



American International University- Bangladesh

Department of Electrical and Electronic Engineering

EEE2104: Digital Logic Design Laboratory

Title: Design of a Half, Full and Parallel adder and subtractor circuits.

Introduction:

Adders and subtractors are digital circuits which are capable of adding and subtracting binary digits. They are the most important part in the design of Arithmetic Logic Unit (ALU). In this experiment different types of adders and subtractors will be designed and their behavior will be observed.

Theory and Methodology:

An adder or summer is a combinational circuit that adds binary numbers. There are mainly two kinds of adders, half adder and full adder. The half adder can add only two single bits of binary digit and outputs the sum of the bits and a carry which is the overflow of the sum. A full adder can add two single bit digits and one carry bit which is the overflow of the sum of the previous stage of addition and outputs the sum and the carry.

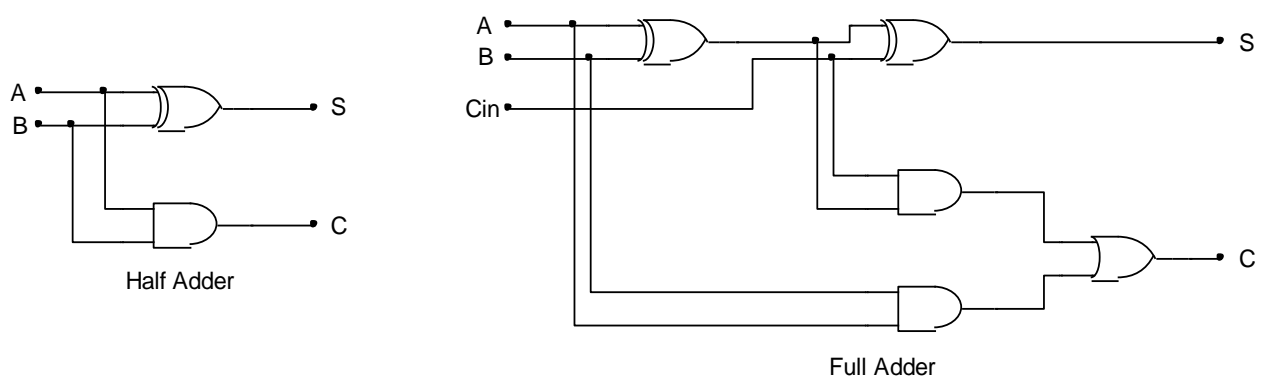


Fig.1: Schematics of Half Adder and Full Adder

The Boolean expression for half and full adder is given below –

Half adder –

$$S = A \oplus B$$

$$C = AB$$

Full adder –

$$S = A \oplus B \oplus \text{Cin}$$

$$\text{Cout} = \text{Cin} (A \oplus B) + AB$$

Truth table for half adder –

| A | B | S | C |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |

Truth table for full adder –

| A | B | Cin | S | C |
|---|---|-----|---|---|
| 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 |

A subtractor is also a combinational circuit that calculates the difference of two binary digits. This is done by taking the two's complement of the subtrahend and then adding it with the minuend. So the subtractor circuit can be designed with the help of adder circuits. Like adders, there are two types of subtractor circuits, half subtractor and full subtractor.

A half subtractor performs a subtraction between two single bits and produces their difference and another output called borrow. A full subtractor performs a subtraction two single bits, taking into account a borrow bit. It outputs the difference of the subtraction and a borrow bit.

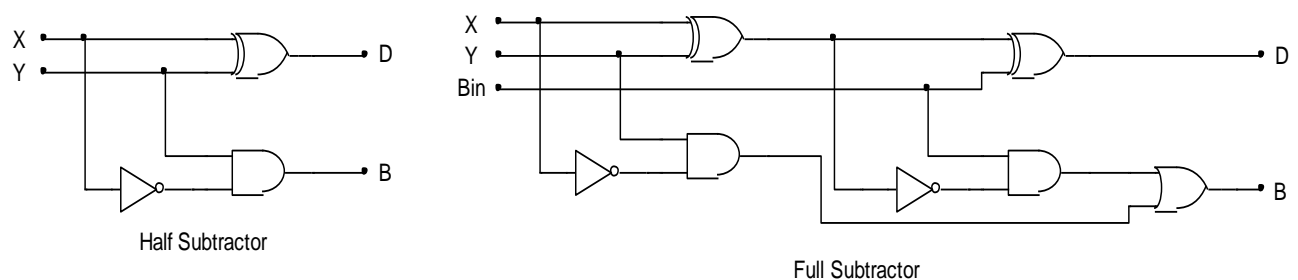


Fig.2: Schematics of Half Subtractor and Full Subtractor

The Boolean expressions for half and full subtractor are given below –

Half subtractor –

$$D = X \oplus Y$$

$$B = X'Y$$

Full subtractor –

$$D = X \oplus Y \oplus \text{Bin}$$

$$\text{Bout} = X'Y + X'\text{Bin} + Y\text{Bin}$$

Truth table for half subtractor –

| X | Y | D | B |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |

Truth table for full subtractor –

| X | Y | Bin | D | B |
|---|---|-----|---|---|
| 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 |

Pre-Lab Homework:

Read about the characteristics of adder and subtractor circuits from any book or websites and use NI Multisim to generate the output of the circuits provided in this lab sheet. Save the simulation results and bring it to the lab.

Apparatus:

- | | |
|------------------------|--------|
| 1. XOR Gates -IC 7486 | 3[pcs] |
| 2. AND Gates - IC 7408 | 3[pcs] |
| 3. NOT Gates -IC 7404 | 2[pcs] |

Precautions:

1. Make sure that all the LEDs and the toggle switches of the trainer board are working properly.
2. Do not short any connections. Short connection can produce heat (due to high current flow) which is harmful for the components.

Experimental Procedure:

1. Connect the circuit according to the figures.
2. Use the toggle switches on the trainer board for providing input signal to the circuits. Connect the outputs to the LEDs on the trainer board.
3. Apply the input signals according to the truth table and observe and note the corresponding output signals.

Simulation and Measurement:

Compare the simulation results with your experimental data and comment on the differences (if any).

Results/ Findings:

Students will implement the circuit in the Trainer Board and match the theoretically obtained truth table by matching outputs for individual input configurations. If the practically obtained truth table does not match they will also investigate the errors.

Reference:

<http://www.circuitstoday.com/half-adder-and-full-adder>