Binary multiplier

Prerequisites

For this assignment it is expected that you are familiar with your protoboard, how to create a logic circuit with SN7400 chips and to interconnect the gates. You should also understand the basic operation of binary addition with half and full adders.

Background information

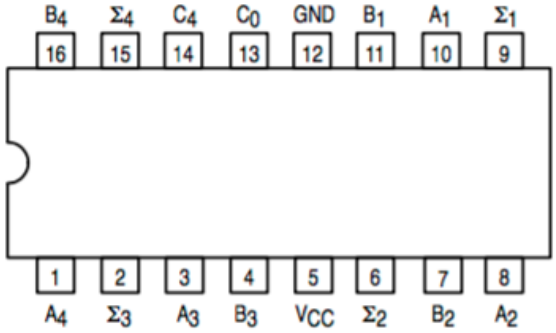
In a computer system, there are many arithmetic functions that take place. Like decimal, most of these can be implemented in the binary system. These can, in turn, be programmed or hardwired. The former may require less hardware but be slower. The latter is usually faster. There is an extra thought with regards to hardware: that sometimes we can implement a function in combinational logic or as a sequential solution using storage elements. Later in this course we will be looking at sequential solutions to problem solving but this assignment is to work with a combinational solution.

Objectives

The objectives of this assignment are to demonstrate the use of adder units to effect multiplication and to extend your skill level with MSI and SSI components on the protoboard.

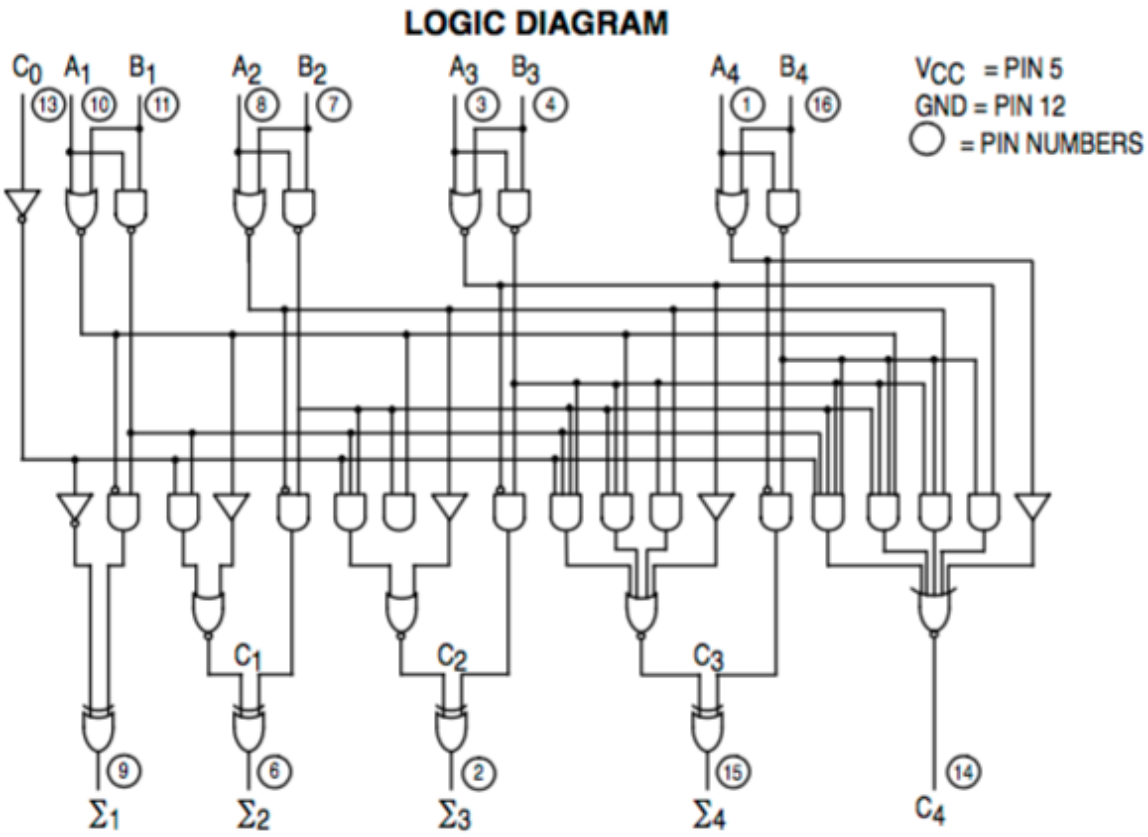
Specifications

Build, on your protoboard, the circuitry that will multiply a 4-bit binary number with a 3-bit binary number. The pin connections and logic circuit of a SN7483 4-bit adder chip are shown schematically below.



Pin connections for the SN7483 chip

$A_1 - A_4$	Operand A Inputs
$B_1 - B_4$	Operand B Inputs
C_0	Carry Input
$\Sigma_1 - \Sigma_4$	Sum Outputs
C_4	Carry Output



Internal gate implementation inside the 74LS83 chip

Theory

You have already had the theory behind this multiplication process in Module 9.1. This, now, is the realization of the procedure.

Procedure

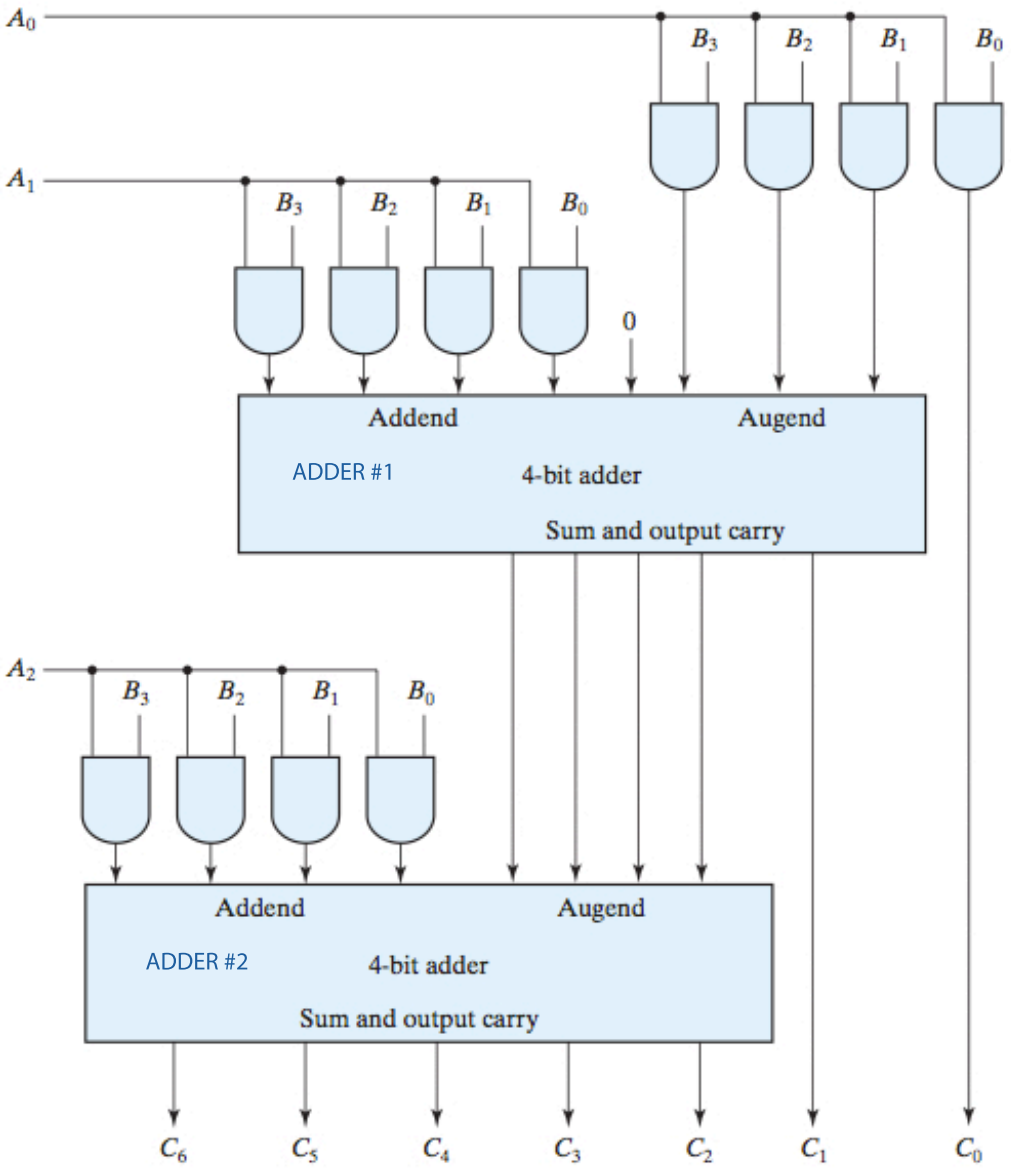
Implement your circuit to give the seven C values as shown in the diagram on page 3.

Testing

Since you have four (B3 to B0) inputs multiplied by three (A2 to A0) values you have the possibility of 16 x 8 tests. That should take you all week – just kidding. I do not expect you to test your circuit exhaustively. So you have to decide what values to choose to convince your boss that it is completely working. (Hint. He will expect some tests at the top, middle, and bottom of the number ranges.) Record your test results in a table such as indicated below.

A0A1A2 | B3B2B1B0 | ADDER #1 outputs including C1| C6C5C4C3C2C1C0

I am aware that you do not have enough LEDs etc to show 7 outputs. I suggest you connect the LEDs to the least significant outputs and use a flying lead or Logic Probe to indicate the others.

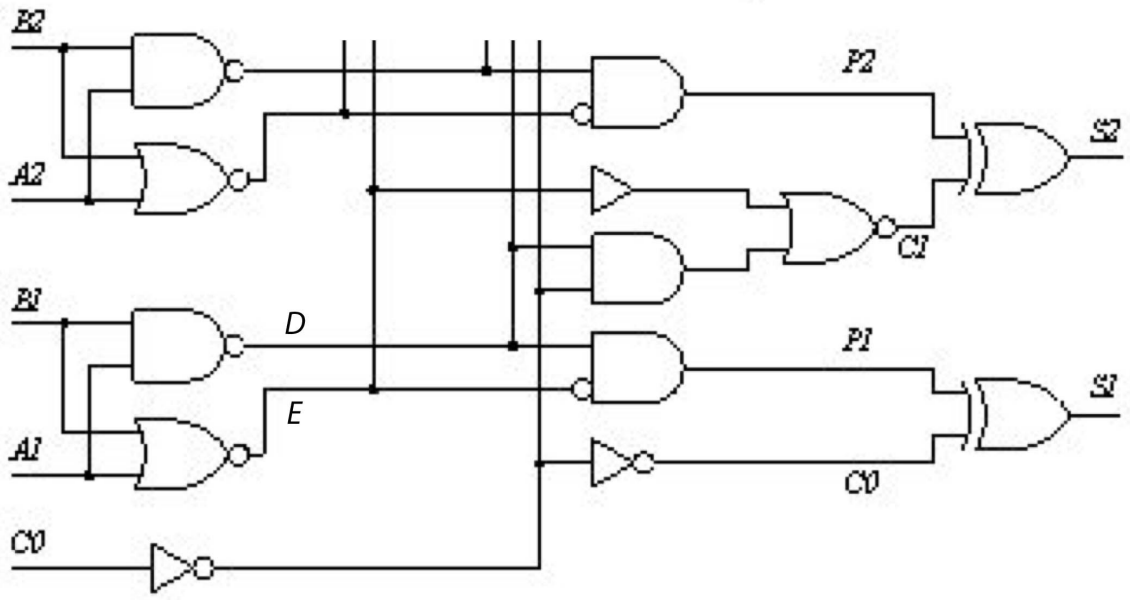


Deliverables

At the hardware assessment, you will be asked to show your circuit working correctly, explain the multiplication operation and demonstrate its working. Your test results are to be in your report which will include the following analysis.

SN7483 circuitry

Here is a section of the Texas Instrument device that covers the two least significant sections of the complete adder circuit on page 2 above. The inputs to be considered are C0, A1, and B1.



Create a truth table with the following headings. Complete it to determine the values of S1 (sum) and C1 (carry) for each of the 8 inputs states.

C0	A1	B1	D	E	P1	S1	(C0'.D)	C1

Question

If the logic gates have a propagation delay of about 10ns each, how long do you think it will take to complete a multiplication with this type of circuit?

Note

If you have a SN74283 in your kit rather than the 7483 you will need to use the following chip pin connections. The logic diagram is still the same, only the pin connections are different.