**Aneesh Panchal - 2K20/MC/21**

# *Experiment VII*

## AIM:

Design of Full Subtractor and Adder using 8:1 Multiplexer.

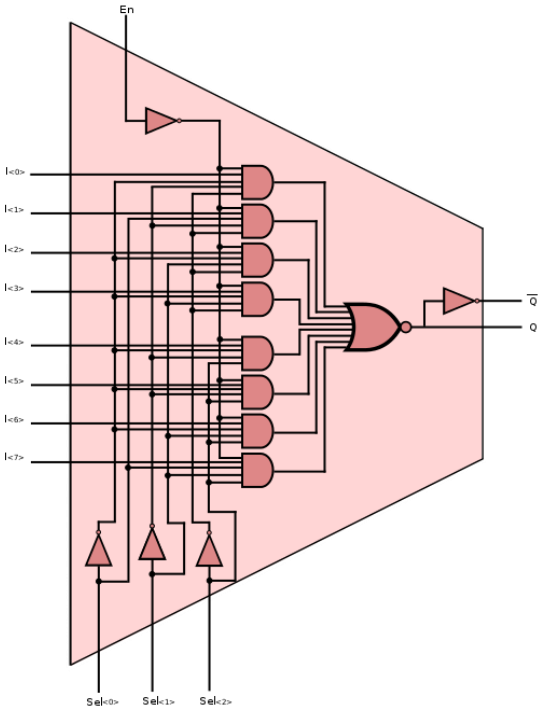
## Theory:

### Multiplexer:

A multiplexer (MUX) is a combinational circuit with many data inputs and based on control inputs, single data outputs are generated.

For n:1 MUX, n number of input lines are required, $log_2 n$ number of control/selection lines are required.

For 8:1 MUX, we have 8 input lines and 1 output line with 3 selection lines.




Truth table for 8:1 MUX

| INPUTS | | | Output |
|---|---|---|---|
| $S_2$ | $S_1$ | $S_0$ | Y |
| 0 | 0 | 0 | $A_0$ |
| 0 | 0 | 1 | $A_1$ |
| 0 | 1 | 0 | $A_2$ |
| 0 | 1 | 1 | $A_3$ |
| 1 | 0 | 0 | $A_4$ |
| 1 | 0 | 1 | $A_5$ |
| 1 | 1 | 0 | $A_6$ |
| 1 | 1 | 1 | $A_7$ |

***Full Adder:***

Full adder is developed to overcome the drawback of Half Adder circuit. It can add two one-bit numbers A and B, and carry c.

The full adder is a three input (A, B, $C_{in}$) and two output (Sum, Carry) combinational circuit.

| Inputs | | | Outputs | |
|---|---|---|---|---|
| A | B | $C_{in}$ | Sum | Carry |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

From here we get,

For Full Adder,

Sum(A,B, $C_{in}$) = Σ(1,2,4,7)

Carry(A,B, $C_{in}$) = Σ(3,5,6,7)

***Full Subtracter:***

The full subtractor is a combinational circuit with three inputs A,B,C and two output D and $B_{out}$. A is the 'minuend', B is 'subtrahend', C is the 'borrow' produced by the previous stage, D is the difference output and $B_{out}$ is the borrow output.

| Inputs | | | Outputs | |
|---|---|---|---|---|
| A | B | $Borrow_{in}$ | Diff | Borrow |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

From here we get,

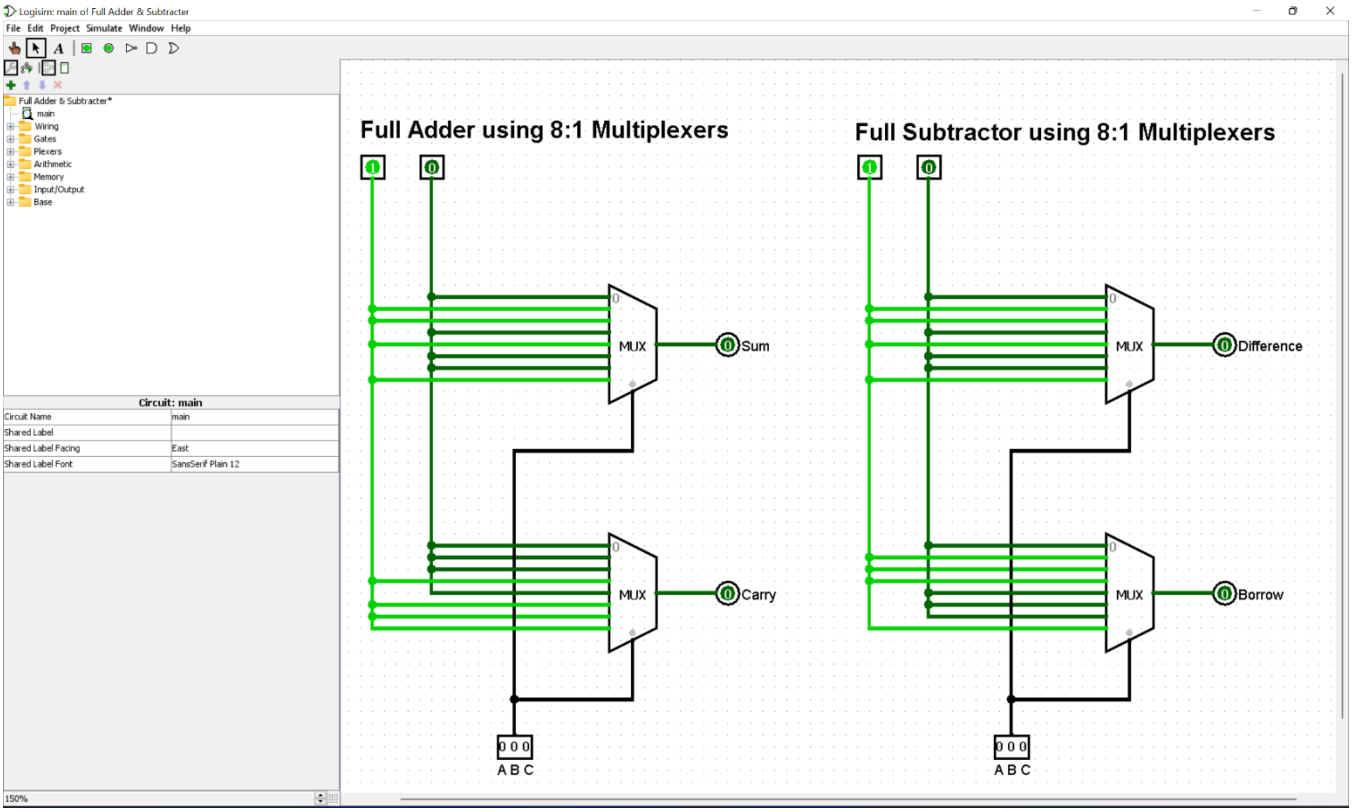
For Full Subtracter,

Difference(A,B,C) = Σ(1,2,4,7)

Borrow(A,B,C) = Σ(1,2,3,7)

## Observations:

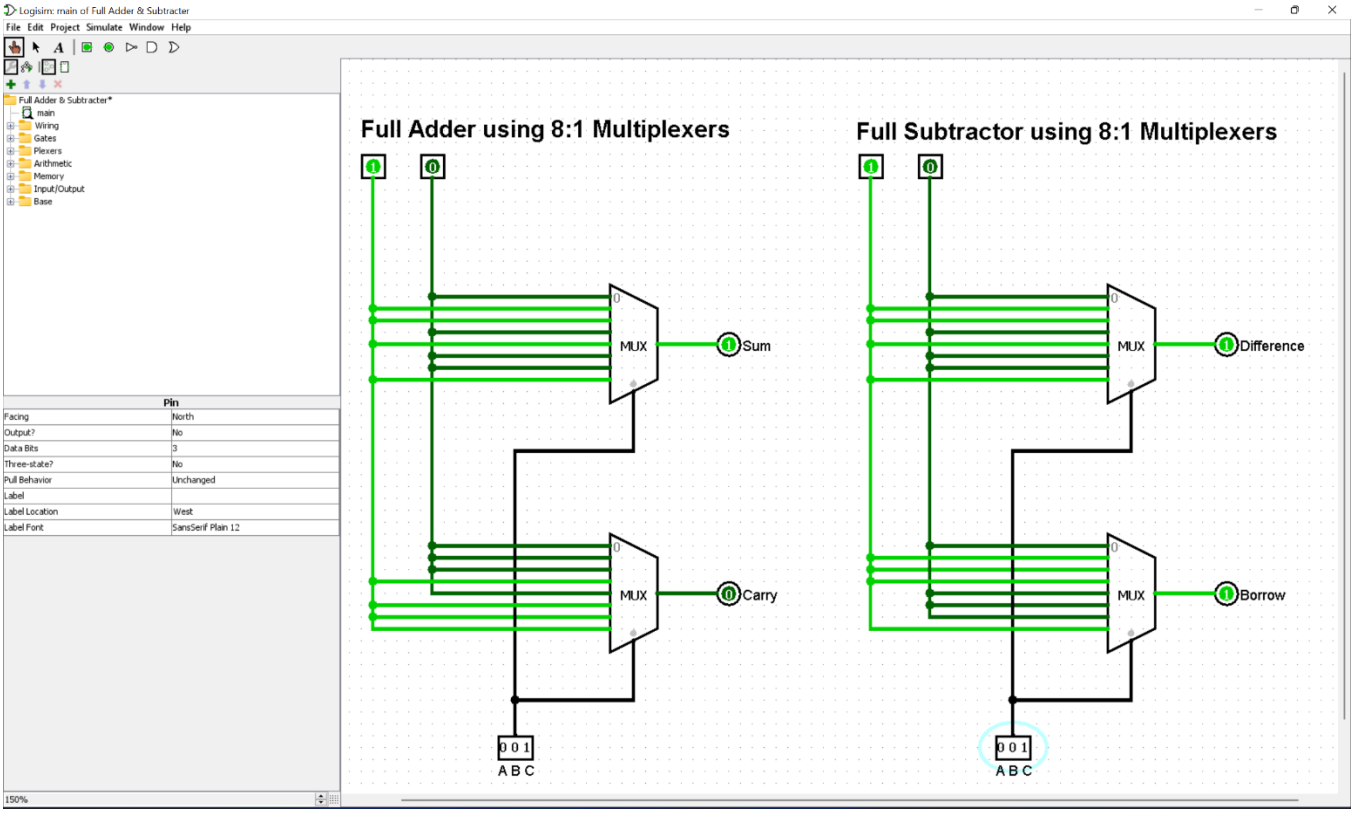
### When A = 0, B = 0 and C = 0:




Full Adder: Sum = 0, Carry = 0

Full Subtracter: Difference = 0, Borrow = 0

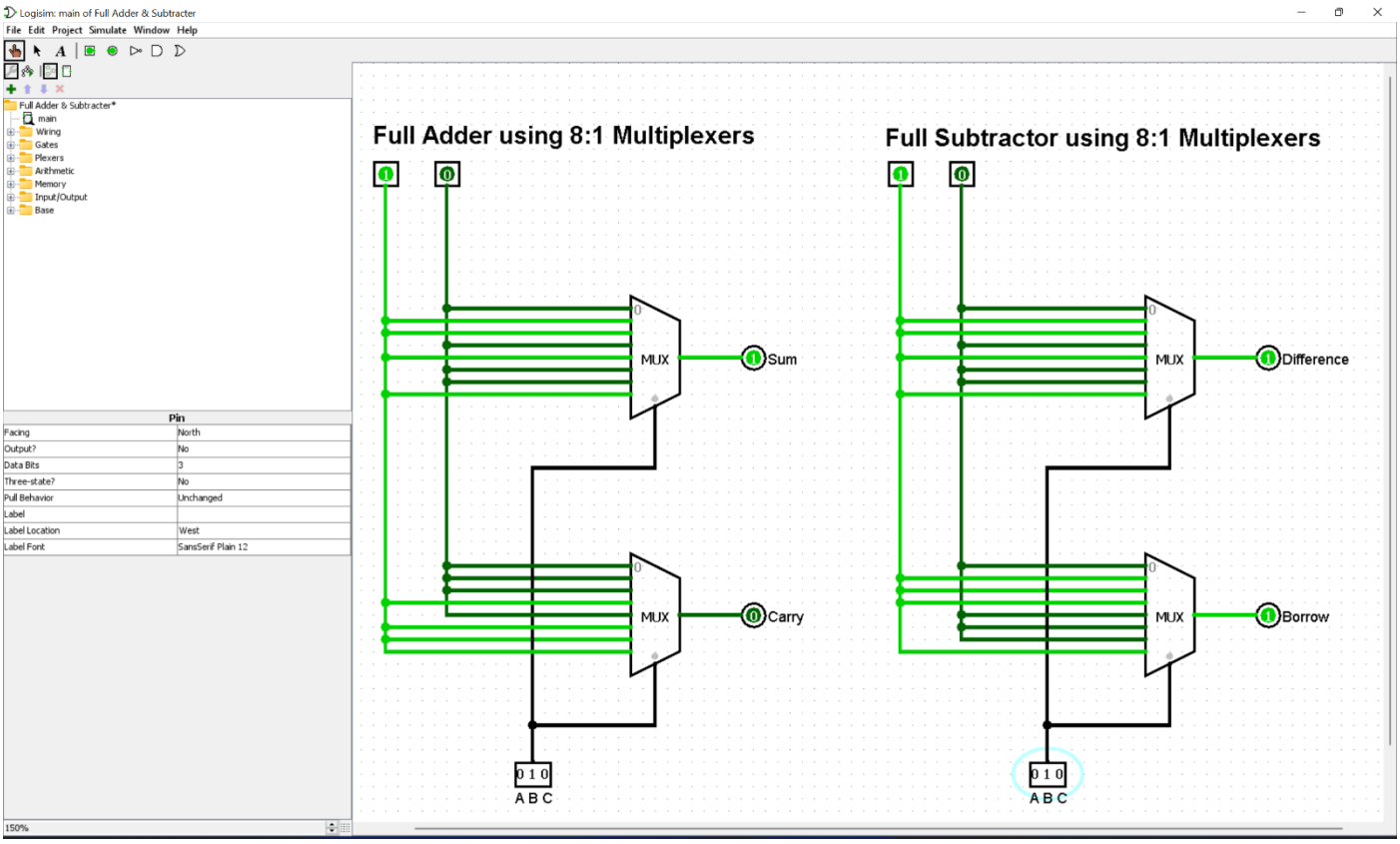
### When A = 0, B = 0 and C = 1:




Full Adder: Sum = 1, Carry = 0

Full Subtracter: Difference = 1, Borrow = 1

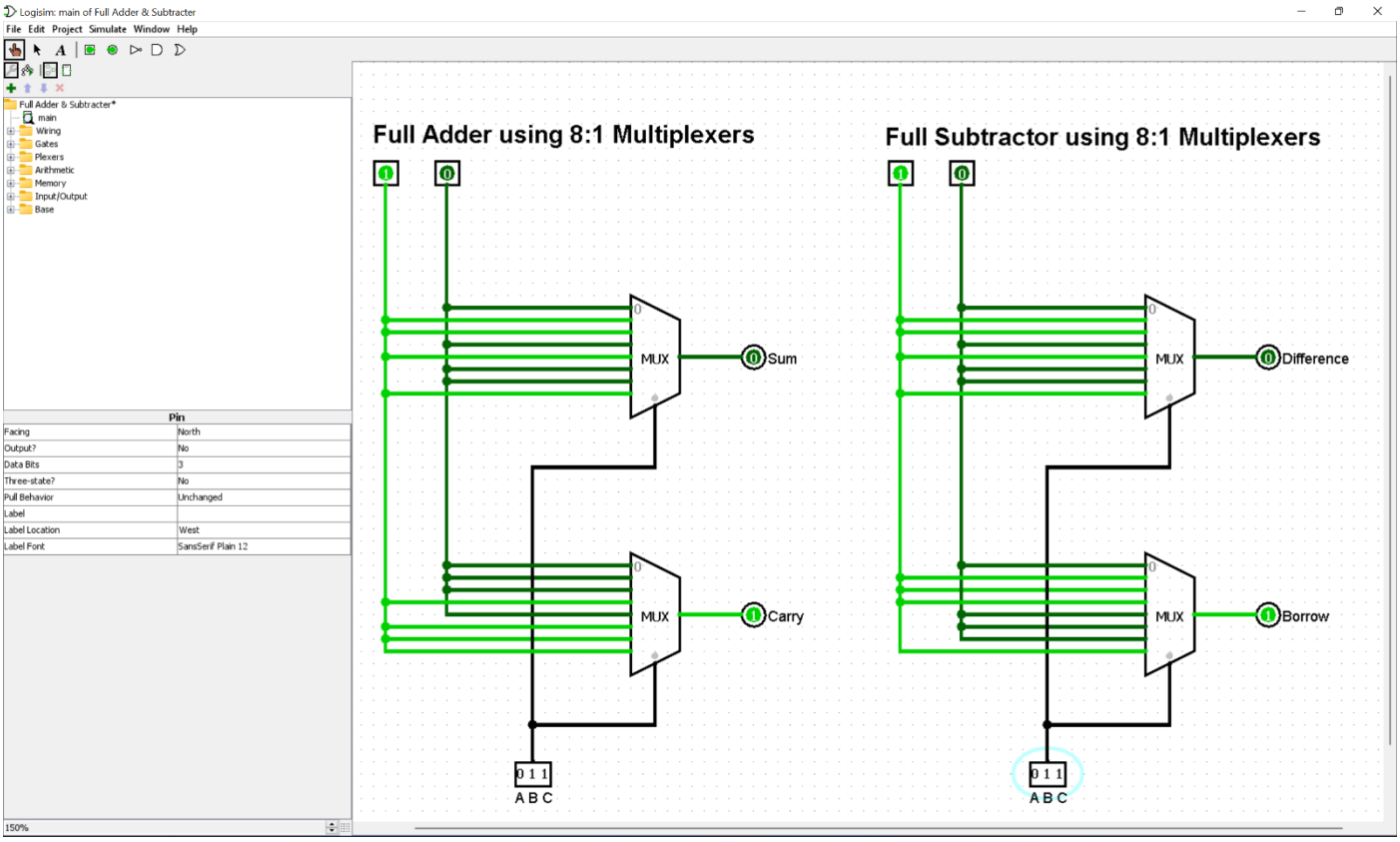
**When A = 0, B = 1 and C = 0:**




Full Adder: Sum = 1, Carry = 0

Full Subtracter: Difference = 1, Borrow = 1

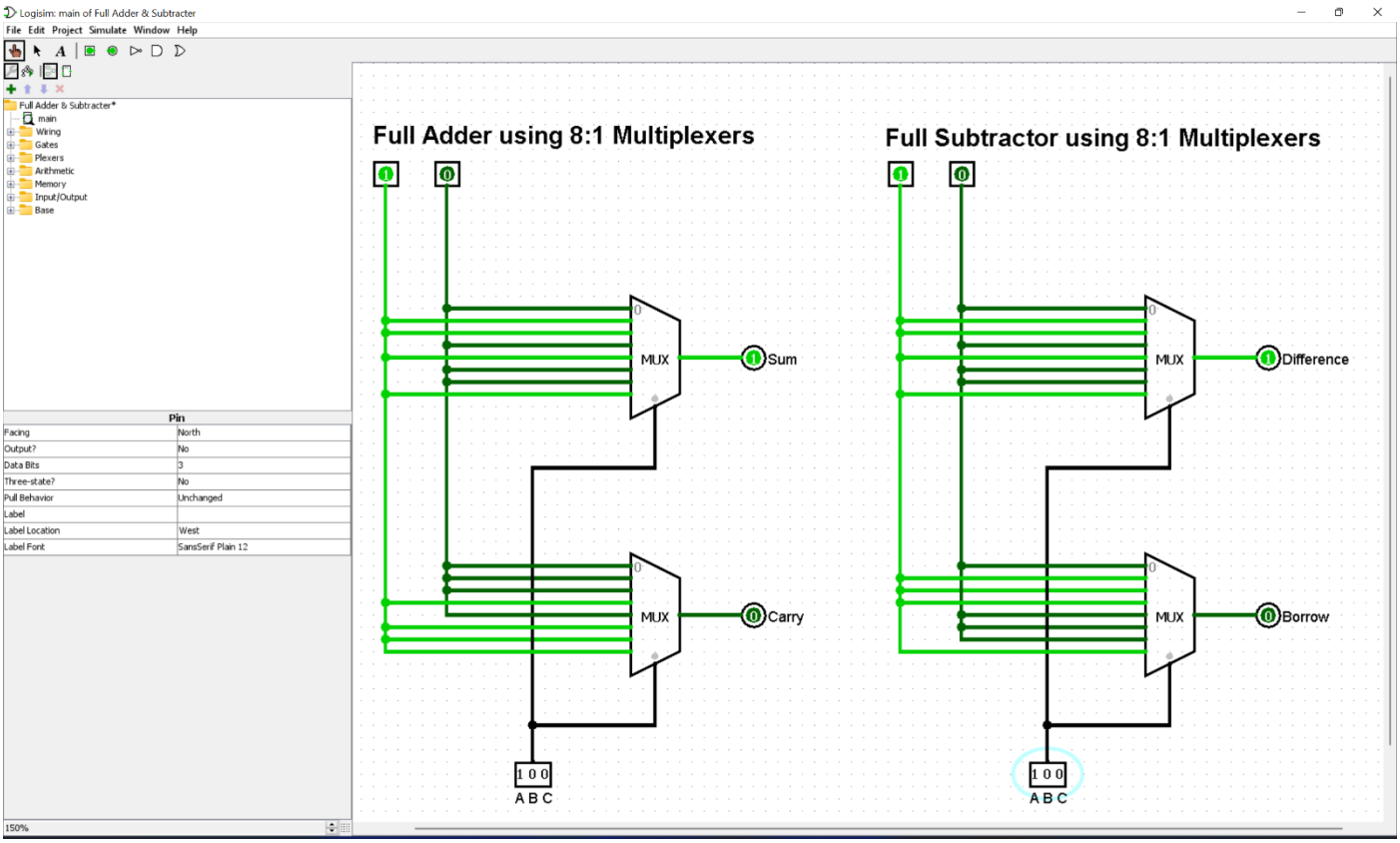
**When A = 0, B = 1 and C = 1:**




Full Adder: Sum = 0, Carry = 1

Full Subtracter: Difference = 0, Borrow = 1

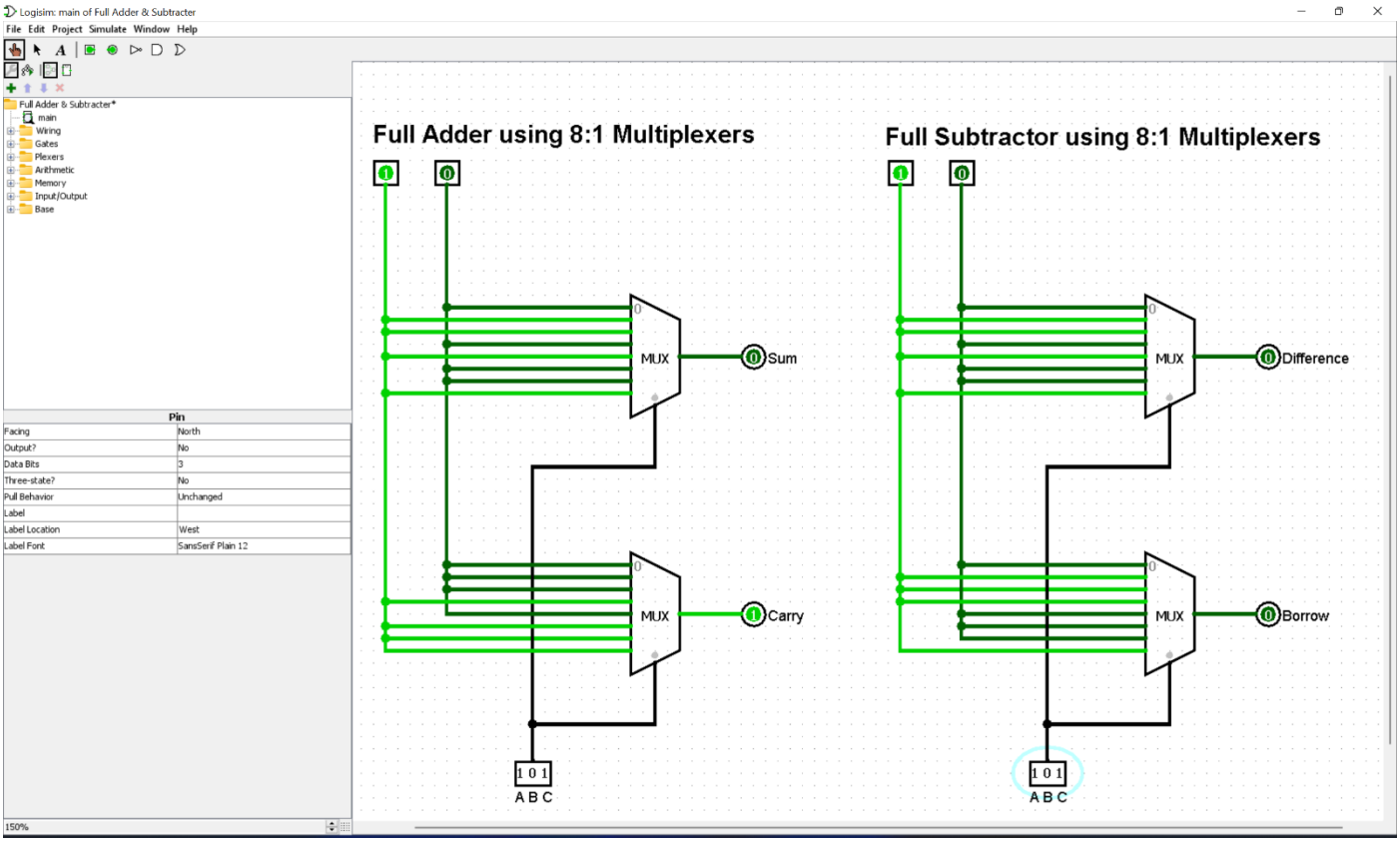
**When A = 1, B = 0 and C = 0:**




Full Adder: Sum = 1, Carry = 0

Full Subtracter: Difference = 1, Borrow = 0

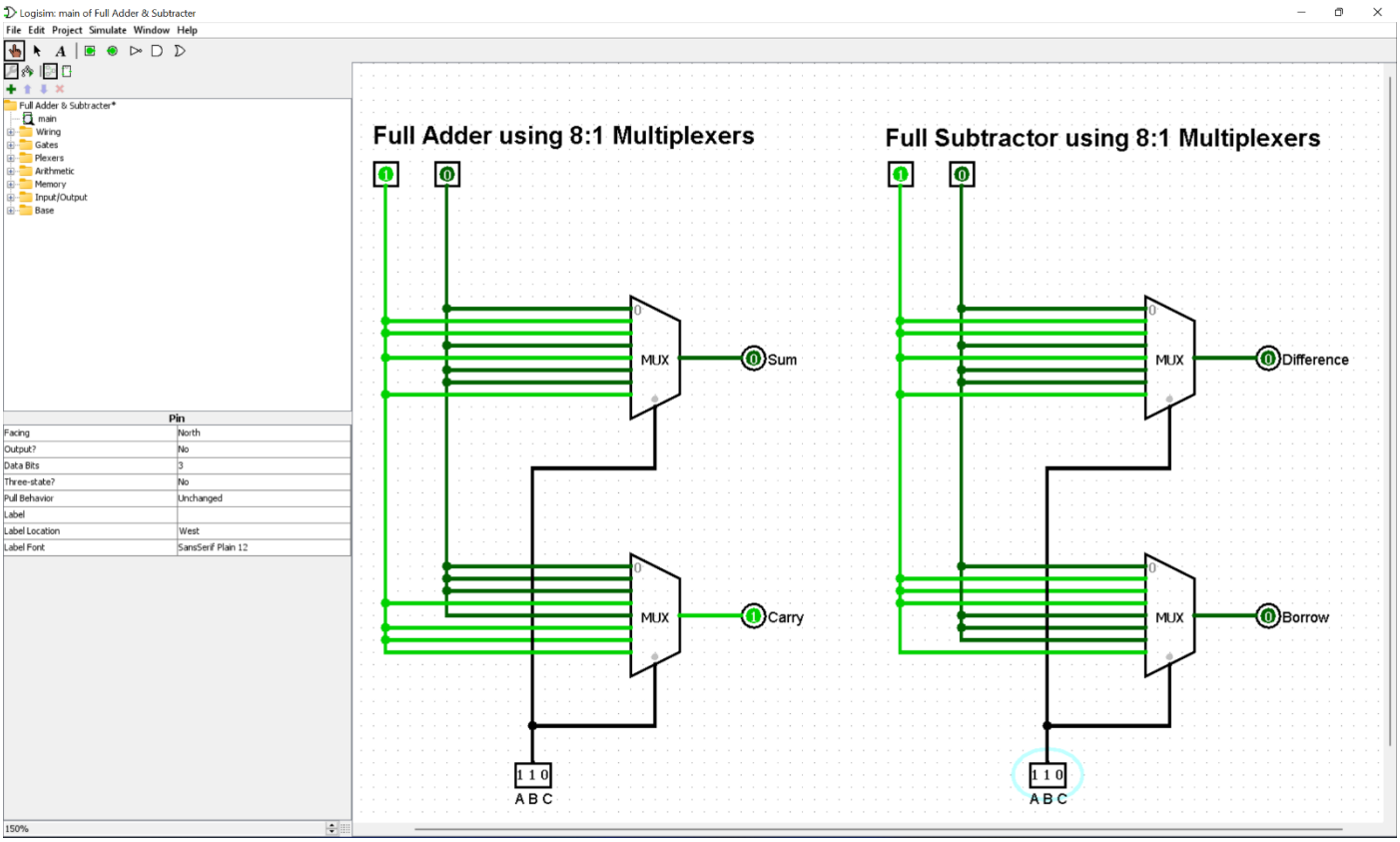
**When A = 1, B = 0 and C = 1:**




Full Adder: Sum = 0, Carry = 1

Full Subtracter: Difference = 0, Borrow = 0

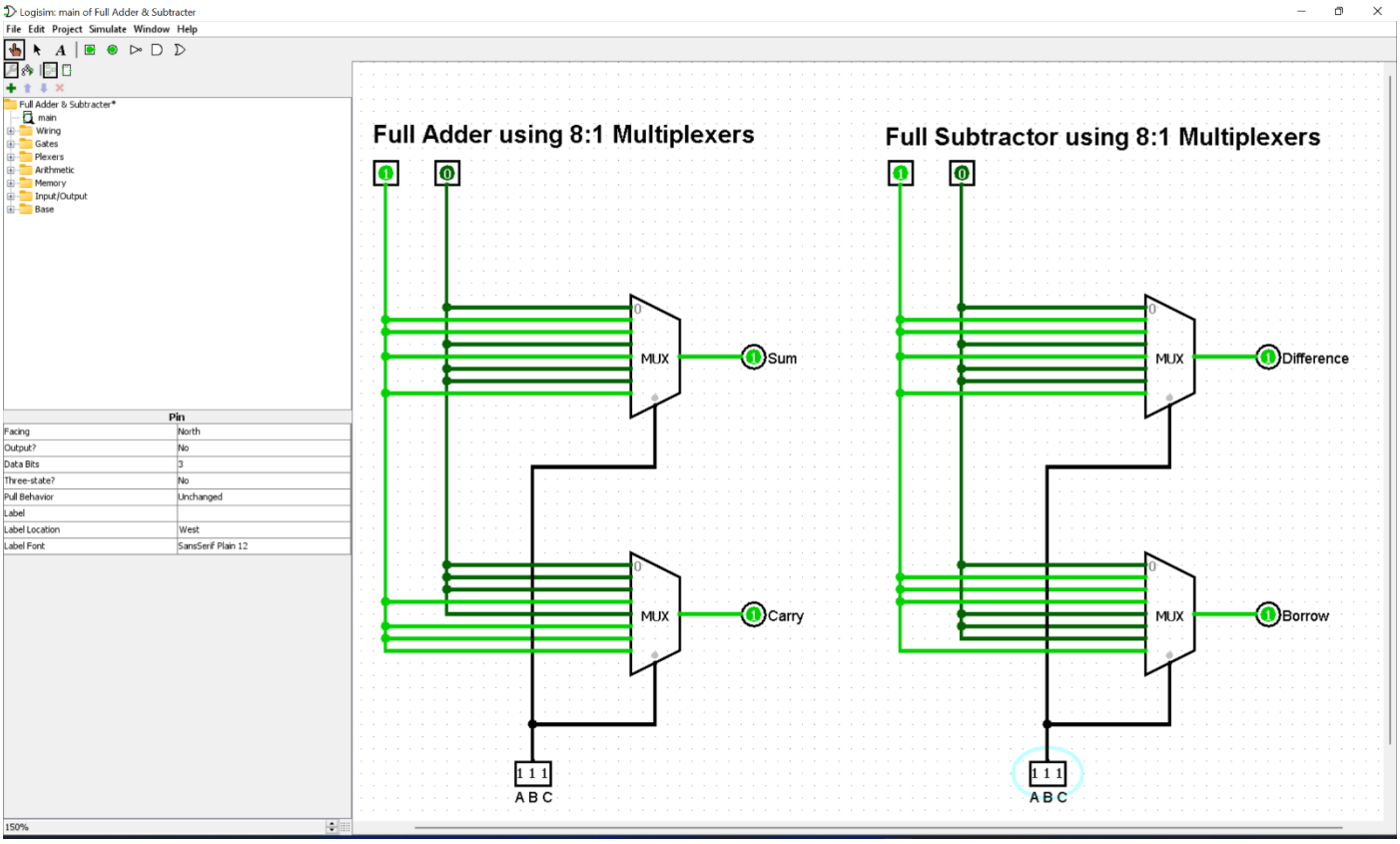
**When A = 1, B = 1 and C = 0:**




Full Adder: Sum = 0, Carry = 1

Full Subtracter: Difference = 0, Borrow = 0

**When A = 1, B = 1 and C = 1:**




Full Adder: Sum = 1, Carry = 1

Full Subtracter: Difference = 1, Borrow = 1