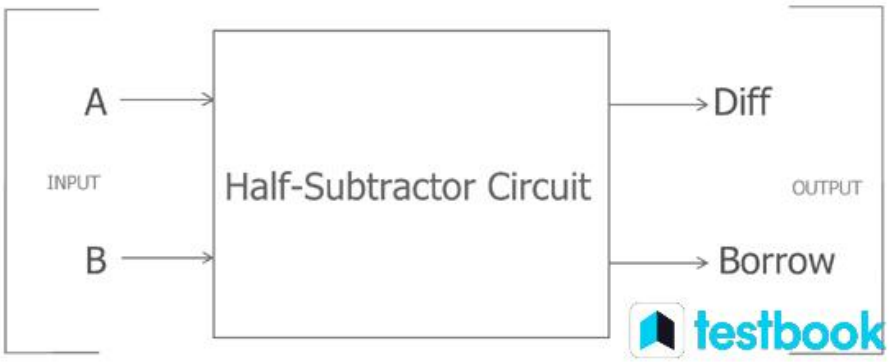
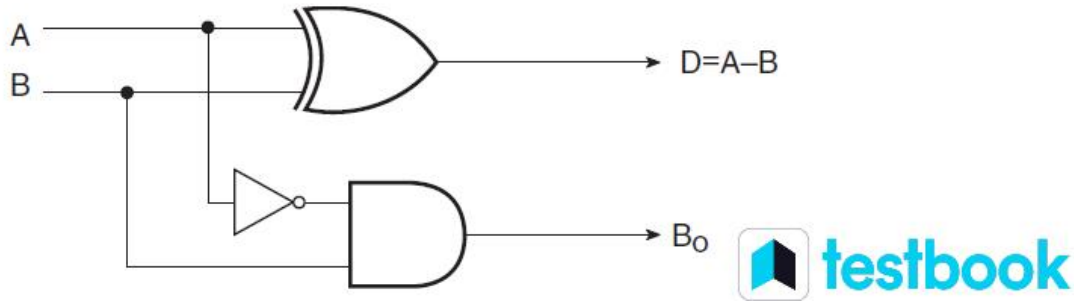
Half Subtractor

Half subtractor is a combinational logic circuit intended to perform the subtraction of two single bits and generate the output. A subtractor circuit with two input variables as A and B displays two outputs i.e Difference and Borrow. The **block diagram** of a Half subtractor is as shown below:



The **half subtractor circuit** or the logical diagram is as shown:



Inputs		Outputs	
A	B	Diff	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Know all about the OR Gate here.

From the above **half subtractor truth table**, we can recognize that the Difference (D) output is the resultant of the Exclusive-OR gate and the Borrow is the resultant of the NOT-AND combination. Then the Boolean expression for a half subtractor is as below.

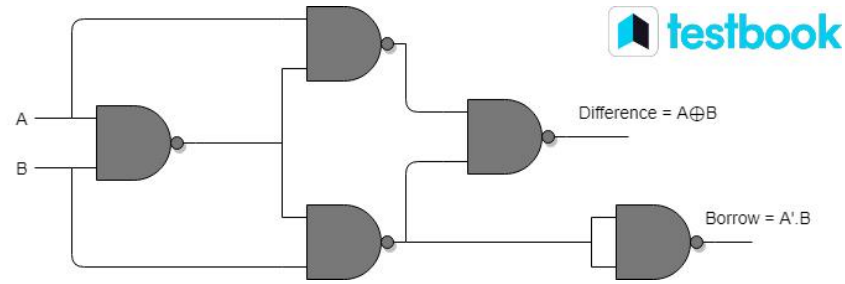
The logical expression for half–subtractor is:◂ ...▸ :

Difference(D)=A‾‾B+AB‾‾ =A⊕B◂...▸

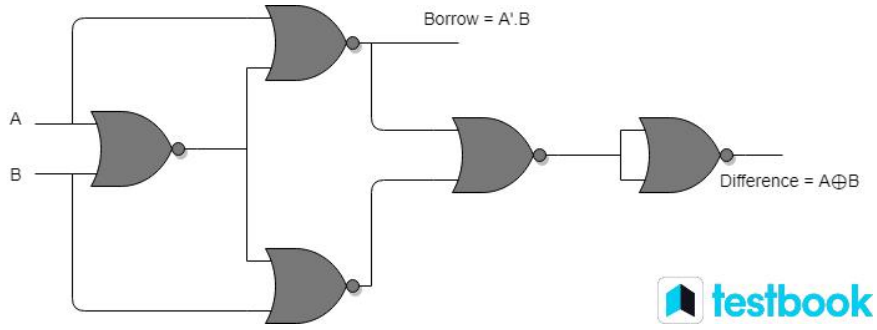
Borrow=A‾‾B

The half-subtractor can be implemented using universal gates i.e the NAND and NOR gate as shown below.

Half-subtractor using NAND gate



Half-subtractor using NOR gate

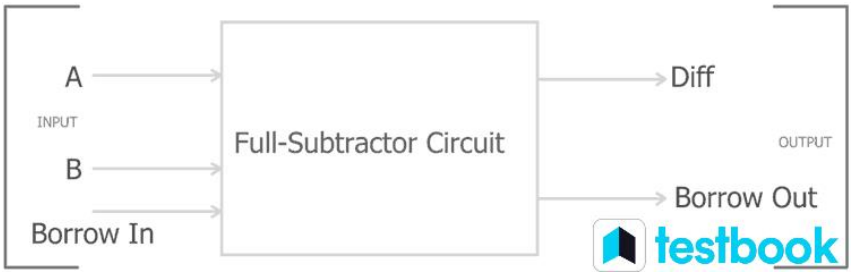


If we examine the Boolean expressions of the half subtractor with a half adder, Then we can figure out that the two expressions for the Sum regarding adder and Difference regarding subtractor are exactly the same and this is because of the Exclusive-OR gate function.

However, the two Boolean expressions for the binary subtractor Borrow are also quite alike to that for the adder Carry. The only difference is that to transform a half adder to a half subtractor the inversion of the minuend input A is made.

Full Subtractor

A full subtractor is again a combinational circuit that delivers subtraction of two bits, one is minuend and the other is subtrahend, taking into account the borrow of the earlier adjacent lower minuend bit. The block diagram of a full subtractor is as shown below:



The full subtractor circuit includes three input variables and two output variables. The three inputs; Consider as A, B and Bin. The two outputs, D and Bout, outline the difference and output borrow, respectively. The **full subtractor truth table** is as shown:

Inputs			Outputs	
A	**B**	**$Borrow_{in}$**	**Diff**	**Borrow**
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

The logical expression for Full−subtractor

$$\text{Difference}=A\bar{}\,B\bar{}\,B_{in}+A\bar{}\,B\,B\bar{}_{in}+A\,B\bar{}\,B\bar{}_{in}+A\,B\,B_{in}=A\oplus B\oplus B_{in}$$

$$=\sum m(1,2,4,7)$$

$$\text{Borrow}=A\bar{}B_{in}+A\bar{}B+BB_{in}$$

$$=\sum m(1,2,3,7)$$

Learn about the AND Gate here.

The combinational circuit of a full subtractor executes the operation of subtraction on three binary bits generating outputs for the difference D and borrow B-out. Exactly like the binary adder circuit, the full subtractor can also be imagined as two half subtractors connected together as shown below.