الجامعة التقنية الوسطى
الكلية التقنية الهندسية الكهربائية
قسم هندسة تقنيات الحاسوب

PROGRAMMABLPE LOGIC CONTROLLER

(PLC)

المرحلة الثالثة
المادة: المسيطرات الرقمية

المحاضرة الثانية / بعد نصف السنة

Digital Controllers
"PLC"

1. The I/O Section

The input/output (I/O) section of a PLC is the section to which all field devices are connected and provides the interface between them and the CPU. Input/output arrangements are built into a fixed PLC while modular types use external I/O modules that plug into the PLC. Figure 1 illustrates a rack-based I/O section made up of individual I/O modules.

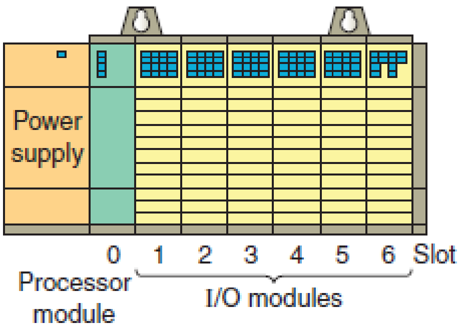


Figure (1): Rack-based I/O section.

In general, rack/slot-based addressing elements include:

Type: The type determines if an input or output is being addressed.

Slot: The slot number is the physical location of the I/O module. This may be a combination of the rack number and the slot number when using expansion racks.

Word and Bit: The word and bit are used to identify the actual terminal connection in a particular I/O module. A discrete (digital) module usually uses only one word, and each connection corresponds to a different bit that makes up the word. With a rack/slot address system the location of a module within a rack and the terminal number of a module to which an input or output device is connected will determine the device's address.

Every input and output device connected to a discrete I/O module is addressed to a specific bit in the PLC's memory. A bit is a binary digit that can be either 1 or 0. Figure 3 illustrates bit level and word level addressing as it applies to an SLC 500 controller.

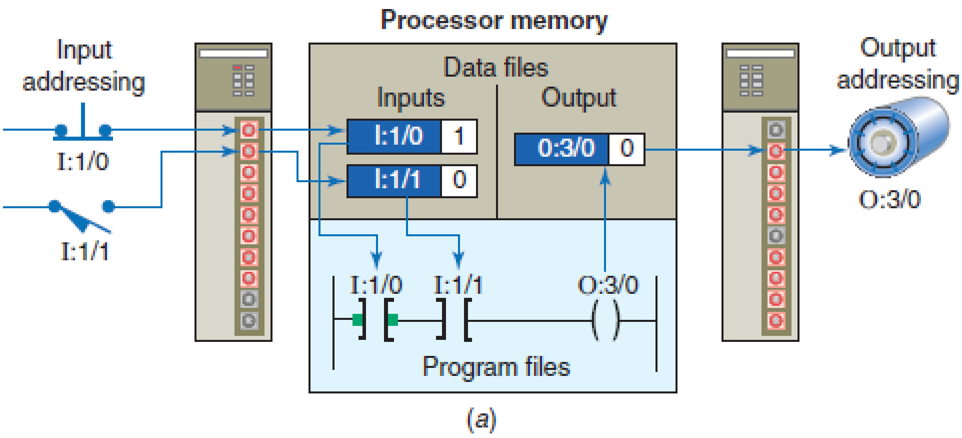


Figure (3): (a): bit level and word level addressing.

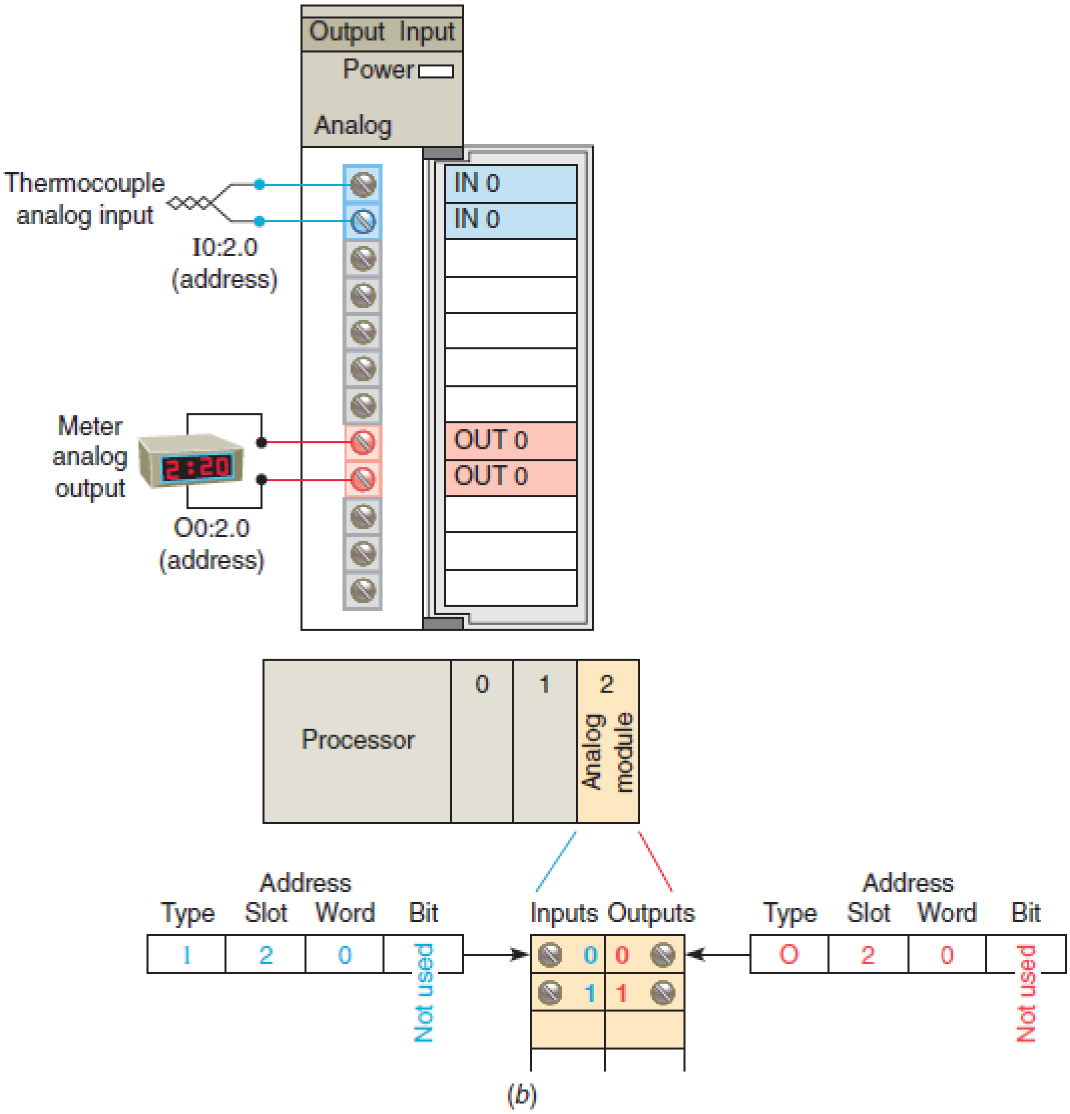


Figure (3):bit level and,(b): word level addressing.

2. Types of I/O modules

2.1:Discrete Inputs modules

The most common type of I/O interface module is the discrete (digital) type. This type of interface connects field input devices of the ON/OFF nature such as selector switches, pushbuttons, and limit switches. Likewise, output control is limited to devices such as lights, relays, solenoids, and motor starters that require simple ON/OFF switching. Each discrete I/O module is powered by some field supplied voltage source. Since these voltages can be of different magnitude or type, I/O modules are available at various AC and DC voltage ratings.

Figure 4 shows the block diagrams for one input of a typical alternating current (AC) discrete input module. The input circuit is composed of two basic sections: the power section and the logic section. An optical isolator is used to provide electrical isolation between the field wiring and the PLC backplane internal circuitry. The input turns LED ON or OFF, indicating the status of the input device. Logic circuits process the digital signal to the processor. Internal PLC control circuitry typically operates at 5 VDC or less volts.

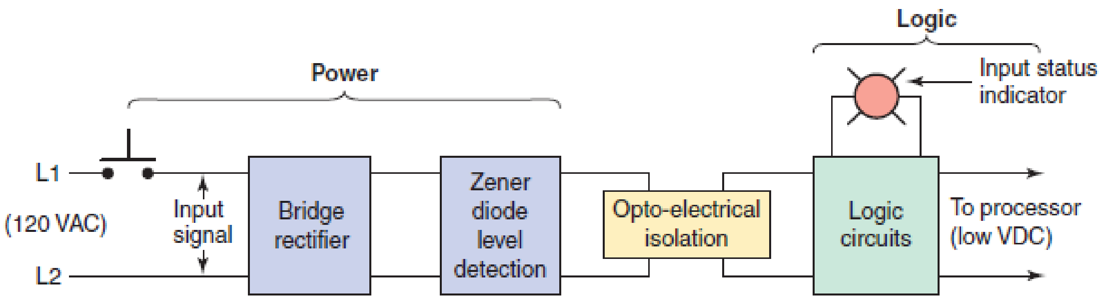


Figure (4): Discrete AC input module block diagram.

2.2: Analog I/O Modules

Circuits of this type sense or drive analog signals. Analog inputs come from devices, such as thermocouples, strain gages, or pressure sensors, that provide a signal voltage or current that is derived from the process variable. Standard Analog Input signals: 4-20mA; 0-10V

Analog outputs can be used to drive devices such as voltmeters, X-Y recorders, servomotor drives, and valves through the use of transducers. Standard Analog Output signals: 4-20mA; 0-5V; 0-10V. The basic type of analog I/O modules has shown in figure 5.

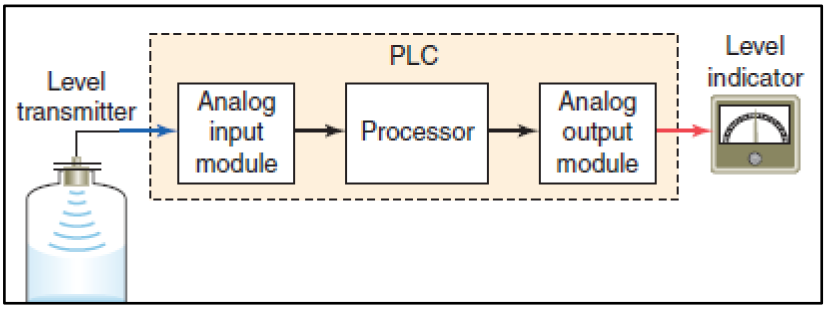


Figure (5): Analog input and output to a PLC.

Analog input modules normally have multiple input channels that allow 4, 8, or 16 devices to be interface to the PLC. The two basic types of analog input modules are voltage sensing and current sensing. Analog sensors measure a varying physical quantity over a specific range and generate a corresponding voltage or current signal. Common physical quantities measured by a PLC analog module include temperature, speed, level, flow, weight, pressure, and position. For example, a sensor may measure temperature over a range of 0 to 500°C, and output a corresponding voltage signal that varies between 0 and 50 mV.

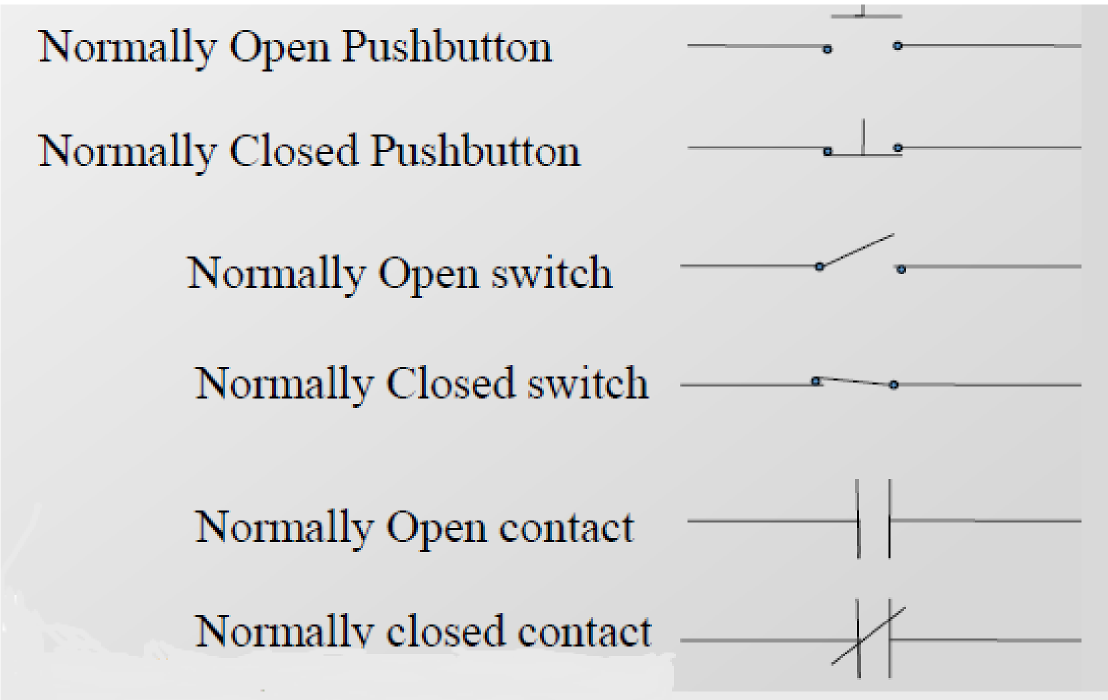
2.3: Special - Purpose I/O module

Circuits of this type are used to interface PLCs to very specific types of circuits such as servomotors, stepping motors PID (proportional plus integral plus derivative) loops, high-speed pulse counting, resolver and decoder inputs, multiplexed displays, and keyboards.

This module allows for limited access to timer and counter presets and other PLC variables without requiring a program loader.

2.4: Discrete Input Symbols

A discrete input also referred as digital input is an input that is either ON or OFF is connected to the PLC digital input. In the ON condition it is referred to as logic 1 or logic high and in the OFF condition maybe referred to as logic o or logic low.



3. Number Systems and Codes

3.1 Decimal System

The decimal system, which is most common to us, has a base of 10. The radix or base of a number system determines the total number of different symbols or digits used by that system. For instance, in the decimal system, 10 unique numbers or digits—i.e., the digits 0 through 9—are used: the total number of symbols is the same as the base, and the symbol with the largest value is 1 less than the base.

3.2: Binary System

The binary system uses the number 2 as the base. The only allowable digits are 0 and 1. With digital circuits it is easy to distinguish between two voltage levels (i.e., 5 V and 0 V), which can be related to the binary digits 1 and 0. To comparison among four common number systems: decimal (base 10), octal (base 8), hexadecimal (base 16), and binary (base 2). Note that all numbering systems start at zero.

3.3: Negative Numbers

If a decimal number is positive, it has a plus sign; if a number is negative, it has a minus sign. In binary number systems, such as used in a PLC, it is not possible to use positive and negative symbols to represent the polarity of a number. One method of representing a binary number as either a positive or negative value is to use an extra digit, or sign bit, at the MSB side of the number. In the sign bit position, a 0 indicates that the number is positive, and a 1 indicates a negative number.

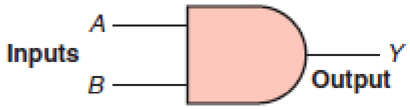
4. Fundamental of Logic

4.1: The Binary Concept

The PLC, like all digital equipment, operates on the binary principle. The term binary principle refers to the idea that many things can be thought of as existing in only one of two states. These states are 1 and 0. The 1 and 0 can represent ON or OFF, open or closed, true or false, high or low, or any other two conditions.

A logic gate is a circuit with several inputs but only one output that is activated by particular combinations of input conditions. The two-state binary concept, applied to gates, can be the basis for making decisions. Examples of logic gate are the AND,OR,NOT,NAND.

AND Gate



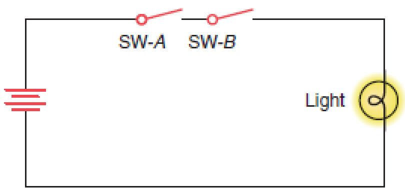
Two-input AND gate symbol

AND truth table

Inputs		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

AND logic gate operates similarly to control devices connected in series.

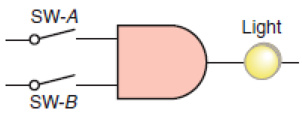
Hardwired circuit



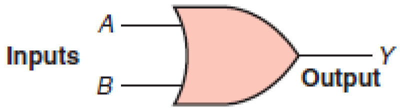
Truth table

SW-A		SW-B		Light	
Open	(0)	Open	(0)	Off	(0)
Open	(0)	Closed	(1)	Off	(0)
Closed	(1)	Open	(0)	Off	(0)
Closed	(1)	Closed	(1)	On	(1)

Logic representation



OR Gate



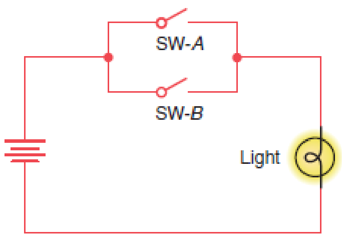
Two-input OR gate symbol

OR truth table

Inputs		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

OR logic gate operates similarly to control devices connected in parallel.

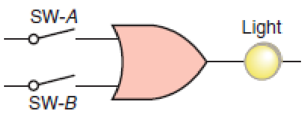
Hardwired circuit



Truth table

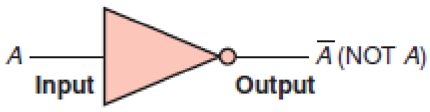
SW-A		SW-B		Light	
Open	(0)	Open	(0)	Off	(0)
Open	(0)	Closed	(1)	On	(1)
Closed	(1)	Open	(0)	On	(1)
Closed	(1)	Closed	(1)	On	(1)

Logic representation



NOT Gate

NOT function constructed using a normally closed pushbutton.



NOT truth table

A	NOT A
0	1
1	0

4.2: Hardwired Logic versus Programmed Logic

The term hardwired logic refers to logic control functions that are determined by the way devices are electrically interconnected. Hardwired logic can be implemented using relays and relay ladder schematics. Relay ladder schematics are universally used and understood in industry. Figure 6 shows a typical relay ladder schematic of a motor stop/start control station with pilot lights. The control scheme is drawn between two vertical supply lines. All the components are placed between these two lines,called rails or legs, connecting the two power lines with what look like rungs of a ladder—thus the name, relay ladder schematic as shown in figure 6.

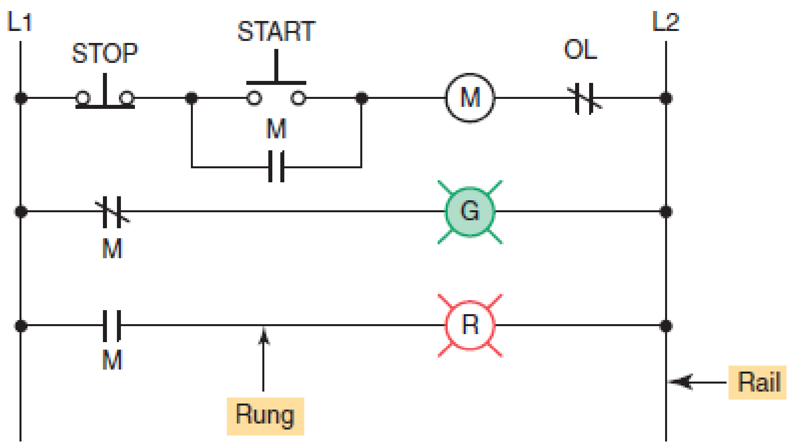


Figure (6): shows the components between input and output.

Programmable control is based on the basic logic functions, which are programmable and easily changed. These functions (AND, OR, NOT) are used either singly or in combinations to form instructions that will determine if a device is to be switched ON or OFF. The form in which these instructions are implemented to convey commands to the PLC is called the language. The most common PLC language is ladder logic. Figure 7 shows a typical ladder logic program for the motor start/stop circuit. The instructions used are the relay equivalent of normally open (NO) and normally closed (NC)contacts and coils.

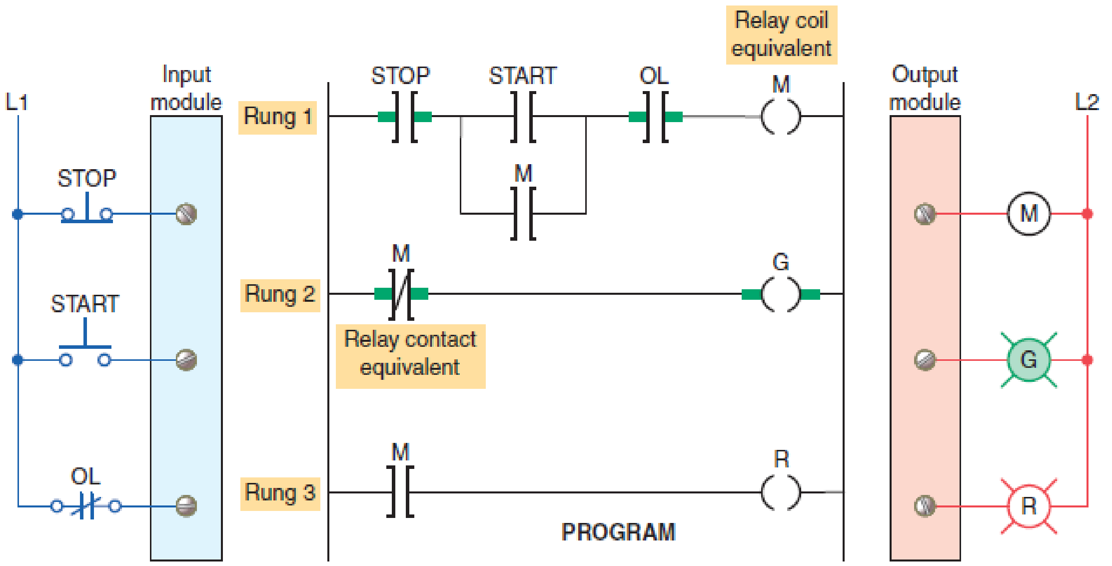


Figure (7): shows a typical ladder logic program for the motor start/stop circuit.

PLC contact symbolism is a simple way of expressing the control logic in terms of symbols. In programmed logic all mechanical switch contacts are represented by a software contact symbol and all electromagnetic coils are represented by a software coil symbol. Because the PLC uses ladder logic diagrams, the conversion from any existing relay logic to programmed logic is simplified. Each rung is a combination of input conditions (symbols) connected from left to right, with the symbol that represents the output at the far right. The symbols that represent the inputs are connected in series, parallel, or some combination of the two to obtain the desired logic. The following groups of examples as shown in figure 8 illustrate the relationship between the relay ladder schematic, the ladder logic program, and the equivalent logic gate circuit.

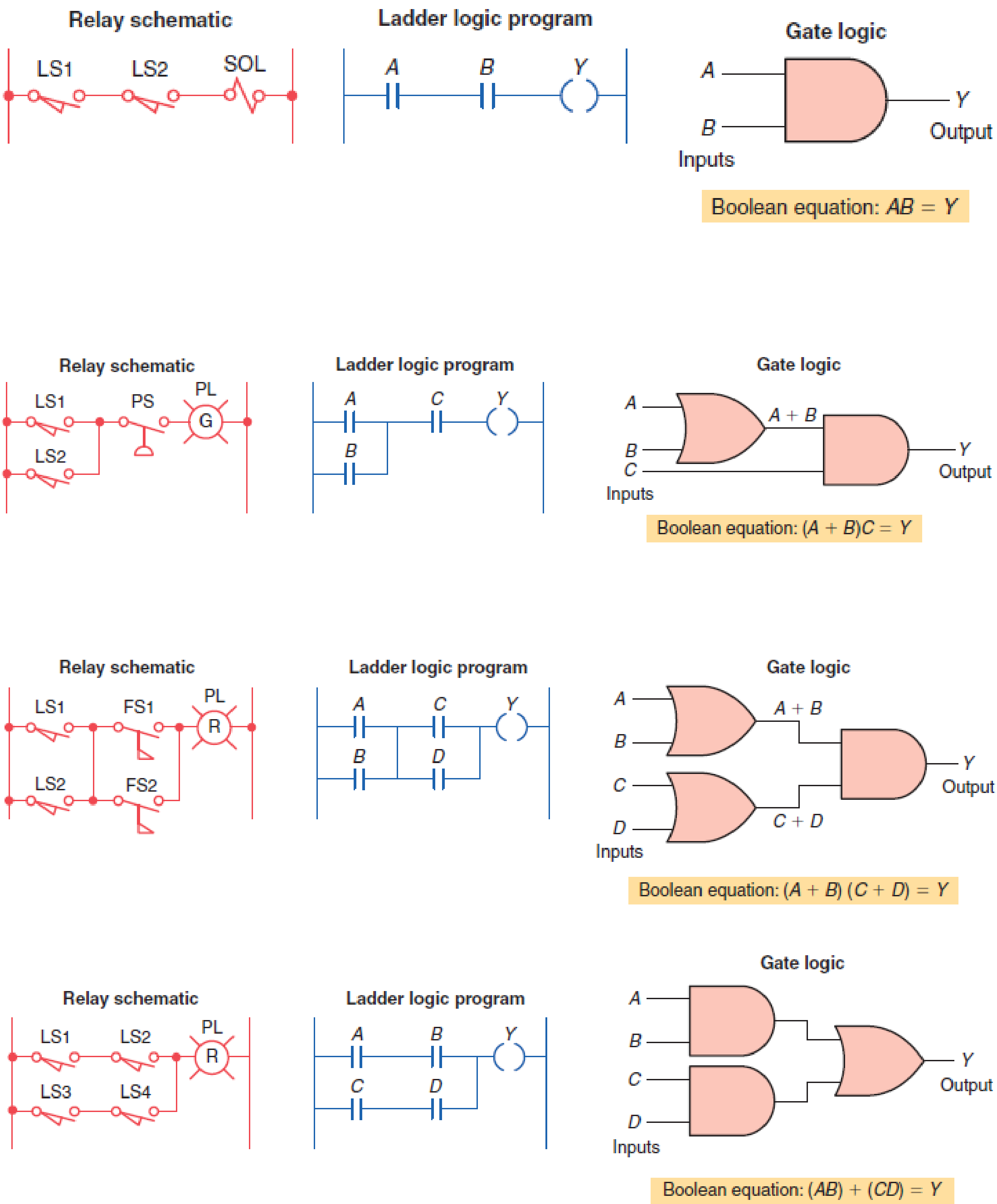


Figure (8): shows the Ladder Logic Diagram for Gates.