



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF AIML

19ECB231 – DIGITAL ELECTRONICS

II YEAR/ III SEMESTER

UNIT 2 – COMBINATIONAL CIRCUITS

TOPIC - BCD ADDER, BINARY MULTIPLIER



BCD ADDER



A 4-bit binary adder that is capable of adding two 4-bit words having a BCD (binary-coded decimal) format. The result of the addition is a BCD-format 4-bit output word, representing the decimal sum of the addend and augend, and a carry that is generated if this sum exceeds a decimal value of 9.

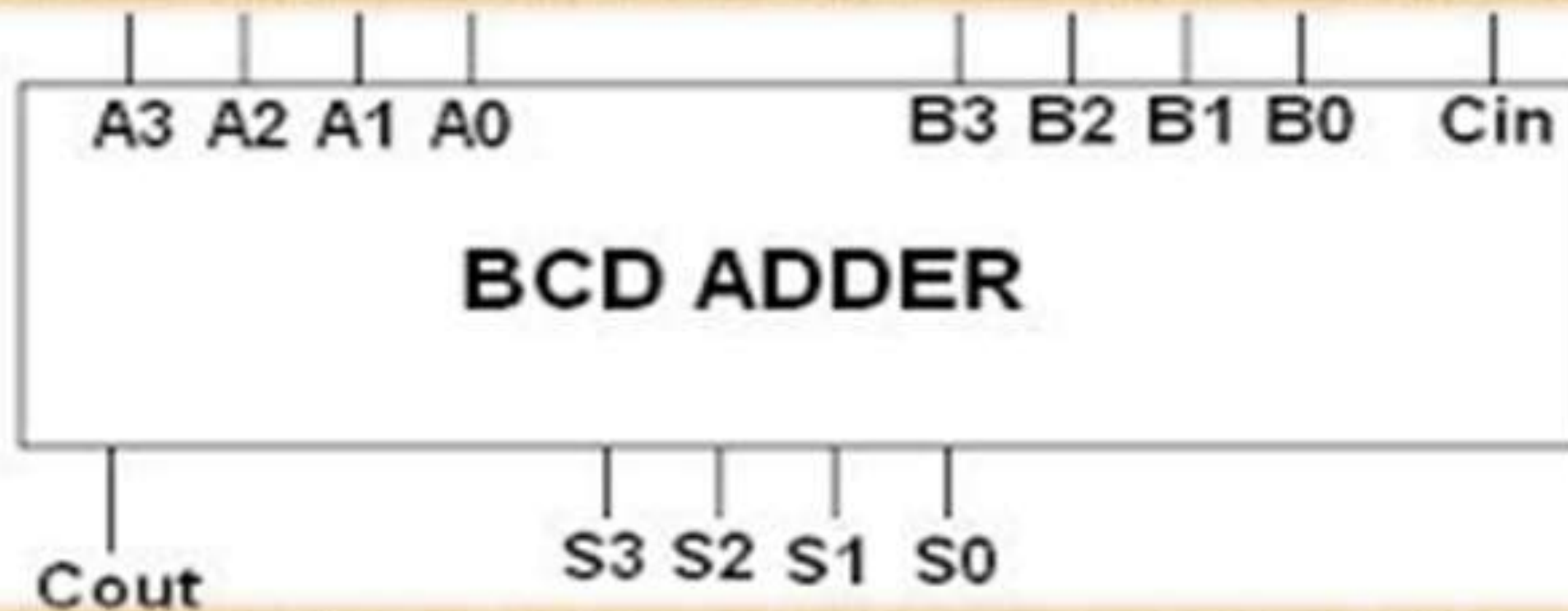


BCD ADDER



FUNCTIONS OF BCD ADDER

- A 4-bit BCD code's used to represent 0 to 9 digits.
- Adding BCD numbers using BCD addition.
- Adding 6 with the sum while exceeding 9 and generating a carry.
- By adding 6 to the sum, make an invalid digit valid.





BCD ADDER



(i) **Case I:** Sum equal to or less than 9 but carry = 0

Decimal	BCD	
7	0 1 1 1	
+ 1	0 0 0 1	
8	1 0 0 0	← Sum

Here, the sum is correct and is in the true BCD form.

(ii) **Case II:** Sum greater than 9 but carry = 0

Decimal	BCD		
7	0 1 1 1		
+ 4	0 1 0 0		
11	1 0 1 1		
	Invalid BCD number		



BCD ADDER



Combinational Logic

Here, it may noted that the sum 1011 is invalid BCD number, so, the answer is not correct. Hence, to correct the answer, we add six (0110) to the invalid BCD answer as under :

$$\begin{array}{r}
 1011 \leftarrow \text{Invalid BCD answer} \\
 + 0110 \leftarrow \text{Add } (6)_{10} \text{ for correction} \\
 \hline
 00010001 \leftarrow \text{Correct answer}
 \end{array}$$

(iii) **Case III:** Sum less than or equal to 9 but carry = 1
 Let us consider the following addition:

Decimal	+	BCD	
9		1 0 0 1	
+ 8	+	1 0 0 0	
-----		-----	
17	1	0 0 0 1	← Wrong result of addition
		}	Sum is invalid BCD number
	Final carry ←		

The result of addition is 0001 0001 = (11)₁₀ which is not correct. Hence, to correct the wrong result, we have to add six (0110) as shown below:

$$\begin{array}{r}
 0001 \leftarrow \text{Incorrect answer} \\
 + 0000 \\
 \hline
 0001 \\
 \underbrace{}_1
 \end{array}
 \qquad
 \begin{array}{r}
 0001 \leftarrow \text{Incorrect answer} \\
 + 0110 \leftarrow \text{Add 6 for correction} \\
 \hline
 0111 \leftarrow \text{Correct BCD answer} \\
 \underbrace{}_7
 \end{array}$$



WHY BCD ADDER IS USED?



The BCD-Adder is used in the computers and the calculators that perform arithmetic operation directly in the decimal number system. The BCD-Adder accepts the binary-coded form of decimal numbers. The Decimal-Adder requires a minimum of nine inputs and five outputs.



WHY BCD IS CALLED 8421 CODE?



The BCD_{8421} code is so called because each of the four bits is given a 'weighting' according to its column value in the binary system.



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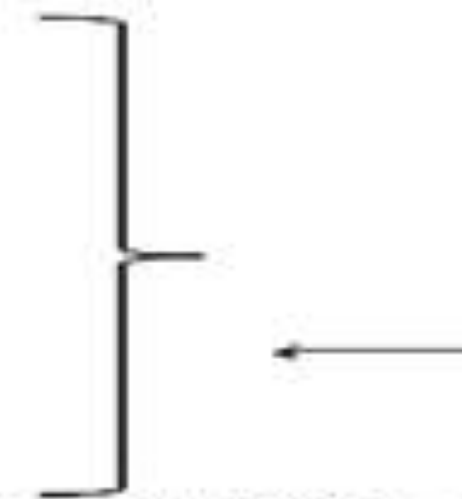
The BCD_{8421} code is so called because each of the four bits is given a 'weighting' according to its column value in the binary system.



TRUTH TABLE



Inputs				Output
S_3	S_2	S_1	S_0	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1



Sum is invalid BCD number. Hence Y= 1



BCD ADDER



K-map:

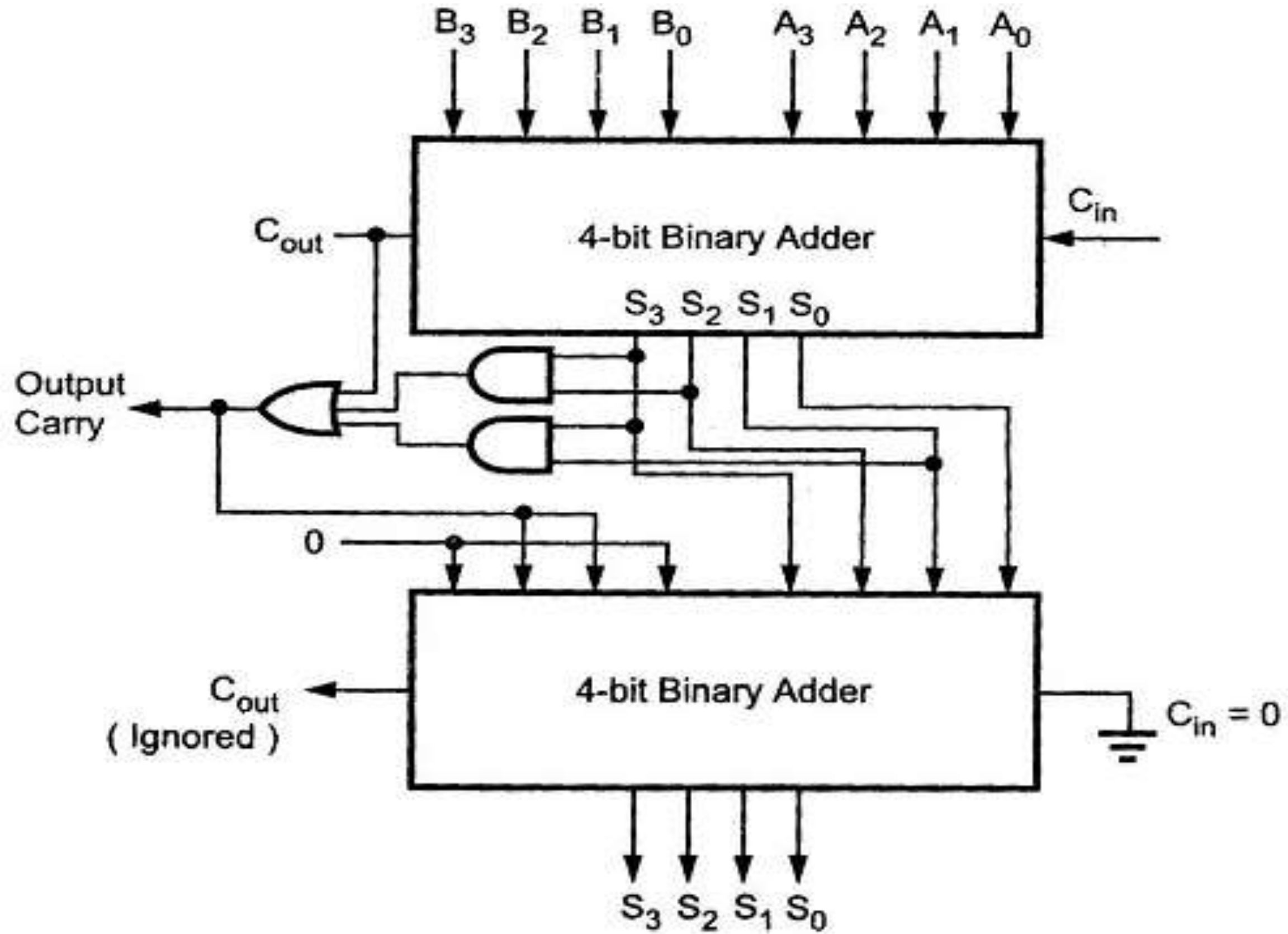
S_3S_2 \ S_1S_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

Annotations: A horizontal box encloses the '1's in the row where $S_3S_2 = 11$. A vertical box encloses the '1's in the column where $S_3S_1 = 1$.

The Boolean expression is
 $Y = S_3S_2 + S_3S_1$



BCD ADDER





BCD ADDER



Case II: Sum > 9 and carry = 0

If $S_3 S_2 S_1 S_0$ of adder-1 is greater than 9, then output Y of combinational circuit becomes 1.

Therefore, $B_3 B_2 B_1 B_0 = 0110$ (of adder-2)

Hence, six (0110) will be added to the sum output of adder-1. We get the corrected BCD result at the output of adder-2.

Case III: Sum ≤ 9 but carry = 1

As carry output of adder-1 is high, we have, $Y' = 1$.

Therefore, $B_3 B_2 B_1 B_0 = 0110$ (of adder-2)

Hence, 0110 will be added to the sum output of adder-1. We get the corrected BCD result at the output of adder-2. This is carried out using the binary adder.



WHAT IS BINARY MULTIPLIER?



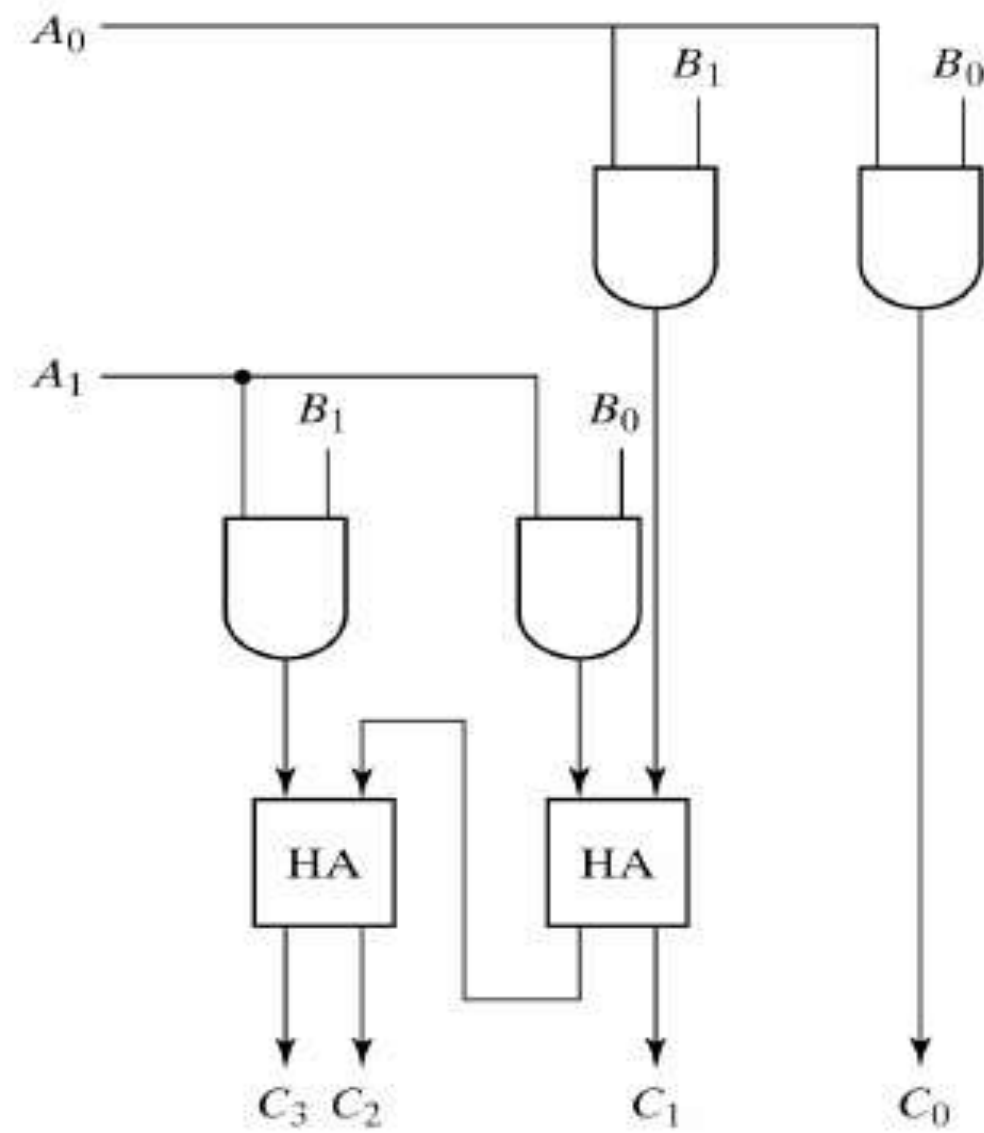
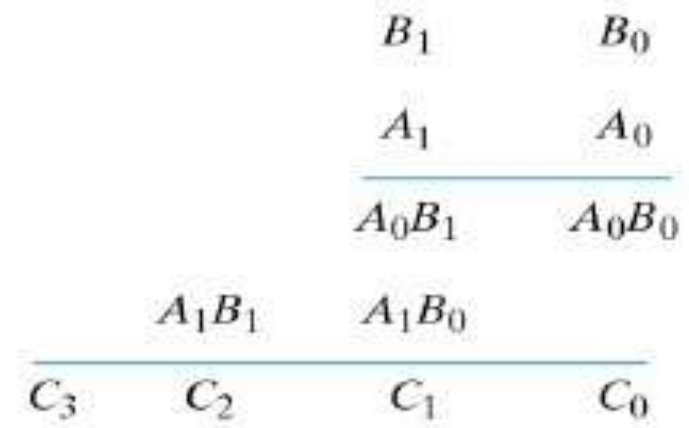
Multiply two binary numbers.

It is built using binary adders.

A variety of computer arithmetic techniques can be used to implement a digital multiplier.



2*2 BIT BINARY MULTIPLIER





THANK YOU