Project Report:

Design and Implementation of a 4-bit ALU

1. Introduction

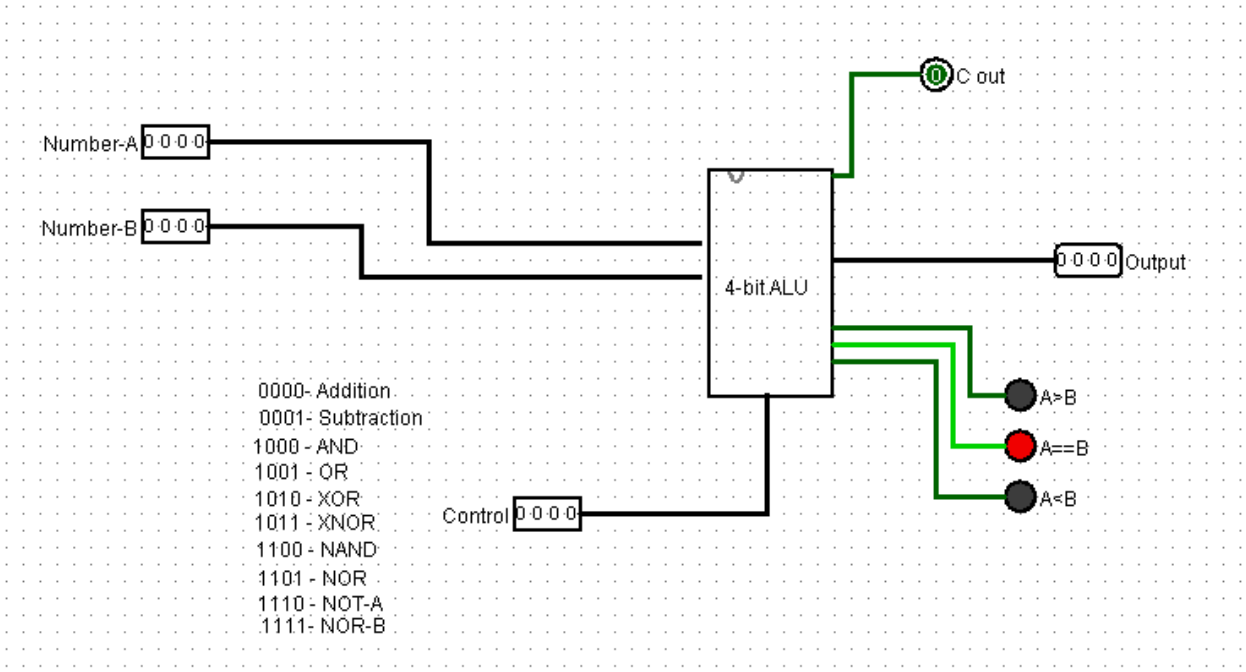
An **Arithmetic Logic Unit (ALU)** is a key part of a CPU that performs arithmetic and logical operations. This project involves designing and simulating a **4-bit ALU** in Logisim, supporting:

- **Arithmetic Operations:** Addition, Subtraction
- **Logical Operations:** AND, OR, XOR, NOT
- **Comparison Operations:** Equality, Greater Than, Less Than

2. ALU Design Overview

Key Components:
Input Registers (A, B) – Two 4-bit inputs
Control Unit – Decodes operation selection
Arithmetic Unit – Handles addition/subtraction
Logic Unit – Performs AND/OR/XOR/NOT
Comparison Unit – Checks A vs B
Multiplexer (MUX) – Selects output based on control signal

Block Diagram:

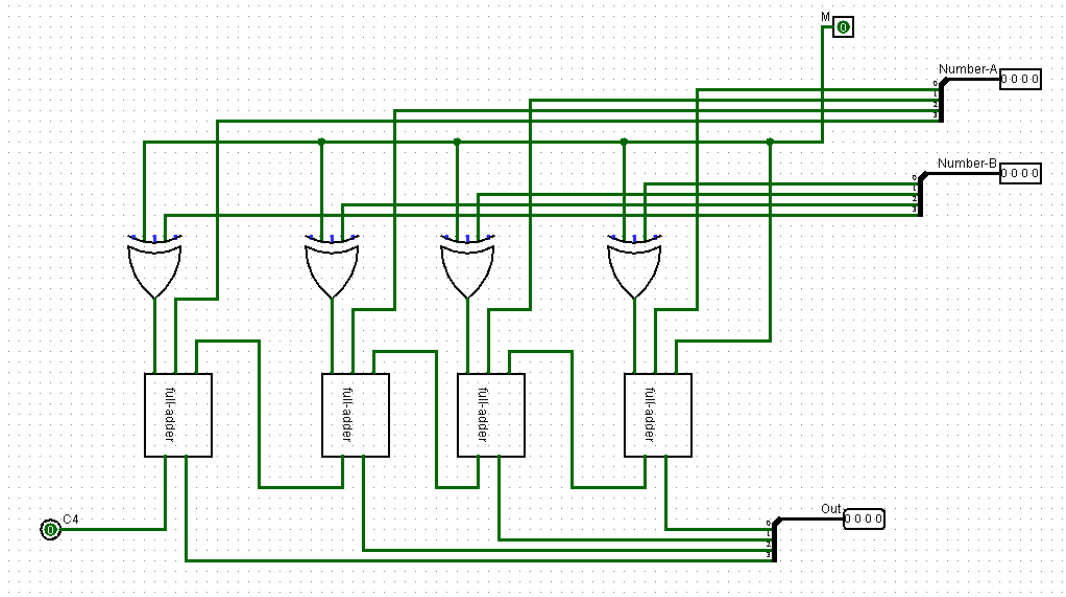


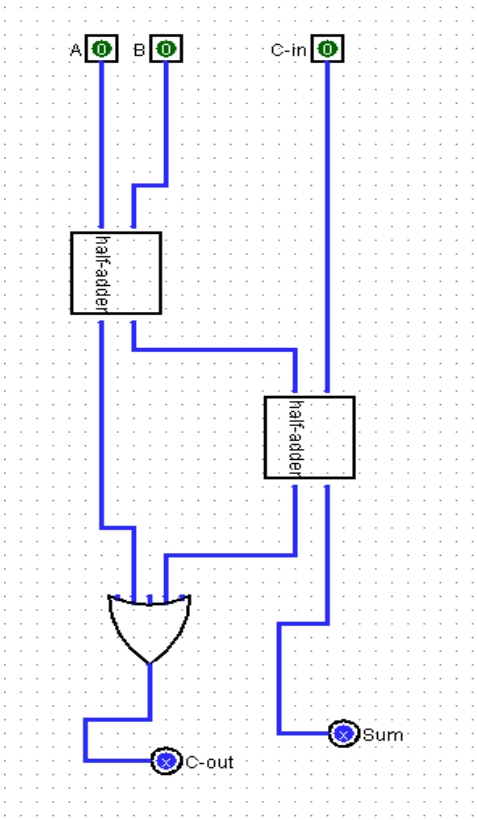
3. Functional Description

3.1 Arithmetic Operations

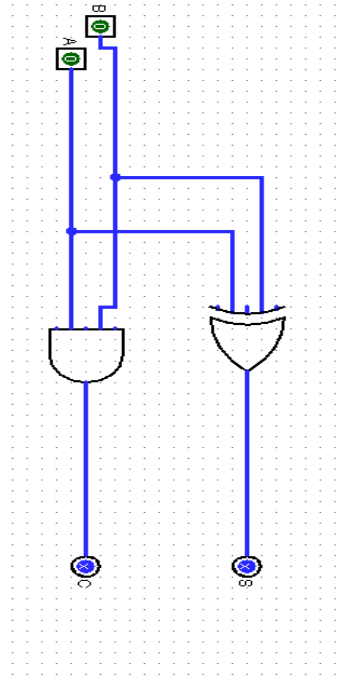
Addition (*A* + B): 4-bit ripple-carry adder

Subtraction (*A* - B): 2's complement method





Full- Adder

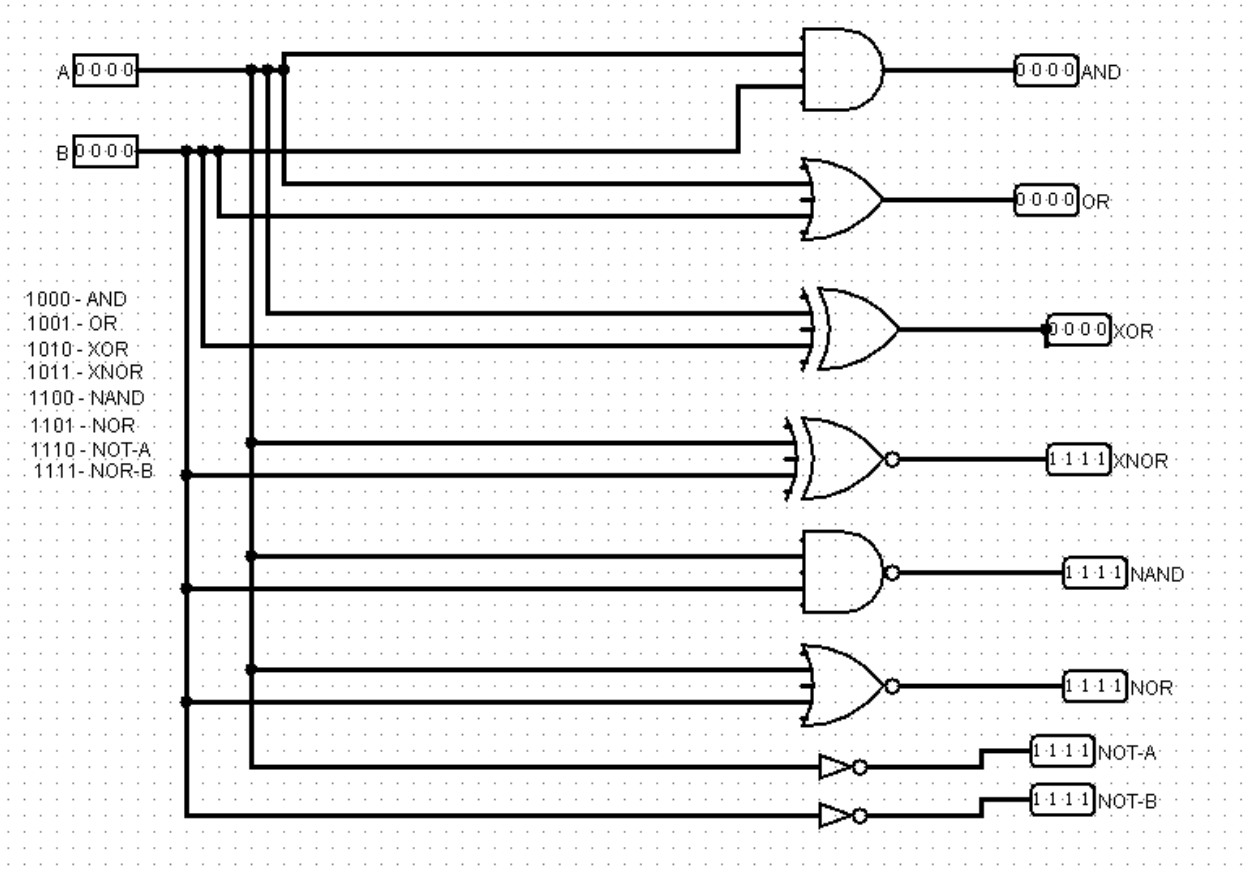


Half-Adder

3.2 Logical Operations

AND, OR, XOR: **Bitwise operations**

NOT: **Inverts input *A***

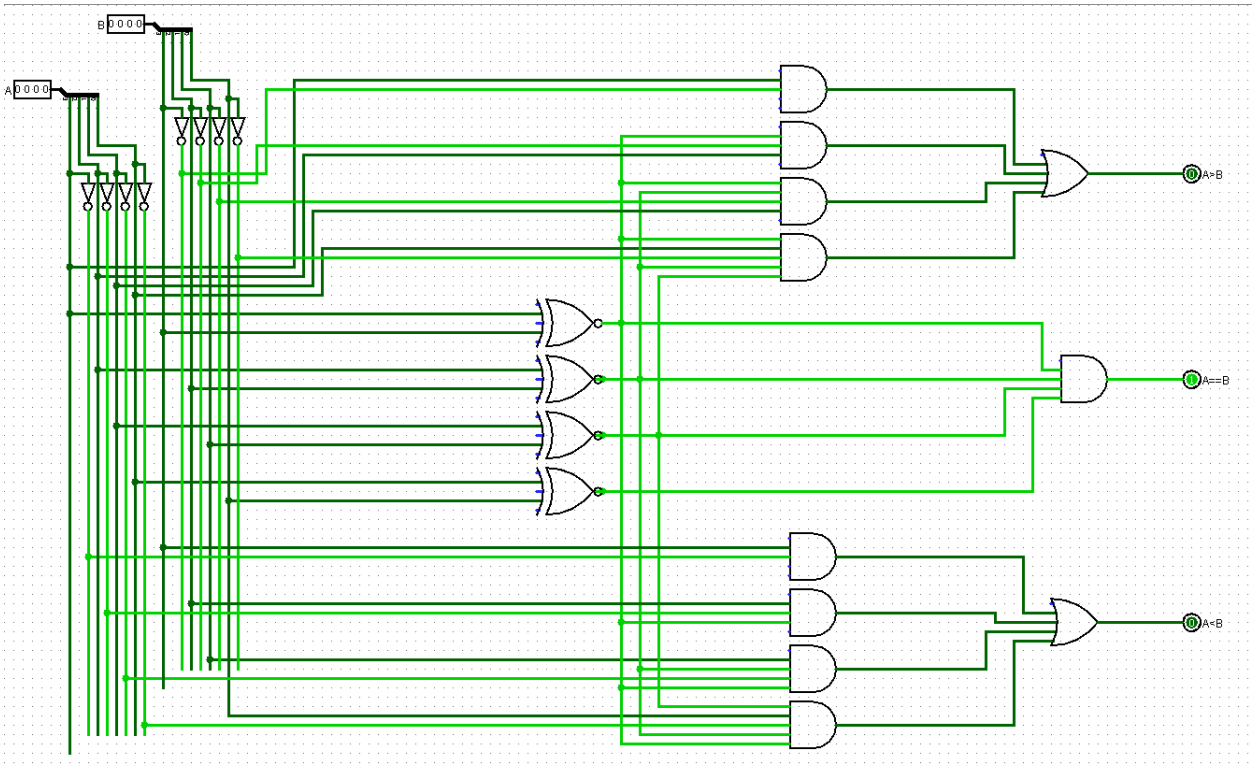


3.3 Comparison Operations

Equality (A == B): XOR gates check bits

Greater Than (A > B): Checks subtraction sign

Less Than (A < B): Opposite of Greater Than



4. Logisim Implementation

4.1 Control Signal Encoding

0000- Addition
0001- Subtraction
1000 - AND
1001 - OR
1010 - XOR
1011 - XNOR
1100 - NAND
1101 - NOR
1110 - NOT-A
1111- NOR-B

4.2 Circuit Components
Basic Logic Gates (AND, OR, XOR, NOT)
4-bit Adder/Subtractor
Multiplexers (MUX) for operation selection
Output LEDs/Displays

5. Simulation Results

A	B	Operation	Result	Pass?
0101	0011	ADD (0000)	1000 (8)	✔
0110	0010	SUB (0001)	0100 (4)	✔
1100	1010	AND (0010)	1000 (8)	✔
1100	1010	OR (0011)	1110 (14)	✔
1100	1010	XOR (0100)	0110 (6)	✔
1100	----	NOT (0101)	0011 (3)	✔
0101	0101	EQ (0110)	1 (True)	✔
0111	0011	GT (0111)	1 (True)	✔
0101	1011	LS (0000)	1 (True)	✔
—	1100	NOT (1001)	0011 (3)	✔
1100	1010	XOR (0100)	0110 (6)	✔

6. Conclusion

- Successfully designed a **4-bit ALU** in Logisim.
- Verified all operations via simulation.