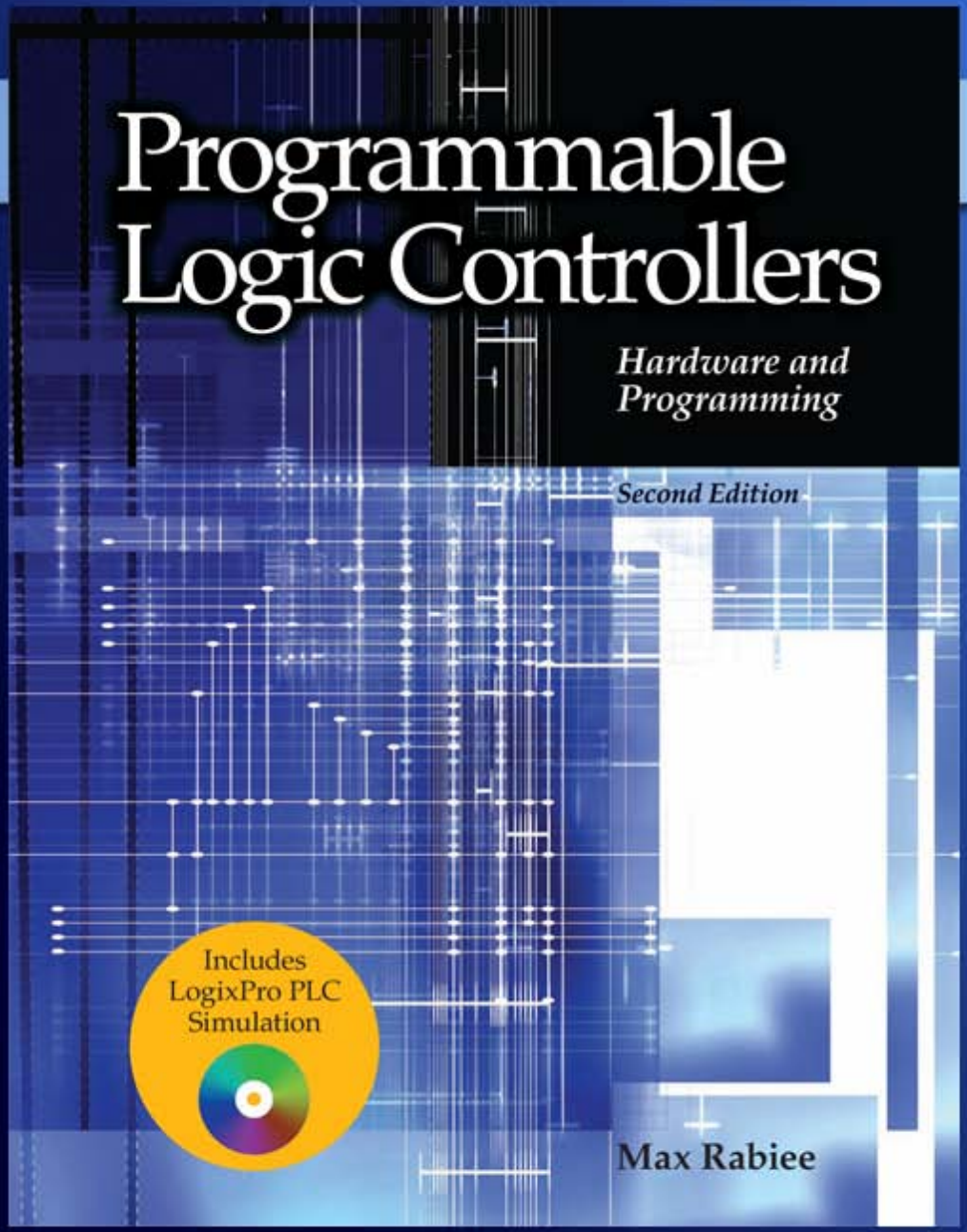


PowerPoint Presentations for

Programmable Logic Controllers

Hardware and Programming

by Max Rabiee

G-W PUBLISHER
The Goodheart-Willcox Co., Inc.
Tinley Park, Illinois

Chapter

7

Programming Logic Gate Functions in PLCs

This presentation will focus on the material needed for this PLC class. The text covers logic theory beyond the scope of this PLC course. The Digital Electronics class at GCCC covers the material in chapter 7 in detail. You will only be studying selected pages from chapter 7 of the text.

Objectives

We will focus on the following:

- Describe combinational and sequential logic gate circuits.
- Create PLC ladder logic programs for NOT (inverter), AND, OR,, XOR, logic gates.
- Convert Boolean expressions to PLC ladder logic diagrams.
- Convert PLC ladder logic diagrams to logic gate circuits and Boolean expressions.

Combinational Logic Gates

- Do not require clock pulses to operate.
- Outputs depend only on their inputs.
- Outputs are generated instantaneously.
- Simply called *logic gates*.

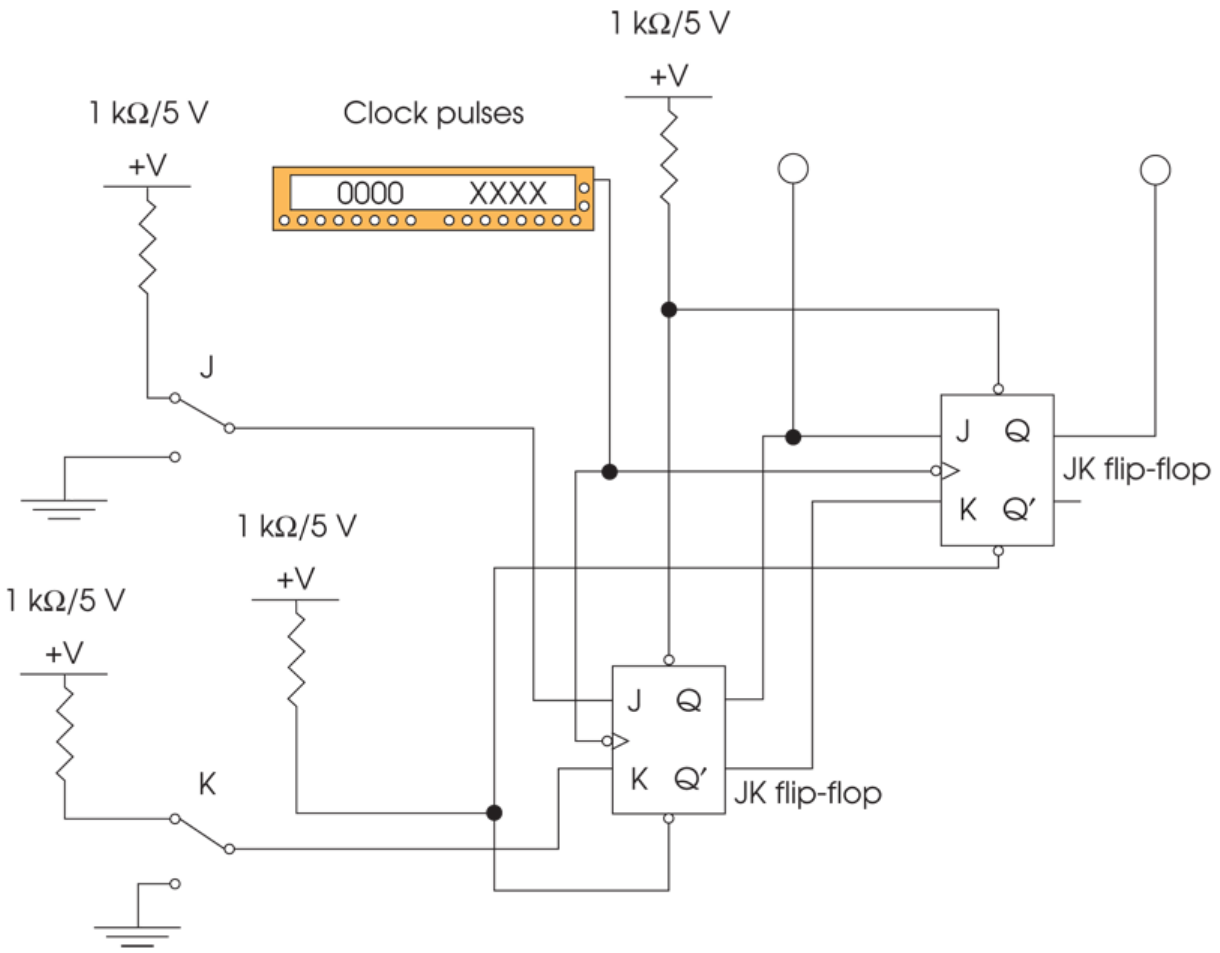
Logic Gates

- NOT.
- AND.
- OR.
- NAND.
- NOR.
- XOR (exclusive OR).
- XNOR (exclusive NOR).

Sequential Logic Devices

- Have outputs that depend on their inputs as well as time.
- Require clock pulses.
- An inherent delay time is always present.
- Flip-flop devices.

Sequential Logic Circuit



Boolean Expressions

- Every gate logic function has its own equation called a Boolean expression

- Boolean algebra:
  - Two states are *true* and *false.*

Boolean Expressions (Cont.)

- True state: (1)
  - Represented by the number one, called logic high or logic one in Boolean algebra.
- False state: (0)
  - Represented by the number zero, called logic low or logic zero.

Boolean Expressions (Cont.)

- Logic high:
  - Represented by the presence of a voltage potential.
  - Represented with five volts (+5 V).
- Logic low:
  - Represented by the absence of a voltage potential.
  - Represented with zero volts (0 V).

Truth Tables

- In Boolean algebra, a table contains the digital input and output points.
- This table is called a truth table.

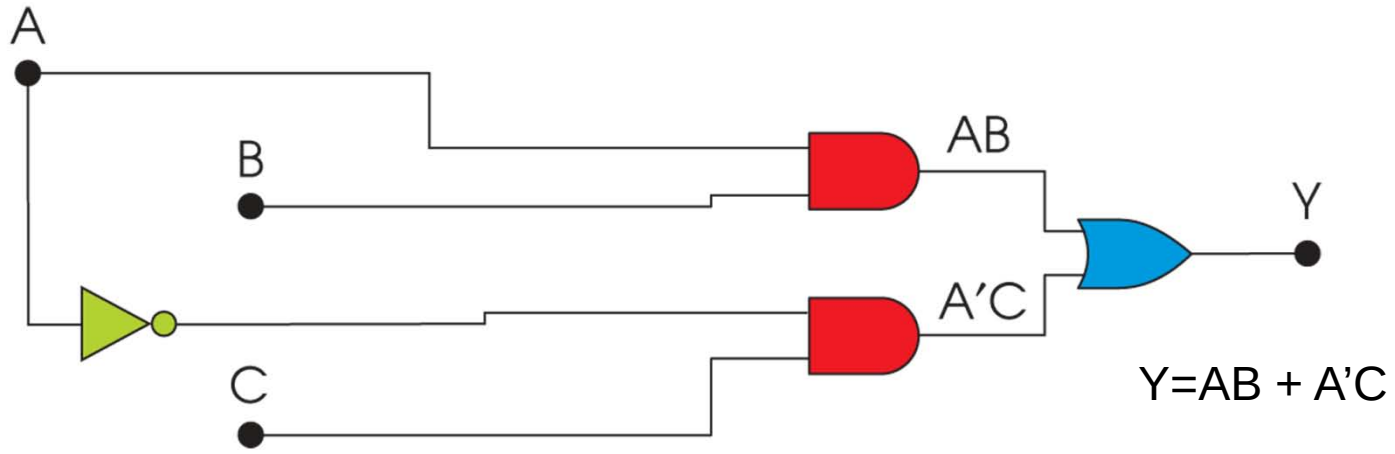
Boolean expression: Y = AB + A′C

Truth Table

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Gate Symbols

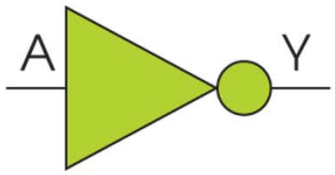
- For every combinational and sequential logic device.
- Used to create logic gate circuits.



NOT Gate

- Output is the inverse of the input.
- Called an *inverter.*

Boolean expression: **Y = A′**



NOT gate symbol

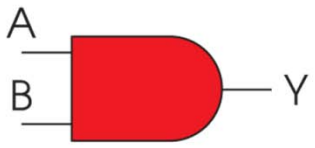
A	Y
0	1
1	0

Truth table

AND Gate

Two-input AND logic gate symbol, its Boolean expression, and its truth table.

Boolean expression: **Y = A · B**



Two-input AND gate

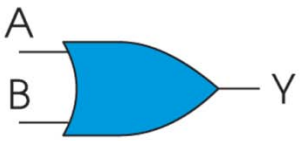
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Truth table

OR Gate

Two-input OR logic gate symbol, its Boolean expression, and its truth table.

Boolean expression: **Y = A + B**



Two-input OR gate

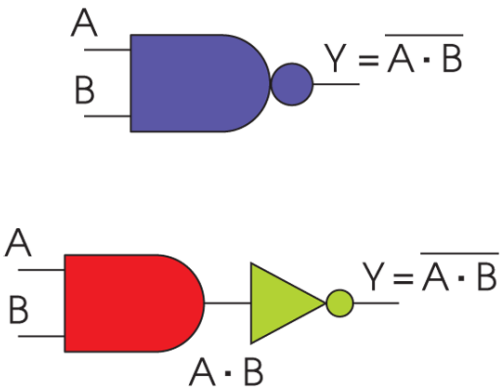
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Truth table

NAND Gate

Two-input NAND logic gate symbol, Boolean expression, and its truth table.

Boolean expression: $Y = \overline{A \cdot B} = \overline{A} + \overline{B}$



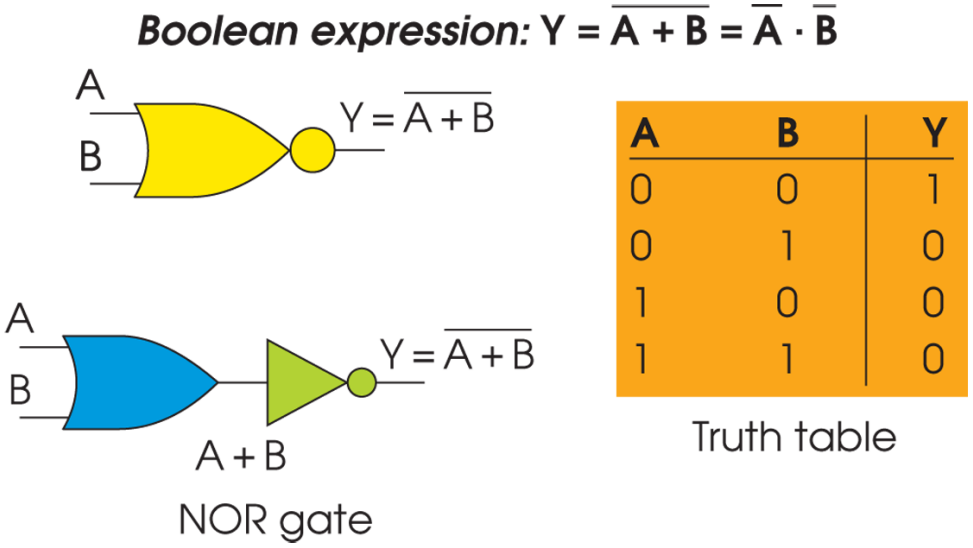
NAND gate

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Truth table

NOR Gate

A two-input NOR logic gate symbol, its Boolean expression, and its truth table.



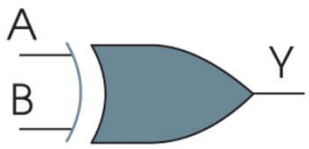
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Truth table

XOR (exclusive OR) Gate

XOR logic gate symbol, its Boolean expression, and its truth table.

Boolean expression: $Y = A \oplus B = A \cdot \overline{B} + \overline{A} \cdot B$



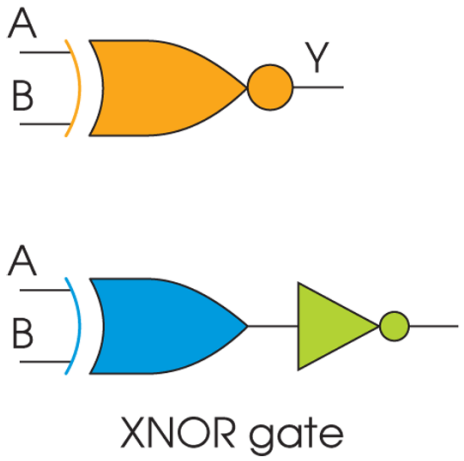
XOR gate

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

XNOR (exclusive NOR) Gate

XNOR logic gate symbol, its Boolean expression, and its truth table.

Boolean expression: $Y = \overline{A \oplus B} = A \cdot B + \overline{A} \cdot \overline{B}$



XNOR gate

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Creating PLC Ladder Logic Diagrams from Boolean Expressions

- Some manufacturers use Boolean expressions to program PLCs.

Example

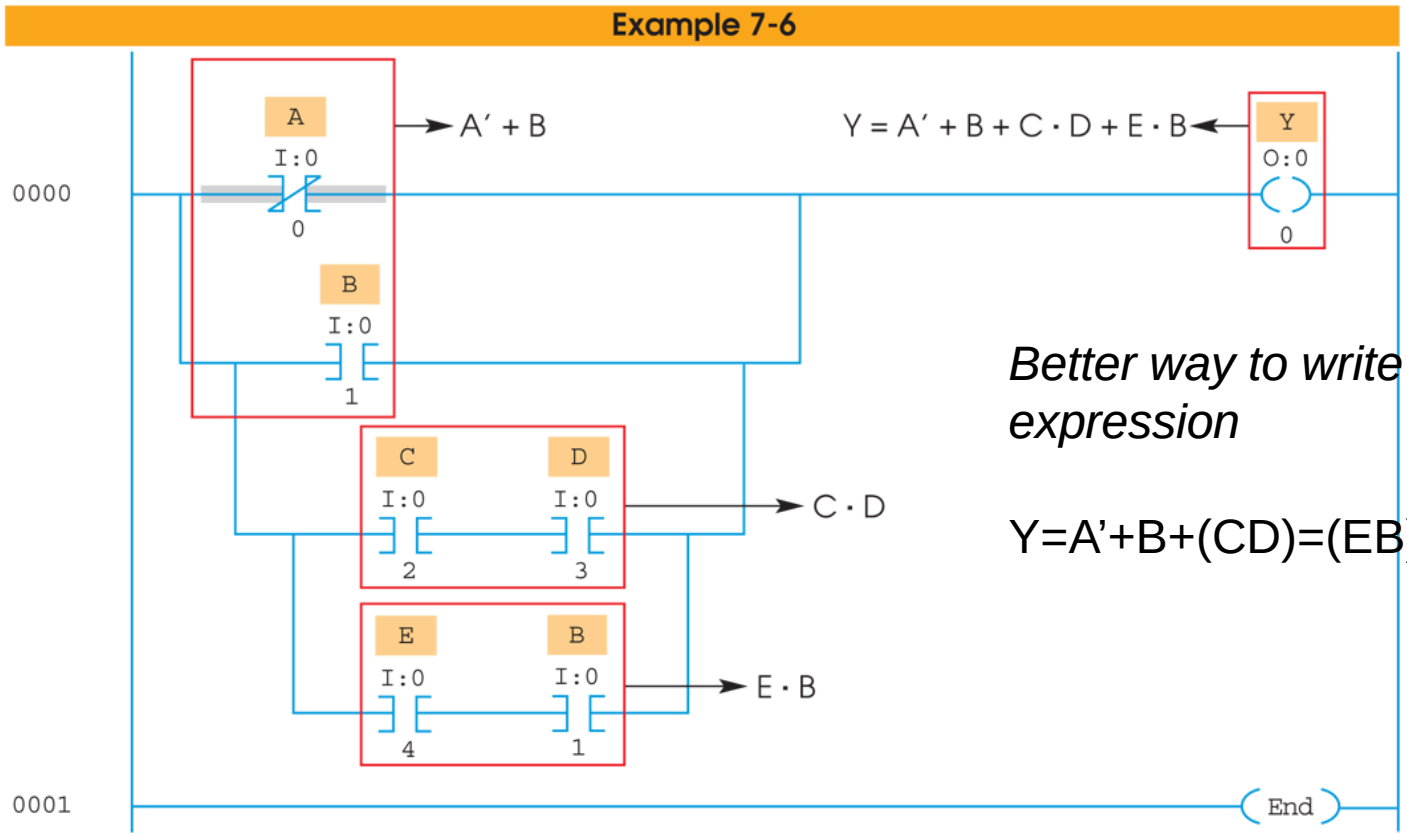
- Create the PLC ladder logic diagram for the following Boolean expression.

$$Y = A' + B + CD + EB$$

Creating PLC Ladder Logic Diagrams from Boolean Expressions (Cont.)

- To create the diagram, each rung or each portion of a rung is created by replacing the Boolean letter with the inputs that match.

PLC Ladder Logic Diagrams from Boolean Expressions



Better way to write the expression

Y=A'+B+(CD)=(EB)