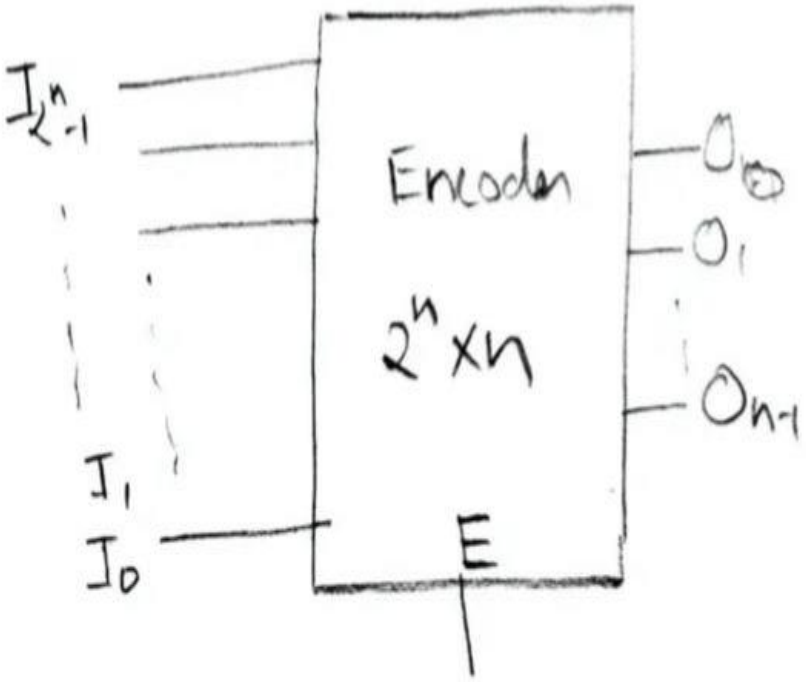
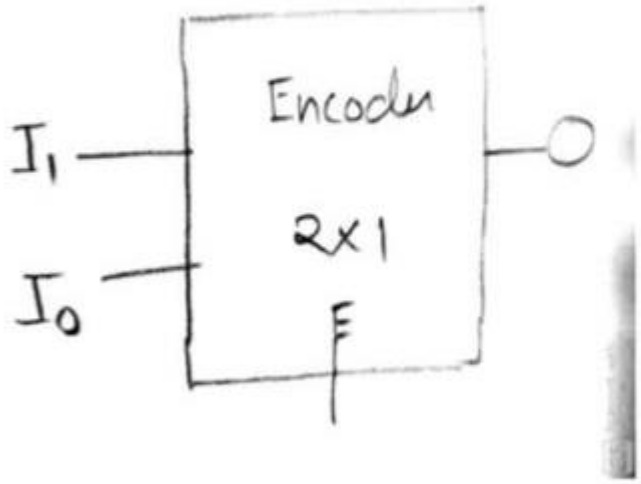
Encoder

- An encoder is a combinational circuit that encode binary information form one of a 2^N input lines and encode it into N output lines, which represent N bit code for the input.
- For simple encoders, it is assumed that only one input line is active at a time.
- Encoder performs the inverse operation of a decoder.

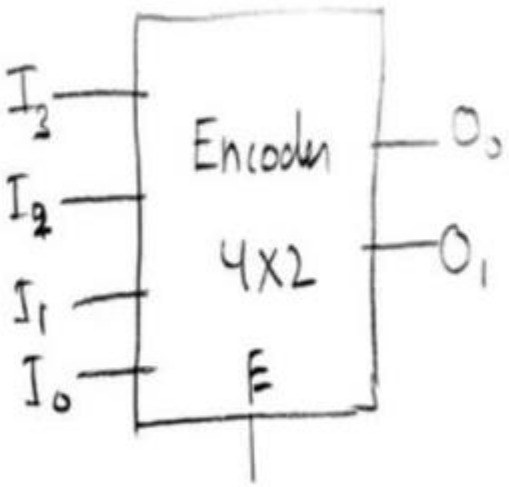


2-to-1 Encoder



I_1	I_0	O_0
0	1	**0**
1	0	**1**

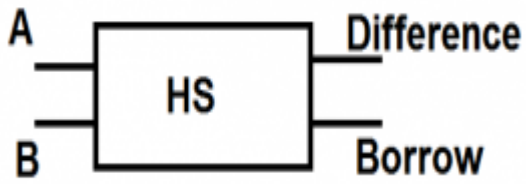
4-to-2 Encoder



I_3	I_2	I_1	I_0	O_1	O_0
0	0	0	1	**0**	**0**
0	0	1	0	**0**	**1**
0	1	0	0	**1**	**0**
1	0	0	0	**1**	**1**

- $O_0 = I_0' I_1' (I_2 \oplus I_3)$
- $O_1 = I_0' I_2' (I_1 \oplus I_3)$

Half Subtractor

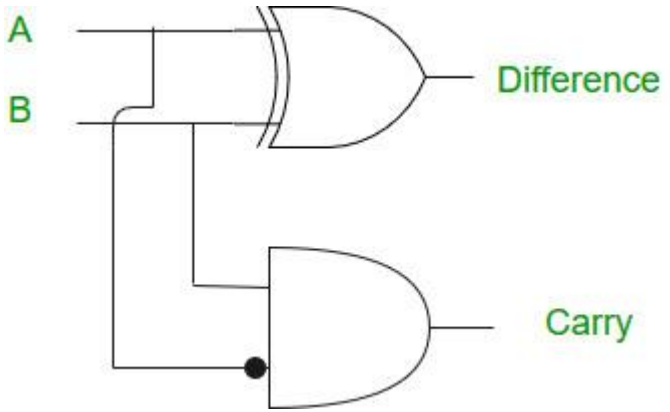


Half Subtractor

Truth Table of Half Subtractor

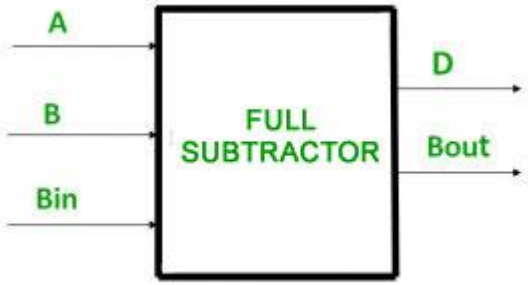
A	B	Diff	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Logic Symbol



Full Subtractor

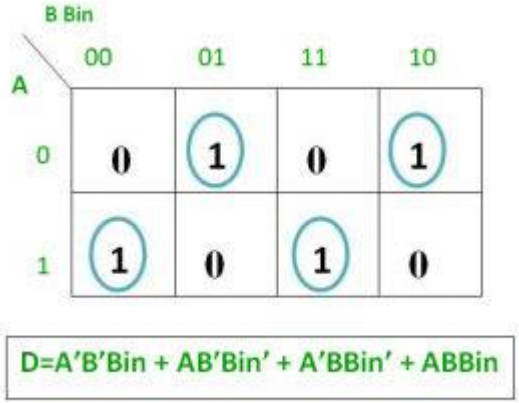
A full subtractor is a **combinational circuit** that performs subtraction of two bits, one is minuend and other is subtrahend, taking into account borrow of the previous adjacent lower minuend bit. This circuit **has three inputs and two outputs**. The three inputs A, B and Bin, denote the minuend, subtrahend, and previous borrow, respectively. The two outputs, D and Bout represent the difference and output borrow, respectively.

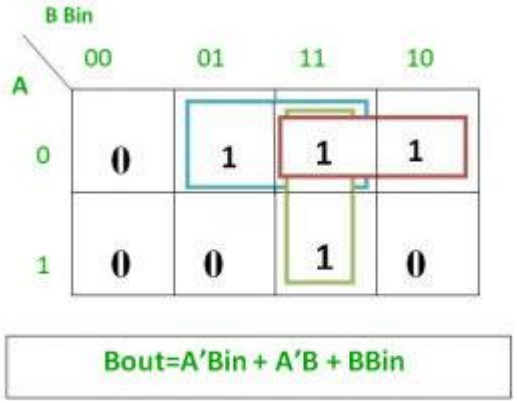


Truth Table

INPUT			OUTPUT	
A	B	Bin	D	Bout
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

From above table we can draw the K-Map as shown for “difference” and “borrow”.





Logical expression for difference –

D = A’B’Bin + A’BBin’ + AB’Bin’ + ABBin
= Bin(A’B’ + AB) + Bin’(AB’ + A’B)
= Bin(A XNOR B) + Bin’(A XOR B)
= Bin (A XOR B)’ + Bin’(A XOR B)
= Bin XOR (A XOR B)
= (A XOR B) XOR Bin

Logical expression for borrow –

$$Bout = A'B'Bin + A'BBin' + A'BBin + ABBin$$
$$= A'B'Bin + A'BBin' + A'BBin + A'BBin + A'BBin + ABBin$$
$$= A'Bin(B + B') + A'B(Bin + Bin') + BBin(A + A')$$
$$= A'Bin + A'B + BBin$$

Logic Circuit for Full Subtractor –