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## Adder

- An adder is a digital logic circuit in electronics that implements addition of numbers.
- In many computers and other kinds of processors, adders are used not only in the arithmetic logic units, but also in other parts of the processor, where they are used to calculate addresses, increment and decrement operators, and similar operations.
- Adders are classified into two types:
  - 1) half adder.
  - 2) full adder.



Let us first take a look at the addition of single bits.

- ▶  $0+0 = 0$
- ▶  $0+1 = 1$
- ▶  $1+0 = 1$
- ▶  $1+1 = 10$  (i.e.  $1+1=0$  with carry = 1)



## Half Adder

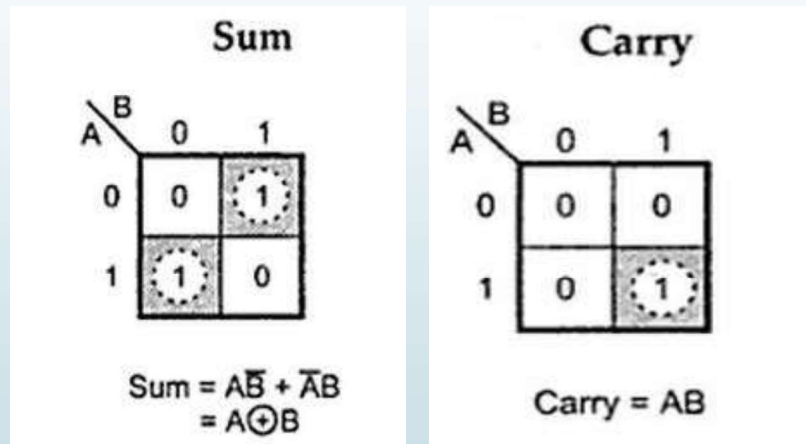
- ▶ The half adder adds two single binary digits  $A$  and  $B$ .
- ▶ It has two outputs, sum ( $S$ ) and carry ( $C$ ).
- ▶ The carry signal represents an overflow into the next digit of a multi-digit addition.



## Truth Table

INPUTS		OUTPUTS	
A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

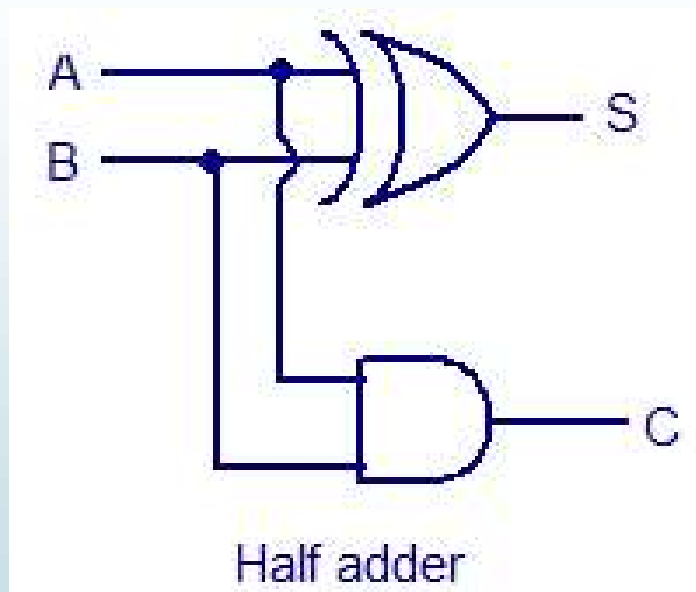
## Solving truth table using K-map



## Analysing results

- ▶ No of inputs = 2
- ▶ No of outputs = 2
- ▶ Inputs are A , B.
- ▶ Outputs are Sum , Carry.
- ▶ Sum can be obtained using XOR logic gate.
- ▶ Carry can be obtained using AND logic gate.

## Designing circuit







## Full Adder

- A full adder adds binary numbers and accounts for values carried in as well as out.
- The main difference between a half-adder and a full-adder is that the full-adder has three inputs and two outputs.
- A one-bit full adder adds three one-bit numbers, often written as  $A$ ,  $B$ , and  $C_{in}$ .
- It has two outputs, sum ( $S$ ) and carry ( $C_{out}$ ).

## Truth Table

A	INPUTS		OUTPUTS	
	B	CIN	COUT	Sum
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

## Solving Truth Table using K-Map

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

K-map for Sum (S)

$$S = A \oplus B \oplus C_{in}$$

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

K-map for Carry (C<sub>out</sub>)

$$C_{out} = (A \cdot B) + (C_{in} \cdot (A \oplus B))$$

## Analysing results

- ▶ No of inputs = 3
- ▶ No of outputs = 2
- ▶ Inputs are  $A$ ,  $B$ ,  $C_{in}$ .
- ▶ Outputs are  $Sum$ ,  $C_{out}$ .

## Designing circuit

