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LAB 1:ADDITION OF TWO UNSIGNED INTEGER BINARY NUMBER

Objective:

- To design n-bit (4-bit) adder for unsigned integer binary numbers.

Theory:

An Adder is a digital logic circuit in electronics that performs the operation of additions of two number. Adders are classified into two types: half adder and full adder. The full adder (FA) circuit has three inputs: A, B and Cin, which add three input binary digits and generate two binary outputs i.e., carry and sum.

The truth table for full-adder is given below which shows the value of the carry out and sum under difference computational values of the input bits. It is clear that when all input bits are 0, the output (S) is 0. The S output is equal to 1 when only one input is equal to 1 or when all three inputs are equal to 1. The C output has a carry 1 if two or three inputs are equal to 1.

Input			Output	
A	B	C_{in}	Sum	Carry
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

From viewing the truth table, the Sum output is only a logic 1 when one or three (but not two) of the inputs is logic 1. The Boolean expression for this is (in reduced form):

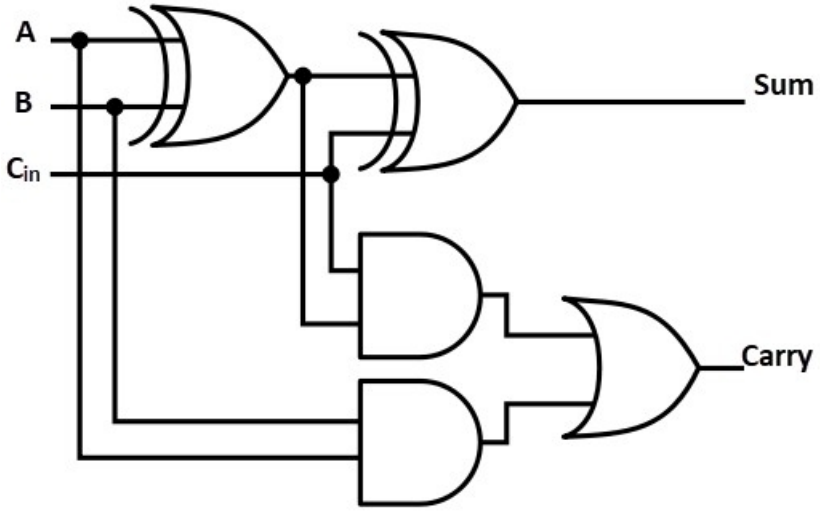
Sum = Cin ⊕ (A ⊕ B)

⊕ ⊕

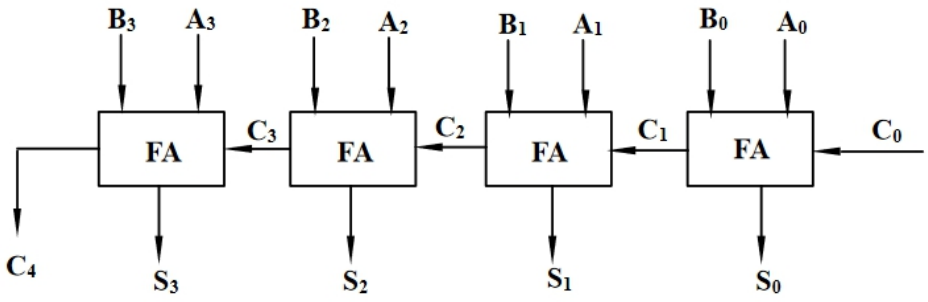
From viewing the truth table, the output is only a logic 1 when two or three of the inputs is logic 1. The Boolean expression for this is (in reduced form):

Carry = (A . B) + (Cin . (A ⊕ B))

This can be drawn as a circuit schematic as shown:



A 4-bit binary adder can be constructed with 4 full-adder connected in cascade with the output carry from one-full-adder connect to the input carry of the next full-adder.



Code:

```
function var = OR(a,b)
  if(a==0 && b==0)
   var = 0;
  else
   var = 1;
  endif
 Endfunction

function var = XOR(a,b)
```

```
  if(a!=b)
    var = 1;
  else
    var = 0;
   endif
Endfunction


function var = AND(a,b)
  if(a==1 && b==1)
   var =1;
   else
    var=0;
   endif
endfunction


function [sum,carry] = fulladder(a,b,c)
  sum = XOR(XOR(a,b),c);
  carry = OR(AND(a,b),AND(XOR(a,b),c));
endfunction


function [sum,carry] = adder(num1,num2)
  carry = 0;
  sum = zeros(1,length(num1));
  for i = length(num1):-1:1
    [sum(i),carry] = fulladder(num1(i),num2(i),carry);
  endfor
Endfunction
```

OUTPUT:

```
>> [sum,carry] = adder([1 0 1 0],[0 0 0 1 ])
sum =

   1   0   1   1

carry = 0
```

Discussion and Conclusion:

Therefore 4-bit binary adder can be designed using 4 full adders cascaded with one after another in series. The circuit implementation was visualized using functions and variables. The circuit consists of basic logic gates like AND, OR, XOR which were also implemented in code. So the binary adder was built with help of the full adder circuit while the full adder circuit was built with help of the basic gates.