Exp. No. 9 Constructing BCD Adder

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4-bit BCD adder using IC- 7483

- A BCD adder adds two BCD digits and produces output as a BCD digit. A BCD or Binary Coded Decimal digit cannot be greater than 9.
- The two BCD digits are to be added using the rules of binary addition. If sum is less than or equal to 9 and carry is 0, then no correction is needed. The sum is correct and in true BCD form.
- But if sum is greater than 9 or carry =1, the result is wrong and correction must be done. The wrong result can be corrected adding six (0110) to it.

For implementing a BCD adder using a binary adder circuit IC 7483, additional combinational circuit will be required, where the Sum 0utput S_3–S_0 is checked for invalid values from 10 to 15. Then the truth table and The Boolean expression **(bold columns)** is, $Y=S_3S_2+S_3S_1$

Invalid BCD numbers, hence Y=1

I/P				O/P
S3	S2	S1	S0	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Table1. Truth table for BCD numbers

- The BCD adder is shown below. The output of the combinational circuit should be 1 if Cout of adder-1 is high. Therefore Y is ORed with Cout of adder 1.
- The output of combinational circuit is connected to B_1B_2 inputs of adder-2 and $B_3=B_1+0$ as they are connected to ground permanently. This makes $B_3B_2B_1B_0= 0110$ if Y' = 1.
- The sum outputs of adder-1 are applied to $A_3A_2A_1A_0$ of adder-2. The output of combinational circuit is to be used as final output carry and the carry output of adder-2 is to be ignored.

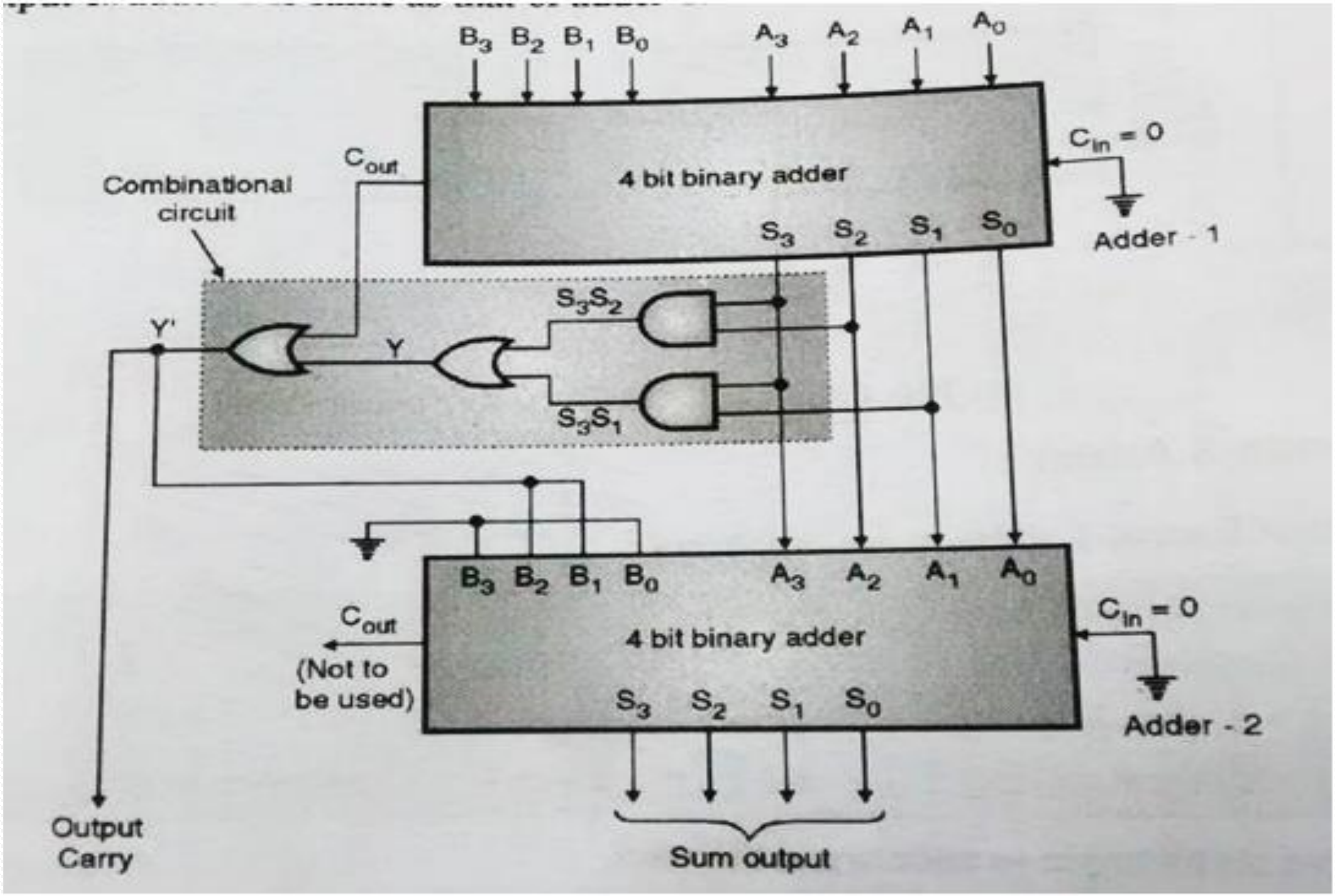


Fig. BCD addition using IC 7483

Case1: Sum ≤ 9 and carry = 0

- The output of combinational circuit Y' = 0. Hence B_3 B_2 B_1B_0 = 0 0 0 0 for adder-2.
- Hence output of adder-1 is same as that of adder-2

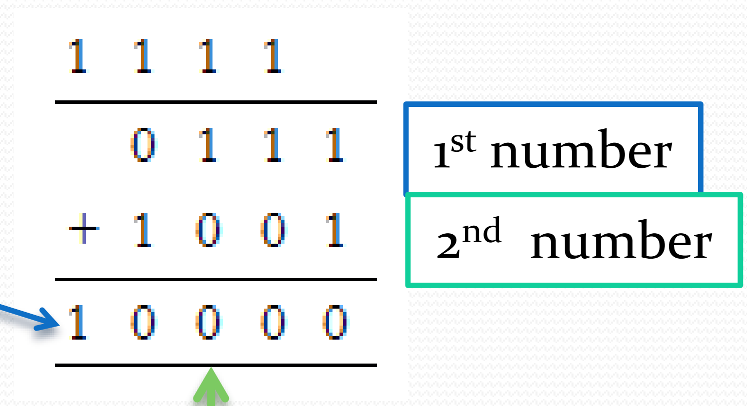
Case2: Sum >9 and carry = 0

- If S_3 S_2 S_1 S_0 of adder -1 is greater than 9, then output Y' of combinational circuits becomes 1.Therefore B_3 B_2 B_1 B_0 = 0 1 1 0 (of adder-2).
- Hence six (0 1 1 0) will be added to the sum output of adder-1. We get the corrected BCD result at the output of adder-2.

- **Case3: Sum ≤ 9 but carry = 1**
- As carry output of addere-1 is high, Y' = 1. Therefore $B_3\ B_2\ B_1\ B_0$ = 0 1 1 0 (of adder-2).
- Hence six (0 1 1 0) will be added to the sum output of adder-1. We get the corrected BCD result at the output of adder-2. Thus the Four bit BCD addition can be carried out using the binary adder.

- Example: Operations 0f : $(0111)_{BCD}+(1001)_{BCD}$
- Thus,
- Cout = 1
- $S_3S_2S_1S_0$=0000

Here sum<9 but carry=1



- Hence, for adder, inputs will be $A_3A_2A_1A_0$ = 0000 and $B_3B_2B_1B_0$ = 0110

give final output as Cout $S_3S_2S_1S_0$ = 10110.

Therefore, $(0111)_{BCD}+(1001)_{BCD} = (00010110)_{BCD}$.

Q. Why do we need to add 6 sometimes to BCD addition?

Four binary digits count up to 15 (1111) but in **BCD** we only use the representations up to 9 (1001). **The difference between 15 and 9 is 6.**

- **To perform BCD subtraction:** BCD number B and nines compliment of A is added by using conventional BCD adder.
- If carry output is 0 then nines compliment of BCD adder output is taken out
- if carry out put is 1 then 0001 is added to the BCD adder output to get the corrected valid magnitude subtraction output.
- In each case carry out of the BCD adder is complimented and taken as Barrow output.
- **The nines' complement of a decimal digit is the number that must be added to it to produce 9; the complement of 3 is 6, the complement of 7 is 2.**