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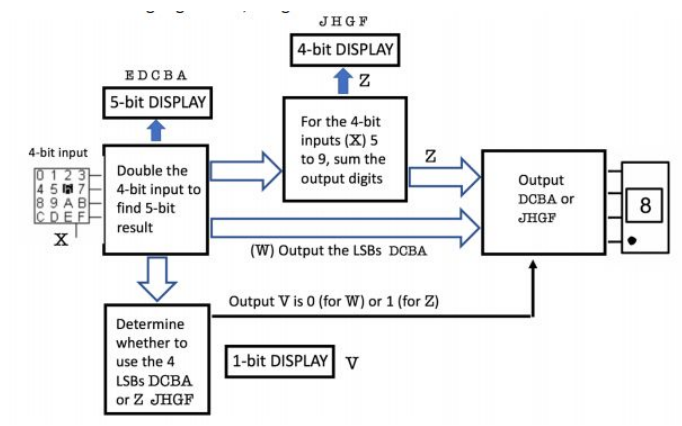
The Luhn Algorithm

Objectives

In this two week lab I successfully modeled the Luhn algorithm on logic works correctly produced the circuit as modeled by the image below.


JHGF
4-bit DISPLAY
Z
EDCBA
5-bit DISPLAY
4-bit input
0 1 2 3
4 5 6 7
8 9 A B
C D E F
X
Double the 4-bit input to find 5-bit result
For the 4-bit inputs (X) 5 to 9, sum the output digits
Z
Output DCBA or JHGF
8
(W) Output the LSBs DCBA
Output V is 0 (for W) or 1 (for Z)
Determine whether to use the 4 LSBs DCBA or Z JHGF
1-bit DISPLAY
V

For example. If X is 1, 2, 3, or 4: Y = W = 2, 4, 6, or 8
If X is 5, 6, 7, 8, or 9: Y = 10, 12, 14, 16, or 18
If Y is 10, 12, 14, 16, or 18: Z = 1, 3, 5, 7, or 9
and W = 10, 12, 14, 0, or 2

After I completed this first part of the lab I then created a second circuit that calculates the last 16th checksum value. Finally I took my modeled circuit from logic works and created my circuit on my protoboard. I first created the two circuits in logic works because it is simply easier to make sure the logic works before working with a breadboard which was the required part of this lab.

Introduction

This lab was based of the Luhn algorithm which is used to calculate credit card numbers. It was created by Hans Peter Luhn, an IBM scientist who lived from 1896 to 1964. His work is can be accredited to the move from physical “cash” transactions to digitized transactions. His algorithm can be broken down into several key parts; the checksum is the furthest right hand digit, going from right to left you double the value of every second digit (however, the check digit is not doubled), when the result of the doubling the number comes out to greater than 9 (for example, 6x2=12) then add the digits of the product (12 will result in adding 1 and 2 giving 3, if we had for example, 16 gives 1 plus 6 equally 7.), calculate the sum of all the products and finally if the total modulo 10 equals 0 then the number is correct.

Procedure

1.) The first step I took to complete this lab was to thoroughly read through the pdf supplied on HuskyCT.

2.) Secondly I worked out the logic for the first circuit from the diagram above (in the objectives section) and with some help from my TA debugged it in logicworks.

3.) Next I built the second circuit which calculates the checksum or the 16th value in the Luhn algorithm. In order to achieve this I created a truth table and from that I made four

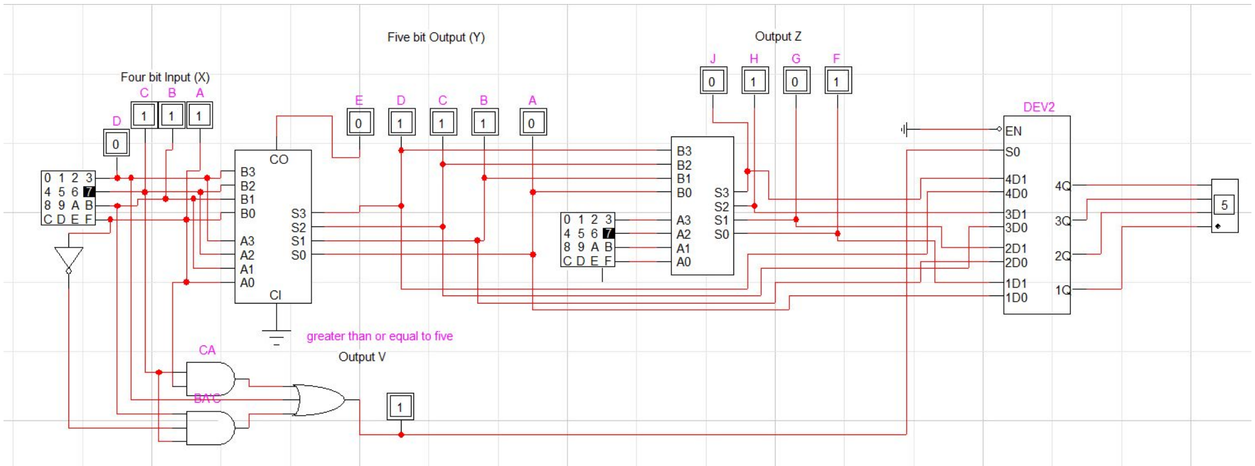
Kmaps which allowed me to generate the logic equations and successfully model this circuit in logicworks.

4.) After my first two circuits were completed I went to work translating my logicworks circuit to my breadboard.

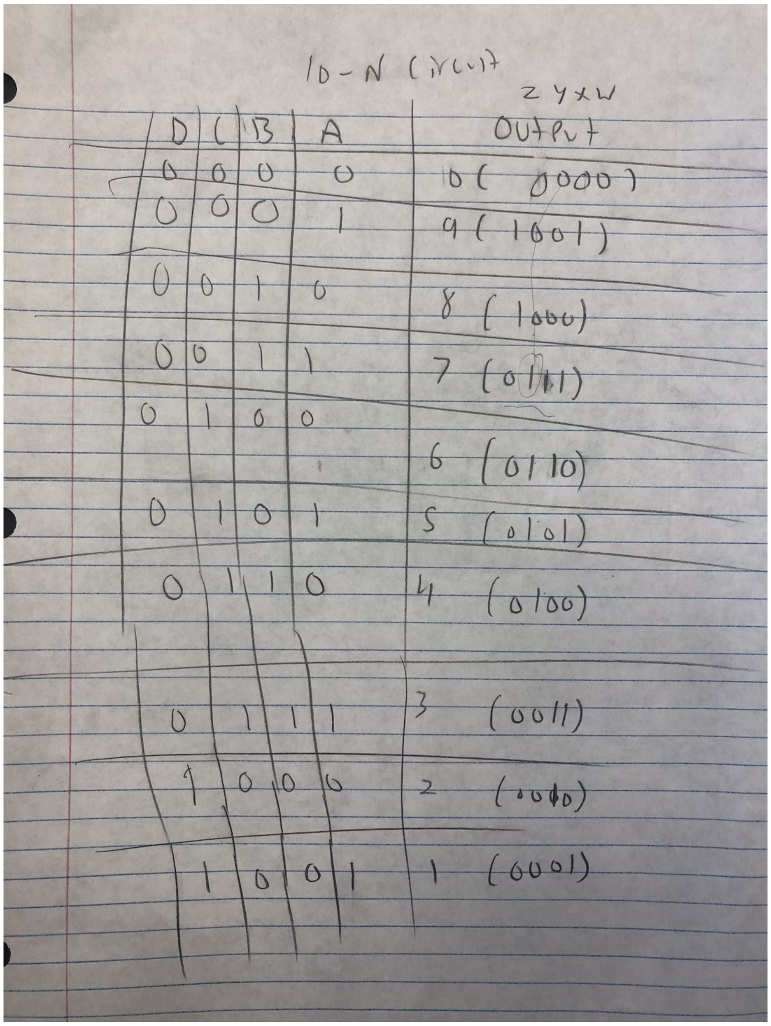
5.) Finally after completing the actual software and hardware versions of this lab I wrapped up by writing this lab report.

Results

(Logicworks for the first circuit)



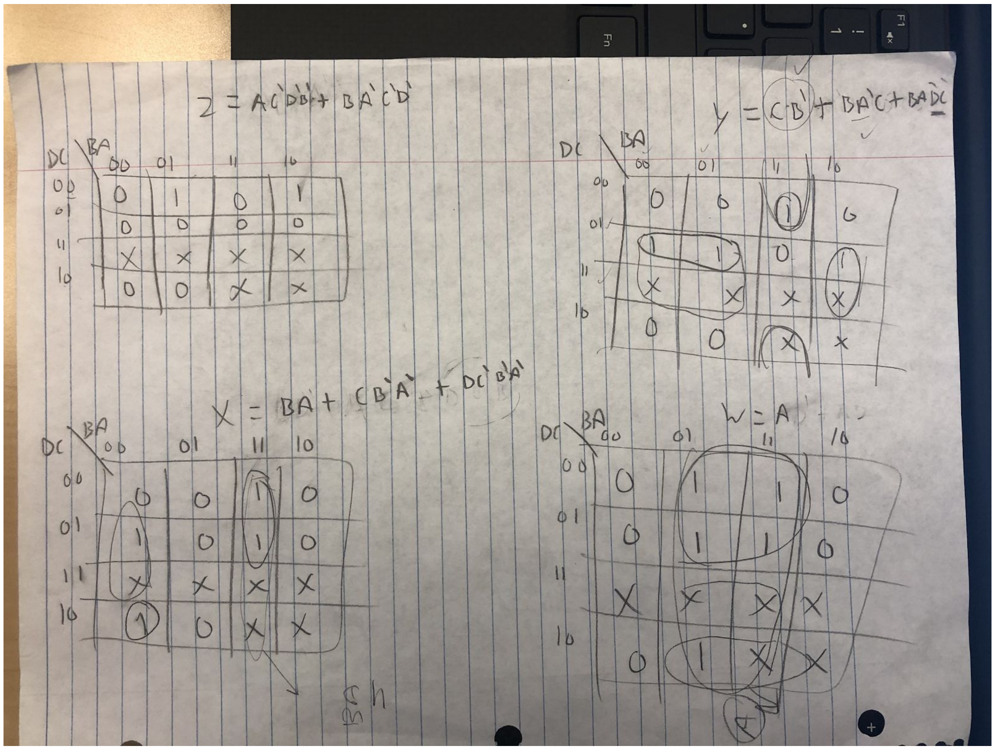
(truth table for second circuit on logic works)



10-N Circuit

D	C	B	A	ZYXW Output
0	0	0	0	10 (0000)
0	0	0	1	9 (1001)
0	0	1	0	8 (1000)
0	0	1	1	7 (0111)
0	1	0	0	6 (0110)
0	1	0	1	5 (0101)
0	1	1	0	4 (0100)
0	1	1	1	3 (0011)
1	0	0	0	2 (0010)
1	0	0	1	1 (0001)

(Kmaps and Equations for second circuit on logic works)



$Z = AC'D'B' + BA'C'D'$

DC \ BA	00	01	11	10
00	0	1	0	1
01	0	0	0	0
11	X	X	X	X
10	0	0	X	X

$Y = CB' + BA'C + BAD'C'$

DC \ BA	00	01	11	10
00	0	0	1	0
01	1	1	0	1
11	X	X	X	X
10	0	0	X	X

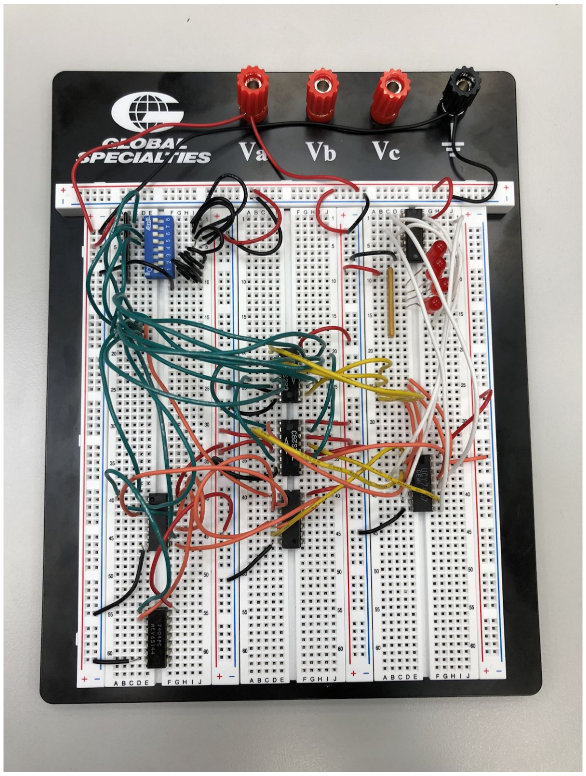
$X = BA + CB'A' + DC'B'A'$

DC \ BA	00	01	11	10
00	0	0	1	0
01	1	0	1	0
11	X	X	X	X
10	1	0	X	X

$W = A$

DC \ BA	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	X	X	X	X
10	0	1	X	X

(Logicworks for the second circuit)



(Physical Circuit representing the first circuit in logic works)

Discussion

I was lucky in the sense that I had minimal issues with this lab. I did have to redo my equations for the second circuit multiple times because of miss grouped minterms and I had to debug my breadboard circuit multiple times. That being said it was a much better lab than the fourth lab which not a lot of students were able to even get to function correctly.

Conclusion

In conclusion I gained a lot of knowledge from this lab in regards to solidified my understanding of k-maps, creating equations , and again completing a hardware circuit. One negative takeaway I have from this lab is that there is no way to test your circuit at home, so how are you supposed to know if it works correctly before its due. I actually had my hardware circuit working before frying my circuit due to my method of trying to tape double a batteries together in order to power it. I believe that taking this in consideration I should receive full marks because my logic works works and all of my wires are in the correct positions.

Questions

1.) I would actually used this logic in my circuit. I used adding seven as subtracting nine thanks to twos complement.

2.) They both end with check digits, they differ in lengths, however they both use algorithms to calculate the numbers.