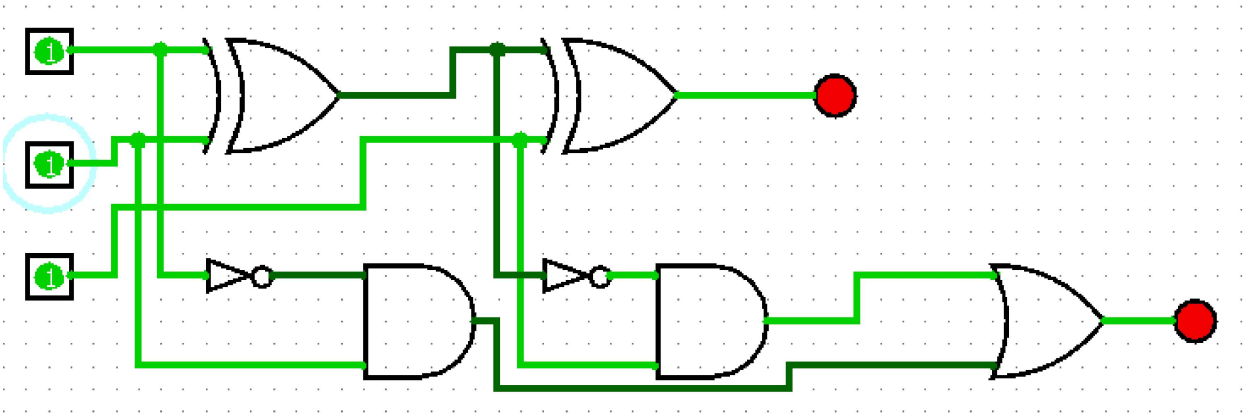


Figure 9:Full Subtractor using two half subtractor