

EGC221

Class Notes

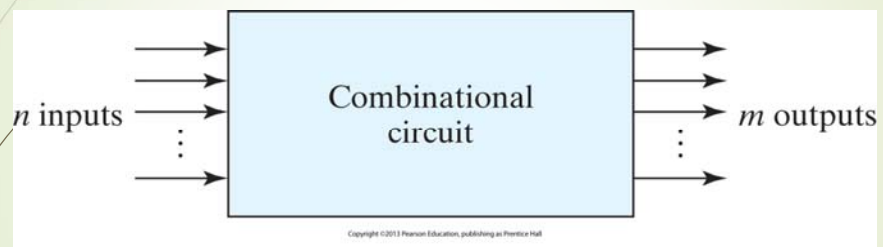
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Block diagram of combinational circuit



Design Steps

- From the specification of the circuit, determine the number of inputs and outputs and assign a symbol to each.
- Derive a truth table, assigning inputs to the left and outputs to the right.
- Place all possible combination of inputs i.e all 0's to all 1's
- Using the problem definition determine each output.
- If combinations are left without a specified output, mark them as don't cares.
- Simplify each output using K-map.
- Draw a circuit for each output per requirement ie. All NAND, all NOR, AND - OR, OR - AND, XOR, etc.

Half-Adder
A, B

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$CY = 1 \quad \begin{array}{c} 1 \\ 1 \\ \hline 0 \\ \text{SUM} \end{array}$$

$$S = A \oplus B$$

$$C = AB$$



$$\begin{array}{c|c} BC & B \oplus C \\ \hline 00 & 1 \\ 01 & 0 \\ 10 & 0 \\ 11 & 1 \end{array}$$

$$\begin{array}{c} 1011 \\ 0010 \\ \hline 1101 \end{array}$$

$$\begin{array}{c} A \downarrow B \downarrow C_{in} \\ \boxed{\begin{array}{c} F(A,B,C) \\ Cout \\ S \end{array}} \end{array}$$

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

$$Cout = \sum m(3, 5, 6, 7)$$

Table 1. 1-bit Full Adder using basic gates truth table

A	B	Cin	Sum	Cout
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

$$\overline{BC} + BC = 1$$

$$\overline{B}\overline{C} + BC =$$

$$SUM = \overline{A}BC + A\overline{B}\overline{C} + A\overline{B}C + AB\overline{C}$$

$$SUM = \overline{A}(\overline{B}C + B\overline{C}) + A(\overline{B}\overline{C} + BC)$$

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

$$= \overline{A}X + A\overline{X}$$

$$= A \oplus X \rightarrow A \oplus B \oplus C$$

$C_{out} = AC + AB + BC$

$C_{out} = \bar{A}BC + A\bar{B}C + ABC + AB\bar{C}$

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

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

Add

$\begin{matrix} A_3 & A_2 & A_1 & A_0 \\ B_3 & B_2 & B_1 & B_0 \\ \hline S_3 & S_2 & S_1 & S_0 \end{matrix}$

Figure 3. Hierarchical block diagram of 4-bit adder

Subtract

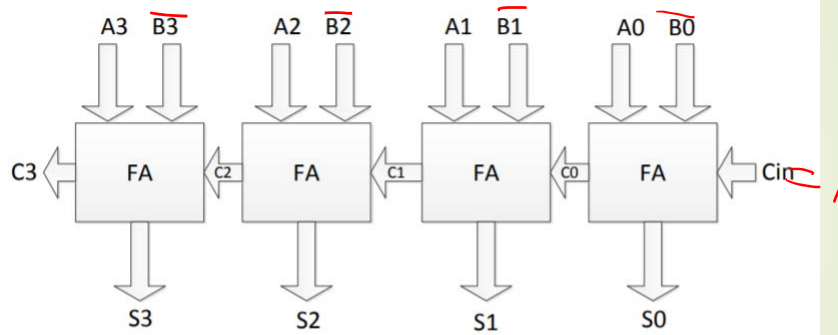
 $A - B$ 

Figure 3. Hierarchical block diagram of 4-bit adder

$$x \oplus y = \bar{x}y + x\bar{y}$$

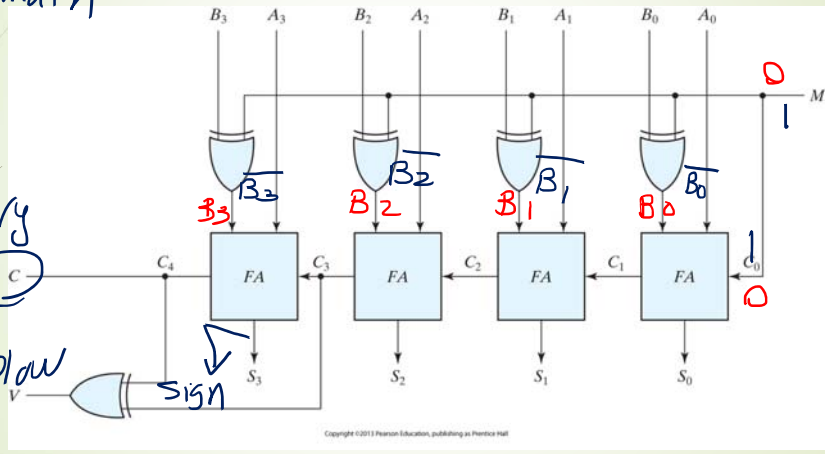
$$0 \oplus y = y$$

$$1 \oplus y = \bar{y}$$

Four-bit adder-subtractor (with overflow detection)

↓ 0101 ↑ 1010

signed domain
 + +
 - -
 - +
 carry
 overflow
 sign



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