CSEE223 Lab

Name: ___________________________

Adder Circuits

Date:_______________

Reading

Lecture on binary addition
Lecture on the Half Adder
Lecture on the Full Adder

Objectives

After performing this experiment, you will be able to construct and understand the operation of the half and full adder circuits..

Materials Needed

1 – 7486 (XOR)
1 – 7408 (AND)
1 – 7432 (OR)
5 – resistor 100Ω
1 – dip switch

Summary of Theory and Operation

An adder or summer is a digital circuit performs addition numbers. Adders are used not only in the computer's ALU, but also in other parts of the processor, where they are used to calculate addresses, table indices, and similar operations. The most common adders operate on binary numbers.

The **half adder** adds two single binary digits A and B. It has two outputs, sum (S) and carry (C). The carry signal represents an overflow into the next digit of a multi-digit addition. With the addition of an OR gate to combine their carry outputs, two half adders can be combined to make a full adder. The simplest half-adder design, pictured on the right, incorporates an XOR gate for S and an AND gate for C. With the addition of an OR gate to combine their carry outputs, two half adders can be combined to make a full adder.

A **full adder** adds binary numbers and accounts for values carried in as well as out. A one-bit full adder adds three one-bit numbers, often written as A, B, and C_{in}; A and B are the operands, and C_{in} is a bit carried in from the next less significant stage. The full-adder is usually a component in a cascade of adders, which add 8, 16, 32, etc. binary numbers. The circuit produces a two-bit output, output carry and sum typically represented by the signals C_{out} and S.
A full adder can be constructed from two half adders by connecting A and B to the input of one half adder, connecting the sum from that to an input to the second adder, connecting C_i to the other input and OR the two carry outputs. Equivalently, S could be made the three-bit XOR of A, B, and C_i, and C_{out} could be made the three-bit majority function A, B, and C_{in}.

Procedure

1. Using Multisim, construct the circuit below.

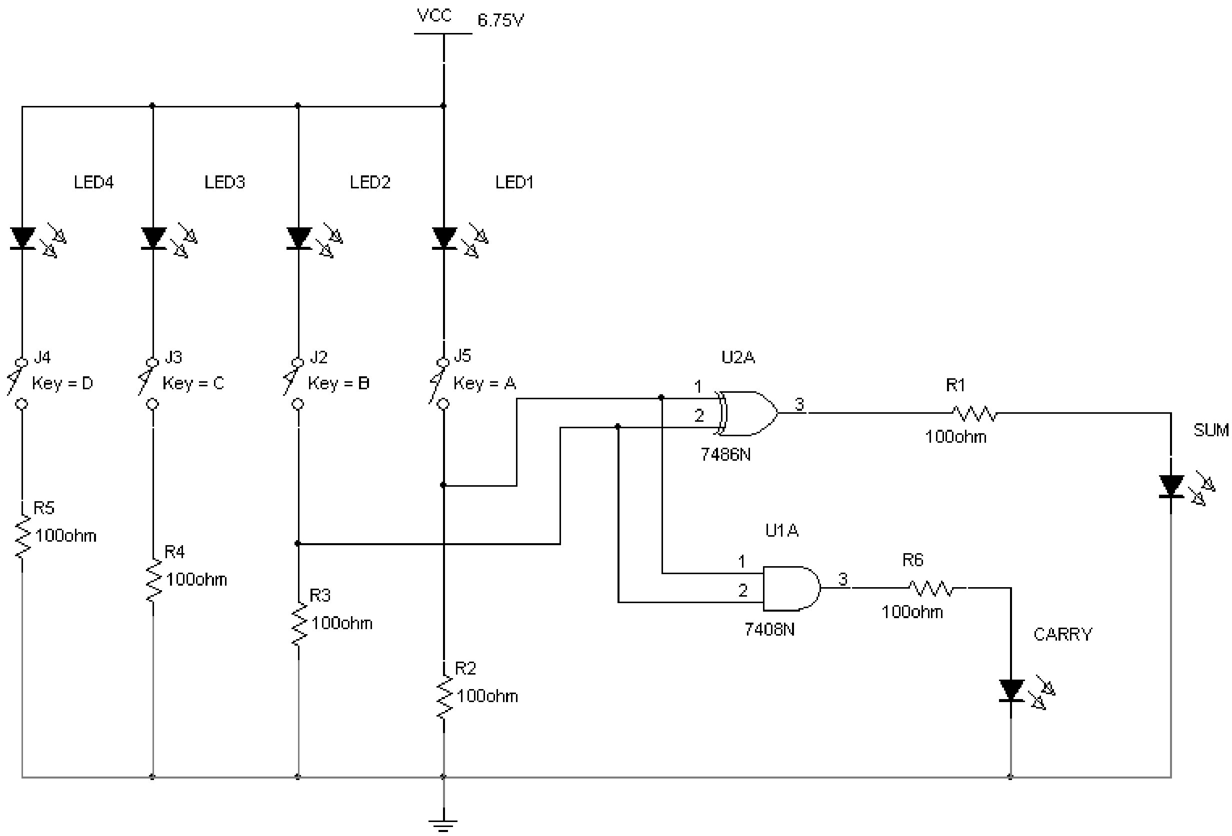


FIG 1

2. Validate the 2-bit Half Adder Truth Table.

Inputs		Outputs	
B	***A***	C_{out}	***S***
0	**0**		
0	**1**		
1	**0**		
1	**1**		

3. Demonstrate to instructor for signoff and credit.

Signoff: _________________

4. Using Multisim, construct the circuit below.

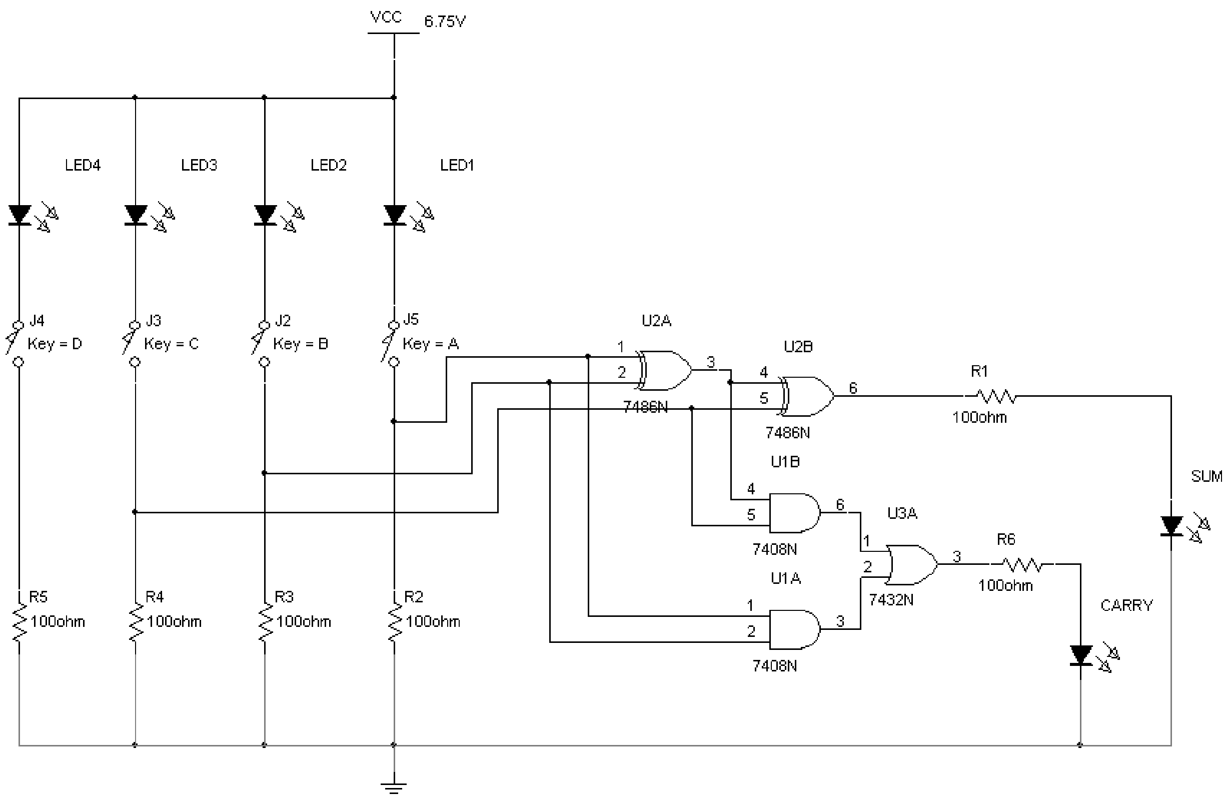


FIG 2

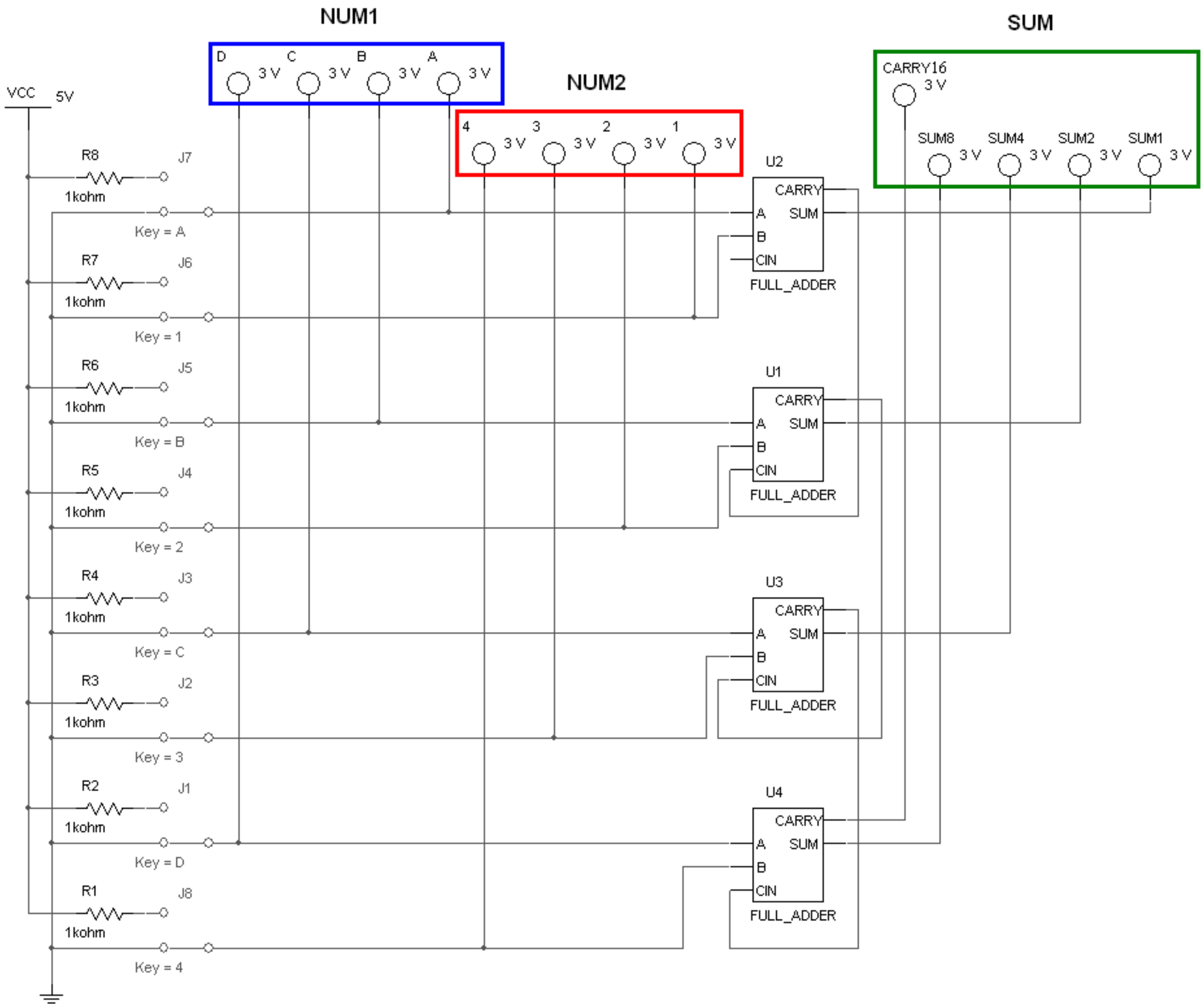
5. Validate the 2-bit Full Adder Truth Table.

Inputs			Outputs	
B	***A***	***C_{in}***	***C_{out}***	***S***
0	**0**	**0**		
0	**1**	**0**		
1	**0**	**0**		
1	**1**	**0**		
0	**0**	**1**		
0	**1**	**1**		
1	**0**	**1**		
1	**1**	**1**		

6. Demonstrate to instructor for signoff and credit.

Signoff: ___________________

7. Using Multisim, construct the 4-bit Adder circuit below. For the NUM1, NUM2, and SUM lamps located inside the rectangular areas, be sure to change the labels to the exact names specified below. Also configure the SPDT switches to the exact keys as specified below.



8. Demonstrate 2 decimal number addition.

NUM1					NUM2					SUM					
Dec	Binary				Dec	Binary				Carry 16	SUM8	SUM4	SUM2	SUM1	Dec Total
2					1										
4					3										
6					5										
8					7										
10					9										
12					11										
14					13										

Signoff: ___________________

Questions

1. Explain the how the half adder operates. (Hint: how does it add 2 binary digits?).

2. Explain the how the full adder operates. (Hint: how does it add 3 binary digits?).

3. What is the purpose of the Carry-In bit/digit?

4. What is the purpose of the Carry-Out bit/digit?