DIGITAL ELECTRONICS

SUBTRACTOR

❖ Objectives

- Definition of Subtractor
- Types of subtractor
- Explaining different subtractors with
  - Truth table
  - Boolean Expression
  - Logic circuit
- Parallel binary subtractor
- Applications

❖ What is Subtractor ?

Subtractor is an electronic logic circuit for calculating the difference between two binary numbers which provides the difference and borrow as output.

Types of Subtractor

- Half Subtractor
- Full Subtractor

Half subtractor

Half Subtractor is used for subtracting one single bit binary number from another single bit binary number.

It has two inputs; Minuend (A) and Subtrahend (B) and two outputs; Difference (D) and Borrow (B_{out}).

Truth Table

Input		Output	
A	B	Difference (D)	Borrow (B_{out})
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Solving truth table using K-map

B \ A	0	1
0	0	0
1	1	0

For Borrow

Borrow = $\bar{A}$.B

B \ A	0	1
0	0	1
1	1	0

For Difference

Difference = A $\oplus$ B

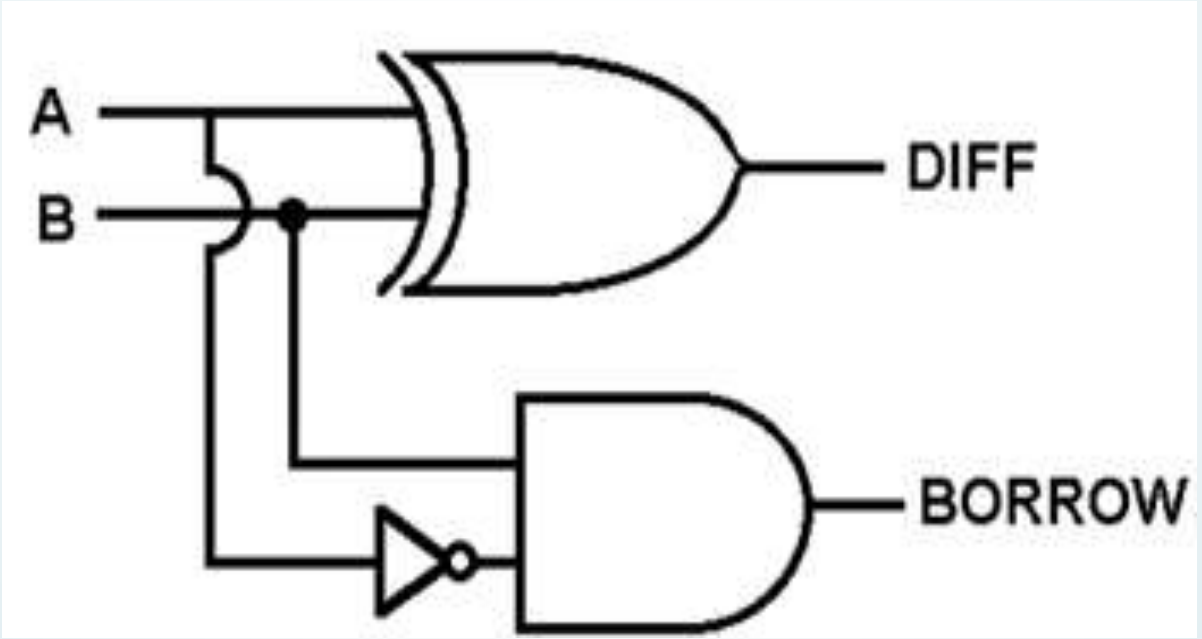
Boolean Expression

From the truth table and K-map, the Boolean Expression can be derived as:

$$\textbf{Difference (D)} = \bar{A}.B + A.\,\overline{B} = A \oplus B$$

$$\textbf{Borrow } (B_{out}) = \bar{A}.B$$

Logical Circuit



➢ fULL subtractor

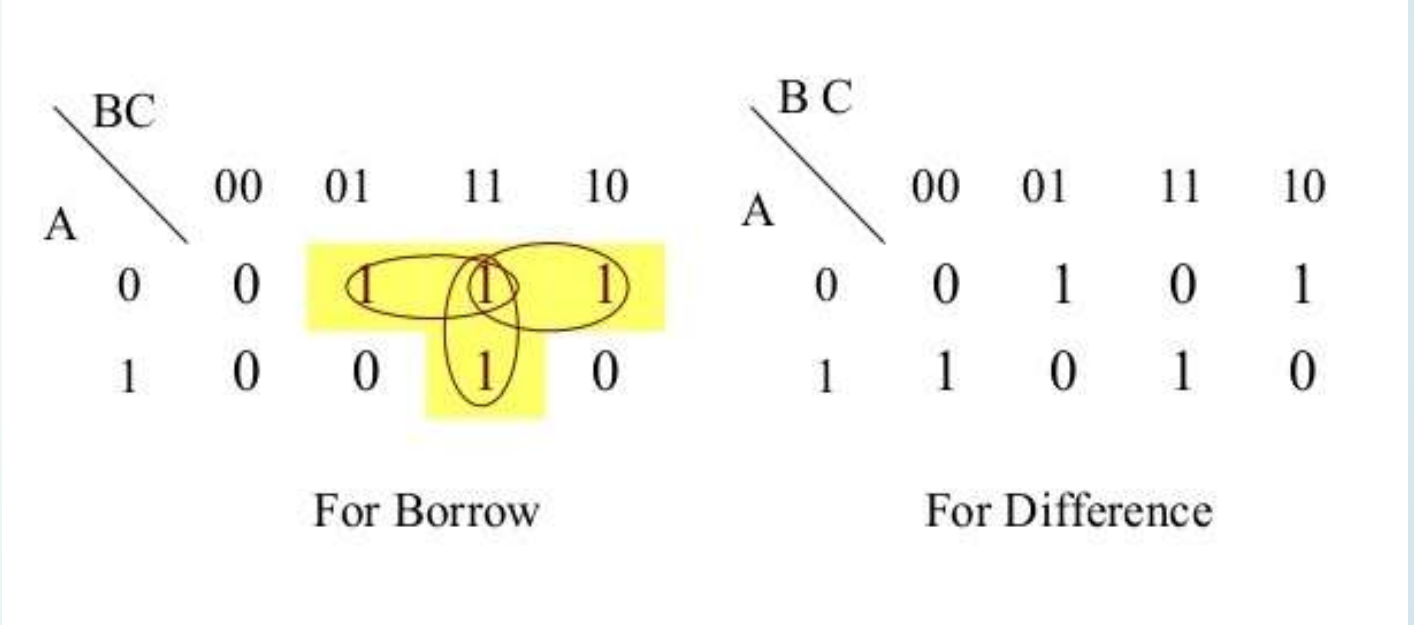
A logic Circuit Which is used for subtracting three single bit binary numbers is known as Full Subtractor.

It has three inputs; Minuend (A), Subtrahend (B) and following Subtrahend (C) and two outputs; Difference (D) and Borrow (B_{out}).

Truth Table

Input			Output	
A	B	C	D	$B_{(out)}$
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Solving Truth Table using K-Map



A \ BC	00	01	11	10
0	0	1	1	1
1	0	0	1	0

For Borrow

A \ B C	00	01	11	10
0	0	1	0	1
1	1	0	1	0

For Difference

K-Map Minimization

From the Truth Table The Difference and Borrow will written as,

Difference=A'B'C+A'BC'+AB'C'+ABC
Reducing it we got,
Difference=A ⊕B ⊕C

Borrow=A'B'C+A'BC'+A'BC+ABC
=A'B'C+A'BC'+A'BC+A'BC+A'BC+ABC
=A'C(B'+B)+A'B(C'+C)+BC(A'+A)
Borrow=A'C+A'B+BC

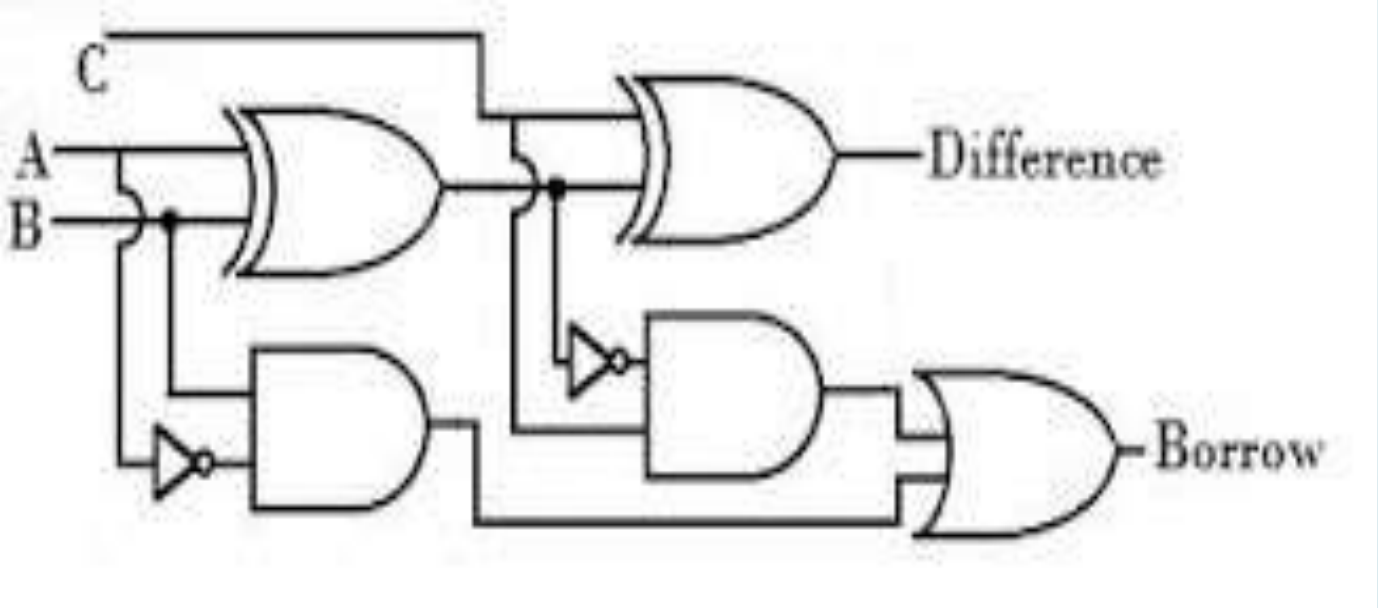
❑ Boolean Expression

From the truth table and k-map minimization, the Boolean Expression can be derived as:

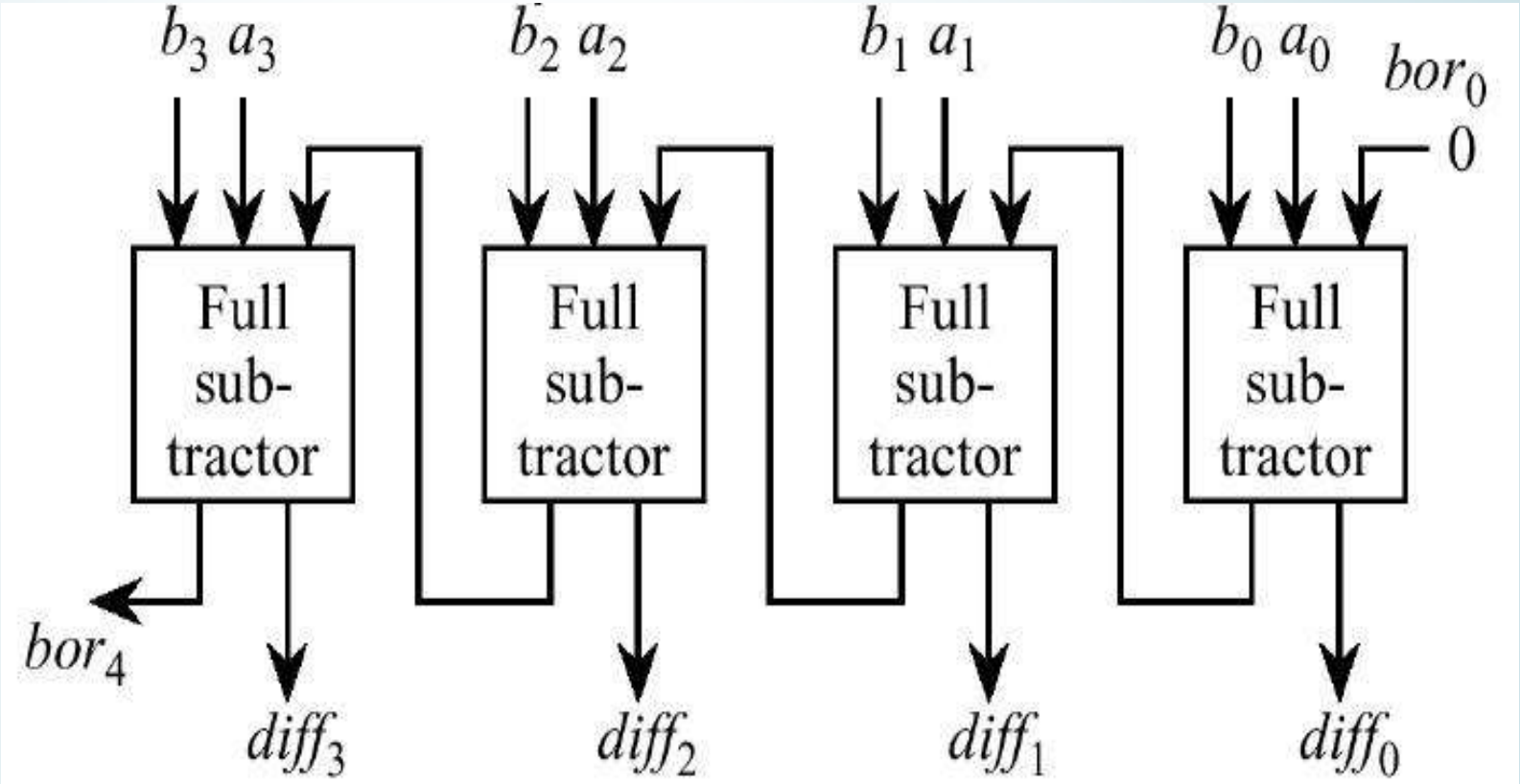
$$D = A \oplus B \oplus C$$

$$B_{(out)} = BC + (B \oplus C)A$$

Logical Circuit



Diagram


b_3 a_3
b_2 a_2
b_1 a_1
b_0 a_0
bor_0
0
Full sub-tractor
Full sub-tractor
Full sub-tractor
Full sub-tractor
bor_4
$diff_3$
$diff_2$
$diff_1$
$diff_0$

❖ Applications

- To attenuate the radio/audio signal
- In amplifier to reduce sound distortion
- In arithmetic logic unit of processors
- Increment and decrement operators
- Calculate addresses

Any question ?