Introduction to Digital Systems
Lab #2

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Indication

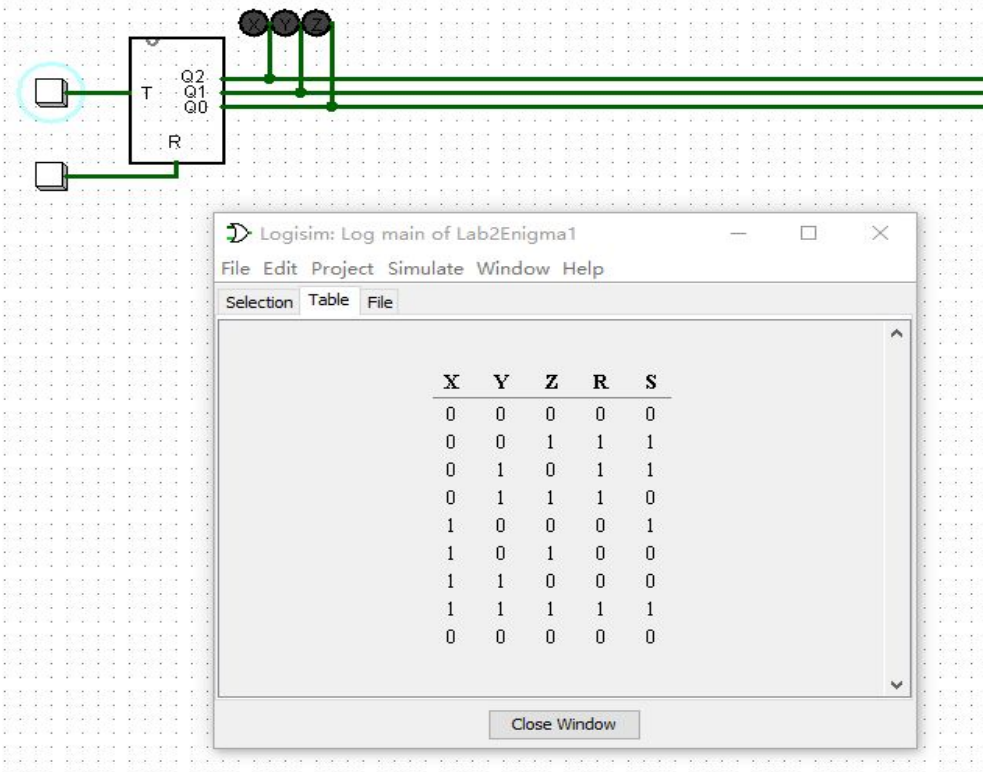
This lab base on 1-bit Enigma (3 inputs and 2 outputs), and getting deeper to build 8-bit Enigma. Except that, there gives a truth table which should the relationship between all inputs and outputs. We will use this table to find gates component that gates can give same outputs as it shows. After we figure out inside of the 1-bit Enigma, we built 8-bit Enigma which connect eight 1-bit Enigma. Later on, we input two values and look at output to consider the system is addition and subtraction.

Part 2

This table is copy from pdf:

X	Y	Z	R	S
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

this figure shows the output of the gates that I builded, it gives same outputs as the pdf(truth table).



Those same output table can proof we build a successful gates component to meet our required.

Part 3

X Hex	X Signed	X Unsigned	Y Hex	Y Signed	Y Unsigned	S Hex	S Signed	S Unsigned
0001 0000	0001 0000	0001 0000	0000 0110	0000 0110	0000 0110	0000 1010	0000 1010	0000 1010
1010 0111	1010 0111	1010 0111	0001 1011	0001 1011	0001 1011	1000 1100	1000 1100	1000 1100
0111 1111	0111 1111	0111 1111	0110 1101	0110 1101	0110 1101	0001 0010	0001 0010	0001 0010

There have two ways to knows the function is subtraction:

X-Y=S

one of the easy way is look at the gates that we built, X unsigned response 16 of as 10 and Y unsigned response 6 as 6, and the output of S unsigned is 10. So obviously 16-6=10 is the function that we are looking for.

the other way:

00010000
- 00000110
00001010

We still using first test pair, as the above we know the addition gives output is 00010110, but the output is 0001010 which means the function is not addition. In fact, 00001010 is the output of subtraction.

Part4

X Hex	X Signed	X Unsigned	Y Hex	Y Signed	Y Unsigned	S Hex	S Signed	S Unsigned
1001 1100	1001 1100	1001 1100	0000 0110	0000 0110	0000 0110	1001 0110	1001 0110	1001 0110
1000 0000	1000 0000	1000 0000	0000 0001	0000 0001	0000 0001	0111 1111	0111 1111	0111 1111
0010 0011	0010 0011	0010 0011	0010 0100	0010 0100	0010 0100	1111 1111	1111 1111	1111 1111

Use the second ways in part 2:

10011100
- 00000110
10010110

As above we use test pair 4) to check our output. As we can see 10011100 minus 00000110 is 10010110, which is same as the output of S. Therefore, our answer are correct.

BONUS

The largest positive value: $2^{8-1} - 1 = 127$

The smallest negative value $-2^{8-1} = -128$

In the part 4, first output 10010110 is -106, second output 01111111 is 127 and the third output 11111111 is -1. As we can all of those three values are in the range. In other word, our result are all correct for both of the unsigned case and signed case.