Zagazig University
Computer and System Engineering
Third Year

BCD Adder

Objective:

1- The student use the previous studies in design not start from zero.
2- The student knows steps to design circuit.
3- How to design adder.

Problem:

You have 2-BCD numbers and you want to get the summation of its.

So

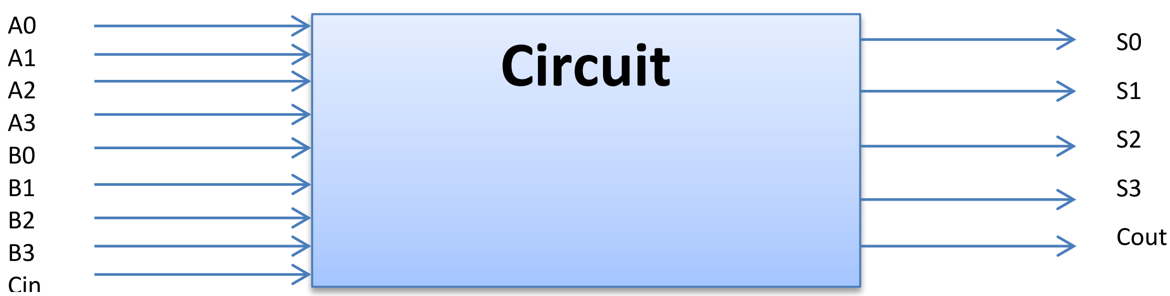
Input: From 0 to 9.

Max number is represented in 4- bit so input is 4-bit for the first number, 4-bit for the second number and one bit for the carry from the previous operation so the input is 9-bit.

Output: Min addition is 0+0+0=0

Max addition is 9+9+1=19

So output 4-bit for the first number and 4-bit for the second number but the max number for the second digit is 1 it represented in 4-bit as 0001 so 3-most significant bits can be neglected so the output is 5-bits.



Design:

Design #1:

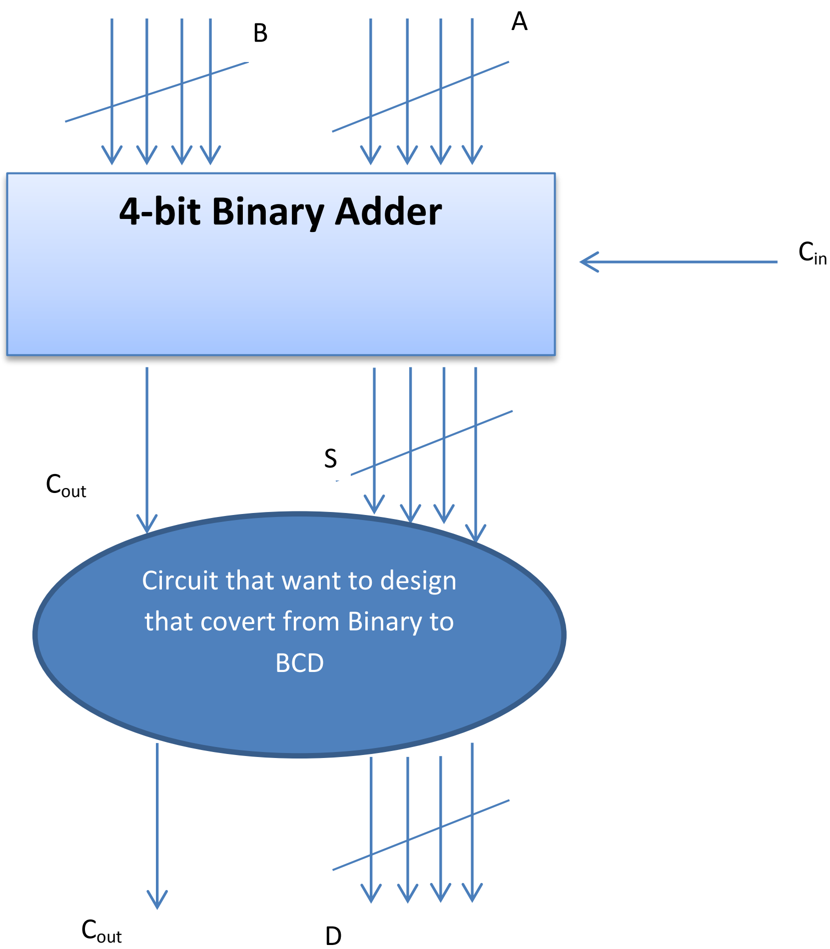
By using truth table: - we have 9- input so we have 2^9 (512) probability case. So it is impossible to design by this way.

Design #2:

Use 4-bit full adder

Input usually binary as shown

If we want to make this 2+7 in BCD 2 represented as $(0010)_{BCD}$ and 7 as $(0111)_{BCD}$ but out from the binary adder is binary so we need a circuit that convert from binary to BCD.



C_{out}	S3	S2	S1	S0	digit	C_{out}	D3	D2	D1	D0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	1
0	0	0	1	0	2	0	0	0	1	0
0	0	0	1	1	3	0	0	0	1	1
0	0	1	0	0	4	0	0	1	0	0
0	0	1	0	1	5	0	0	1	0	1
0	0	1	1	0	6	0	0	1	1	0
0	0	1	1	1	7	0	0	1	1	1
0	1	0	0	0	8	0	1	0	0	0
0	1	0	0	1	9	0	1	0	0	1
0	1	0	1	0	10	1	0	0	0	0
0	1	0	1	1	11	1	0	0	0	1
0	1	1	0	0	12	1	0	0	1	0
0	1	1	0	1	13	1	0	0	1	1
0	1	1	1	0	14	1	0	1	0	0
0	1	1	1	1	15	1	0	1	0	1
1	0	0	0	0	16	1	0	1	1	0
1	0	0	0	1	17	1	0	1	1	1
1	0	0	1	0	18	1	1	0	0	0
1	0	0	1	1	19	1	1	0	0	1

Design as 5-functions we can deduce them (C_{out}, d3, d2, d1 and d0) by k-map or Boolean algebra.

You can deduce them as min-terms and represented them

So this design may be represented but it too long.

Design #3:

We also use 4-bit binary adder but by notice from the previous table Number from 0 to 9 represented as them but from 10 to 19 represented as following:

1- $(01010)_2$ $(10000)_{BCD}$

$(10)_{10}$ $(16)_{10}$

2- $(01011)_2$ $(10001)_{BCD}$

$(11)_{10}$ $(17)_{10}$

: : : :

: : : :

: : : :

: : : :

: : : :

: : : :

: : : :

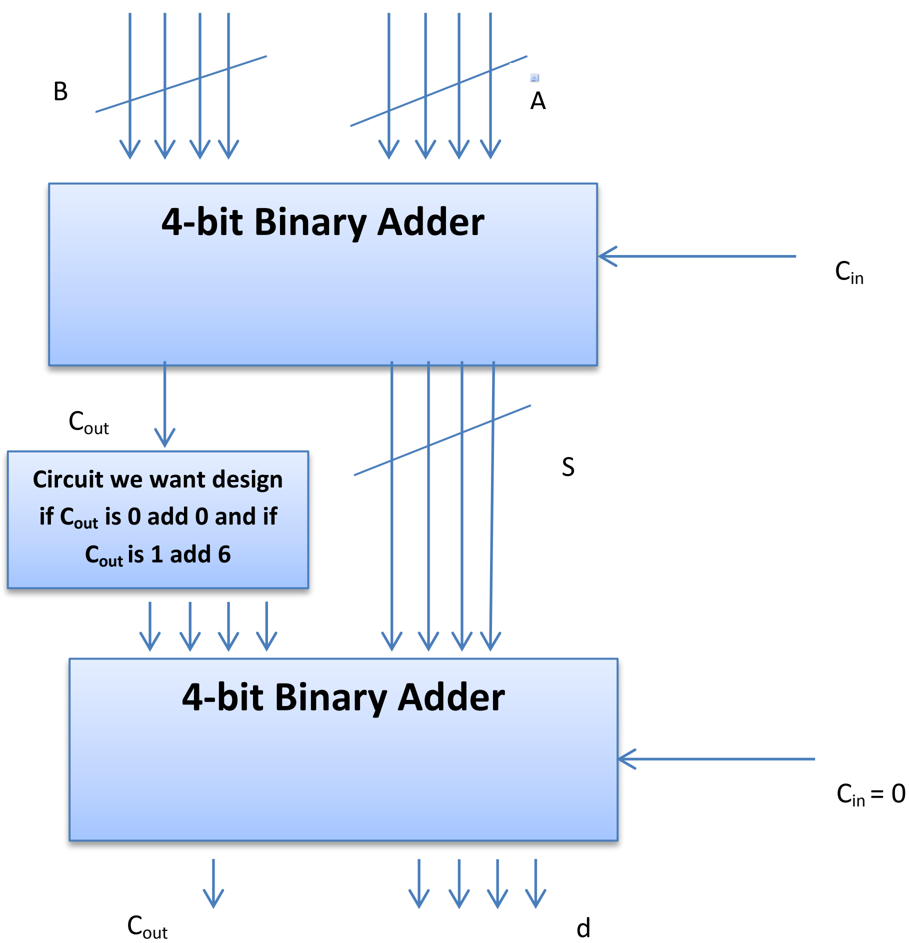
10- $(10011)_2$ $(11001)_{BCD}$

$(19)_{10}$ $(25)_{10}$

Note that the difference between the numbers represented is always 6.

<u>Trick:-</u>

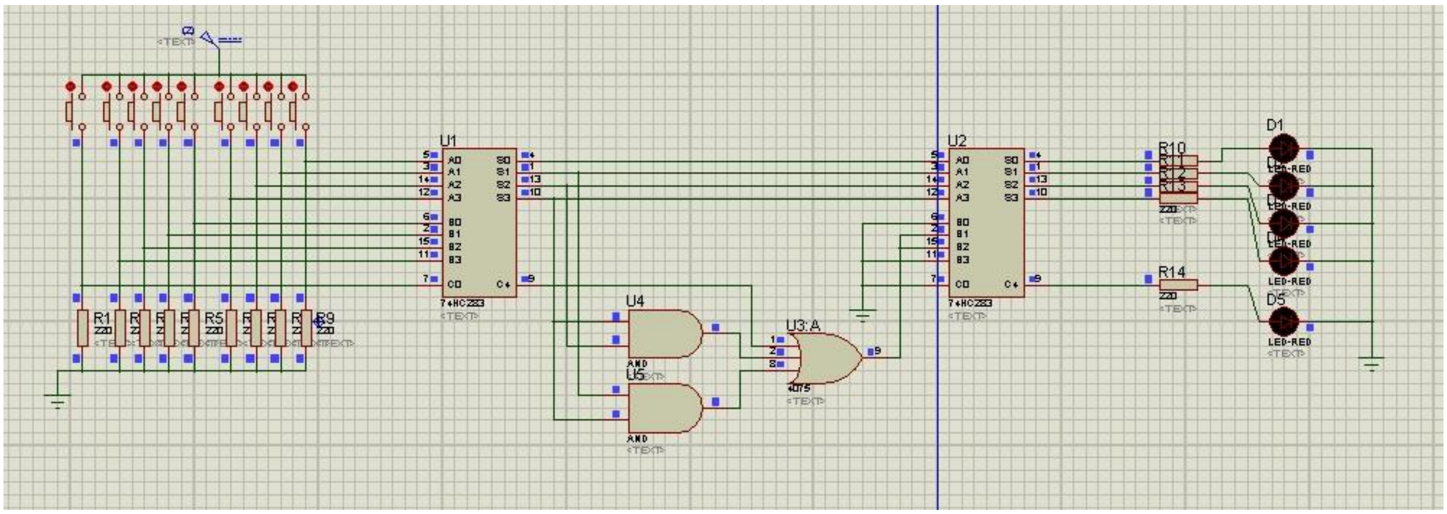
If the C_{out} is 0 we add 0 to the binary number from the full adder and if C_{out} is 1 so we add 6.

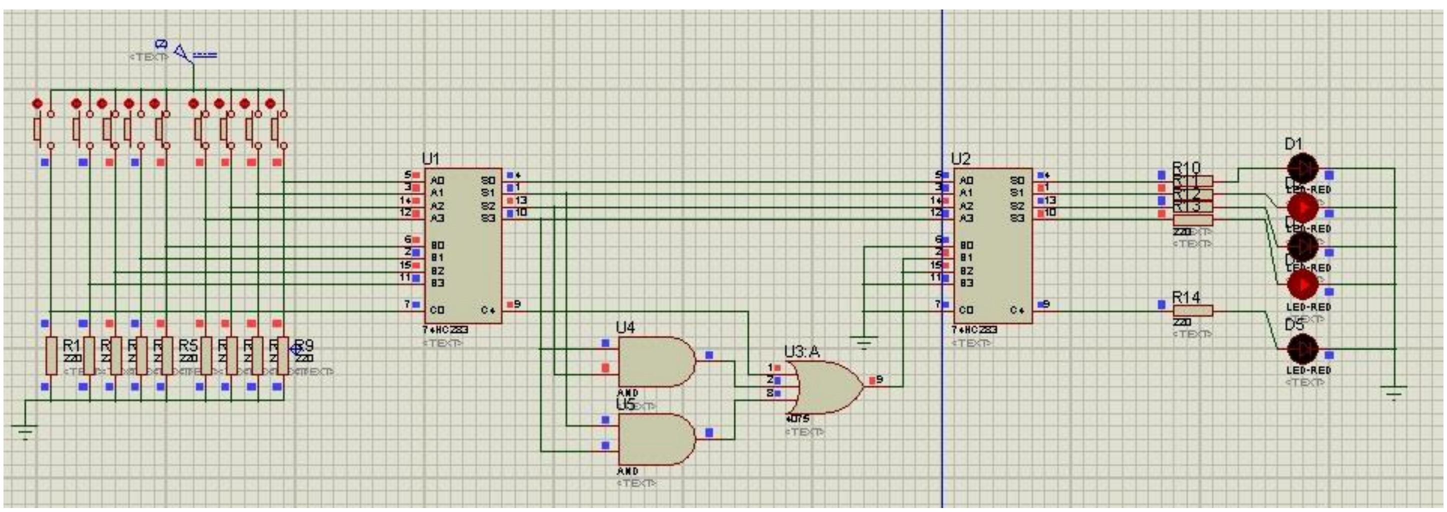


0	0	0	0
0	0	0	0
1	1	1	1
0	0	1	1

1	1	1	1
X	X	X	X
X	X	X	X
X	X	X	X

$Z = C_{out} + S3S2 + S3S1$





Report:

Design a Circuit to multiply 4*3 bit (analysis –design- hardware)

Prepared by Eng. / Ahmed Osman

Thanks for regards