



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB231 – DIGITAL ELECTRONICS

II YEAR/ III SEMESTER

BCD ADDER, BINARY MULTIPLIER
/19ECB231/ Digital Electronics
/P.UmaMAheswari/AP/ECE/SNSCT

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.

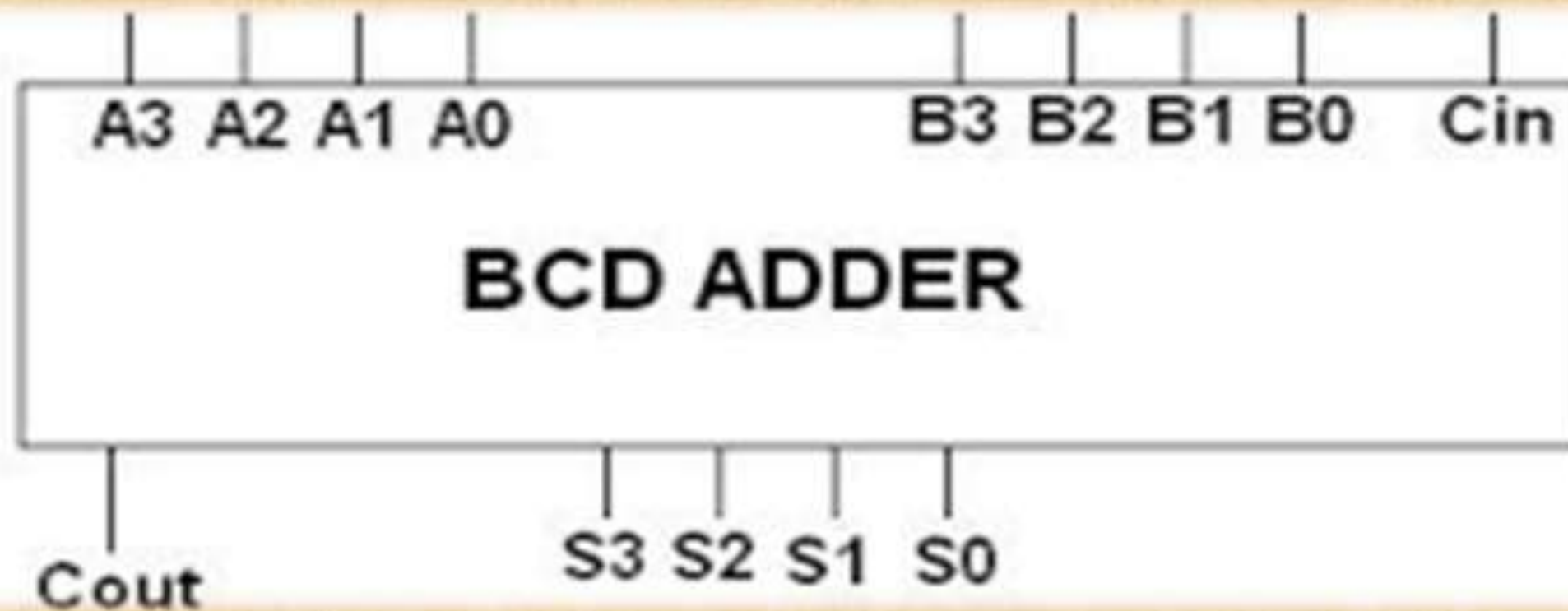


BCD ADDER



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 :

$$\begin{array}{r}
 1011 \leftarrow \text{Invalid BCD answer} \\
 + 0110 \leftarrow \text{Add } (6)_{10} \text{ for correction} \\
 \hline
 00010001 \leftarrow \text{Correct answer} \\
 \underbrace{1000}_1 \quad \underbrace{0001}_1
 \end{array}$$

(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
<hr style="width: 50%; margin: 0 auto;"/> 17		<hr style="width: 50%; margin: 0 auto;"/> 1 0 0 0 1
		← Wrong result of addition
	Final carry ←	← Sum is invalid BCD number

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:

$$\begin{array}{r}
 0001 \quad 0001 \leftarrow \text{Incorrect answer} \\
 + 0000 \quad 0110 \leftarrow \text{Add 6 for correction} \\
 \hline
 0001 \quad 0111 \leftarrow \text{Correct BCD answer} \\
 \underbrace{1000}_1 \quad \underbrace{0111}_7
 \end{array}$$



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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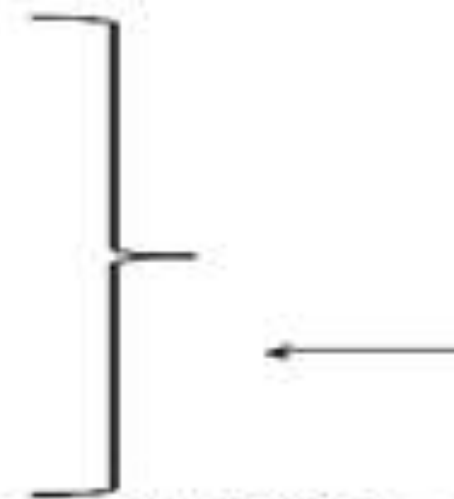
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TRUTH TABLE



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:

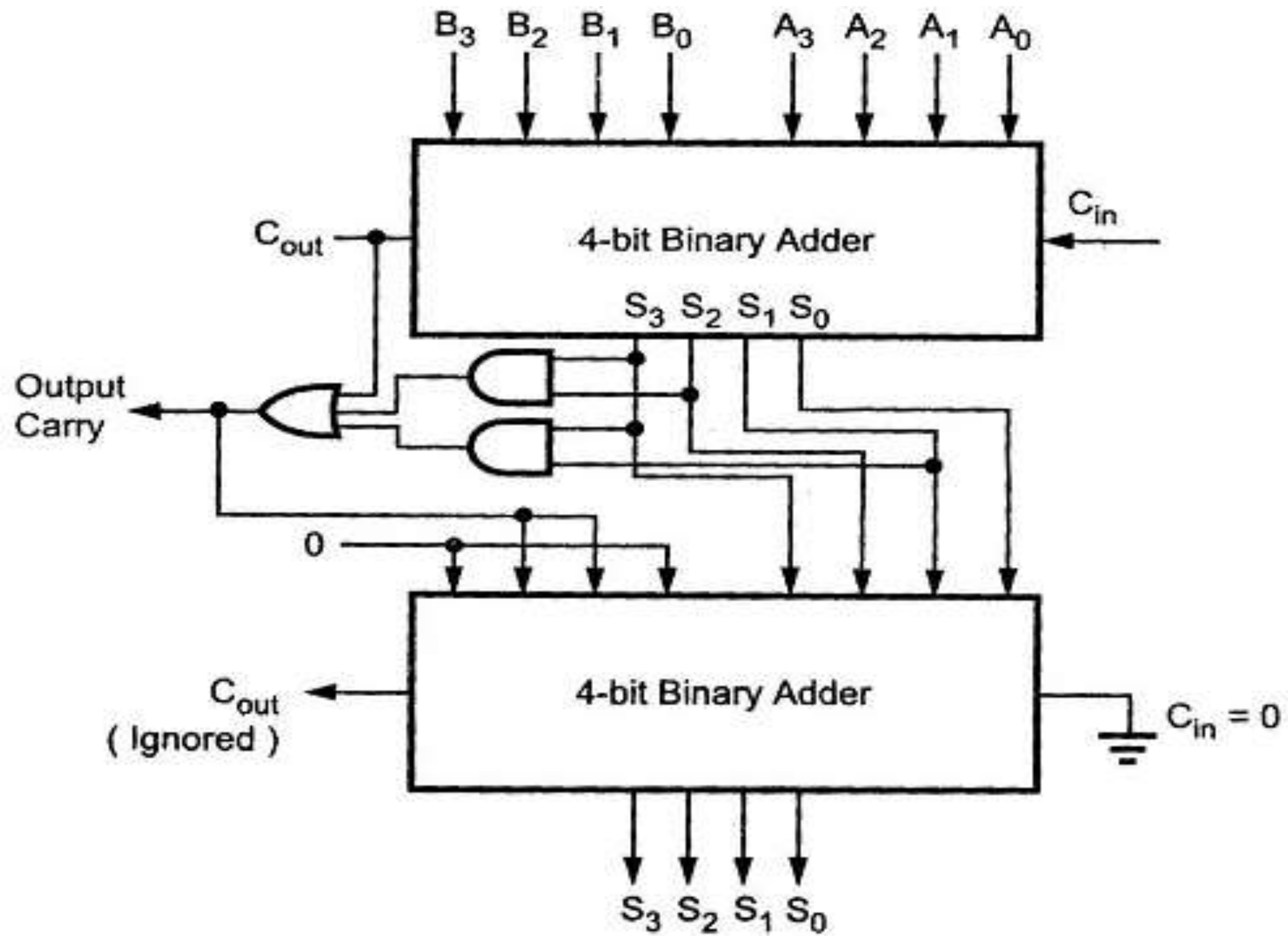
S_3S_2 \ S_1S_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

Annotations: A horizontal box encloses the '1' values in the $S_3S_2 = 11$ row, with an arrow pointing to the label S_3S_2 . A vertical box encloses the '1' values in the $S_3S_1 = 10$ column, with an arrow pointing to the label S_3S_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?



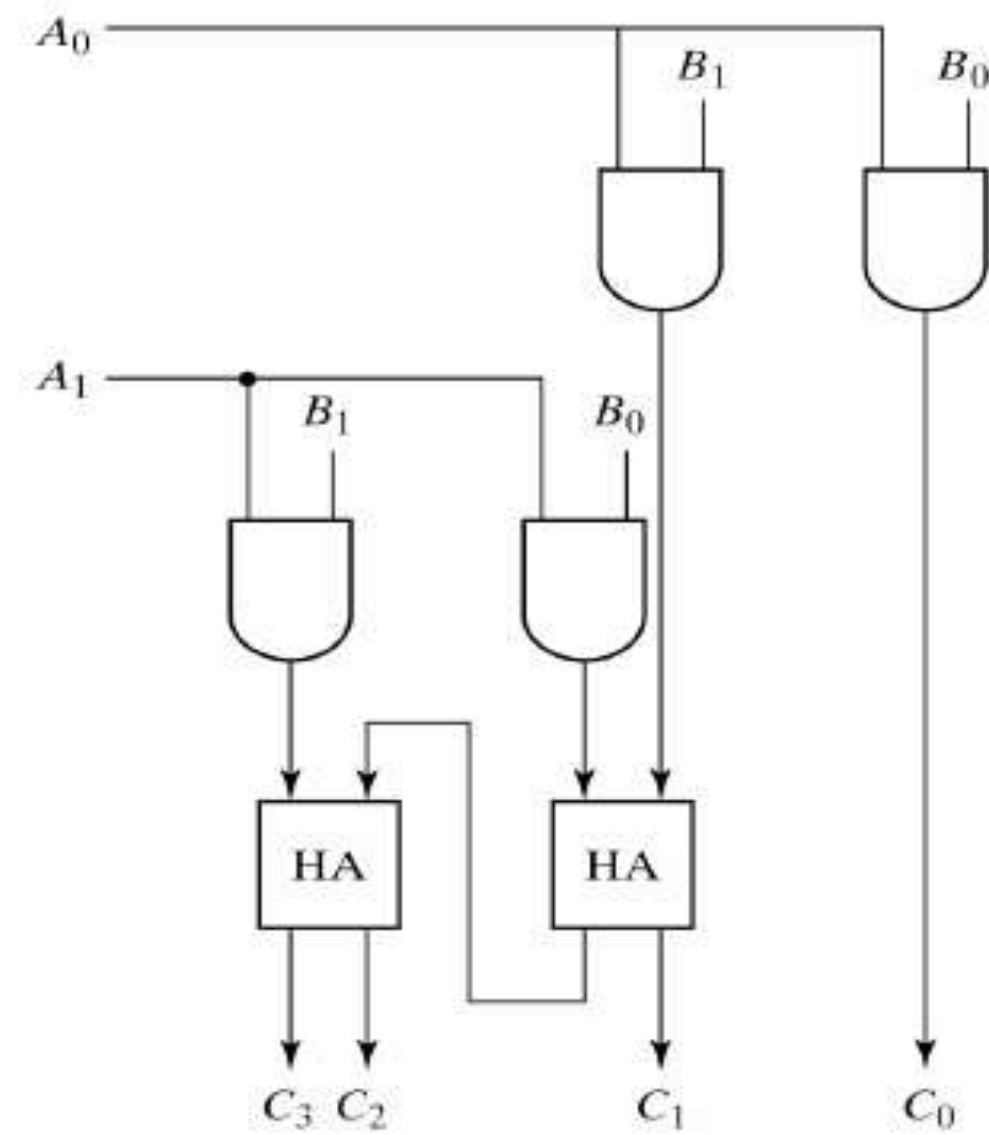
Multiply two binary numbers. It is built using binary adders. A variety of computer arithmetic techniques can be used to implement a digital multiplier.



2*2 BIT BINARY MULTIPLIER



		B_1	B_0
	A_1	$A_1 B_1$	$A_1 B_0$
	A_0	$A_0 B_1$	$A_0 B_0$
C_3	C_2	C_1	C_0





THANK YOU