Digital Logic Design

(EL-1005)

LABORATORY MANUAL

SPRING 2024

LAB 08

Binary Multiplier

Instructor: Engr. Misbah Malik

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STUDENT NAME ROLL NO SEC

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FACULTY'S SIGNATURE & DATE

MARKS AWARDED: /02

NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES (FAST-NUCES), KARACHI

Lab Session 08: Binary Multiplier

OBJECTIVES:

- To study the basic operation and design of multiplier circuits.
- To learn how to implement 2x2 bit multiplier circuit.
- To learn how to implement 3x3 bit multiplier circuit.

APPARATUS: Logic trainer, Logic probe

COMPONENTS: ICs 74LS02, 74LS00, ICs 74LS02, 74LS00, 74LS08, 74LS32, 74LS04, Logic Works

THEORY:

A multiplier is a combinational logic circuit that we use to multiply binary digits. Just like the adder and the subtractor, a multiplier is an arithmetic combinational logic circuit. It is also known as a binary multiplier or a digital multiplier.

Multiplication in binary Number system is similar to its decimal counterpart. Two numbers A and B can be multiplied by partial products: for each digit in B, the product of that digit in A is calculated and written on a new line, shifted leftward so that its rightmost digit lines up with the digit in B that was used. The sum of all these partial products gives the final result. Since there are only two digits in binary, there are only two possible outcomes of each partial multiplication:

- If the digit in B is 0, the partial product is also 0.
- If the digit in B is 1, the partial product is equal to A.

For example, the binary numbers **1011** and **1010** are multiplied as follows:

- The AND gates produce the partial products.
- For a 2-bit by 2-bit multiplier, we can just use two half adders to sum the partial products. In general, though, we'll need full adders.
- Here C3 -C0 are the product, not carries.

How does binary multiplication work and how to design a 2-bit multiplier?

Binary multiplication works just like normal multiplication. There are four main rules that are quite simple to understand:

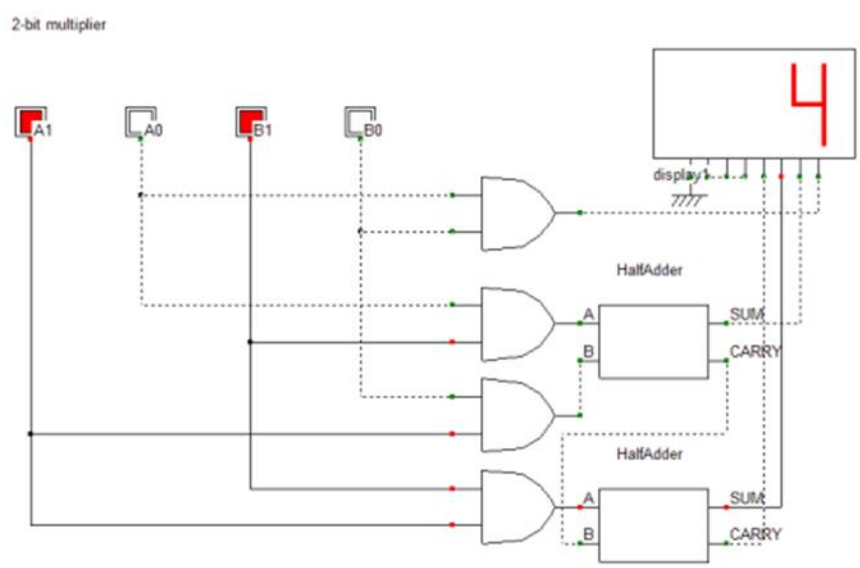
0 x 0 = 0
0 x 1 = 0
1 x 0 = 0
1 x 1 = 1

Suppose you have two binary digits A1A0 and B1B0, here's how that multiplication would take place.

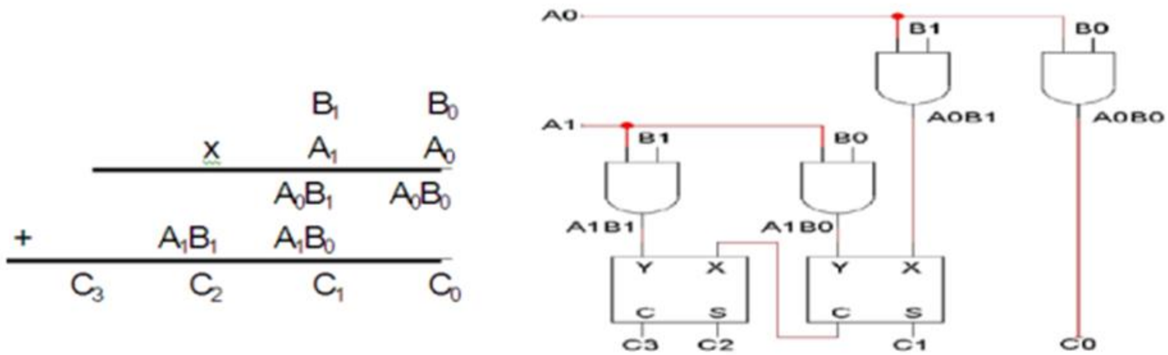
	A1	A0
	B1	B0
	A1B0	A0B0
A1B1	A0B1	X
A1B1+C	A0B1+A1B0	A0B0

As the number of bits increases, we keep shifting each successive partial product to the left by 1 bit. In the end, we add the digits while keeping in mind the carry that might generate.

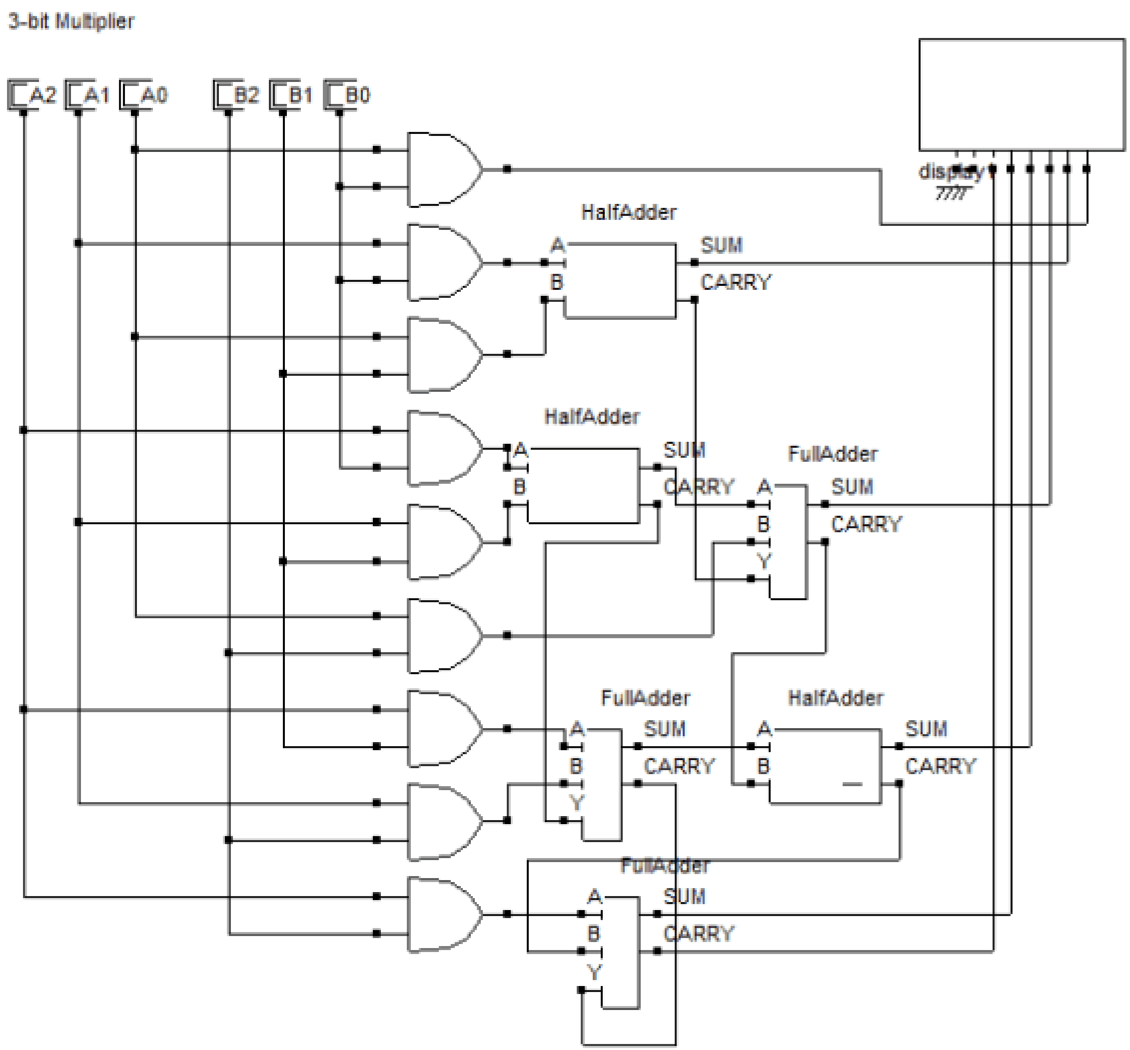
Based on the above equation, we can see that we need four AND gates and two half adders to design the combinational circuit for the multiplier. The AND gates will perform the multiplication, and the half adders will add the partial product terms. Hence the circuit obtained is as follows.



A 2x2 Binary Multiplier

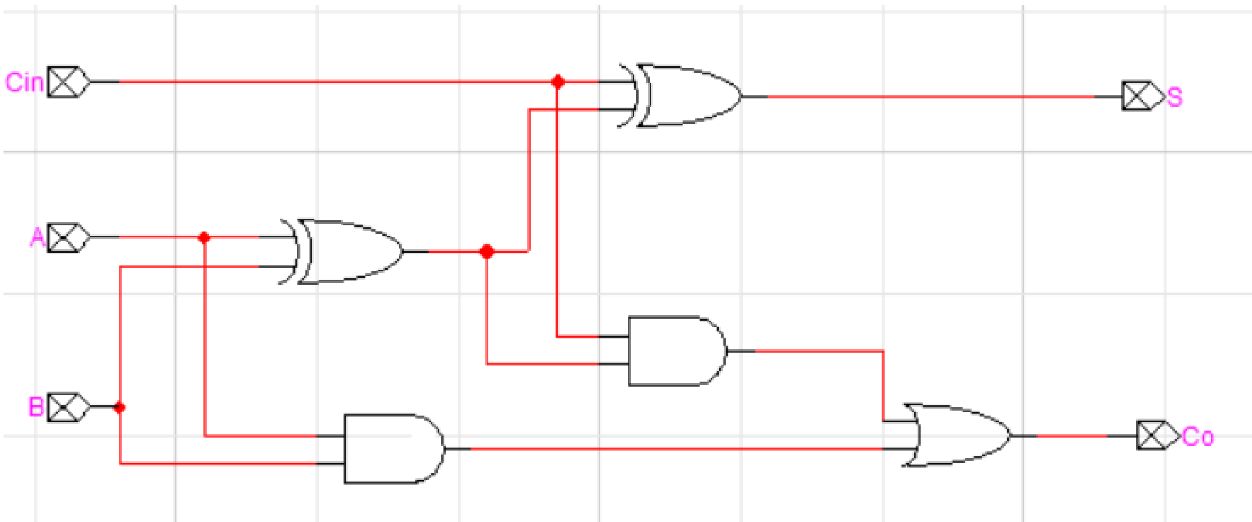


A 3x3 Binary Multiplier



STEPS TO ADD YOUR OWN SUBPARTS & LIBRARIES.

1. First build a full adder circuit.



2. Create a new symbol: File → New → Device Symbol
3. Indicate subcircuit: Options → Subcircuit and Part Type
4. Select 'Create a subcircuit symbol and select an open circuit to attach to it'
5. Select 'FullAdder.cct' or the circuit file in which you have implemented full adder, press 'ok'and 'done'.
6. Automatically generate a symbol: Options → Auto Create Symbol
7. Change part name, and pin locations if you want. Press 'Generate Symbol'.
8. Save the symbol to a library. You can create a new library at this time.

LAB TASKS

Name ________________________________ Student ID _______________ Section _________

Exercise # 1

Design 2*2 Bit Binary Multiplier Circuit in Logic Works, write truth table.

Exercise # 2

Design 3*3 Bit Binary Multiplier Circuit in Logic Works.