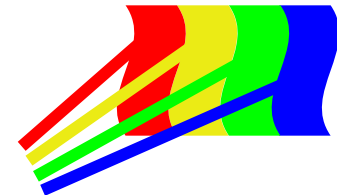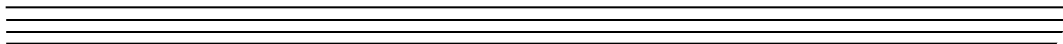# Digital Electronics

Principles & Applications

Seventh Edition

Arithmetic Circuits

INTRODUCTION

- **Binary Addition**

- **Half Adders**

- **Full Adders**

- **Parallel Adding**

Binary Addition

- **Conceptually similar to decimal addition**

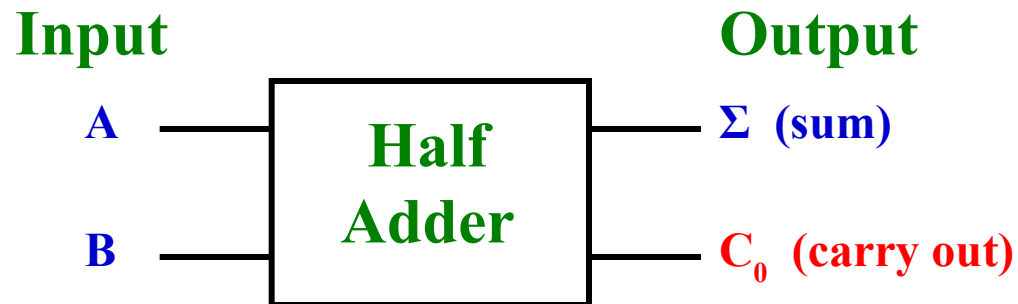- ***Example:*** **Add the binary numbers 1010 and 11**

(carry)

$$
\begin{array}{ccccc}
 &   & 1 &   &   \\
 & 1 & 0 & 1 & 0 \\
+ &   &   & 1 & 1 \\
\hline
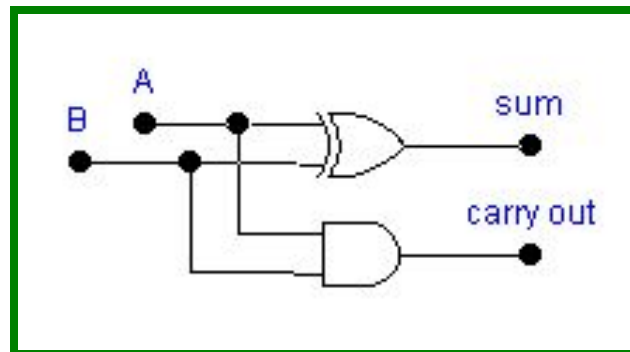 & 1 & 1 & 0 & 1 \\
\end{array}
$$

Half Adder

- **Logic device that adds two binary numbers**

- **Only adds Least Significant Digit (LSD) column (1s column) in binary addition**
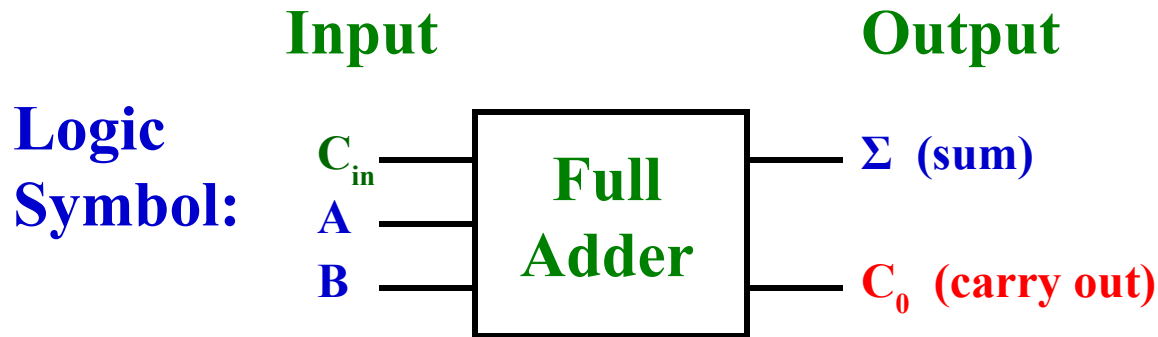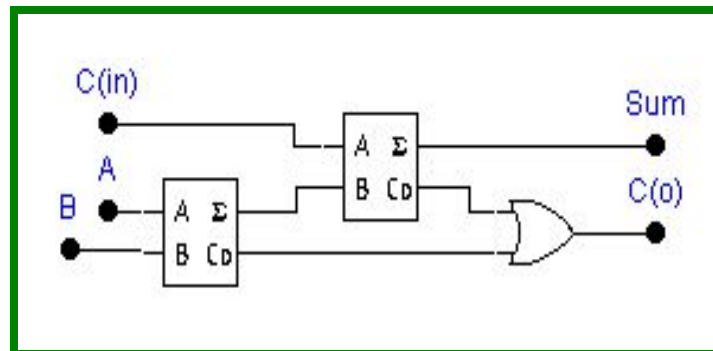
Logic Symbol:

Input

A ———

B ———

Half Adder

Output

Σ (sum)

C_0 (carry out)

Logic Diagram:

Full Adder

Used for adding binary place values other than the 1s place

Input   **Output**

Logic Symbol:

C_{in} ———— | **Full Adder** | ———— Σ **(sum)**

A ————

B ———— C_0 **(carry out)**

Logic Diagram:

Parallel Adding

- **Use half adder for LSD**
- **Use full adder for other digits**

A_2 A_1 A_0
$+ B_2$ B_1 B_0

Parallel Adder

1 1 1 0 + 0 1 1 0

LOW = HA

A Ci Σ
B Co

2s FA

A Ci Σ
B Co

8s FA

A Ci Σ
B Co

A Ci Σ
B Co

16s

1s
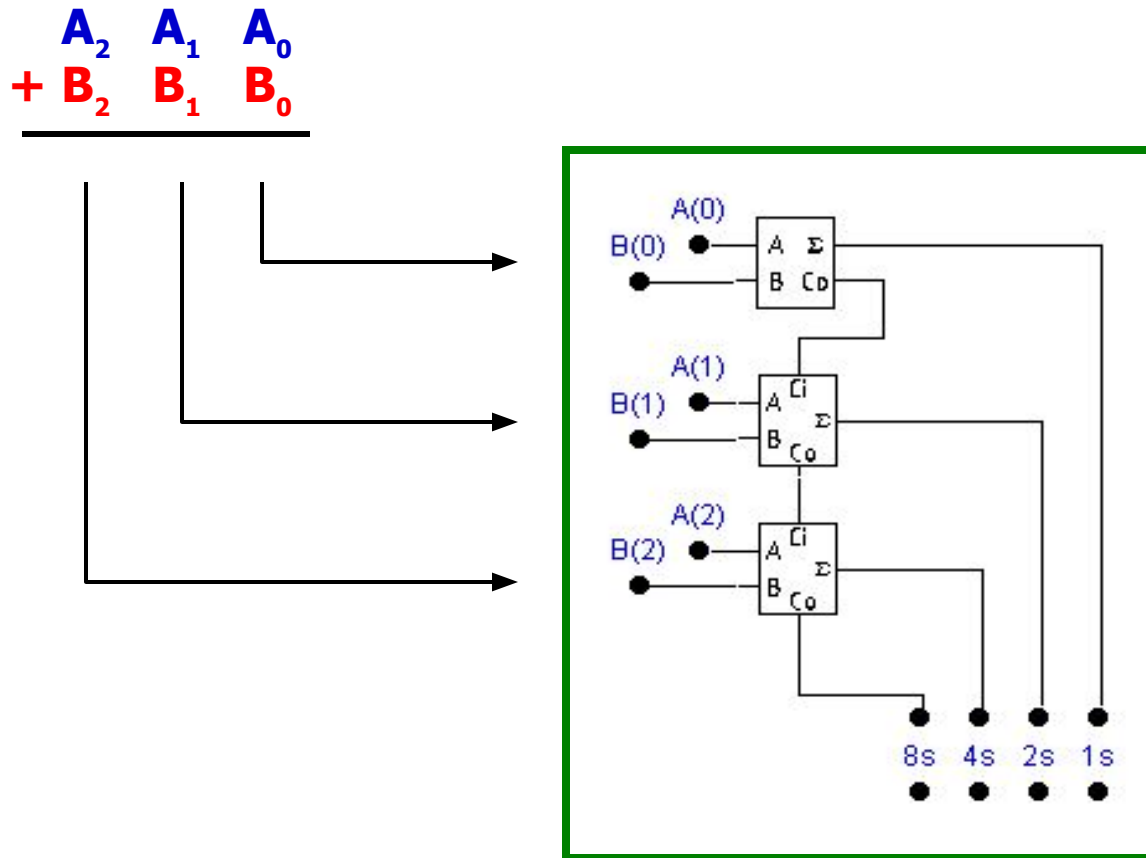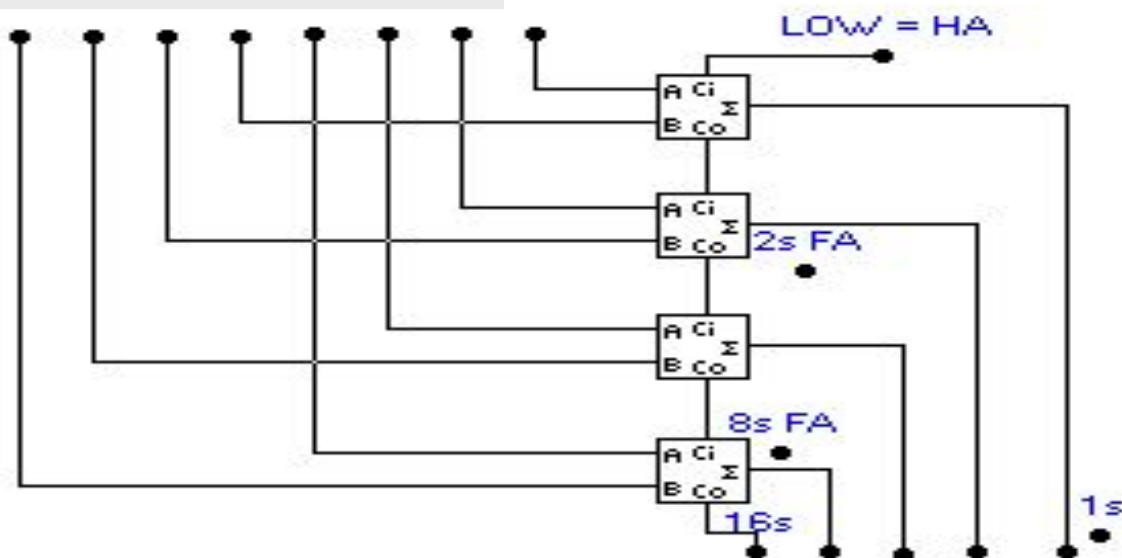
1 0 1 0 0

SUM appears here

Parallel adders are available in IC form.

1s place uses half-adder

2s, 4s, 8s places use full adders

Practical Suggestion for Binary Math

- **Use a scientific calculator.**

- **Most scientific calculators have DEC, BIN, OCT, and HEX modes and can either convert between codes or perform arithmetic in different number systems.**

- **Most scientific calculators also have other functions that are valuable in digital electronics such as AND, OR, NOT, XOR, and XNOR logic functions.**
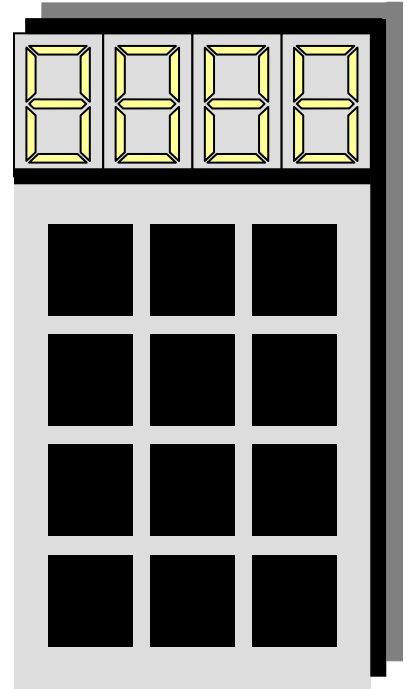
REVIEW

- **Binary Addition**

- **Half Adders**

- **Full Adders**

- **Parallel Adding**