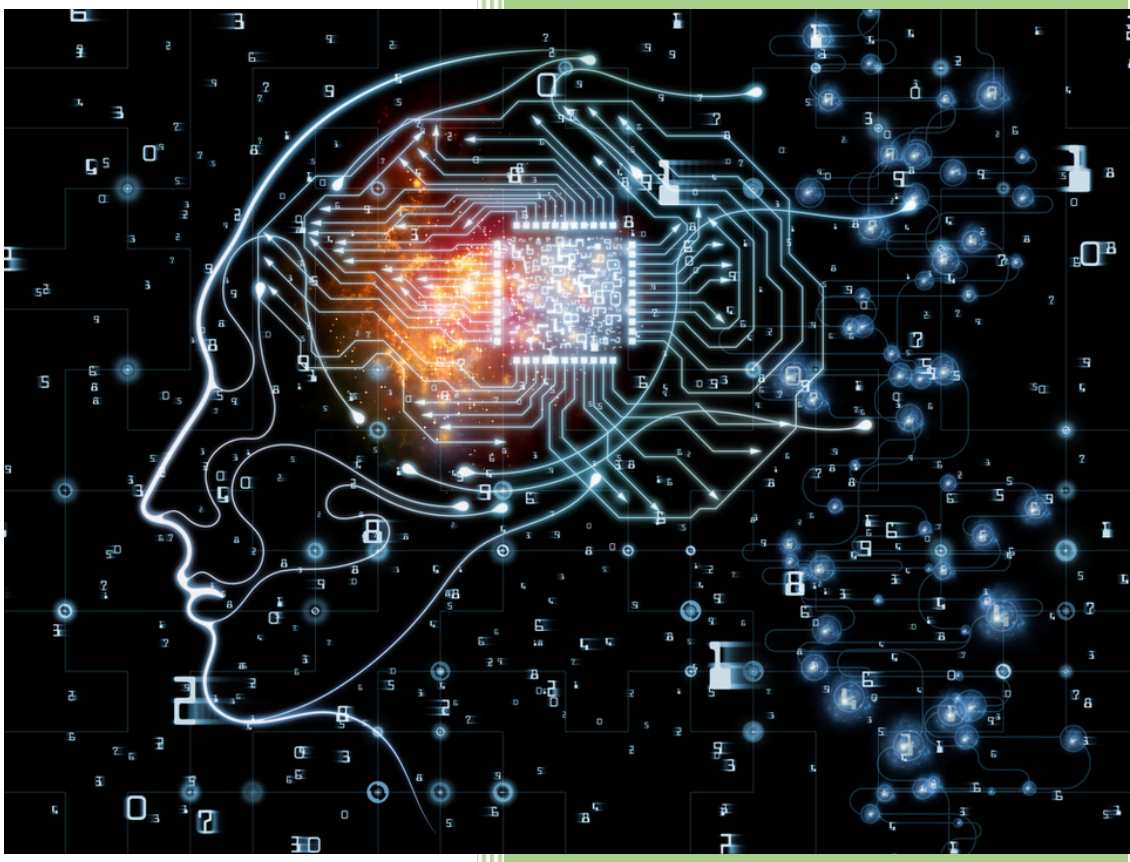
Digital Logic Design Project



4-bit full adder

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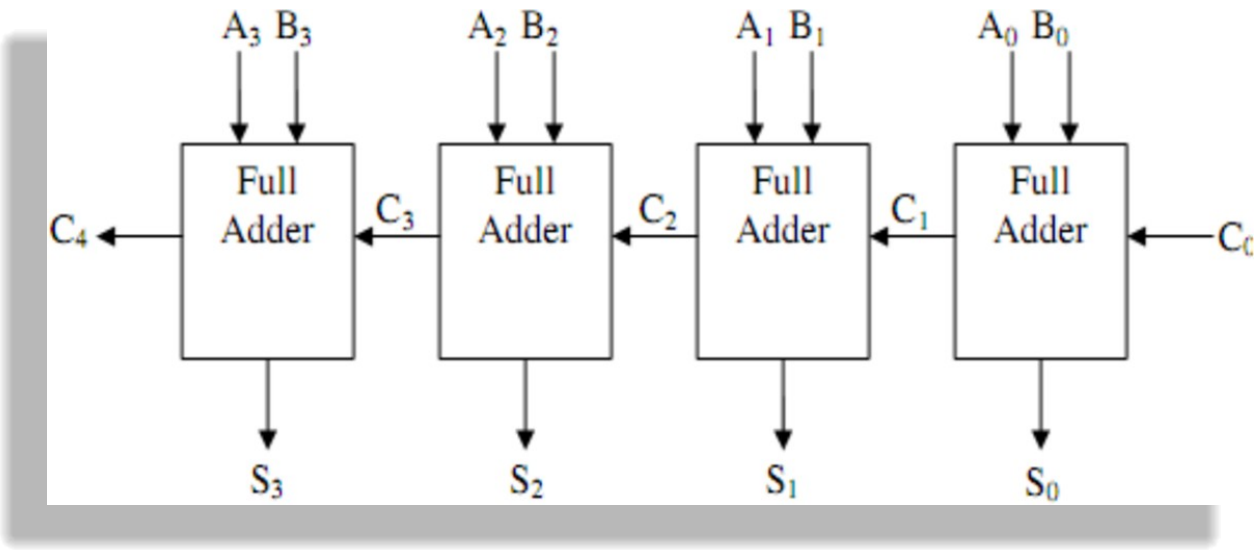
Timeline:	22/05/2023

Contents

4 – Bit full adder



Idea

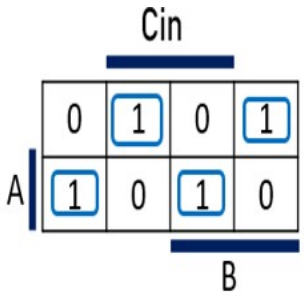
- A four bit full Adders is a Logical Circuit that takes Carry and two expressions with four bits as its inputs (A and B) and a carry-in bit (C-in), and as a result shows the Four bits and two outputs: the sum of the two numbers (S) and a carry-out bit (C-out)." The Circuit of Four bit Full Adder consists of the XOR Gate, AND Gate and OR Gate. We have learnt about them in detail.
- 4-bit full adder is used to minimize the total delay of the adder, the area used to implement the adder, and its average power consumption.

Objective

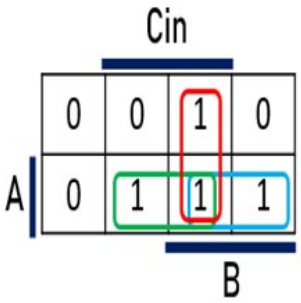
- 4-bit full adder performs the function of 4-bit addition that gives a sum and two bits of carry as output.

K-maps & Full adder Diagram

Sum:



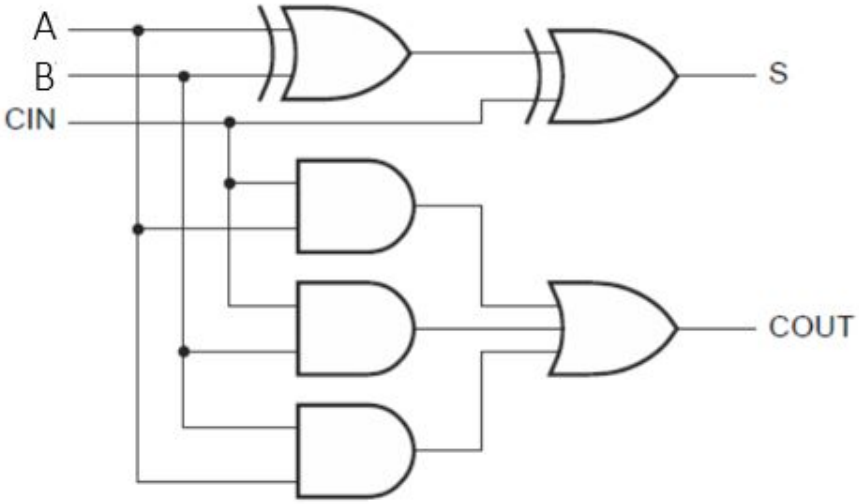
Carry-Out:



Sum: A' B' Cin + A B' Cin + A B Cin

Sum: A ⊕ B ⊕ Cin

Carry-Out: A Cin + A B + B Cin



Boolean Function

S0 = A0 ⊕ B0 ⊕ Cin

Cout0 = A Cin + A B + B Cin

S1 = A1 ⊕ B1 ⊕ Cout0

Cout1 = A Cin + A B + B Cin

S2 = A2 ⊕ B2 ⊕ Cout1

Cout2 = A Cin + A B + B Cin

S3 = A3 ⊕ B3 ⊕ Cout2

Cout3 = A Cin + A B + B Cin

Code of Truth Table

```
#include <iostream>
#include <iomanip>
using namespace std;
void generateTruthTable() {
    int a[4], b[4], carryIn, carryOut, sum[4];
    cout << setw(4) << "A3" << setw(4) << "A2" << setw(4) << "A1" << setw(4) << "A0"
        << setw(4) << "B3" << setw(4) << "B2" << setw(4) << "B1" << setw(4) << "B0"
        << setw(8) << "CarryIn"
        << setw(10) << "CarryOut"
        << setw(8) << "Sum3" << setw(8) << "Sum2" << setw(8) << "Sum1" << setw(8) <<
"Sum0" << endl;
    for (int i = 0; i < 16; ++i) {
        a[3] = (i & 8) >> 3;
        a[2] = (i & 4) >> 2;
        a[1] = (i & 2) >> 1;
        a[0] = (i & 1);
        for (int j = 0; j < 16; ++j) {
            b[3] = (j & 8) >> 3;
            b[2] = (j & 4) >> 2;
            b[1] = (j & 2) >> 1;
            b[0] = (j & 1);
            carryIn = 0;
            carryOut = 0;
            for (int k = 0; k < 4; ++k) {
                sum[k] = a[k] ^ b[k] ^ carryIn;
```

```
            carryOut = (a[k] & b[k]) | ((a[k] ^ b[k]) & carryIn);
            carryIn = carryOut;
         }

        cout << setw(4) << a[3] << setw(4) << a[2] << setw(4) << a[1] << setw(4) << a[0]
            << setw(4) << b[3] << setw(4) << b[2] << setw(4) << b[1] << setw(4) << b[0]
            << setw(8) << carryIn
            << setw(10) << carryOut
            << setw(8) << sum[3] << setw(8) << sum[2] << setw(8) << sum[1] << setw(8) <<
sum[0] << endl;
      }
   }
}
int main() {
   generateTruthTable();
}
```

Truth Table

A3	A2	A1	A0	B3	B2	B1	B0	CIn	COut	S3	S2	S1	S0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0	0	0	1
0	0	0	0	0	0	1	0	0	0	0	0	1	0
0	0	0	0	0	0	1	1	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	0	1	0	1	0	0	0	1	0	1
0	0	0	0	0	1	1	0	0	0	0	1	1	0
0	0	0	0	0	1	1	1	0	0	0	1	1	1
0	0	0	0	1	0	0	0	0	0	1	0	0	0
0	0	0	0	1	0	0	1	0	0	1	0	0	1
0	0	0	0	1	0	1	0	0	0	1	0	1	0
0	0	0	0	1	0	1	1	0	0	1	0	1	1
0	0	0	0	1	1	0	0	0	0	1	1	0	0
0	0	0	0	1	1	0	1	0	0	1	1	0	1
0	0	0	0	1	1	1	0	0	0	1	1	1	0
0	0	0	0	1	1	1	1	0	0	1	1	1	1
0	0	0	1	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	1	0	0	0	0	1	0
0	0	0	1	0	0	1	0	0	0	0	0	1	1
0	0	0	1	0	0	1	1	0	0	0	1	0	0
0	0	0	1	0	1	0	0	0	0	0	1	0	1
0	0	0	1	0	1	0	1	0	0	0	1	1	0
0	0	0	1	0	1	1	0	0	0	0	1	1	1

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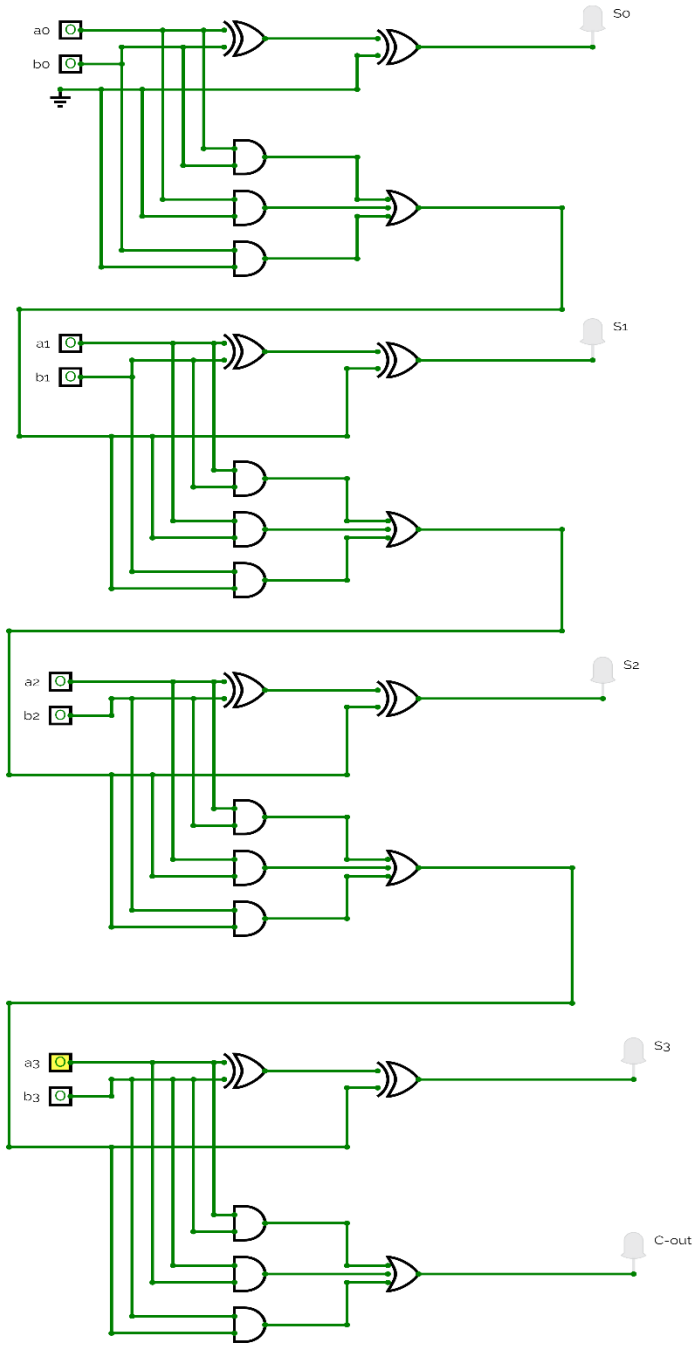
Simulator

Circuit’s link:

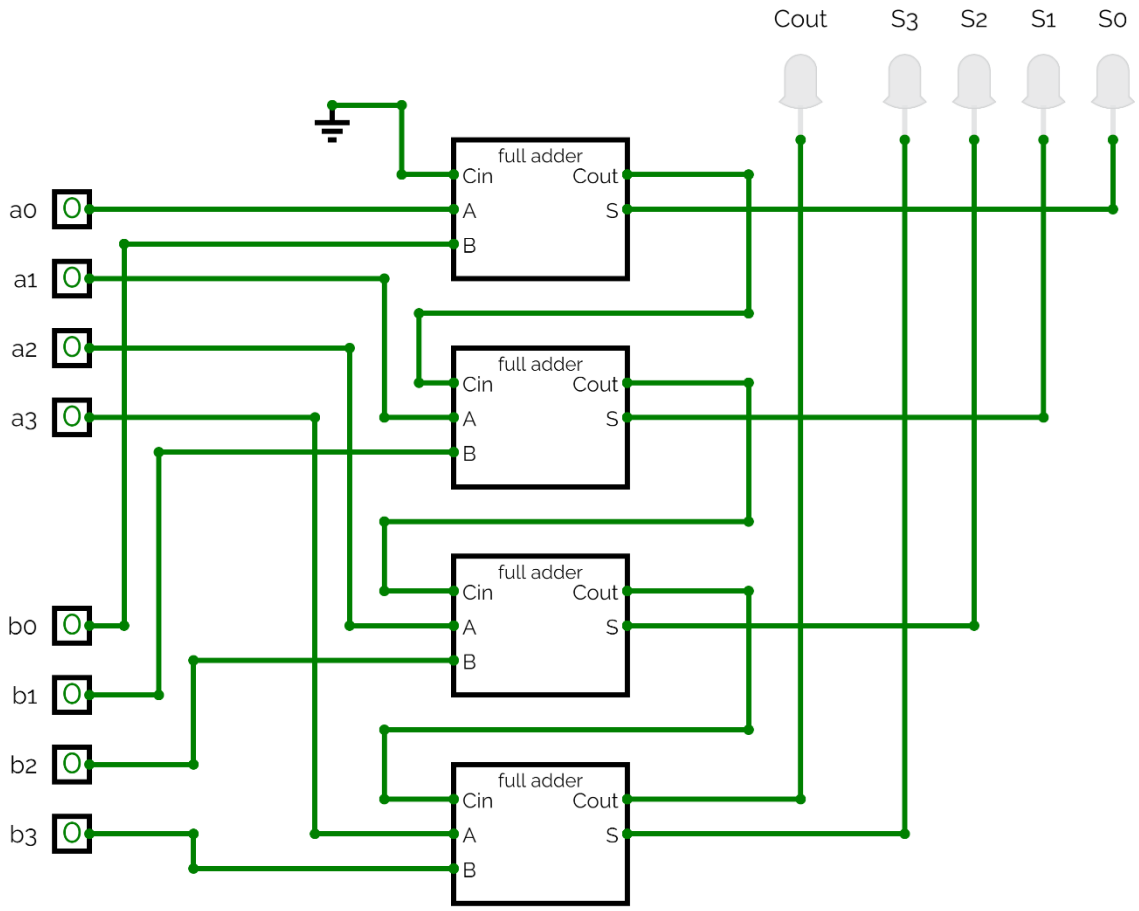
https://circuitverse.org/simulator/embed/finalsimulatoryarab



Simulator with IC

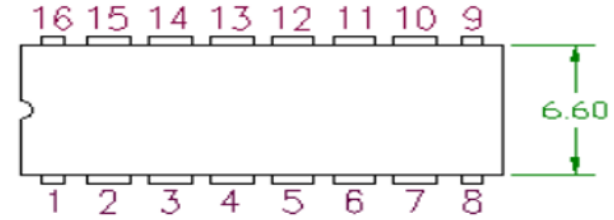
Circuit's Link:

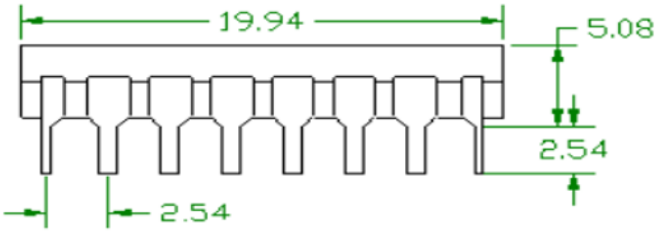
https://circuitverse.org/simulator/embed/4-bitfulladder_with_ic



Hardware Data Sheet

The data sheet information of the 4-bit full adder IC:





Pin Number	Description
1	A4 Input
2	Sum 3 Output
3	A3 Input
4	B3 Input
5	Vcc - Positive Power Supply
6	Sum 2 Output
7	B2 Input
8	A2 Input
9	Sum 1 Output
10	A1 Input
11	B1 Input
12	Gnd - Ground
13	C0 Input
14	C4 Input
15	Sum 4 Output
16	B4 Input

Components of Hardware

- switches 4 bit
- 13 resistor 1k
- IC of 4-bit full adder
- A power supply of 6 volts
- Connection wires
- Breadboard