DIGITAL CIRCUITS LABORATORY
Experiment-5
4-bit Adder and Subtractor

Tanish H Talapaneni
200020050

Aim: To study the working of a simple half adder and then design a controlled 4-bit adder+subtractor.

Summary: Implementation of the designed Adder+Subtractor Circuit using the 74LS83 IC. Rigging up of the designed circuit.

Components used: 74LS83 IC(Adder), DIP Switches, LED Display, Breadboard, Power supply, 1k ohm resistor.

Procedure:

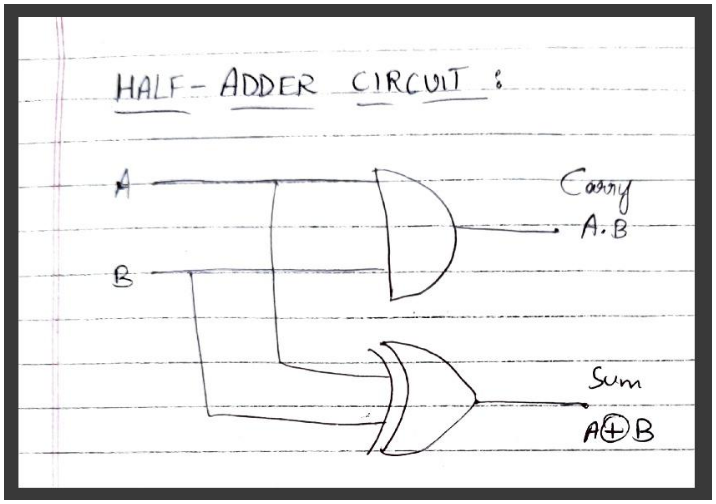
- Connect the circuit as shown in diagrams and give it power input.
- Select inputs from the truth table. Make the changes in the switch accordingly.
- Glowing LED implies that output was 1, otherwise 0.
- Verify if the simulation matches with the expected values.

Truth Table:

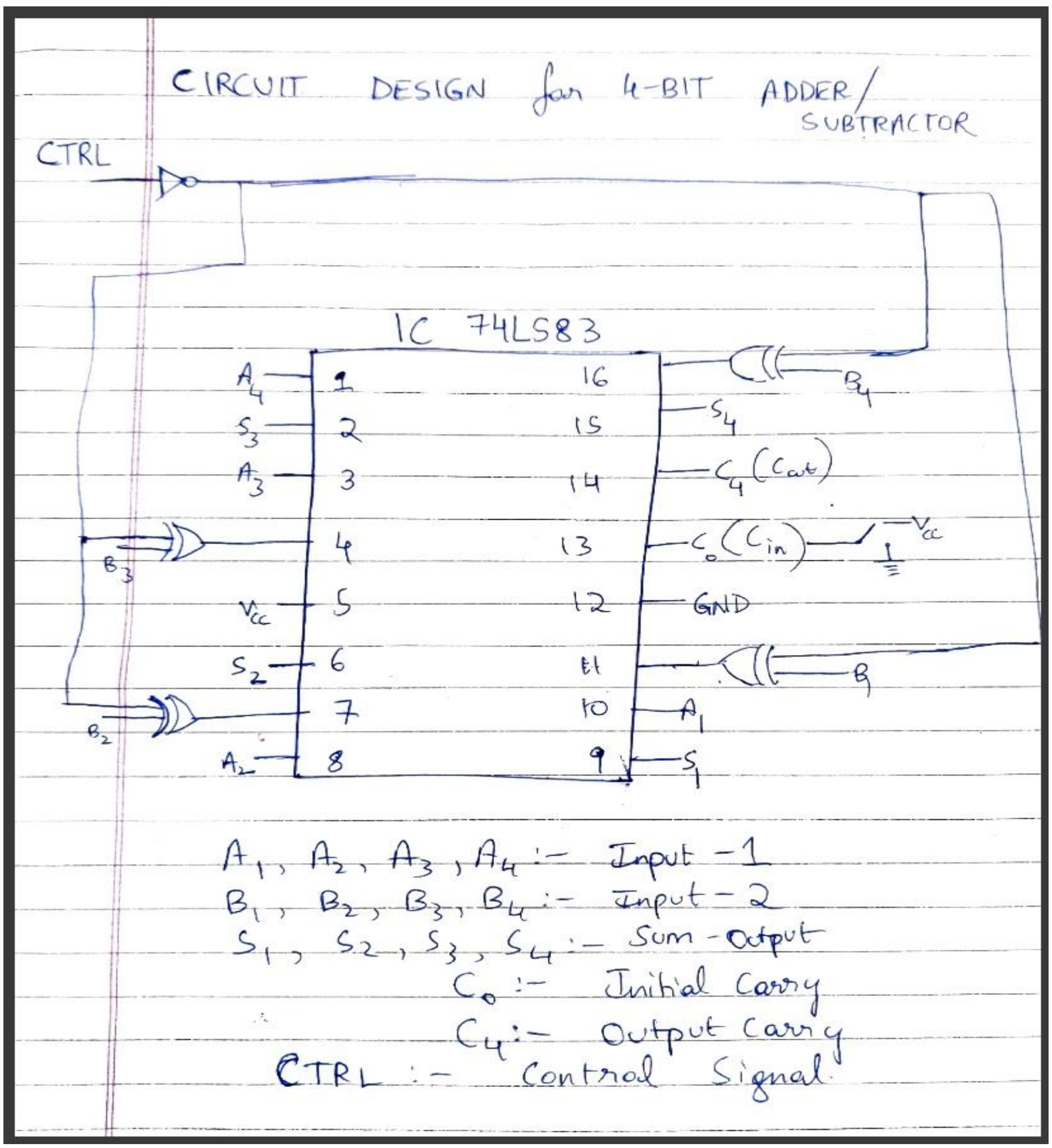
Half Adder

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

Gate Design:



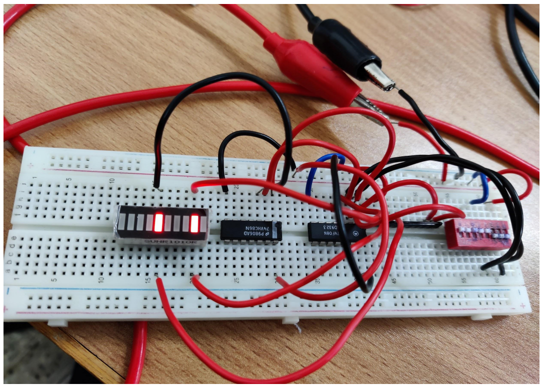
HALF-ADDER CIRCUIT :
A
B
Carry
A.B
Sum
A⊕B

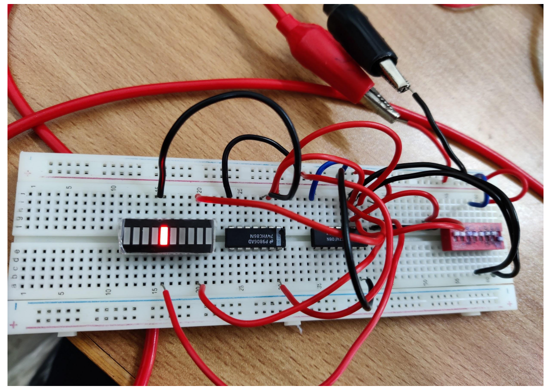


CIRCUIT DESIGN for 4-BIT ADDER/SUBTRACTOR
CTRL
IC 74LS83
A4
S3
A3
B3
Vcc
S2
B2
A2
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
B4
S4
C4 (Cout)
C0 (Cin)
Vcc
GND
B1
A1
S1
A1, A2, A3, A4 :- Input -1
B1, B2, B3, B4 :- Input - 2
S1, S2, S3, S4 :- Sum - Output
C0 :- Initial Carry
C4 :- Output Carry
CTRL :- Control Signal

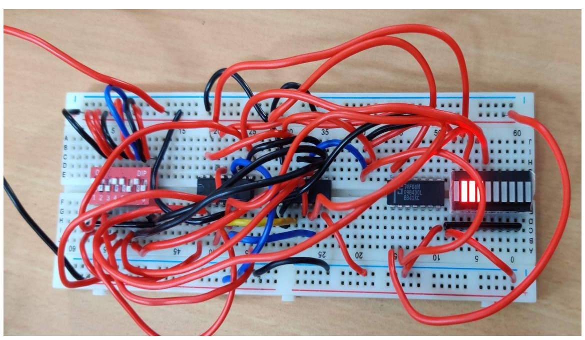
Hardware:

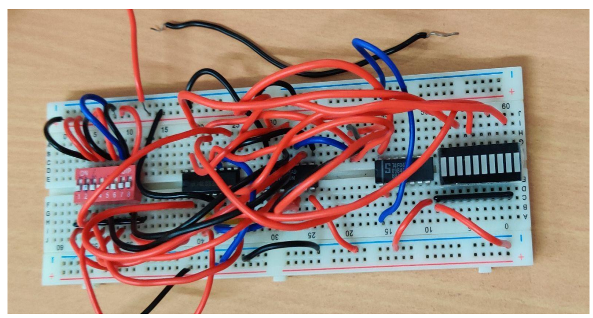
Half-Adder

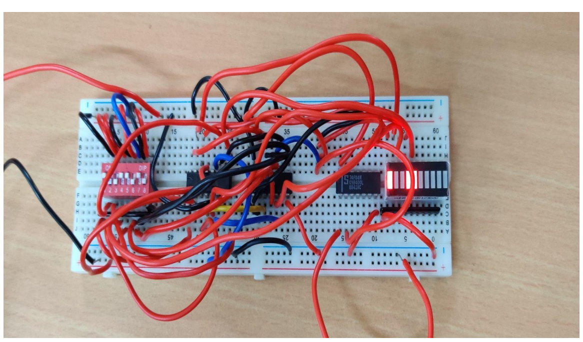


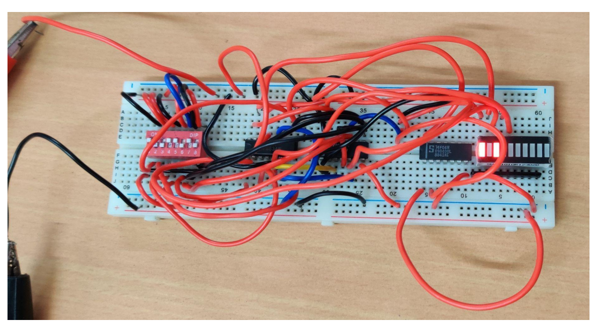


4-bit Adder/Subtractor using 74LS83 and minimum number of 2-input gates









Results and Discussions: We finally understood how we can use Adders and subtractors to implement arithmetic calculations.We were able to verify it with the theoretical results and were also able to implement it practically using different combinations. We implemented both ways of subtraction, one using one's complement and the other using two's complement.
For subtraction, the 1's complement and the 2's complement were implemented in the same circuit using the floating pin(13) of the input carry which was connected to ground for 1's complement and to Vcc for 2's complement.
Using CTRL, for the Control Signal 0, the circuit behaved as a subtractor and for control signal 1 the circuit behaved as an adder.
Designing the circuits strengthened our understanding of gate-logic, and the concepts of full-adder/subtractor and implementing it on the breadboard was fun.

Conclusion:

Half-Adder: When both the inputs are in different states then the sum bit is HIGH and carry bit is LOW. When both the input signals are low, then the sum bit and the carry bit both are LOW. But, when both the inputs are high, the sum bit is LOW and the carry bit is HIGH.

4-bit Adder/Subtractor: When the control signal was LOW, the circuit behaved as a subtractor, as a 1's complement when the input carry was set to ground and 2's complement when the input was set to Vcc. When the control signal was high, the circuit behaved as an Adder.
When this circuit was tested with arbitrary 4-input signals, the output matched the desired results. Hence it concluded to implement addition and subtraction of the 2 input signals through the same circuit.
I was able to verify the working of a 4-bit adder and a subtractor, theoretically with its practical implementation, using a Digital IC, and was able to switch between an adder and a subtractor