

# BCD to Excess-3 Converter

## Truth table

85  
79  
86  
84  
92

Binary	BCD Input				Excess-3 output			
	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>	B <sub>0</sub>	E <sub>3</sub>	E <sub>2</sub>	E <sub>1</sub>	E <sub>0</sub>
0	0	0	0	0	0	0	1	1
1	0	0	0	1	0	1	0	0
2	0	0	1	0	0	1	0	1
3	0	0	1	1	0	1	1	0
4	0	1	0	0	0	1	1	1
5	0	1	0	1	1	0	0	0
6	0	1	1	0	1	0	0	1
7	0	1	1	1	1	0	1	0
8	1	0	0	0	1	0	1	1
9	1	0	0	1	1	1	0	0

$G_2 = B_2 B_0$

B <sub>3</sub> B <sub>2</sub> \ B <sub>1</sub> B <sub>0</sub>	00	01	11	10
00	0	0	0	0
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

$G_3 = B_1 B_2$

$G_1 = B_3$

$E_3 =$

$E_3 = B_0 + B_2 B_0 + B_2 B_1$

$E_3 = B_3 + B_2 (B_0 + B_1)$

B<sub>3</sub>B<sub>2</sub>  
00  
01  
11  
10

B <sub>3</sub> B <sub>2</sub> \ B <sub>1</sub> B <sub>0</sub>	B <sub>1</sub> B <sub>0</sub>	$\bar{B}_1 \bar{B}_0$	$\bar{B}_1 B_0$	$B_1 \bar{B}_0$
B <sub>3</sub> B <sub>2</sub>				
$\bar{B}_3 \bar{B}_2$				
$\bar{B}_3 B_2$				
$B_3 \bar{B}_2$				
$B_3 B_2$				

$\bar{A} \bar{B} = \overline{A+B}$

$B_2 (B_1 + B_0) + B_2 \bar{B}_1 \bar{B}_0$

$\bar{B}_2 (B_1 + B_0) + B_2 (\bar{B}_1 + \bar{B}_0)$

$= B_2 \oplus (B_1 + B_0)$

$E_2 =$

B <sub>3</sub> B <sub>2</sub> \ B <sub>1</sub> B <sub>0</sub>	00	01	11	10
$\bar{B}_3 \bar{B}_2$	0	1	1	1
$\bar{B}_3 B_2$	1	0	0	0
$B_3 \bar{B}_2$	X	X	X	X

$G_1 = \bar{B}_2 B_1$

$E_2 = \bar{B}_2 B_1 + \bar{B}_2 B_0 +$

$B_2 \bar{B}_1 \bar{B}_0$

$= \bar{B}_2 (B_1 + B_0) + B_2 \bar{B}_1 \bar{B}_0$

$B_3 B_2$   $B_1 B_0$

	00	01	11	10
00	1	0	1	0
01	1	0	1	0
11	x	x	x	x
10	1	0	x	x

$$E_1 = \overline{B_1} B_0 + B_1 B_0$$

$$E_1 = B_1 \oplus B_0$$

$L_{G1} = 0$        $L_{G2}$

$$= \overline{B_1} \overline{B_0} \quad = B_1 B_0$$

$$E_0 =$$

$B_3 B_2$   $B_1 B_0$

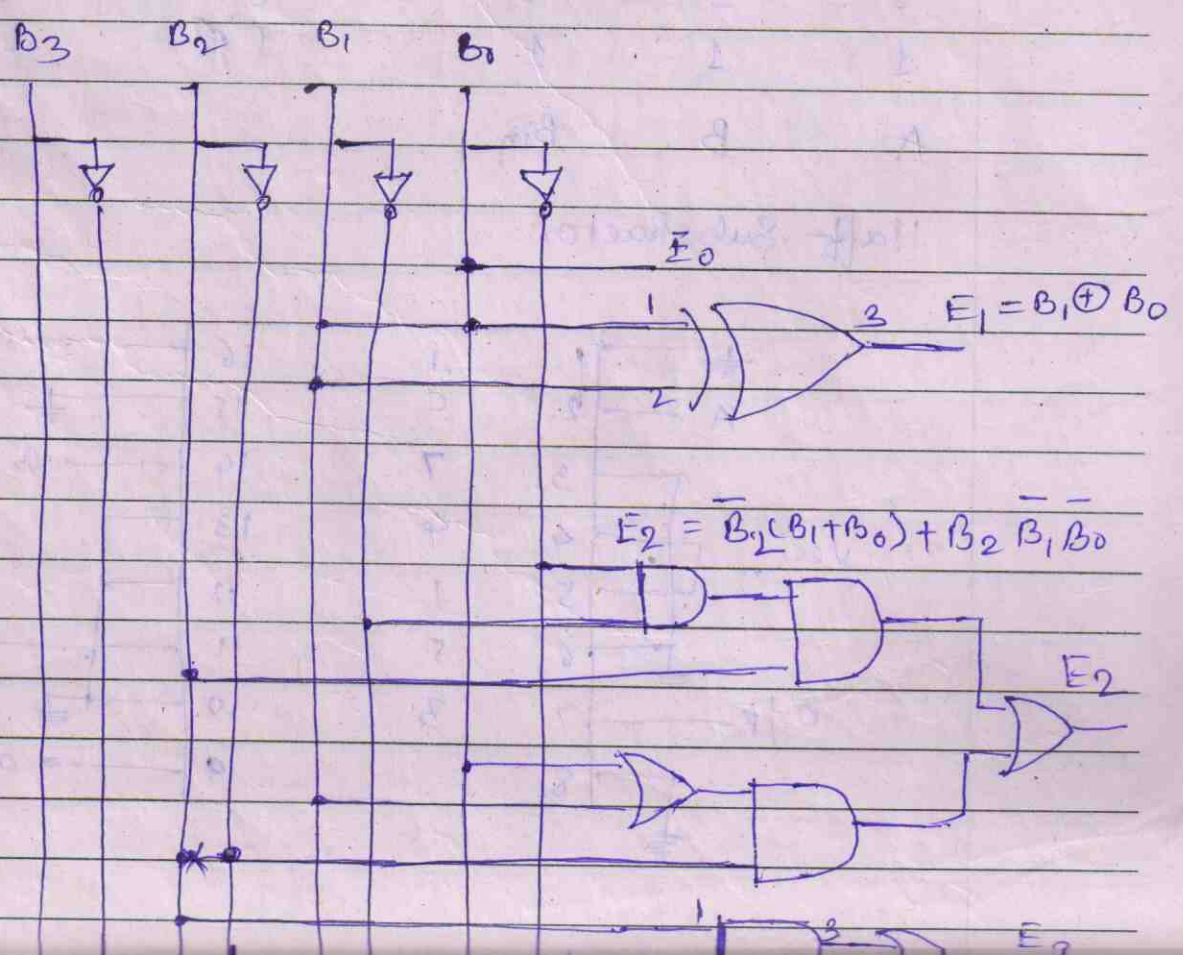
	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	x	x	x	x
10	1	0	x	x

$L_{G1}$        $L_{G2} = B_0$

$$E_0 = B_1 B_0 + \overline{B_1} \overline{B_0}$$

$$= B_0$$

$$E_0 = \overline{B_0}$$



## Half Subtractor:

Input		Diff	Output	
A	B		Borrow	
0	0	0	0	D <sub>0</sub>
0	1	1	1	D <sub>1</sub>
1	0	1	0	D <sub>2</sub>
1	1	0	0	D <sub>3</sub>

## Full Subtractor:

(S<sub>2</sub>) (S<sub>1</sub>)

Input		Diff	Output	
A	B		Borrow	
0	0	0	0	D <sub>0</sub>
0	1	1	1	D <sub>1</sub>
1	0	1	0	D <sub>2</sub>
1	1	0	1	D <sub>3</sub>

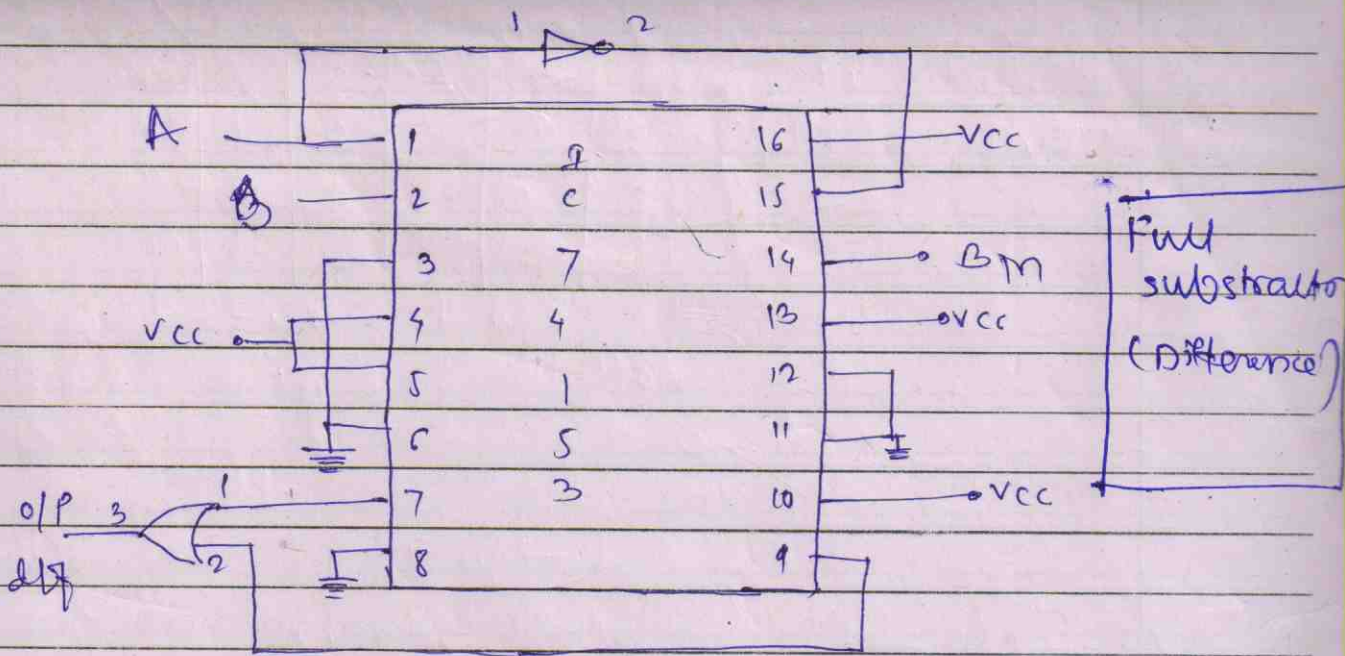
Bin

A	B	Bin	Diff	Borrow	D <sub>7</sub>
0	0	0	0	0	D <sub>0</sub>
0	1	1	1	1	D <sub>1</sub>
1	0	0	1	0	D <sub>2</sub>
1	1	1	0	1	D <sub>3</sub>
1	0	0	1	0	D <sub>4</sub>
1	1	1	0	1	D <sub>5</sub>
1	1	1	1	1	D <sub>6</sub>
1	1	1	0	1	D <sub>7</sub>

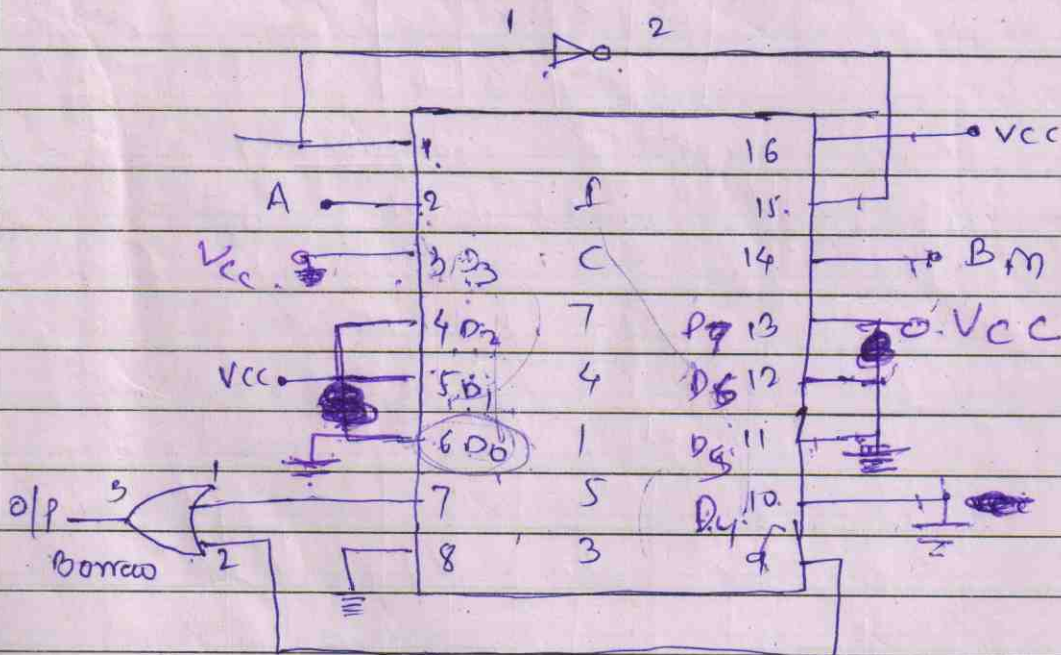
## Half Subtractor



# full Subtractor (Difference)



# full Subtractor (Borrow)



## BCD Adder:-

- BCD is less efficient than binary.
- BCD ~~Binary~~ needs more bits than binary to encode the same decimal no.
- BCD arithmetic is more complicated than binary arithmetic.
- The advantage of a BCD code is that the conversion from decimal to BCD or vice versa is simpler.

	Decimal	Binary	BCD
	0	0000	0000
	1	0001	0001
	2	0010	0010
BCD &	3	0011	0011
Binary are	4	0100	0100
different	5	0101	0101
same.	6	0110	0110
	7	0111	0111
	8	1000	1000
	9	1001	1001
	10	1010	0001 0000
	11	1011	0001 0001
BCD & binary	12	1100	0001 0010
are different	13	1101	0001 0011
	14	1110	0001 0100
	15	1111	0001 0101

Advantages of BCD codes.

- ① It is very similar to decimal system.
- ② we need to remember binary equivalent of decimal no. 0 to 9 only.

Disadvantages.

- ① The addition & subtraction of BCD have different rules.
- ② BCD arithmetic is more complicated.
- ③ BCD needs more no. of bits than binary to represent the same decimal no. so BCD is less efficient than binary.

