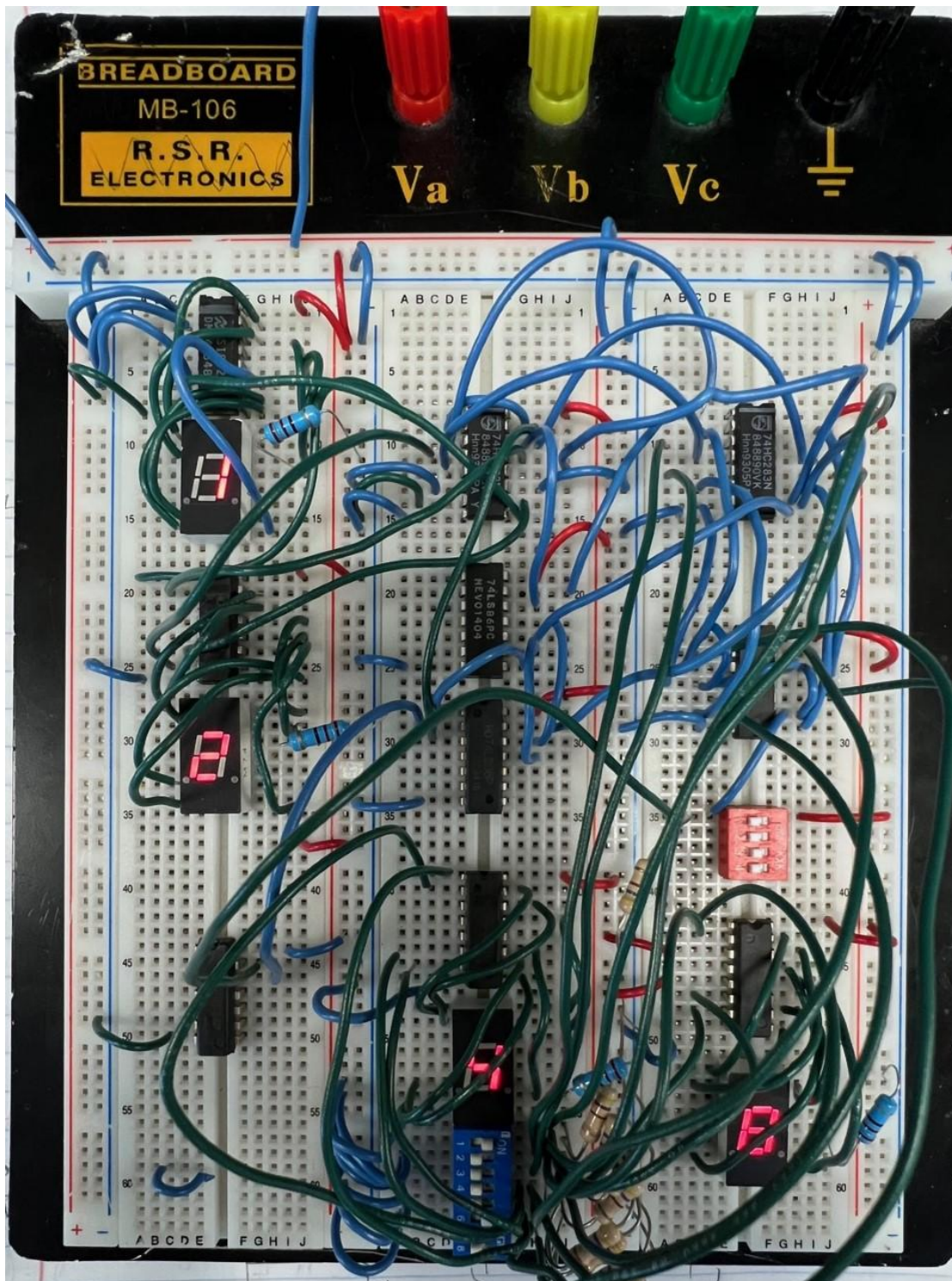


Lab 6- Build a 4 Bit BCD Adder / Subtractor



Jason Cardente, Daniel Cardone, Ethan Herron, Jackson Staheli, Nick Vaughan, Henry Warfield

(11/7/22-11/10/22)

Objectives:

- Build a 4 bit BCD adder / subtractor. Use a 7 segment display for your input and answers.

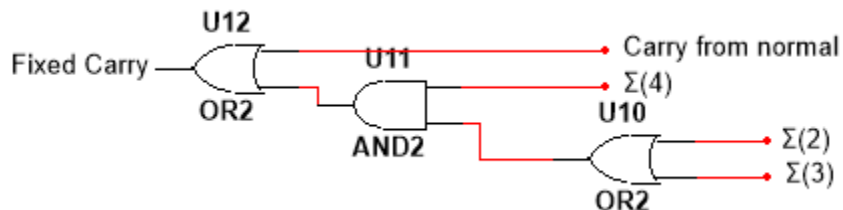
Materials List:

- Multisim
- 5v DC Power Supply
- 7486 Quad 2-input XOR Gate
- 7402 Quad 2-input NOR Gate
- 7408 Quad 2-input AND Gate
- 7414 Inverter
- 1 by 8 Dip-switch Array
- M74 7-Segment Display (4)
- 7448 BCD to 7-Segment Decoder (4)
- 470 Ω Resistor (8)

Procedure:

1. To start creating a 4 bit BCD adder we need to use not only a normal adder, but also a correction adder as BCD is only able to produce numbers from 0-9. So we started by making the error correction circuit between the two adders that will fix this problem by adding six and this is shown in figure 1-1.

Figure 1-1: Error correction circuit between adders (adds 6)



2. We then were able to create a BCD adder/subtractor in multisim which can be shown in figure 1-2 where we used 7 segment-displays with a BCD to decimal decoder in order to show a numerical value on the 7-segment.

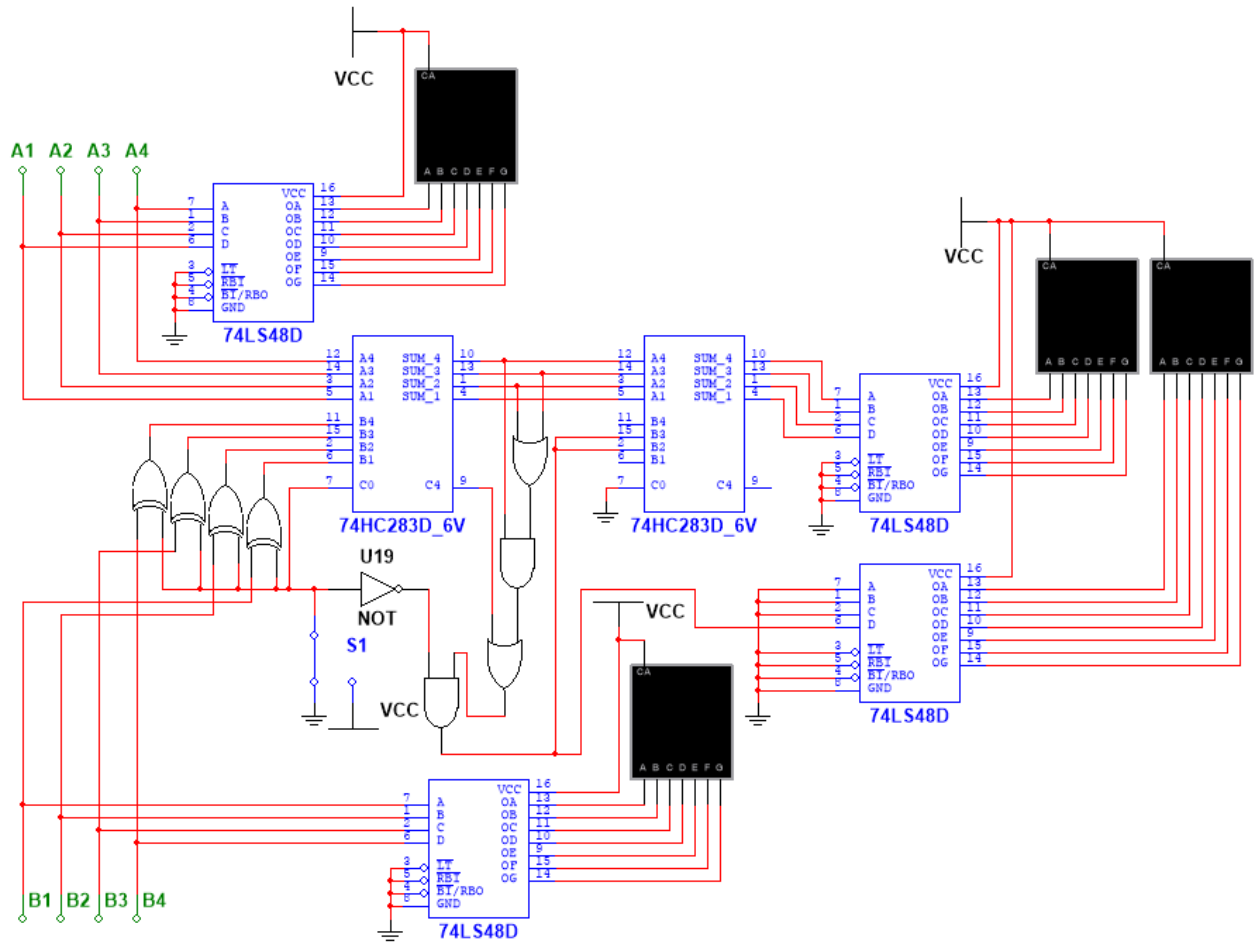


Figure 1-2: 4-Bit BCD Adder/Subtractor with decoders

3. We then used a 4 input seven segment display in order to make the circuit simplified so we can have better testing values with little issues. We then put the circuit into add mode and decided to add $9+9$ or $1001_2 + 1001_2$ in order to get 18 or $0001\ 1000_{BCD}$ which can be shown in figure 1-3.

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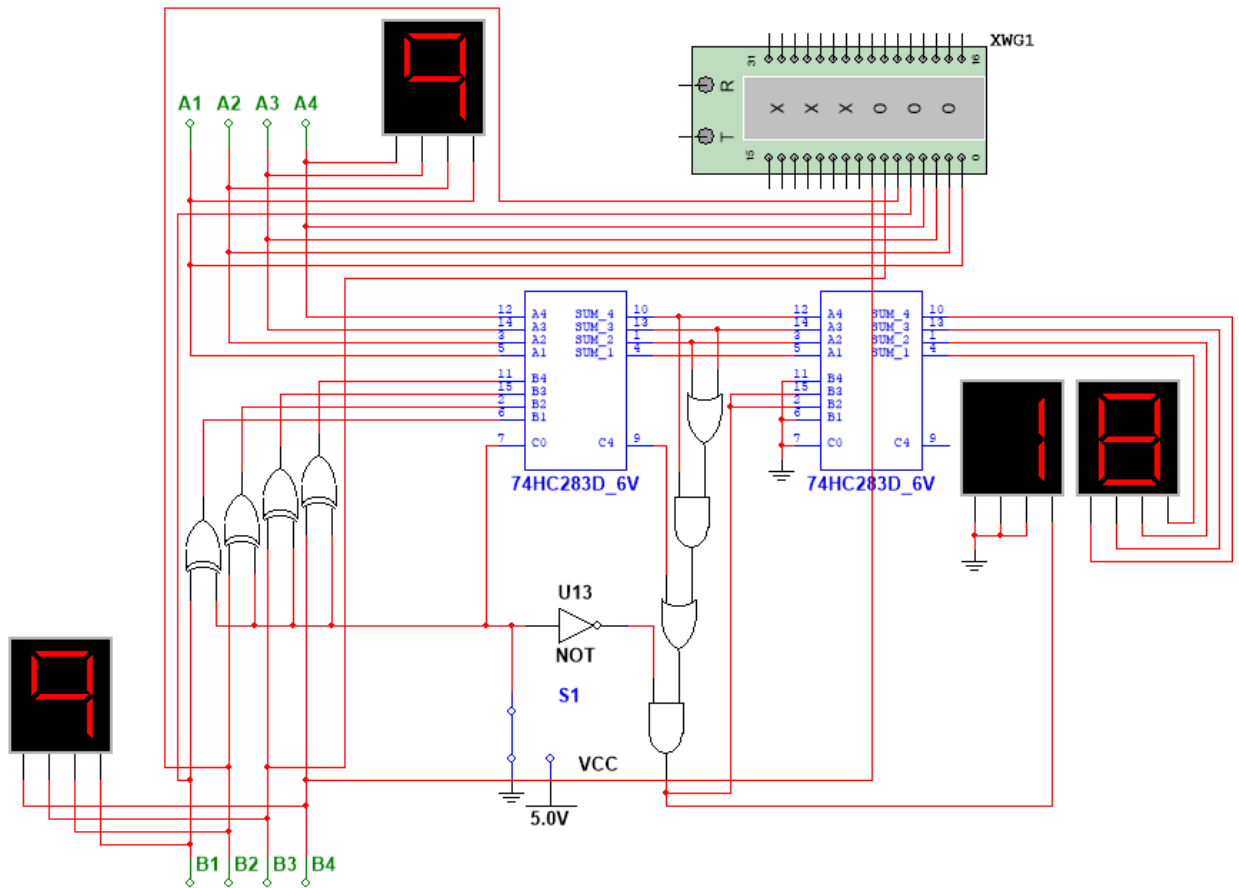


Figure 1-3: Simplified 4-Bit BCD Adder/Subtractor in add mode adding 9+9

4. We then put the circuit into subtract mode in order to test this mode and we used the values of $9 - 2$ or $1001_2 - 0010_2$ in order to get $0000\ 0111_{BCD}$ which can be shown in figure 1-4.

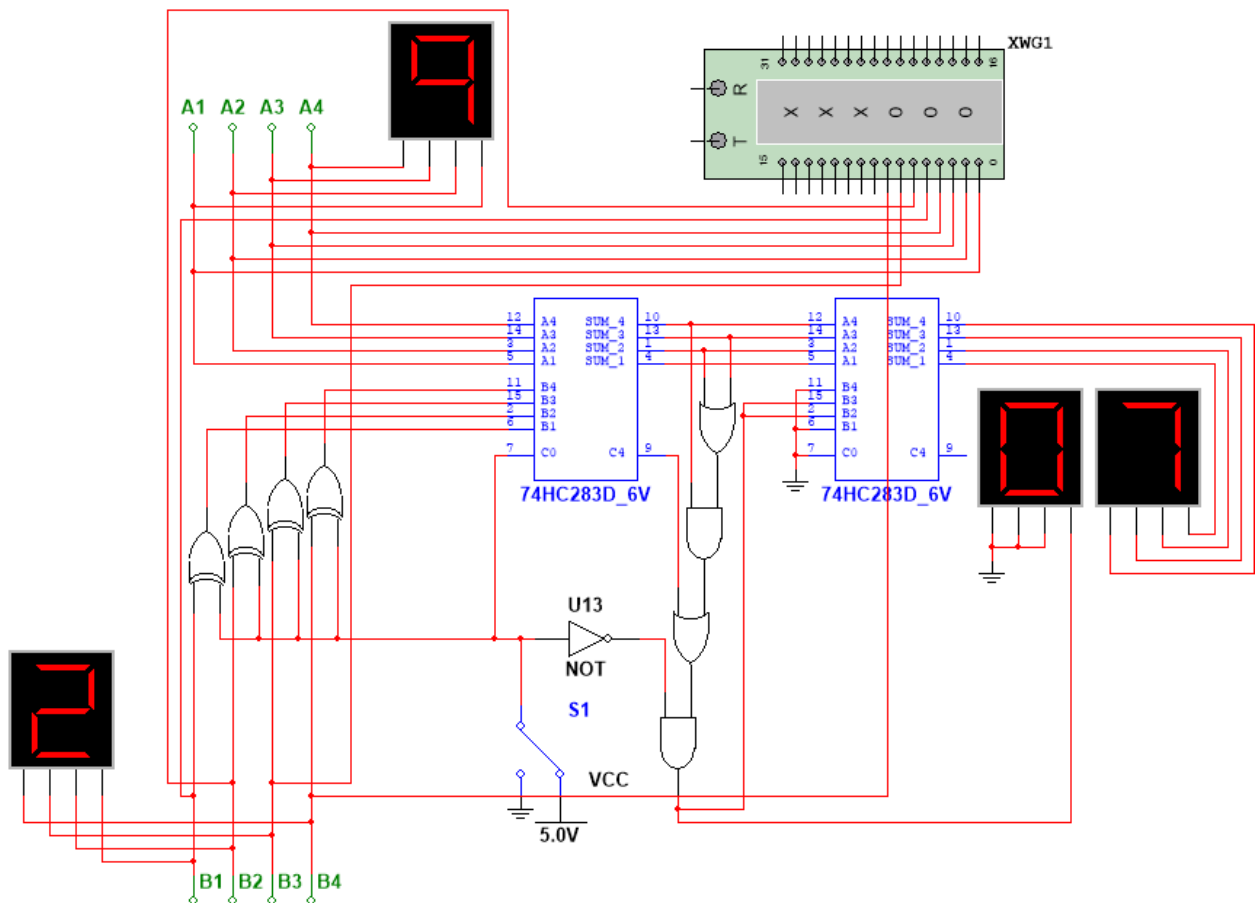


Figure 1-4: Simplified BCD adder/subtractor subtracting 9-2

- We then created a BCD adder/subtractor on the protoboard and tested it in add as well as subtract mode in which the circuit was working properly.

Discussion:

Symptom: Subtracting two numbers gave an answer that was 16 greater than the correct value.

Troubleshooting: After looking over our circuit and correcting an issue with our two's complement circuit outputting all 0's in subtract mode, our issue remained and we spoke to an instructor.

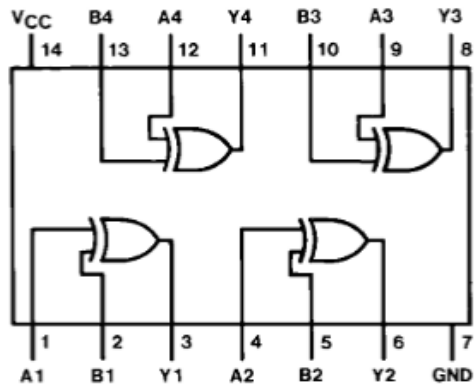
Solution: The inverter and AND gate modifying the carry-out correction circuit were both added, since they were needed to prevent this part of the circuit from being activated and creating issues.

Conclusion:

- In a BCD Adder/Subtractor circuit, you need a correction circuit for when the sum is greater than 9. This correction circuit adds 6 to the sum when it is greater than 9 in order to display the answer in BCD rather than binary. This also allows the sum to be correctly shown by the 7-segment displays, as those require a BCD input.
- This circuit will add six to the initial output if an invalid BCD value occurs or if there is a carry out.
- To have the circuit add, you will connect the switch to ground, for subtraction, you tie it to +5V.
- Subtracting is not possible with a BCD adder/subtractor, so exclusive-OR Gates are used to turn the input into its two's complement value (invert then add 1) so you can "subtract" the two numbers.
- For subtraction, we put an AND gate and an inverter on the correction, as the Exclusive-OR Gates already inverted our inputs, so we put this in to get the correction circuit to work properly

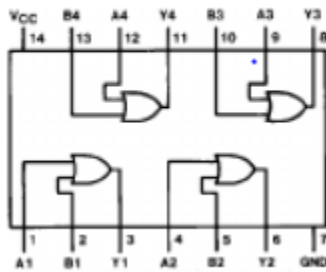
Datasheets:

☐ 7486 Datasheet XOR



☐ 7432 Datasheet OR

Connection Diagram



Function Table

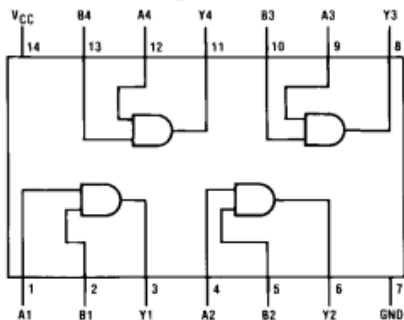
$Y = A + B$

Inputs		Output
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	H

H = HIGH Logic Level
L = LOW Logic Level

☐ 7408 Datasheet AND

Connection Diagram



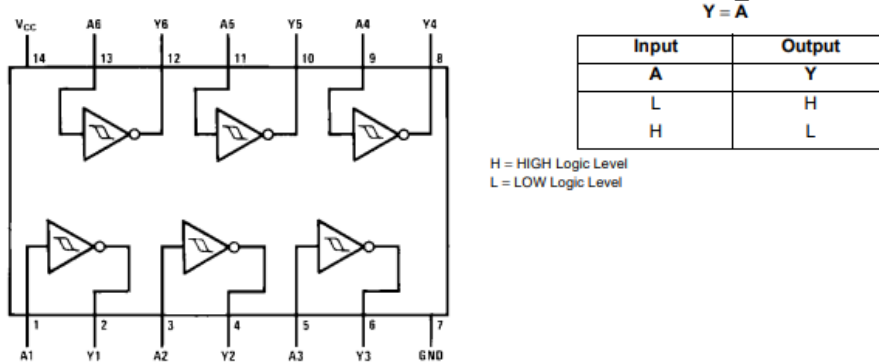
Function Table

$Y = AB$

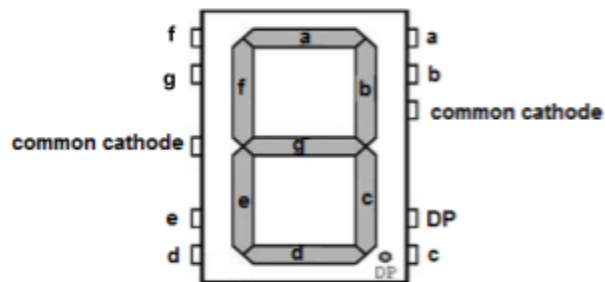
Inputs		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

H = HIGH Logic Level
L = LOW Logic Level

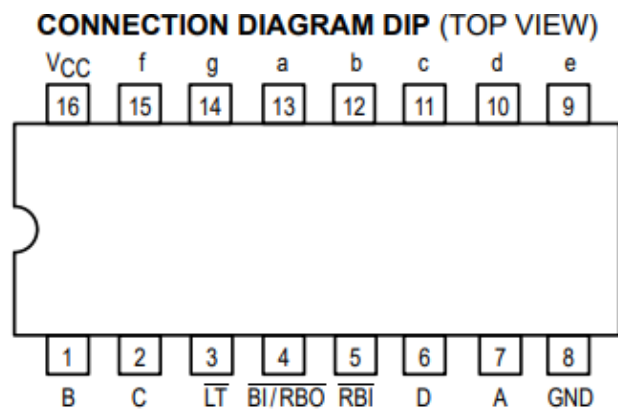
☐ 7414 Datasheet Inventor



☐ M74 7-Segment Display



☐ 7448 BCD to 7-Segment Decoder



☐ 74283 Adder Datasheet

