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Ripple Carry Adder Design Using Universal Logic Gates

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Abstract

Now days a lot of refinements and huge amount of time is utilized on exploring layout to minimize the gate size or other circuitry such as an memory element or adder in an integrated circuit (IC). In this research paper an analysis on power and other parameters of Ripple Carry adder which is designed using UNIVERSAL GATES is discussed. And here layout design and simulation is done with the help of Microwind and DSCH tool.

Keywords: Full Adder, Ripple Carry Adder (RCA), Power, Simulation.

Introduction

Adder is basically a circuit used in digital arithmetic for addition of two numbers which can be designed with the help of CMOS[16]. And in today's scenario trend of CMOS (**C**omplementary Symmetry Metal Oxide Semiconductor) technology improvement continues to be driven with the need of integrating more functions within given silicon area that is single chip in order to increase operating speed, to reduce the cost and less power consumption. Past few years it is seen that there is tremendous use of nano-scale technologies for industrial production of high performance integrated circuits(IC) and the two important characteristics of CMOS devices which are very important are noise immunity and low static power consumption. So many researchers are working in this field to achieve such goals[1, 2, 3, 4, 5].

Here Microwind and DSCH software or tool is used (which is basically a CMOS circuit editor and simulation tool) for logic and layout-level design which was developed since 1998[6].

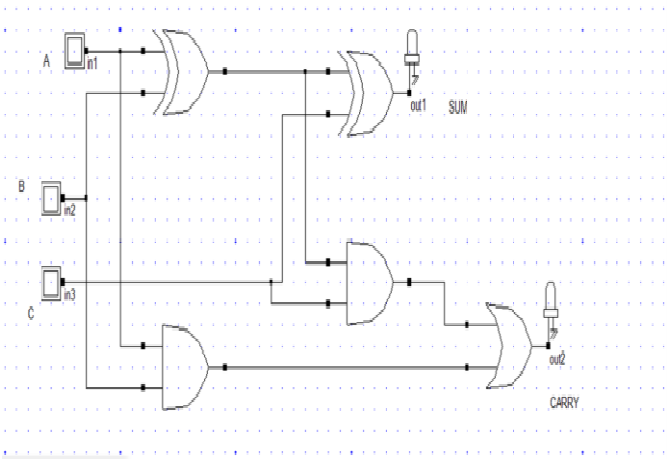
In this paper, a Ripple Carry Adder based on NAND and NOR logic gate layout is designed using Microwind as they are helpful in designing of multiplier and many other things. So firstly we design all the individual components and then further their alignment and connected is done properly.

Material and Methods

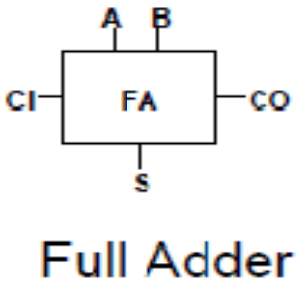
Firstly here Full Adder design is discussed which is the basic component in designing of ripple carry adder

Basic Full adder: A full adder circuit is basically used for adding and consist of A_n, B_n and C_n-1 where A_n and B_n are the *n*th order bits of the numbers *A* and *B* respectively and C_n-1 is the carry generated from the addition of (*n*-1)th order bits and also has C (CI) as carry input, Co (carry/out2) as carry output and S (out1/SUM) as Sum.

Tables 1 show the truth table and figure 1(a-b) shows the logic and symbol of a 1-bit full adder.



(a)



Full Adder

(b)

Figure-1
(a) Logic and (b) Block Diagram of 1-bit basic Full Adder

Table-1
Truth Table of 1-bit basic Full Adder

Input Bit for Number		Carry Input(C/CI)	Sum bit Output(S)	Carry Bit output(Co)
A	B			
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

Ripple Carry adder: Logical circuit with multiple full adders can be used for adding *N*-bit numbers and each full adder inputs a *Cin*, which is the *Cout* of the previous adder. Such kind of adder is known as *Ripple Carry Adder*, since each carry bit "ripples" to the next full adder

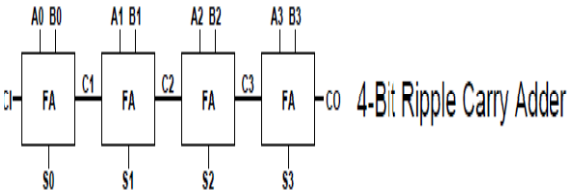


Figure-2
Block Diagram of 4-Bit Ripple Carry Adder

So ripple carry adder in digital electronics is that circuit which produces the arithmetic sum of two binary numbers which can be constructed with full adders connected in cascaded with the carry output from each full adder connected to the carry input of the next full adder in the chain as shown in figure 2. From which it can be noticed that bits a0and b0 in the figure represent the least significant bits of the numbers which is to be added and sum in form of output represented by the bits s0–s3.

Ripple Carry Adder Design Using Universal Gates: NAND Gate: Figure 3 shows how NAND gates are replaced by XOR gate and in figure 4 design of RCA based on NAND gate and its symbol, this is done simply just by replacing XOR gate of Full adder by NAND gate.

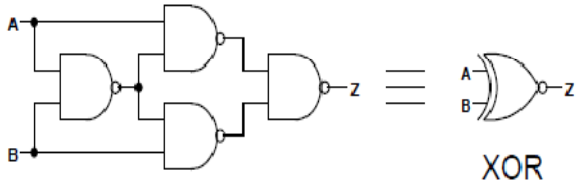


Figure-3
Replacement of XOR gate by NAND gate

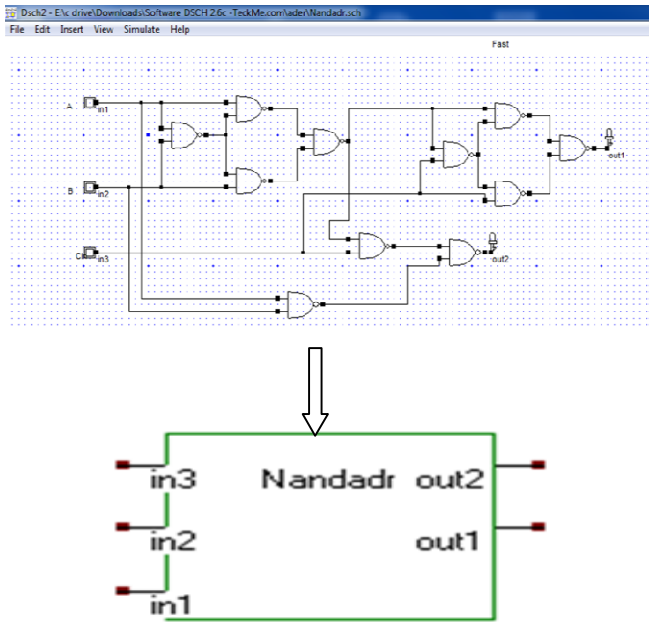
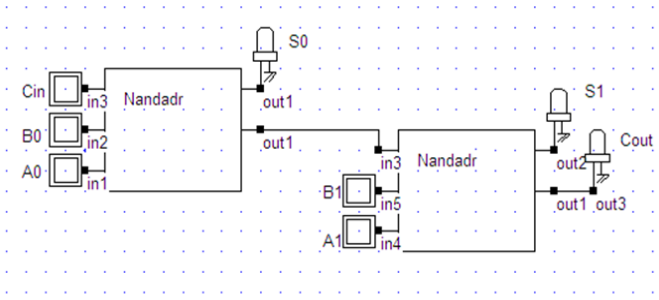
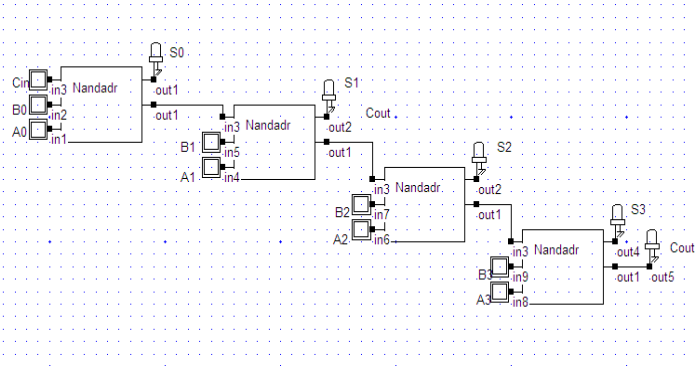


Figure-4
RCA design using NAND gate and its symbol

Figure 5 shows n-Bit RCA NAND gate based design just by cascading block symbol of RCA using NAND gate.



(a)



(b)

Figure-5(a-b)
(a) 2-Bit RCA (b) 4-Bit RCA realization using NAND gate realization

Figure-6 shows the layout diagram designed under Microwind tool/ software.

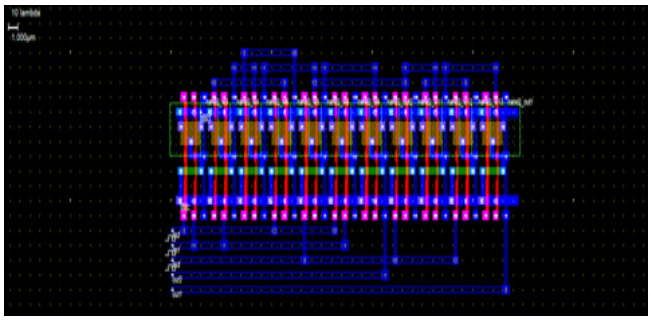


Figure-6
Layout Diagram of NAND gate based RCA

NOR Gate: Figure-8 shows the design of RCA based on NOR gate simply just by replacing gates used in basic Full adder which is shown in figure-7.

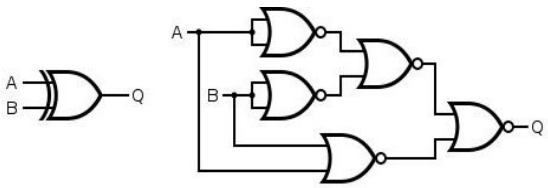


Figure-7
Replacement of XOR gate by NOR gate

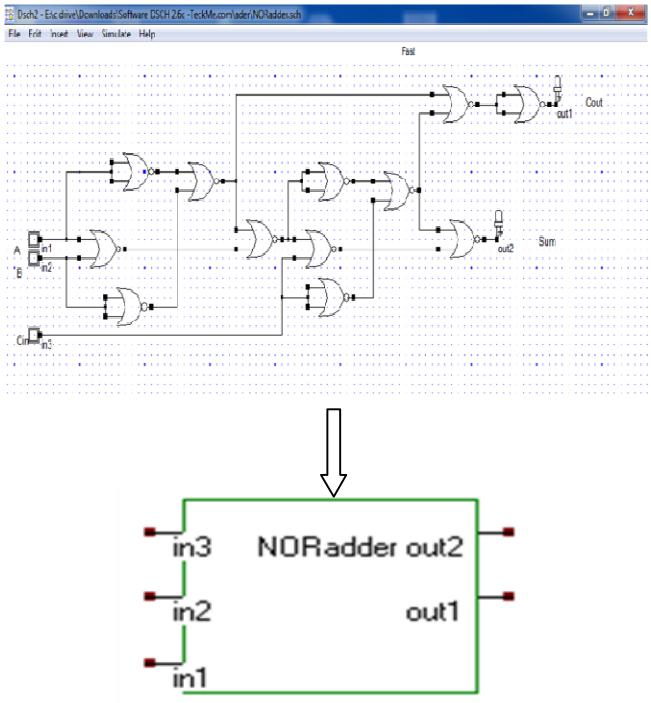
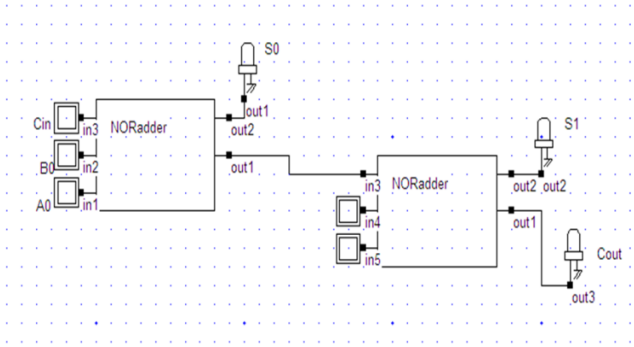
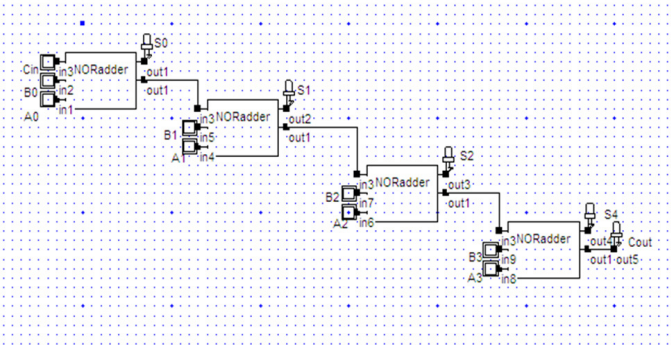


Figure-8
RCA design based on NOR gate and its symbol

Figure-9 shows how n-Bit RCA NOR gate based can be implement or design by cascading.



(a)



(b)

Figure-9(a-b)
(a) 2-Bit RCA (b) 4-Bit RCA realization using NOR gate realization

Figure-10 shows the layout diagram designed under Microwind tool/ software.

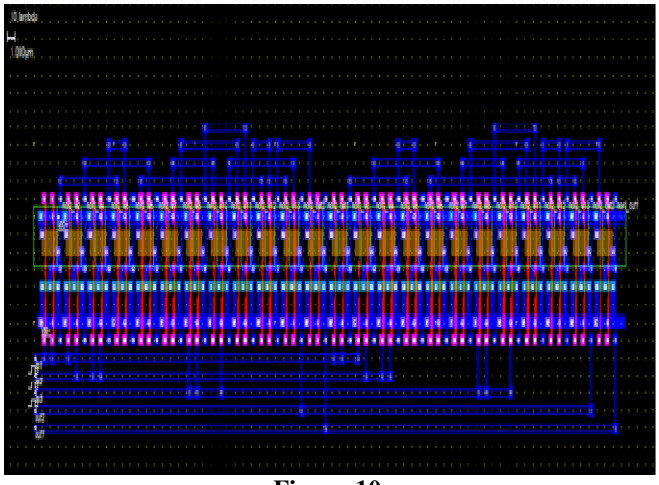


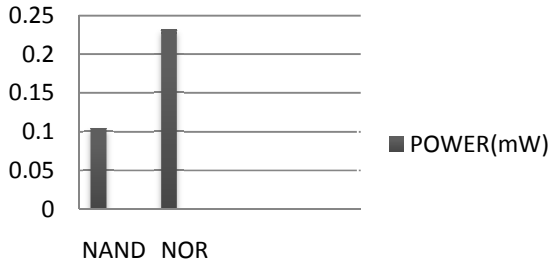
Figure-10
Layout Diagram of NOR gate based RCA

Results and Discussion

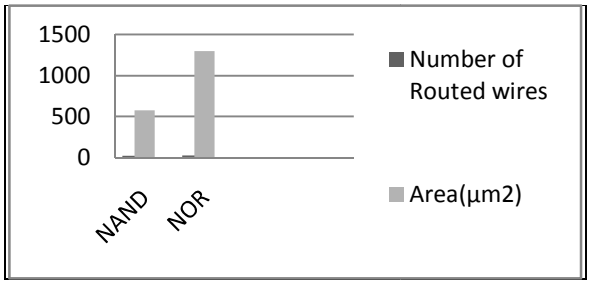
As CMOS logic dissipates less power than any other logic circuits since it talk about switching power (dynamic power) only. So Here power consumption and the number of routed wires of NAND and NOR based RCA Adder are displayed in table 2 as shown below. These results are obtained under Microwind software and designing is done under DSCH tool which is a part of Microwind software.

Table-2
Comparison of RCA design using Universal Gates

Universal gates	NAND	NOR
Number of Routed wires	24	26
Area(μm^2)	577.7	1298.1
Power(mW)	0.105	0.232



(a)

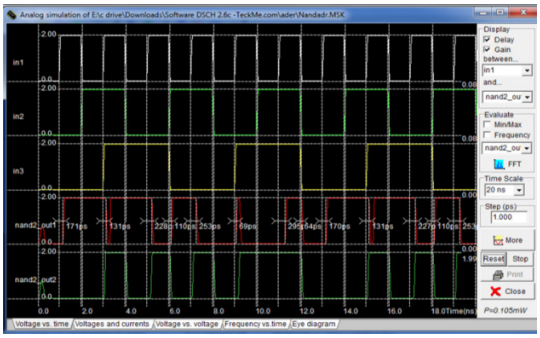


(b)

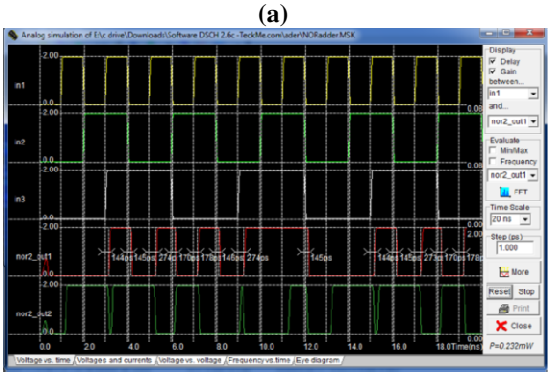
Figure-11
Graphical Presentation of (a) Power and (b) Area and Number of routing wires of NAND and NOR gate based RCA

Conclusion

In this paper a compact and basic 4 –bit Ripple Carry Adder designed using NAND and NOR gates (universal gates) which is shown with their design topology, detailed analysis and its ease of verification. Here while designing basic approach (that is gate level approach) is used and for that universal gate are used and found NAND gate based design proved to be more efficient than NOR gate based design. While other types of adders as Carry Select adder, Carry Skip Adder, Carry look ahead adder etc. require more area than the ripple carry adder. That's why there is always a scope to trade off between the speed and the size of the device while designing any adder circuit and can be used for various applications[7-10].



(a)



(b)

Figure-12
Analog simulation of NAND and NOR gate based RCA

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