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1.0 Objectives

The experiment is based on the “Boolean Addition” with full adders.
The objective of this experiment is to build gate based digital logic circuit of n-bit full adders and the outcome of this experiment is :

1.To know about the processing of n-bit Binary addition.
2.To know about Half Adder and Full Adder.
3.To know about how to build circuits with n-bit adders.

2.0 Components

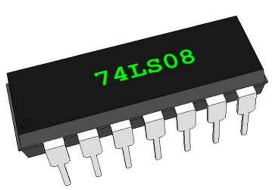
1. Logisim Software
2. IC 7408 [And Gate]
3. IC 7432 [OR Gate]
4. IC 7404 [Not Gate]
5. IC 74LS86 [X-OR Gate]

3.0 Theory

3.1 Logic Gates

3.1.1 AND Gate :

This gate is used for boolean multiplication and it has multiple inputs but only one output. Here,we can get the output ‘1’ when the value of inputs is ‘1’



Input	Input	Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

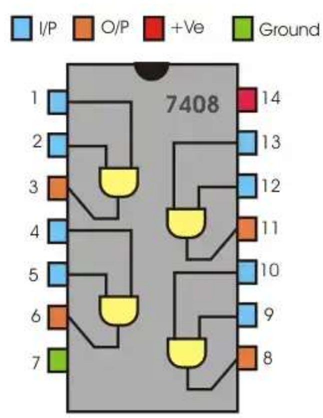
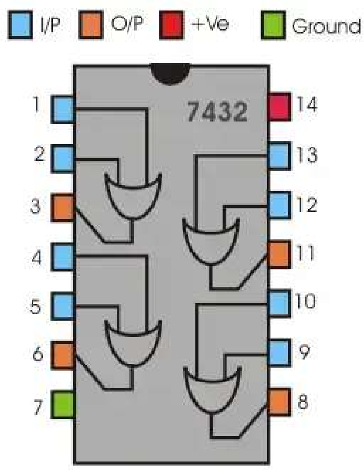
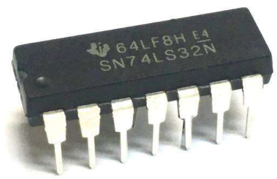


Figure 3.0.1: AND Gate circuit and its Truth Table

3.1.2 OR Gate :

This gate is used for boolean addition and it has multiple inputs but only one output. But here,we can get the output ‘1’ when the value of any input is ‘1’.





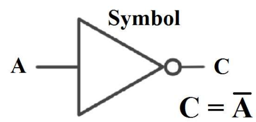
Inputs		Outputs
X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

Figure 3.0.2 : OR Gate circuit and its Truth Table

3.1.3 NOT Gate :

This gate is used for complement and it has only one input and only one output. Here,we can get the output ‘1’ when the value of the input is ‘0’ and vice versa.

NOT Gate



Truth Table

INPUT	OUTPUT
A	NOT A
0	1
1	0

Figure 3.0.3 : NOT Gate circuit and its Truth Table.

3.1.4 X-OR Gate :

This gate is based on NOT , AND & OR gates . Here, if the two inputs are equal then the output will be 0 and for other cases the output will be 1.

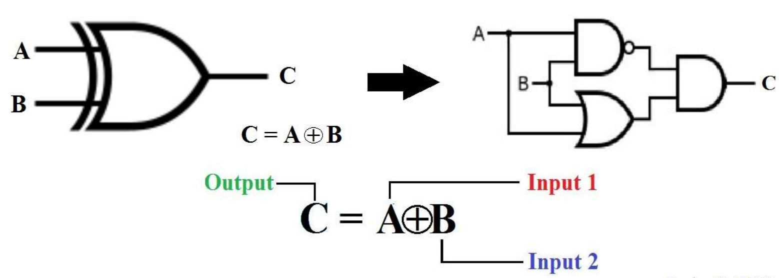


Figure 3.0.4: X-OR Gate circuit .

3.2 Arithmetic Adder

In digital electronics, an adder is used for arithmetic addition of binary numbers. It is an integrated logic circuit that takes two binary numbers, performs an addition operation on them, and produces the sum and carry out as output. The adder circuit can be designed to handle numbers of different sizes, such as 4-bit, 8-bit, or any other desired length.

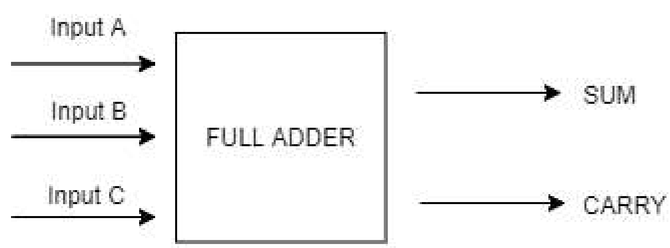


Figure 3.2.1: ADDER

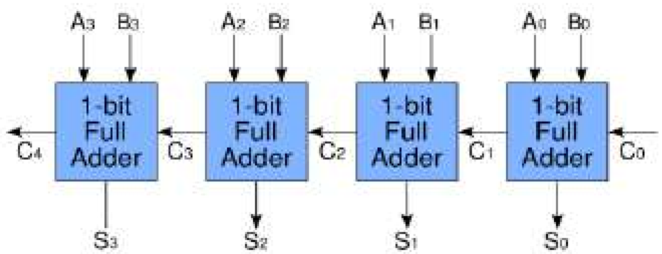
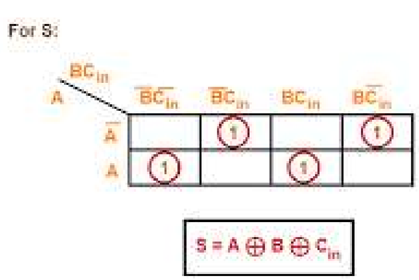
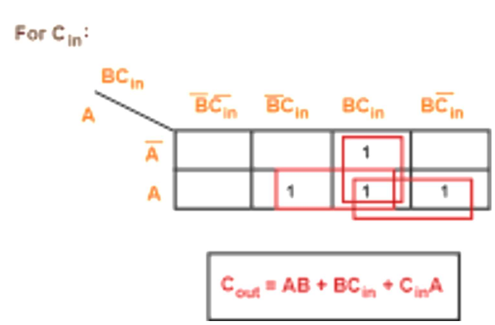


Figure 3.2.2: 4-BIT ADDER

The process of adding with a full adder involves combining two binary digits along with a carry input to produce the sum and the carry output. Here are the steps to perform addition using a full adder:

1. Obtain the two binary digits to be added, A and B. Additionally, have the carry input, Cin and initially the value of carry in will be 0.
2. The two input bits, A and B, are added together along with the carry input, Cin. The full adder circuit internally performs an XOR operation between A, B, and Cin to generate the sum bit.
3. Simultaneously, the full adder circuit performs an AND operation between A, B, and Cin to determine the carry output, Cout





4.0 Problem/Design Solve Procedure

Step-01: We found the simplified version of the sum of input A,B and Cin using K-Map
And the result of sum is ;

Sum = (A ⊕ B) ⊕ Cin

And the simplified version of Carry out is,

Cout = (AB + BC) + AC

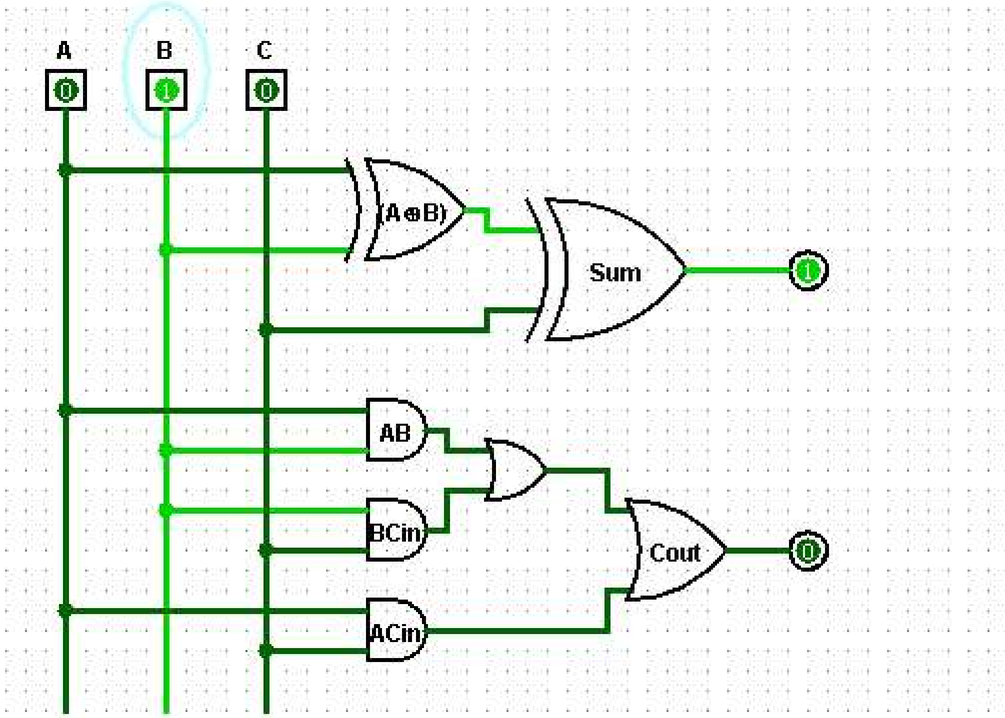
Now we have to build the truth table for input A,B,Cin and output of Sum and Cout.

A	B	C_{input}	Sum	C_{output}
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

Now we need to draw the circuit diagram in Logisim Software for this truth table and check the software generated truth table and my truth table to confirm that the circuit is perfect or not.

Step-02: Now we need to draw the circuit diagram of **1 bit Full Adder** in Logisim Software for this truth table

4.1: 1 bit Full Adder



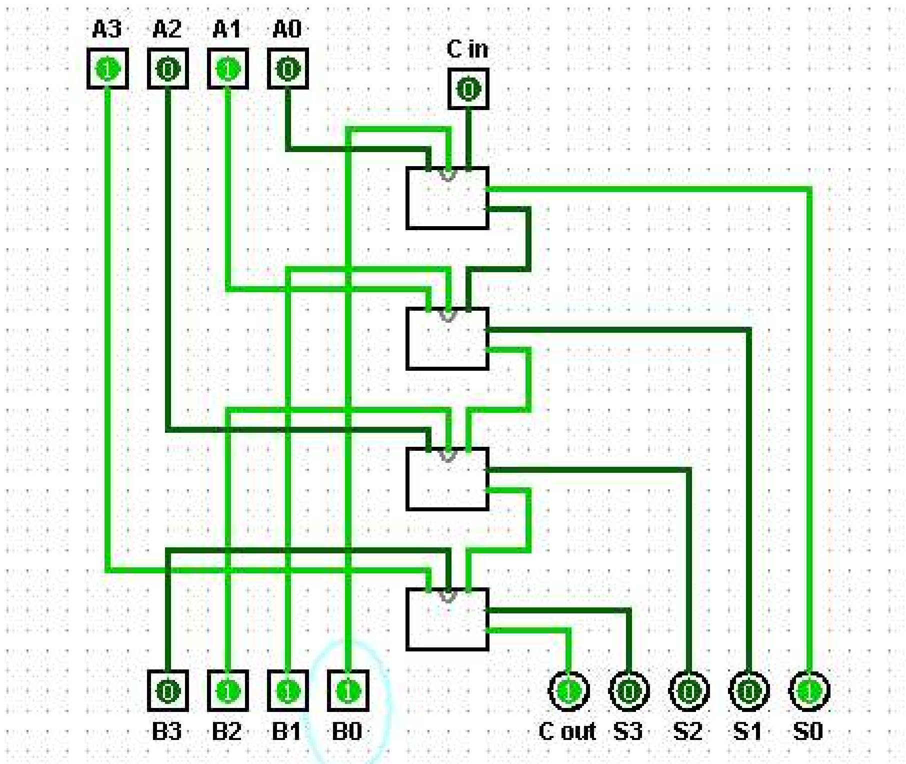
Step-03: Now we need to check the software generated truth table and my truth table to confirm that the circuit is perfect or not.

A	B	C	x	y
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

The Software generated truth table is equal to handmade truth table and it is confirmed that the circuit is perfect.

Step 04: Now we have to build the circuit for **4 1 bit Full Adder** using Logisim
Software.

4.2: 4 1 bit Full Adder



Here, we use four 1 bit full adders and inputs as A,B and Cin and outputs as Cout and Sum. As we make a 4 1 bit full adder that's why we need for inputs of A [A0,A1,A2,A3] and inputs of B [B0,B1,B2,B3] and a Carry input which initialize with 0.

In the first adder we use input as A0,B0 and Cin=0 and the output is Cout and S0.

In the second adder we use input as A1,B1 and Cin = Cout of 1st adder and the output is Cout and S1.

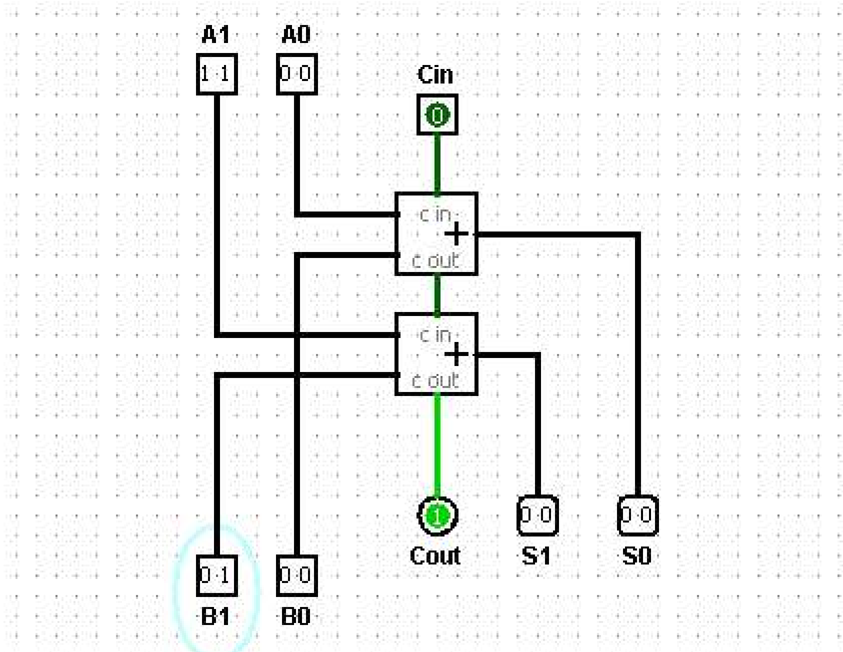
In the Third adder we use input as A2,B2 and Cin = Cout of 2nd adder and the output is Cout and S2.

In the forth adder we use input as A3,B3 and Cin = Cout of 3rd adder and the output is Cout and S3.

We use a poke tool to put the input values and we should input the values as MSB to LSB. After that we get the output and the MSB of output is Cout and then the values of sum and we should also consider them from MSB to LSB.

Step 05: Now we have to build the circuit for **2 2 bit Full Adder** using Logisim Software.

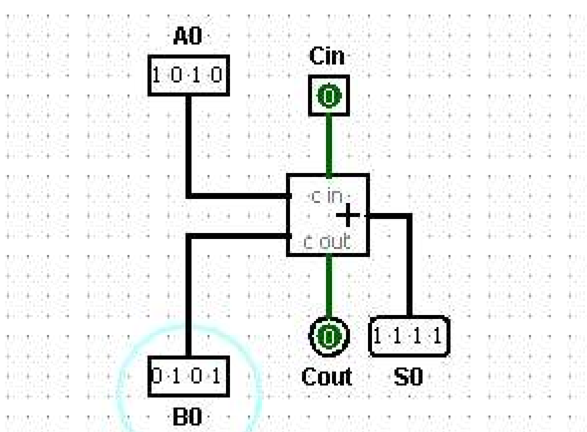
4.3: 2 2 bit Full Adder



The process of Input and output is same as 4 1 bit Full adder but the difference is here the input A and B are containing 2 bit inputs and Cin is initialized with 0 and in second step Cin is the Cout of the previous adder and we find the output also in 2 bits.

Step 06: Now we have to build the circuit for **1 4 bit Full Adder** using Logisim Software.

4.4: 1 4 bit Full Adder:



Here the adder contains 4 bit and the input A and B are containing 4 bit inputs and Cin is initialized with 0 and in the second step Cin is the Cout of the previous adder and we find the output also in 4 bits and the MSB of the output must be the value of Cout.

5.0 Discussion

5.1 What I learnt throughout this experiment

1. Learn about the processing of X-OR gate.
2. Learn about Half and Full Adder and their implementation.
3. Learn about how we can add binary numbers of n-bit using n-bit adders.

5.2 The problems I faced while experimenting

1. To find out the minimum pair from K-Map.
2. To absorb the concept of carry input and carry output.
3. To know the concept of n-bit adders.

5.3 How these circuits can be used in real life

Full adder is a combinational logic circuit which takes three inputs as 2 operands (A, B) an one carry in (Cin) and generates output as sum and carry out.

The advantage of the circuit is that it is easy to construct and it is used in various applications like multi bit adders, multipliers, arithmetic programmable state machines etc.

The disadvantage of full adder starts to appear when multiple full adder circuits are cascaded as the propagation delay increases so the next stages needs to wait for the carry in of previous stages for such applications the ripple carry look ahead adders are used in which the Carrie is calculated previously to the addition using a logic.