North South University

Department of Electrical & Computer Engineering

LAB REPORT

Course Name: **CSE332L- Computer Organization and Architecture Lab**

Experiment Number: 03

Experiment Name: **Design a 4-bit Binary Multiplier**

Experiment Date: 29 June, 2022

Report Submission Date: 5 July, 2022

Section: 02

Group Number: 01

Student Name: Md. Baker	Score
Student ID: **1911672642**	
Remarks:	

Exp: Design a 4-bit Multiplier

Objectives:

- We have become familiarized with 4-bit Multiplier.
- We have understood the theory and implement the multiplication unit
- We have checked Multiplying bits and showed the sum outputs

Apparatus:

- ✓ 7408 AND IC
- ✓ 7483 or 74283 4-bit Adder IC
- ✓ Trainer Board
- ✓ Wires

Theory:

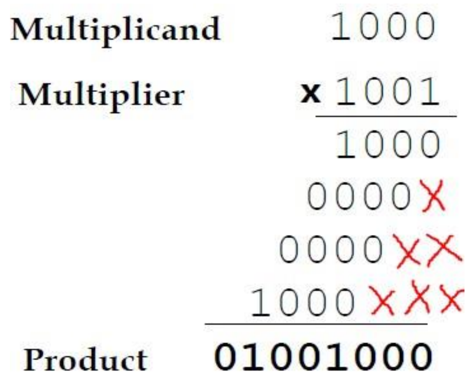
A binary multiplier is a combinational logic circuit or digital device used for multiplying two binary numbers. The two numbers are more specifically known as multiplicand and multiplier and the result is known as a product. The multiplicand & multiplier can be of various bit size. The product's bit size depends on the bit size of the multiplicand & multiplier. The bit size of the product is equal to the sum of the bit size of multiplier & multiplicand. Binary multiplication method is same as decimal multiplication. Binary multiplication of more than 1-bit numbers contains 2 steps. The 1st step is single bit-wise multiplication known as partial product and the 2nd step is adding all partial products into a single product. Partial products or single bit products can be obtained by using AND gates. However, to add these partial products we need full adders & half adders. The schematic design of a digital multiplier differs with bit size. The design becomes complex with the increase in bit size of the multiplier.

The design of a combinational multiplier to multiply two 4-bit binary number is illustrated below:

			A_3	A_2	A_1	A_0
			B_3	B_2	B_1	B_0
			$A_3 . B_0$	$A_2 . B_0$	$A_1 . B_0$	A0. B0
		$A_3 . B_1$	$A_2 . B_1$	$A_1 . B_1$	$A_0 . B_1$	
	$A_3 . B_2$	$A_2 . B_2$	$A_1 . B_2$	$A_0 . B_2$		
$A_3 . B_3$	$A_2 . B_3$	$A_1 . B_3$	$A_0 . B_3$			
S6	S5	S4	S3	S2	S1	S0

Binary Multiplication Procedure:

- ✓ **m x n** bits = **m + n** bit product
- ✓ **m + n** bits required to represent all possible products
- ✓ There are only two possibilities in every step
- ✓ If multiplier bit = 1
- ✓ copy multiplicand (1 x multiplicand)
- ✓ If multiplier bit = 0
- ✓ place 0 (0 x multiplicand)
- ✓ Need an adder unit to add



LOGIC CIRCUIT DIAGRAM

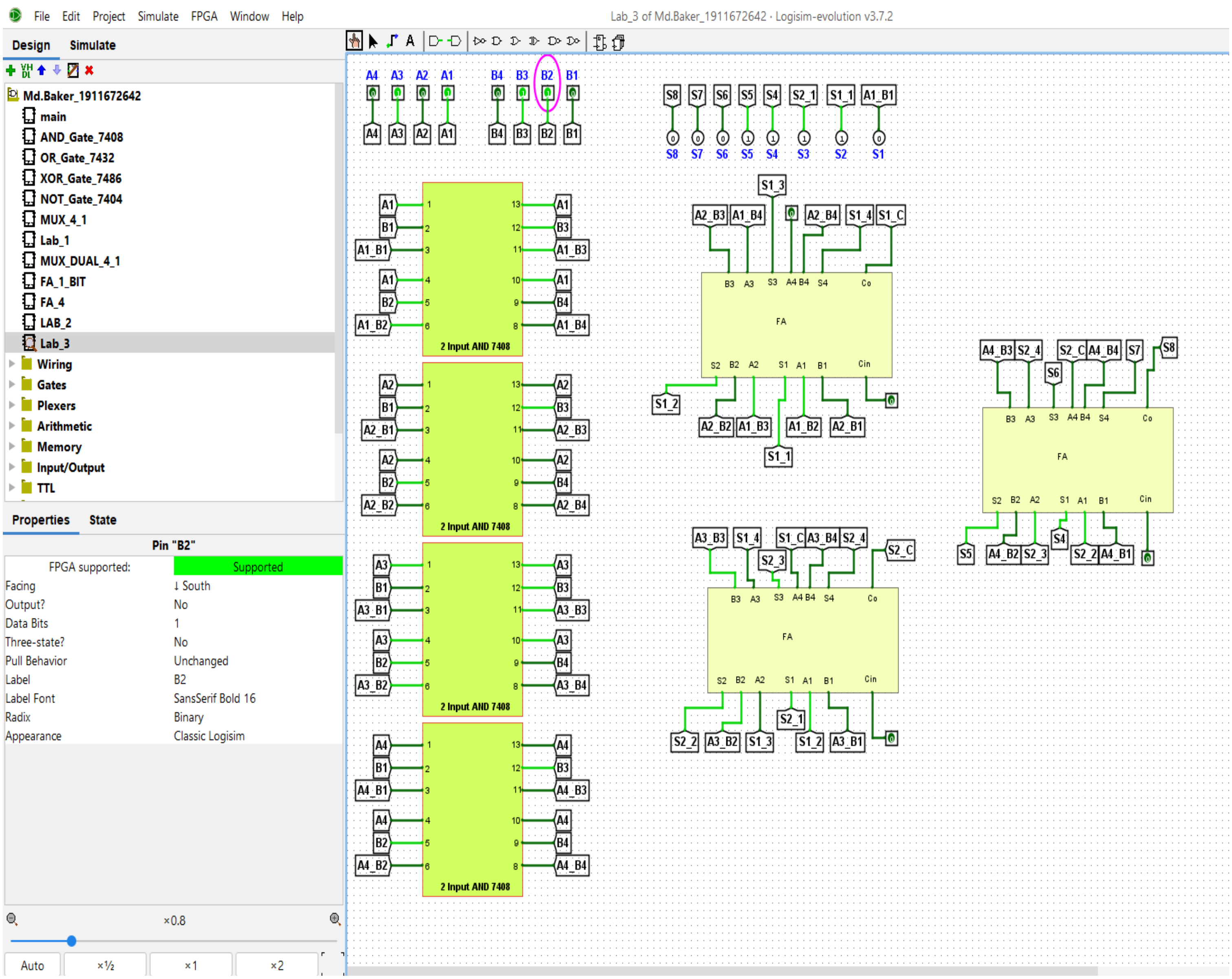


Fig: Design a 4-bit Multiplier

Data Table:1 Theoretical

Multiplicand A4 A3 A2 A1	**Multiplier** B4 B3 B2 B1	**Product** **S8 S7 S6 S5 S4 S3 S2 S1**	**Result in Decimal**
1 0 0 0	1 0 0 1	0 1 0 0 1 0 0 0	**8 × 9 = 72**
0 1 0 1	0 0 1 0	0 0 0 0 1 0 1 0	**5 × 2 = 10**
0 1 1 1	0 0 1 1	0 0 0 1 0 1 0 1	**7 × 3 = 21**
0 1 0 0	1 0 0 0	0 0 1 0 0 0 0 0	**4 × 8 = 32**
0 1 0 1	0 1 1 0	0 0 0 1 1 1 1 0	**5 × 6 = 30**
1 0 0 1	0 1 0 0	0 0 1 0 0 1 0 0	**9 × 4 = 36**
1 1 1 1	1 0 1 1	1 0 1 0 0 1 0 1	**15 × 11 = 165**

Data Table:2 Experimental

Multiplicand A4 A3 A2 A1	**Multiplier** B4 B3 B2 B1	**Product** **S8 S7 S6 S5 S4 S3 S2 S1**	**Result in Decimal**
1 0 0 0	1 0 0 1	0 1 0 0 1 0 0 0	**8 × 9 = 72**
0 1 0 1	0 0 1 0	0 0 0 0 1 0 1 0	**5 × 2 = 10**
0 1 1 1	0 0 1 1	0 0 0 1 0 1 0 1	**7 × 3 = 21**
0 1 0 0	1 0 0 0	0 0 1 0 0 0 0 0	**4 × 8 = 32**
0 1 0 1	0 1 1 0	0 0 0 1 1 1 1 0	**5 × 6 = 30**
1 0 0 1	0 1 0 0	0 0 1 0 0 1 0 0	**9 × 4 = 36**
1 1 1 1	1 0 1 1	1 0 1 0 0 1 0 1	**15 × 11 = 165**

Discussion:

In our third lab class our goal was to design a 4-bit binary multiplication unit. A 4-bit binary multiplication unit was designed in Logisim.

We know for binary multiplication we need basic AND operation and binary addition. As we are constructing 4-bit multiplier we have used four 2 input AND gate and three 4-bit full adder. In this multiplication operation if the multiplier bit is high or 1 then output will be shifted copy of the multiplicand. On the other hand, if multiplier bit is 0 then the result will be also 0.

For this experiment, we used 4 And IC and 3 4-bit Adder IC to build the circuit. In the circuit we have 4-bit two inputs A (A1, A2, A3, A4), B (B1, B2, B3, B4). First, we did AND operation to all the B inputs with A1 and rest 3 result into 4-bit ADDER three inputs starting from LSB. In this ADDER. Then in next 4-bit inputs of ADDER- we did and operation to all the Bin put with A2. Then first output of ADDER to output pin S2. In next adder, first 4-bit input - rest 3 sum of last ADDER and Cout starting from LSB to MSB. And in next 4-bit input of 4-bit ADDER- we have to do AND operation to all the B inputs with A3. In this ADDER first sum connected as output like S3.
In the last ADDER first 4-bit input - rest 3 sum of last ADDER and Cout starting from LSB to MSB and in next 4-bit input of 4-bit ADDER- we have to do AND operation to all the B inputs with A4. And connect all the output as S4, S5, S6, S7, S8 sequentially of ADDER all sum outputs.

Data testing: In data testing - First 4-bit input of multiplier and next 4-bit input of multiplicand. Then we will see the result in S[marked] output.
For example:
$8 \times 9 = 72$
Here
Multiplier: 8 = 1000
Multiplicand: 9 = 1001
In A input :1000
In B input :1001
And the output like= 01001000 (result)