Experiment / Assignment / Tutorial No. 2

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Batch: B1	Roll No.: 1711072	Experiment / assignment / tutorial No.: 2

Title: Binary Adders and Subtractors

Objective: To implement half and full adder–subtractor using gates and IC 7483

Expected Outcome of Experiment:

CO2: Use different minimization technique and solve combinational circuits, synchronous & asynchronous sequential circuits.

Books/ Journals/ Websites referred:

- R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill
- M .Morris Mano, "Digital Logic & computer Design", PHI
- http://physics.niser.ac.in/labmanuals/sem5/elect/7_ADDER%20SUBTRACTOR%20CIRCUITS.pdf

Pre Lab/ Prior Concepts:

Adder: Addition of two binary digits is most basic operation performed by the digital computer. There are two types of adder:

- Half adder
- Full adder

Half Adder: Half adder is combinational logic circuit with two inputs and two outputs. It is the basic building block for addition of two single bit numbers.

Full adder: A half adder has a provision not to add a carry coming from the lower order bits when multi bit addition is performed. for this purpose a third input terminal is added and this circuits is to add A,B,C where A and B are the nth order bits of the number A and B respectively and C is the carry generated from the addition of (n-1) order bits. This circuit is referred to as full adder.

Subtractor: Subtraction of two binary digits is one of the most basic operations performed by digital computer .there are two types of subtractor:

- Half subtractor
- Full subtractor

Half subtractor: Logic circuit for the subtraction of B from A where A,B are 1 bit numbers is referred to as half subtract or .the subtract or process has two input and difference and borrow are the two outputs.

Full subtractor: As in the case of the addition using logic gates, a full subtractor is made by combining two half-sub tractors and an additional OR-gate. A full subtractor has the borrow in capability (denoted as BOR_{IN}) and so allows cascading which results in the possibility of multi-bit subtraction.

IC 7483

For subtraction of one binary number from another, we do so by adding 2's complement of the former to the latter number using a full adder circuit.

IC 7483 is a 16 pin, 4-bit full adder. This IC has a provision to add the carry output to transfer and end around carry output using Co and C4 respectively.

2's complement: 2's complement of any binary no. can be obtained by adding 1 in 1'scomplement of that no.

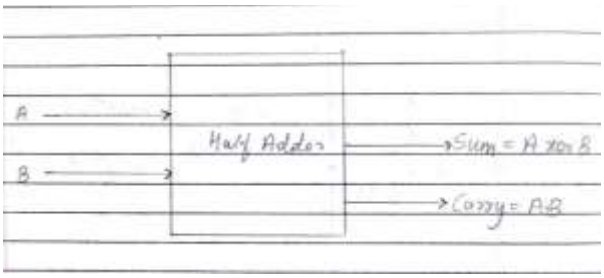
e.g. 2's complement of $+(10)_{10}$ =1010is

1C of 1010	0101
	+ 1
$-(10)_{10}$	0110

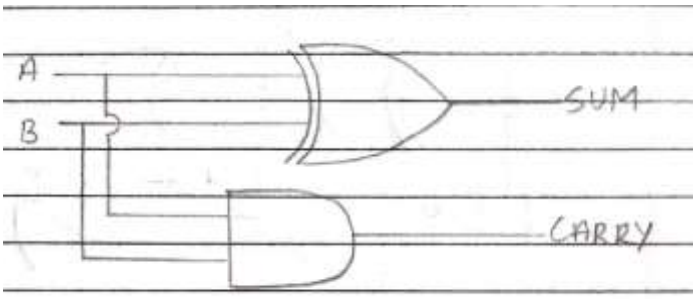
In 2's complement subtraction using IC 7483, we are representing negative number in 2's complement form and then adding it with 1st number.

Implementation Details:

Half Adder Block Diagram



Half Adder Circuit



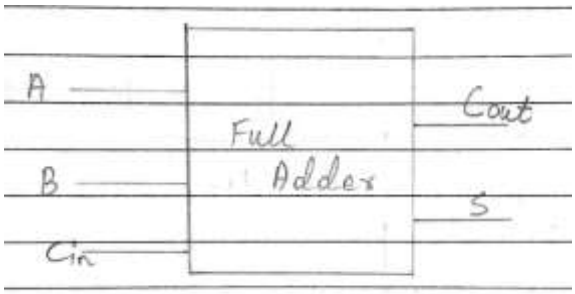
Truth Table for Half Adder

Inputs		**Outputs**	
A	**B**	**S**	**C**
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

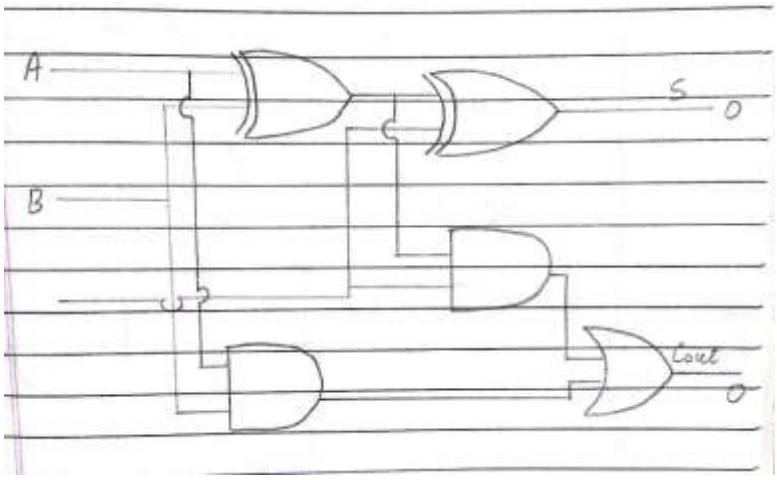
From the truth table (with steps):

S=A.B'+A'.B
C=A.B

Full Adder Block Diagram



Full Adder Circuit



Truth Table for Full Adder

A	B	C	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

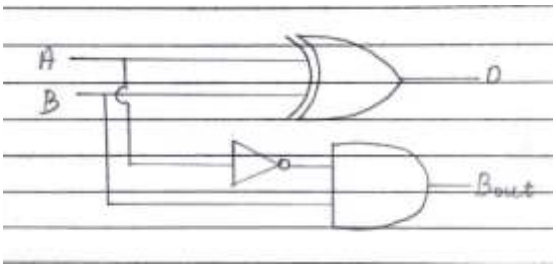
From the truth table (with steps):

$S=A'.B'.C_{in}+A'.B.C_{in}'+A.B'.C_{in}'+A.B.C_{in}$

C_{out}(Carry) $=A.C_{in}+A.B+B.C_{in}$

Half Subtractor Block Diagram

Half Subtractor Circuit



Truth Table for Half Subtractor

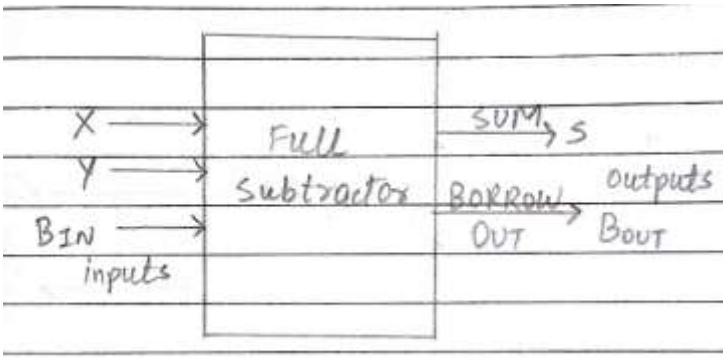
A	B	DIFFERENCE (D)	BORROW(Bo)
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

From the truth table (with steps) :

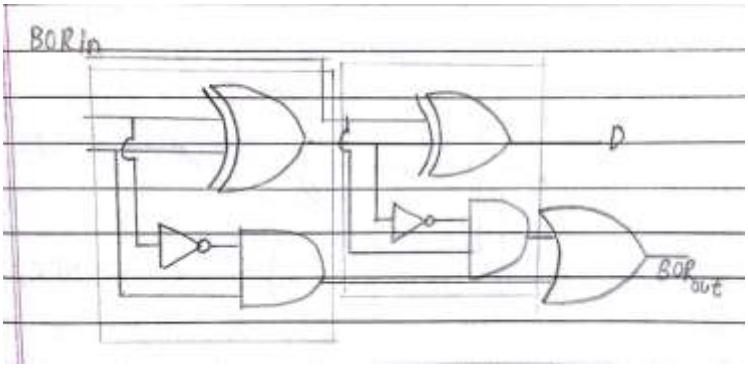
Difference(D)=A'.B+A.B'

Borrow(Bo)=A'.B

Full Subtractor Block Diagram



Full Subtractor Circuit



Truth Table for Full subtractor:

A	B	B_{IN}	D	BOR_{OUT}
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

From the truth table (with steps):

Difference (D)=$A'.B'.B_{in}+A'.B.B_{in}'+A.B'.B_{in}'+A.B.B_{in}$
$BOR_{out}=A'.B+A'.B_{in}+B.B_{in}$

IC 7483
Procedure:

1) Locate the IC 7483 and 4-not gates block on trainer kit.
2) Connect 1st input no. to A4-A1 input slot and 2nd (negative) no. to B4-B1 through 4-not gates (1C of 2nd no.)
3) Connect high input to C_0 so that it will get added with 1C of 2nd no. to get 2C.
4) Connect 4-bit output to the output indicators.
5) Switch ON the power supply and monitor the output for various input combinations.

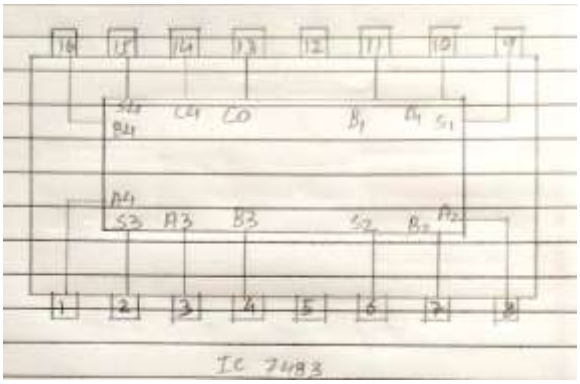
Example:

1) $7_{10} - 2_{10} = 5_{10}$

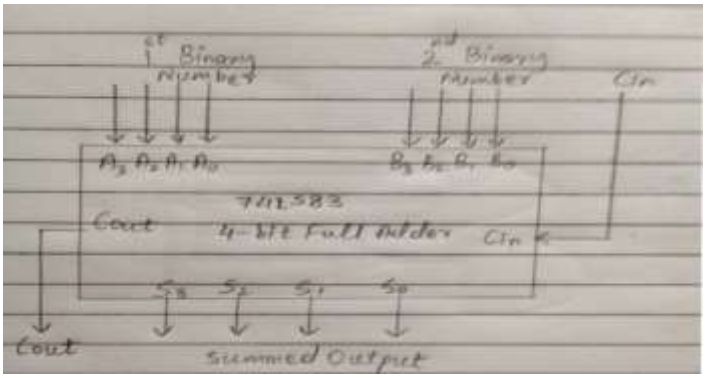
7	0111
2	0010
1'C of 2	1101
	+ 1
2'C of 2	1110

```
  0111
+ 1110
  0101
```

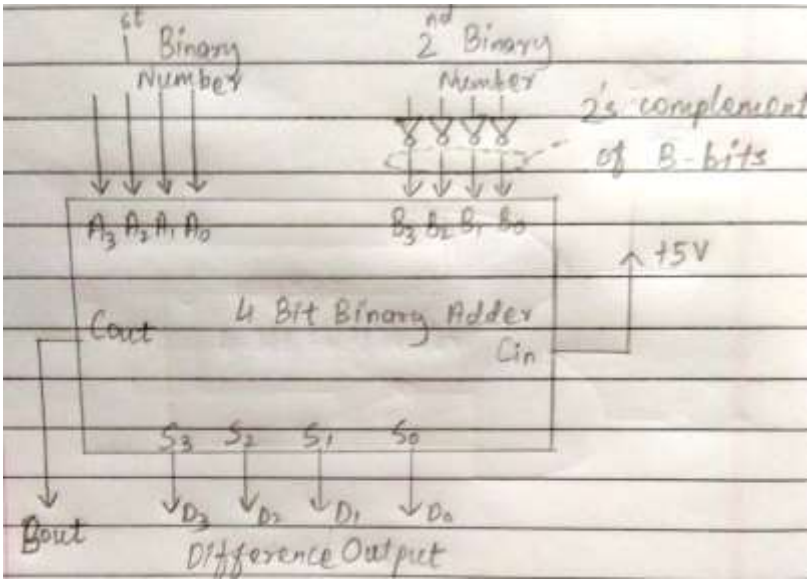
Pin Diagram IC7483



Adder



Subtractor



Post Lab Descriptive Questions:

1. What is difference between half and full adder, half and full subtractor?

Ans. **Full adder and half adder:**

The difference between half adder and full adder is that full adder has three inputs and two outputs. The two inputs are A and Band the third is a carry input Cin.The output carry is designated as Cout and the normal output is designated as S whereas half adder has two inputs and one output and carry is neglected in half adder. It isn't neglected in full adder.

Full subtractor and half adder:

The difference between half subtractor and half subtractor is also the same. Half subtractor has two inputs and one output while full subtractor has 3 inputs and 2 outputs and bits are borrowed in full subtractor. It is not restricted to one bit subtraction.

2. Perform the following Binary subtraction with the help of appropriate ICs:
   a) 7-5
   b) 5-7
   c) 9-4

Ans. a) The binary form of 7 is:0111

The binary form of 5 is: 0101

1's complement of 5 is:1010

+ 1

2's complement of 5 is:1011

Thus 7-5 is:

0111

+1011

$(0010)_2 = (2)_{10}$

b) The binary form of 5 is: 0101

The binary form of 7 is: 0111

1's complement of 7 is: 1000

+ 1

2's complement of 7 is: 1001

Thus 5-7 is:

0101

+1001

$(1110)_2$

The answer is a negative number. Hence we take the 2's complement

1's complement: 0001

+1

2's complement: $(0010)_2 = (2)_{10}$

c) The binary form of 9 is:1001

The binary form of 4 is: 0100

1's complement of 4 is: 1011

+ 1

2's complement of 4 is: 1100

Thus 9-4 is:

1001

+1100

$(0101)_2 = (5)_{10}$

Conclusion:

The binary circuit for half/full adder and subtractor were studied by both basic gates and dedicated gates for various test cases with correct outputs.