CALCULATOR

1. INTRODUCTION

We have implemented a calculator which performs the basic 4 operations which are addition,subtraction,division,multiplication.

WORKING PROCEDURE

Input is given from the user using 4*3 Keypad which is connected to an arduino,From the arduino the input is sent to icoboard when the mathematical computation is done and the result is sent back to another arduino which is connected to an LCD where the output is displayed. After the two 4 BIT numbers are entered if 0 is pressed addition is done,if 1 is pressed subtraction is done,if 2 is pressed division is done.Due to lack of pins in arduino to perform 4 BIT multiplication we have shown the results of multiplication in Serial monitor.

REQUIRED COMPONENTS

Icoboard, SD card, LCD, 4*3 keypad, jumper wires, potentiometer, Breadboard, 2 Arduinos.

ALGORITHM EXPLANATION FOR ADDITION AND SUBTRACTION

Let A and B be two 4-bit inputs(which are 4 input buses, each) and Cin is input carry.If Cin is â0â 4-bit addition is performed when its â1â 4-bit subtraction is performed. The 4 Bit Full Adder performs addition of two 4-bit inputs A and B (which are 4 input buses, each) along with a Carry-in which will be 0 for addition, and gives out a 4 Bit Sum and a Carry-Out Bit. The 4 Bit Full Subtractor performs the subtraction of B from A (4 input buses, each) and gives a 4 Bit Difference along with a Borrow Bit. We can construct a 4 Bit Full Adder using four 1 Bit Full Adders in a specific way. Letâs see how the Truth Table of a 1 Bit Full Adder looks.

S=!Cin.A.!B+!Cin.!X.Y+Cin.!X.!Y+Cin.X.Y

Cout = A.B + B.Cin + Cin.A

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

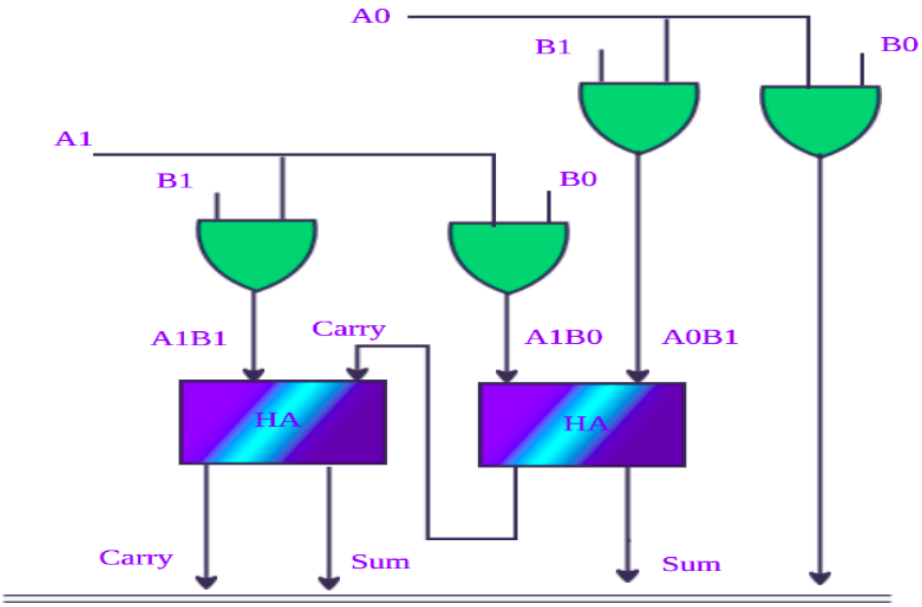
For a N bit adder we have 4 bits in the A bus: A3, A2, A1, A0 and 4 bits in the B bus: B3, B2, B1, B0. Here, the bits A3 and B3 represent the MSB (Most Significant Bit). The corresponding bits are added, bitwise and if thereâs Carry generated itâs passed on to the next bit where it should be added. Since we are adding only two such numbers, 4 bits for Sum and one additional bit for Carry-Out would be sufficient.

For a 4 Bit Subtractor, we can obtain the result using 2âs complement of B. 2âs complement of B would be B! + 1. Hence A - B = A + B! + 1. Hence by including an XOR gate just before sending the input bits of B to the Full Adder, we can get the operation of Subtraction. The two inputs to the XOR gate would be each individual B bit along with Cin.

ALGORITHM EXPLANATION FOR MULTIPLICATION

Multiplier is very similar to decimal multiplication.Note that in binary multiplication, the processes involves shifting the multiplicand, and adding the shifted multiplicand or zero. Each bit of the multiplier determines whether a 0 is added or a shifter version of the multiplicand (0 implies zero added, 1 implies shifted multiplicand added). Thus, we can infer a basic shift-and-add algorithm to implement unsigned binary multiplication. The implementation is discussed in details with diagram

Circuit Level Implementation of multiplier is shown below



The block diagram implementation of multiplier shows that the circuit requires four AND gates and two half-adders.We extended the same for 4 BIT numbers in our algorithm

ALGORITHM EXPLANATION OF 4 BIT DIVISION

Here we have explained the algorithm we used for two 4 BITS division.Let us take an example for better understanding
11 divided by 3
11 is 1011 in binary which is dividend.
03 is 0011 in binary which is divider.

```
      1011    |
    -0011     |
    ----------|      0   Difference is negative :Copy dividend and put 0 in quotient.
      1011    |
     -0011    |
    ----------|     00   Difference is negative :Copy dividend and put 0 in quotient.
      1011    |
     -0011    |
    ----------|    001   Difference is positive :Use difference and put 1 in quotient.
       0101   |
      -0011   |
    ----------|   0011   Difference is positive :Use difference and put 1 in quotient.
         10   |
```

Quotient in binary is 0011 which is 3 in decimal and remainder is 10 in binary which is 2 in decimal

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