Digital Logic Design (EL-1005)

LABORATORY MANUAL

Spring-2024

LAB 06
Adder and Subtractor Implementations

STUDENT NAME ROLL NO SEC

INSTRUCTOR SIGNATURE& DATE

MARKS AWARDED: /10

NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES (NUCES), KARACHI

Prepared By: Muhammad Nouman Hanif

Lab Session 06: Adder and Subtractor Implementations

OBJECTIVES:

After completing this lab, you would be able to know

- Distinguish between Half Adder and Full Adder, their functions and logic diagrams
- Define some useful terminologies like CARRY, SUM, Difference, and Borrow

APPARATUS:

- Logic Works

COMPONENTS:

ICs 74LS00 (NAND), 74LS02 (NOR), 74LS04 (NOT), 74LS08 (AND), 74LS32 (OR), 74LS86 (XOR), 74LS266 (XNOR)

Introduction:

Adder:

In electronics, an *adder* or *summer* is a digital circuit that performs addition of numbers.

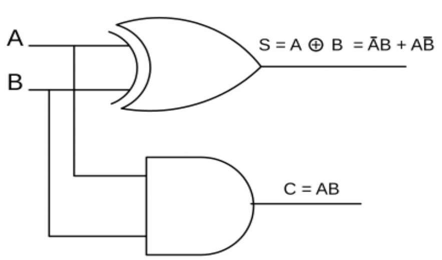
For single bit adders, there are two general types:

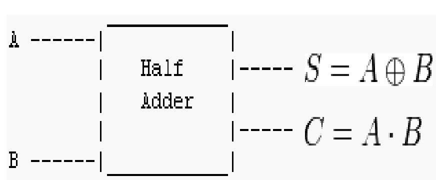
1. Half Adder
2. Full Adder

1. Half Adder

A **half adder** is a logic circuit which performs addition of two binary one-bit inputs and has two binary outputs as a result. The outputs are designated as **Sum (S)** and **Carry (C)**.

Circuit Diagram





$\text{Sum}(A,B) = \bar{A}B + A\bar{B}$

$\text{Carry}(A,B) = AB$

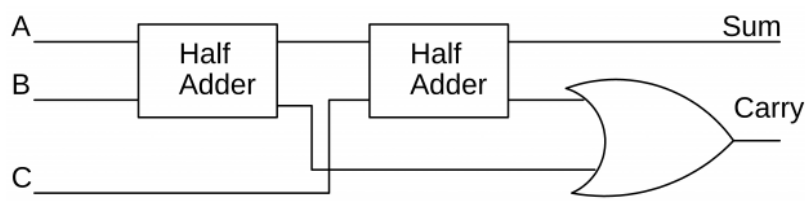
Truth Table:

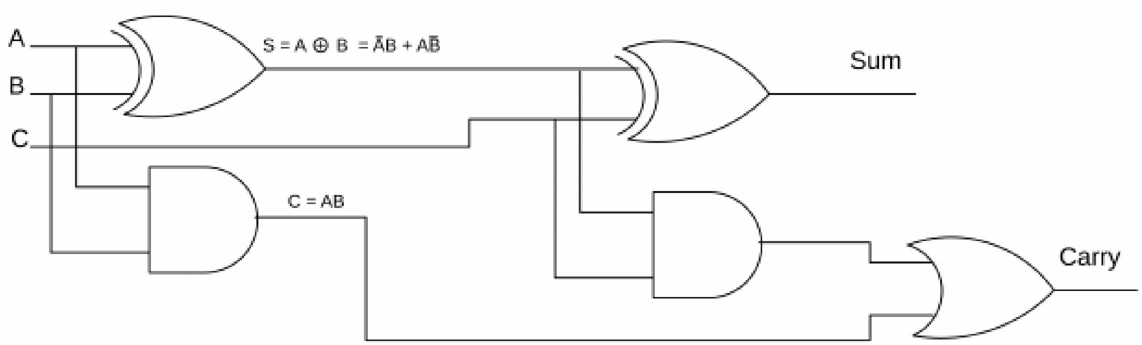
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

2. Full Adder:

The downfall of half adders is that while they can generate a carry out output, they cannot deal with a carry in signal. This means that they can only ever be stand-alone units, and catted to add multiple bit numbers.

A full adder solves this problem by adding three numbers together - the two addends as in the half adder, and a carry in input. The outputs of the full adder are designated as Sum (S) and Carry Out (C_{out}). A block diagram of Full Adder implementation is as follows:





$$\text{Sum}(A,B,C) = \bar{A}\bar{B}C+\bar{A}B\bar{C}+A\bar{B}\bar{C}+ABC$$
$$\text{Carry}(A,B,C) = \bar{A}BC+A\bar{B}C+AB\bar{C}+ABC$$

Truth Table:

Inputs			Outputs	
A	**B**	**Cin**	**S**	**Cout**
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

Subtractor:

In electronics, a subtractor is a digital circuit that performs subtraction of numbers.

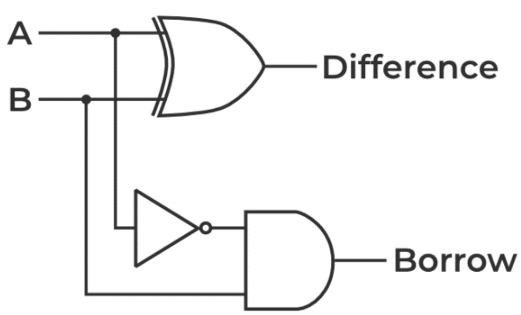
For single bit adders, there are two general types:

1. Half Subtractor
2. Full Subtractor

1. Half Subtractor

A half subtractor circuit performs the subtraction of two binary inputs and has two binary outputs as a result. The outputs of the half subtractor are designated as Difference (D) and Borrow (B). The difference and borrow are the binary difference and borrow and has either '0' or '1' logic.

Circuit Diagram:



D = A'B + AB' = $A \oplus B$

B = A'B

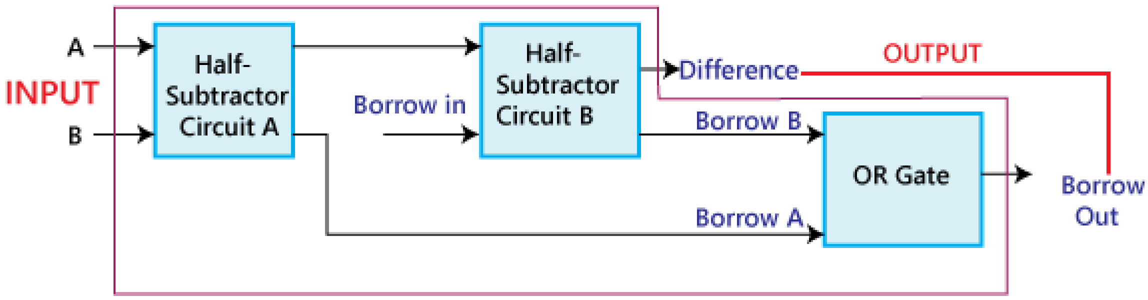
Truth Table:

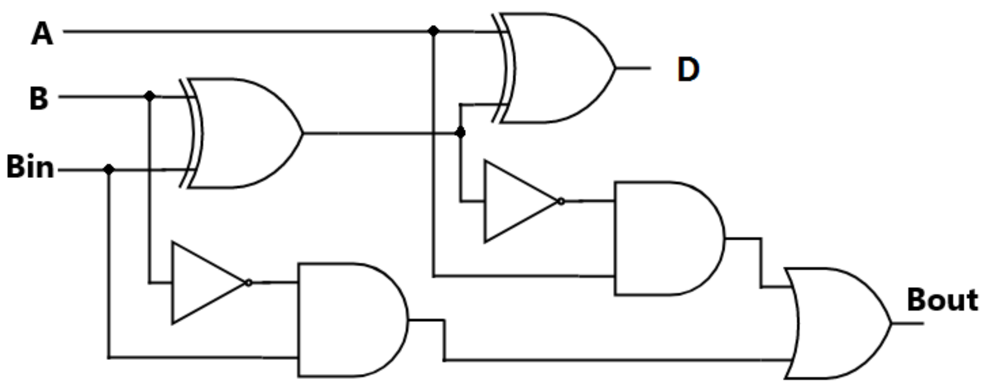
A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

2. Full Subtractor

Full subtractor is a logic circuit that performs binary subtraction of two 2-bit numbers. It generates two outputs namely "Difference" and "Borrow".

Circuit Diagram:





$D = A'B'B_{in} + AB'B_{in}' + A'BB_{in}' + ABB_{in} = A \oplus B \oplus B_{in}$

$B_{out} = A'B_{in} + A'B + BB_{in}$

Truth Table:

Inputs			Outputs	
A	**B**	**Bin**	**D**	**Bout**
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