Adders:-

Adders are important not only in computers, but in many type of digital systems in which numerical data are processed. There are two types of adders:-

1- Half adder
2- Full adder

1- Half Adder (H.A) :-

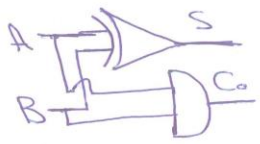
It is a digital circuit having two inputs and two outputs. The inputs are the inputs bits of the binary number and outputs are the sum of them and carry of them. The truth table and the block diagram are shown below:-

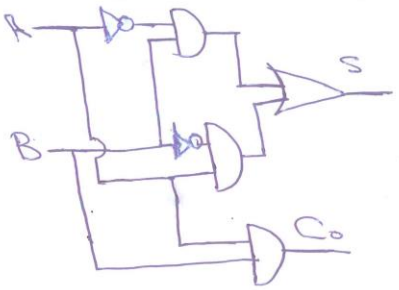
AB	SCo
0 0	0 0
0 1	1 0
1 0	1 0
1 1	0 1

by mean of using gates, we can have different forms of H.A.

$S = \bar{A}B + A\bar{B} = A \oplus B$

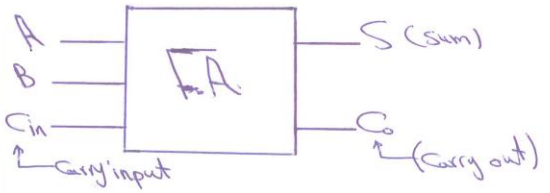
$C_o = AB$





2- Full Adder (F.A)

Application for the H.A are limited. The H.A is no sufficient for adding more than two one-bit numbers. Full Adder is a logic circuit that can add 3-bit and have two outputs. These outputs are the sum of three bits inputs and the second output is carry of them. The truth table and the bolock diagram are shown below:-



A B Cin	S Co
0 0 0	0 0
0 0 1	1 0
0 1 0	1 0
0 1 1	0 1
1 0 0	1 0
1 0 1	0 1
1 1 0	0 1
1 1 1	1 1

From the truth table:-

$S = \sum 1,2,4,7$

$= \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$

$= \bar{A}(\bar{B}C_{in} + B\bar{C}_{in}) + A(\bar{B}\bar{C}_{in} + BC_{in})$

$= \bar{A}(B \oplus C_{in}) + A(\overline{B \oplus C_{in}})$

$= \bar{A}(B \oplus C_{in}) + A(\overline{B \oplus C_{in}})$

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

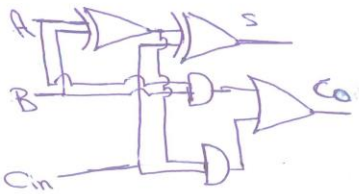
$B \odot C_{in} = \overline{B \oplus C_{in}}$

$C_o = \sum 3,5,6,7$

$= \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$

$= AB(\bar{C}_{in} + C_{in}) + C_{in}(\bar{A}B + A\bar{B})$

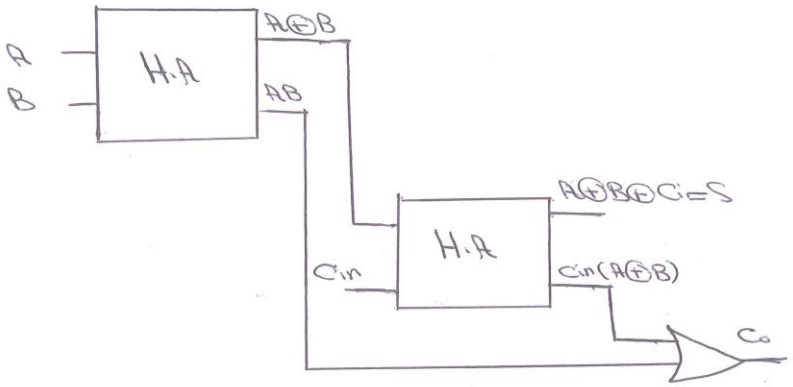
$= AB + C_{in}(A \oplus B)$



Ex:- Implement Full-Adder circuit diagram by using H.A blocks and any gate:-

Solution:- $S = A \oplus B \oplus C$
$C_o = AB + C_i(A \oplus B)$] F.A معادلات الجمع الكامل

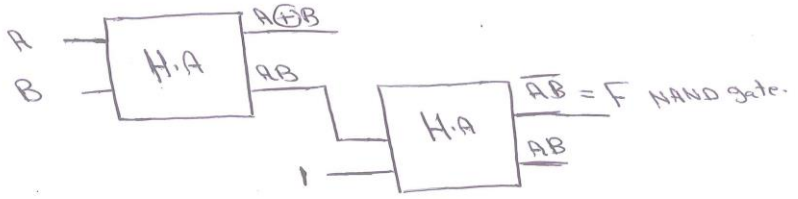
$S = A \oplus B$
$C_o = AB$] H.A معادلات نصف الجمع



Ex:- Design NAND gate by using H.A's only:-

Solution:- $F = \overline{AB}$] الجمع الكامل لتوليد

$S = A \oplus B$
$C_o = AB$] معادلات نصف الجمع

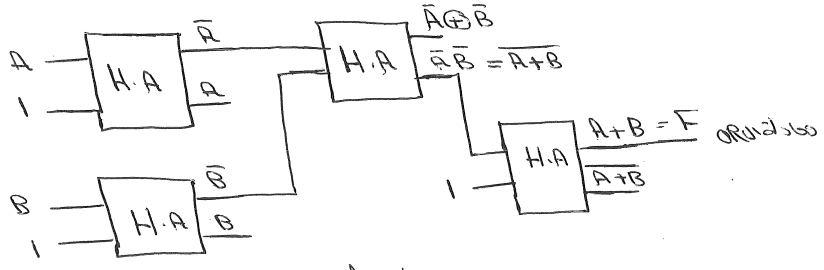


Note:- $A \oplus 1 = \bar{A}$
$A \oplus 0 = A$] Very Important.

Ex:- Design OR gate by using H.A only:-

Solution:- $F = A + B$] الخرج المطلوب

$S = A \oplus B$
$C_o = AB$] الخارجين من الدائرة



Ex:- Implement the following functions below, using H.A blocks only:-

$X = A \oplus B \oplus C \quad y = \bar{A}Bc + A\bar{B}c \quad Z = AB\bar{C} + C(\bar{A}+\bar{B})$

$W = ABC$

Solution:- $X = A \oplus B \oplus C$

$y = \bar{A}Bc + A\bar{B}c = C(\bar{A}B + A\bar{B}) = C(A \oplus B)$

$Z = AB\bar{C} + C(\bar{A}+\bar{B}) = AB\bar{C} + C(\overline{AB}) = AB \oplus C$

] الخارجين المطلوبين من الدائرة

$W = ABC$

$S = A \oplus B$
$C_o = AB$] الخارجين من الدائرة