الجامعة التقنية الوسطى
الكلية التقنية الهندسية الكهربائية
قسم هندسة تقنيات الحاسوب

PROGRAMMABLE LOGIC CONTROLLER

(PLC)

المرحلة الثالثة
المادة: المسيطرات الرقمية

Digital Controllers

"PLC"

1. Basics of PLC Programming

The memory map or structure for a PLC processor consists of several areas, some of these having specific roles. Allen-Bradley PLCs have two different memory structures identified by the terms ***rack-based systems*** and ***tag-based systems***. The memory organization for rack-basedsystems.

The memory space can be divided into two broad categories: **program files** and **data files**.

Program files: is the part of the processor memory that stores the user ladder logic program. This logic consists of instructions that are programmed in a ladder logic format. Most instructions require one word of memory.

The data files: store the information needed to carry out the user program. This includes information such as the status of input/output devices, timer and counter values, data storage, and so on. Contents of the data table canbe divided into two categories: status data and numbers or codes. Status is ON/OFF type of information represented by 1s and 0s, stored in unique bit locations. Number or code information is represented by groups of bits that are stored in unique byte or word locations. The memory organizations of the rack-based Allen-Bradley PLC-5 and SLC 500 controllers are very similar. Figure 1 shows the program and data file organization for the SLC 500 controller. The contents of each file are as follows.

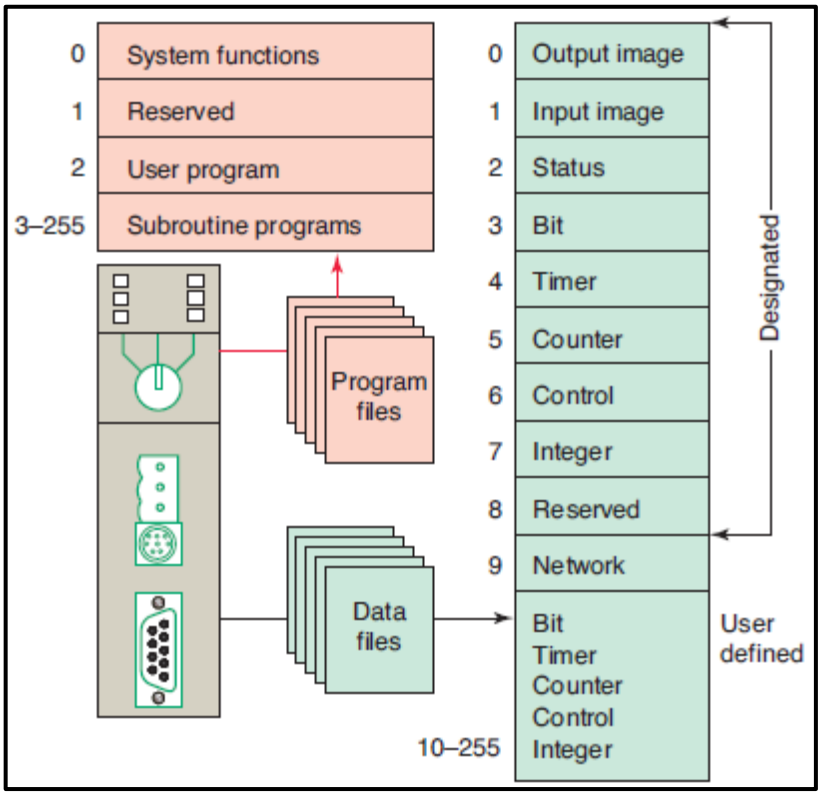

Figure (1): Program and data file organization for the SLC 500 controller.

2. PLC Wiring Diagram and Ladder Logic Program and Sensors

2.1 Electromagnetic Control Relays

The PLC's original purpose was the replacement of electromagnetic relays with a solid-state switching system that could be programmed to make logic decisions but are not designed to handle heavy current or high voltage. An electrical relay is a magnetic switch. It uses electromagnetism to switch contacts. A relay will usually have only one coil but may have any number of different contacts. Figure 2 illustrates the operation of a typicalcontrol relay.

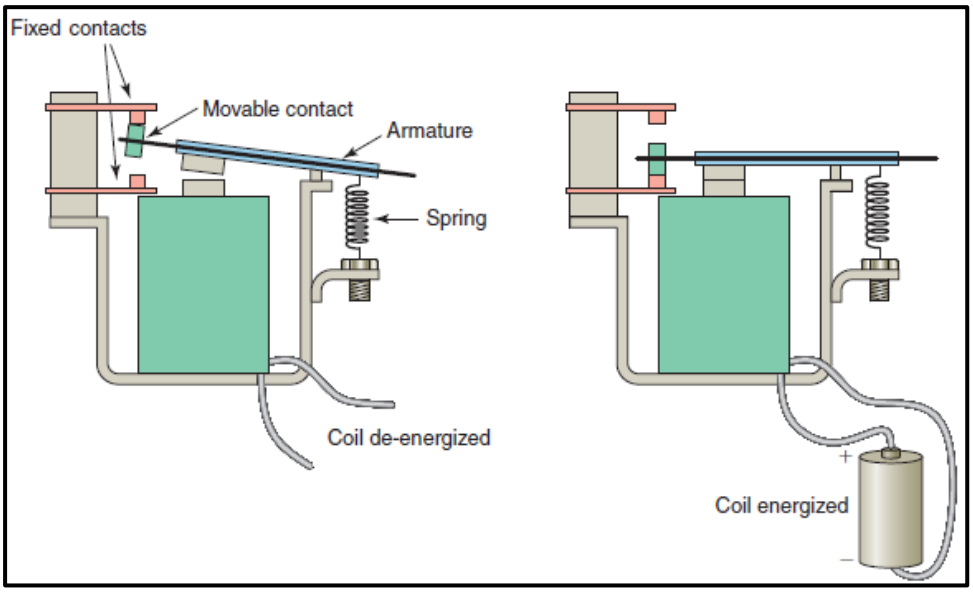

Figure (2): shows the operation of a typical control relay

A typical control relay used to control two pilot lights is shown in Figure 3

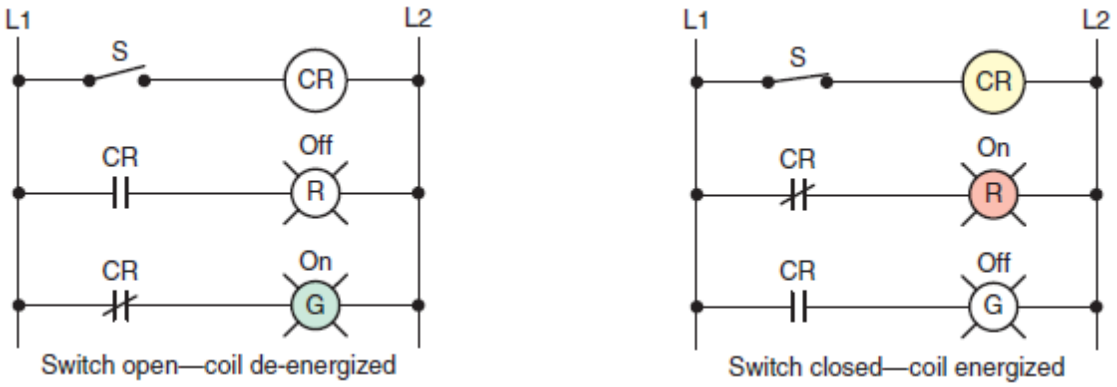

Figure 3: shows Control relay used to control two pilot lights.

Control relay coils and contacts have separate ratings. Coils are rated for the type of operating current (DC or AC) and normal operating voltage. Contacts are rated in terms of the maximum amount of current the contacts are capable of handling at a specified voltage level and type(AC or DC).

2.2 Contactors

A contactor is a special type of relay designed to handle heavy power loads that are beyond the capability of control relays. Programmable controllers normally have an output Capacity capable of operating a contactor coil, but not that needed to operate heavy power loads directly.

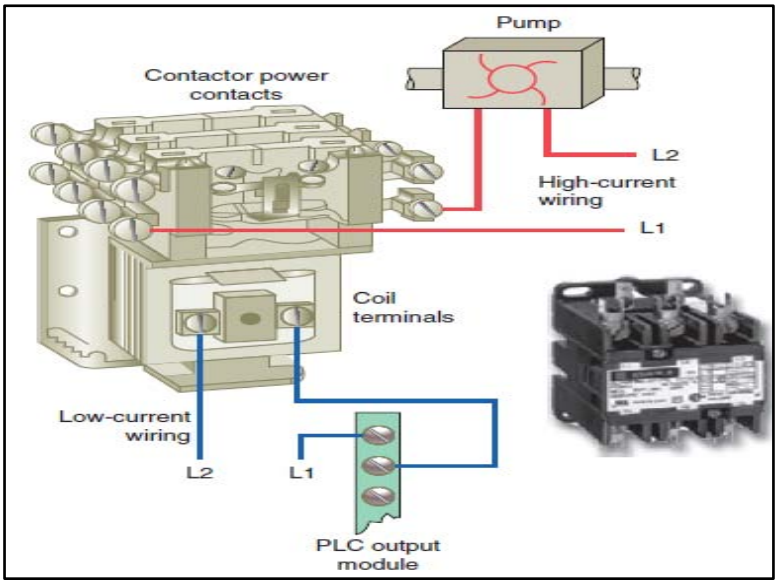

Figure (4): Illustrates the application of a PLC used in conjunction with a contactor to switch power on and off to a pump.

2.3 Motor Starters

A motor starter is designed to provide power to motors. The motor starter is made up of a contactor with an overload relay attached physically and electrically.

2.4 Manually Operated Switches

Manually operated switches are controlled by hand. These include toggle switches, pushbutton switches, knife switches, and selector switches. Pushbutton switches are the most common form of manual control. A pushbutton operates by opening or closing contacts when pressed. Figure 5 shows commonly used types of pushbutton switches.

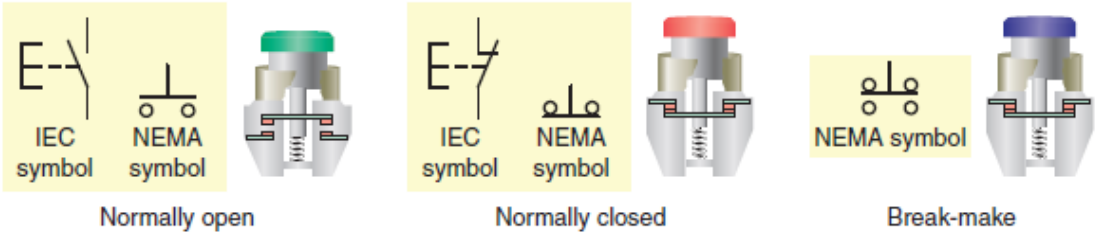

Figure (5): commonly used types of pushbutton switches.

2.5 Sensors

Sensors are used for detecting, and often measuring the magnitude of something. They convert mechanical, magnetic, thermal, optical, and chemical variations into electric voltages and currents.

2.6 Proximity Sensor

Proximity sensors or switches, such as that shown in Figure 6, are pilot devices that detect the presence of an object (usually called the target) without physical contact. These solid-state electronic devices are completely encapsulated to protect against excessive vibration, liquids, chemicals, and corrosive agents found in the industrial environment.

Figure (6): Proximity sensor.

Proximity sensors are used when:

• The object being detected is too small, lightweight, or soft to operate a Mechanical switch.

• Rapid response and high switching rates are required, as in counting or ejection control applications.

• An object has to be sensed through nonmetallic barriers such as glass, plastic, and paper cartons.

• Hostile environments demand improved sealing properties, preventing proper operation of mechanical switches.

•Long life and reliable service are required.

•A fast electronic control system requires a bounce free input signal.

Most sensor applications operate either at 24V DC or at 120V AC. The method of connecting a proximity sensor varies with the type of sensor and its application. Figure 7 shows a typical three-wire DC sensor connection. The three-wire DC proximity sensor has the positive and negative line leads connected directly to it.

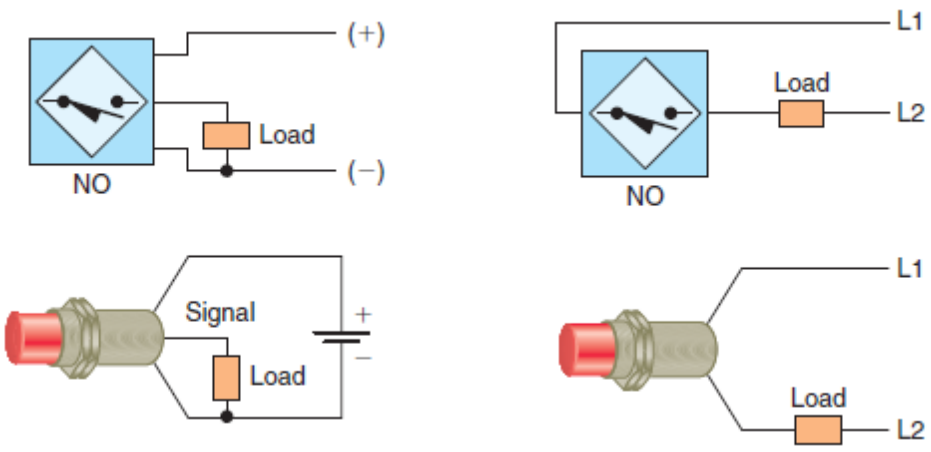

Figure (7): Typical three-wire DC sensor connection and typical two-wire proximity sensor connection.

2.7 Magnetic Reed Switch

A magnetic reed switch is composed of two flat contact tabs that are hermetically sealed (airtight) in a glass tube filled with protective gas, as illustrated in Figure 8 When a magnetic force is generated parallel to the reed switch, the reeds become flux carriers in the magnetic circuit.

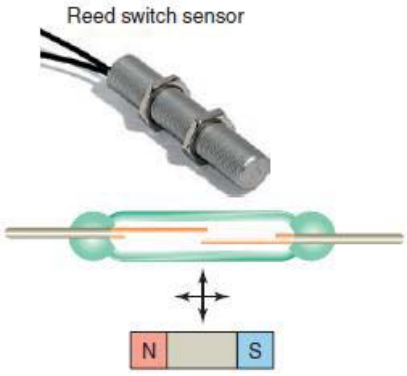

Figure (8): Magnetic reed switches.

2.8 Light Sensors

The ***photovoltaic cell*** and the ***photoconductive cell***, illustrated in Figure 9, are two examples of light sensors. The photovoltaic or solar cell reacts to light by converting the light energy directly into electric energy. The photoconductive cell (also called a photo resistive cell) reacts to light by change in the resistance of the cell.

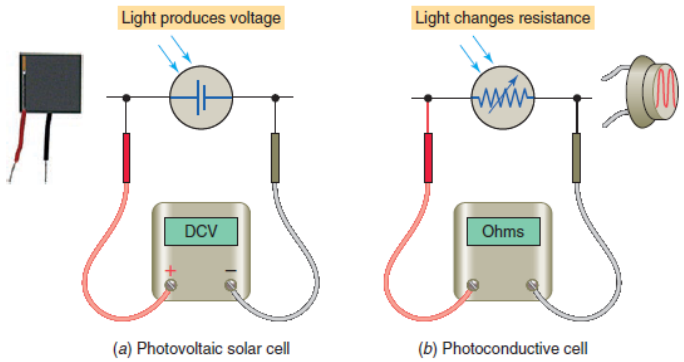

Figure (9): Shows the Light sensor.

A ***photoelectric sensor*** is an optical control device that operates by detecting a visible or invisible beam of light and responding to a change in the received light intensity. Photoelectric sensors are composed of two basic components: a transmitter (light source) and a receiver (sensor). These two components may or may not be housed in separate units.

2.9 Temperature Sensors

The thermocouple is the most widely used temperature sensor. Thermocouples operate on the principle that when two dissimilar metals are joined, a predictable DC voltage will be generated that relates to the

difference in temperature between the hot junction and the cold junction

Figure 10. The hot junction (measuring junction) is the joined end of a thermocouple that is exposed to the process where the temperature measurement is desired. The cold junction (reference junction) is the end of a thermocouple that is kept at a constant temperature to provide a reference point.

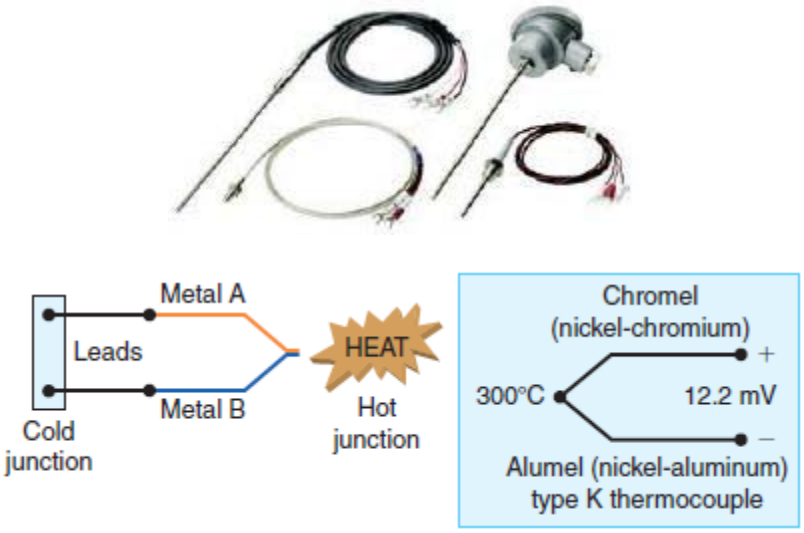

Figure (10): Thermocouple Temperature Sensors.