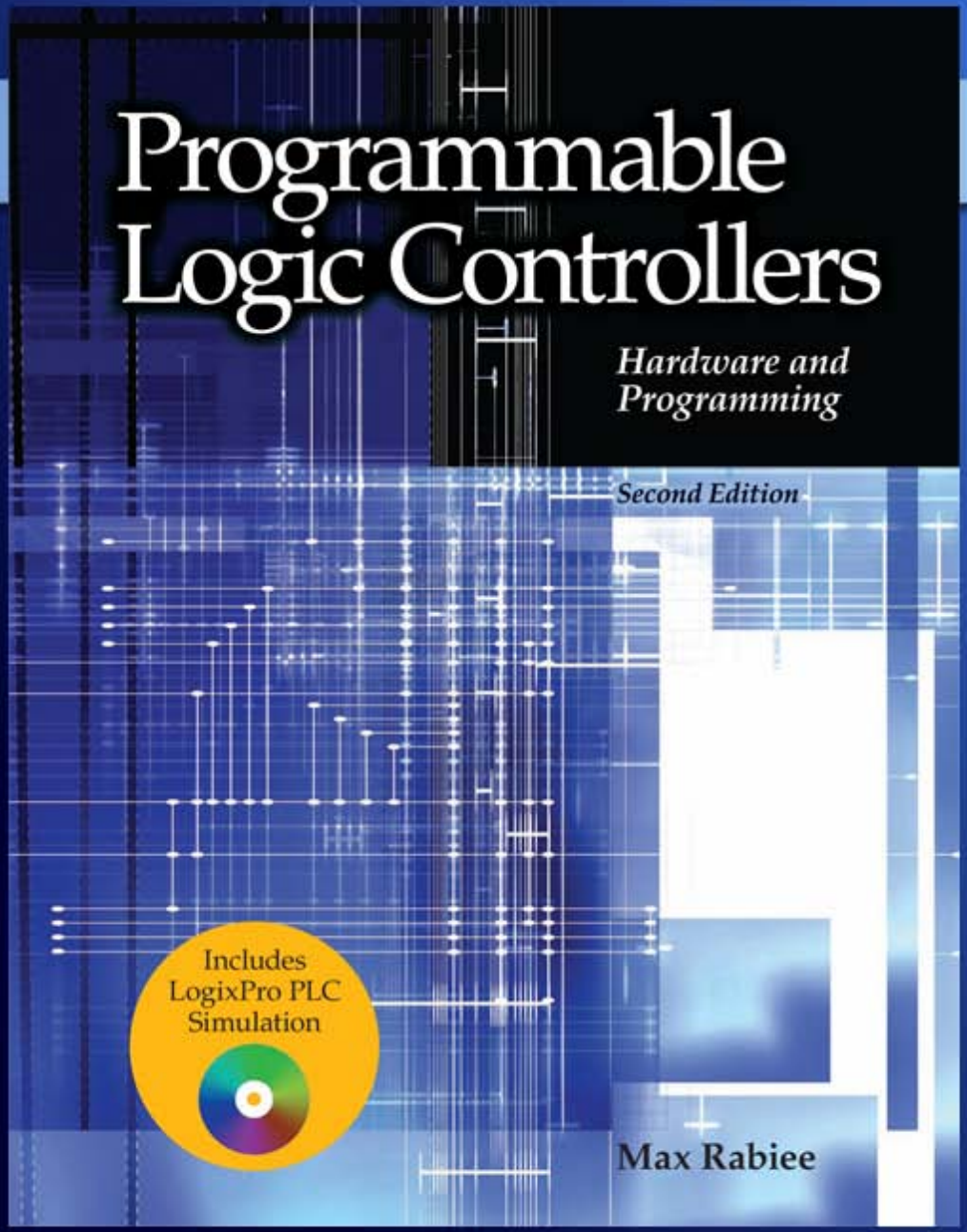


PowerPoint Presentations for

Programmable Logic Controllers

Hardware and Programming

by Max Rabiee

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

Chapter

6

PLC Programming

Objectives

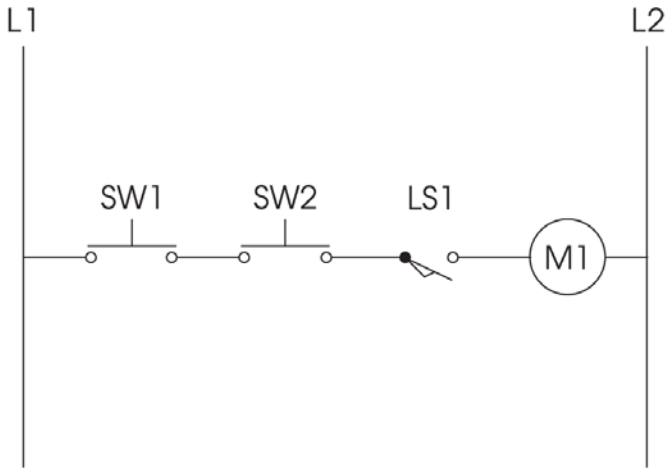
- List the rules for creating a PLC ladder logic diagram.
- Convert a relay logic diagram to a PLC ladder logic diagram.
- Create ladder logic diagrams when the PLC is in the offline mode.
- Download PLC ladder logic diagrams and test them on a trainer.

Objectives

- Use the force instruction for troubleshooting.
- Create and print program reports.
- Save and open ladder diagram project files.

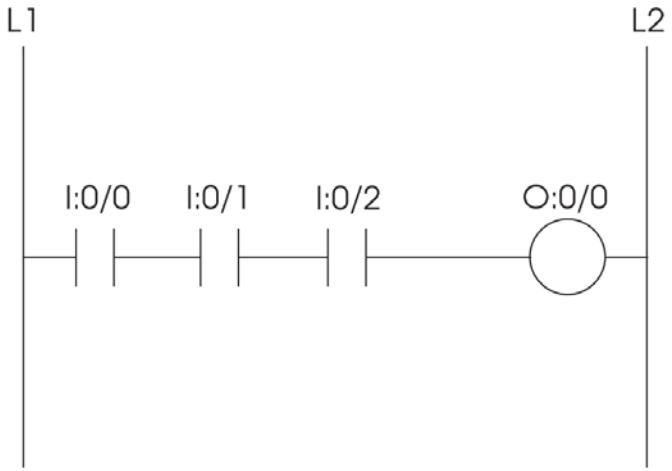
Creating PLC Ladder Logic Diagrams from Relay Logic Diagrams

- To create relay logic diagrams, use input device symbols and output device symbols.
- Input and output port addresses are assigned to each input and output device.
- Each row is called a *rung*.



Creating PLC Ladder Logic Diagrams from Relay Logic Diagrams (Cont.)

- **Rule 1.** Place a contact in the upper-left corner of the ladder logic diagram.
- **Rule 2.** Place the coil at the end of the rung.

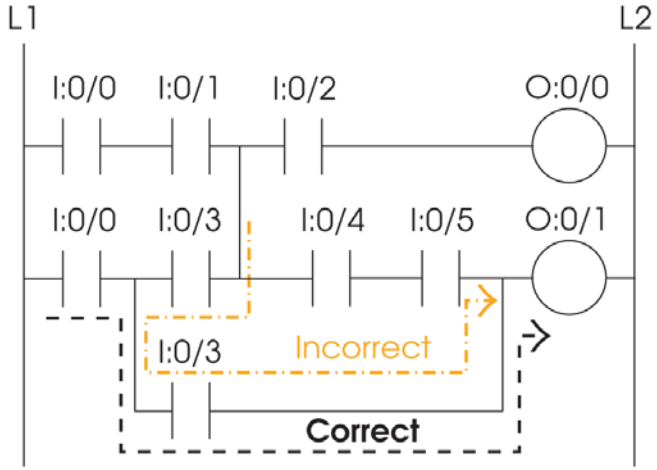


Creating PLC Ladder Logic Diagrams from Relay Logic Diagrams (Cont.)

- **Rule 3.** All contacts must be placed horizontally.
- **Rule 4.** Outputs cannot be connected in series with other outputs.

Creating PLC Ladder Logic Diagrams from Relay Logic Diagrams (Cont.)

- **Rule 5.** Program execution flow must be from left to right.
- **Rule 6.** Place the rung numbers on the left side of each rung.



Rung Comments

- Placed on the top of each rung.
- Describe major function of following rungs.
- Specify location of each contact associated with a coil.
  - Place contact next to the coil the number of the rung the associated contact is on.

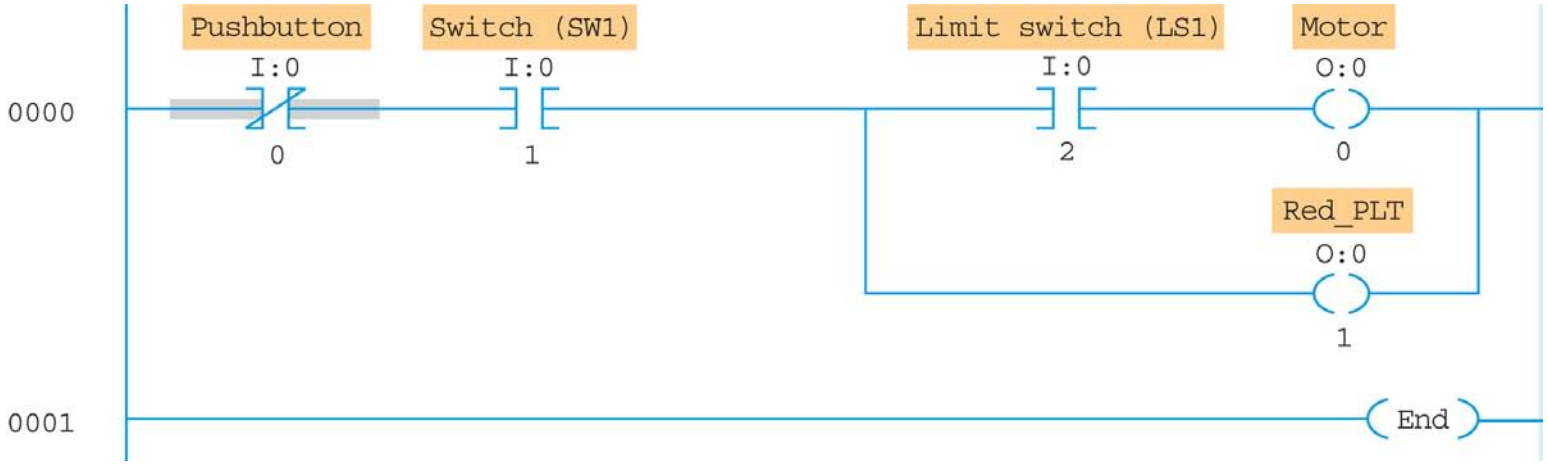
Programming Ladder Logic Diagrams with NO and NC Switches

- After constructing the relay logic diagram:
  - Assign addresses to each input and output device.
  - Connect input/output devices to the PLC ports.
  - Create PLC ladder diagram.

Programming Ladder Logic Diagrams with NO and NC Switches (Cont.)

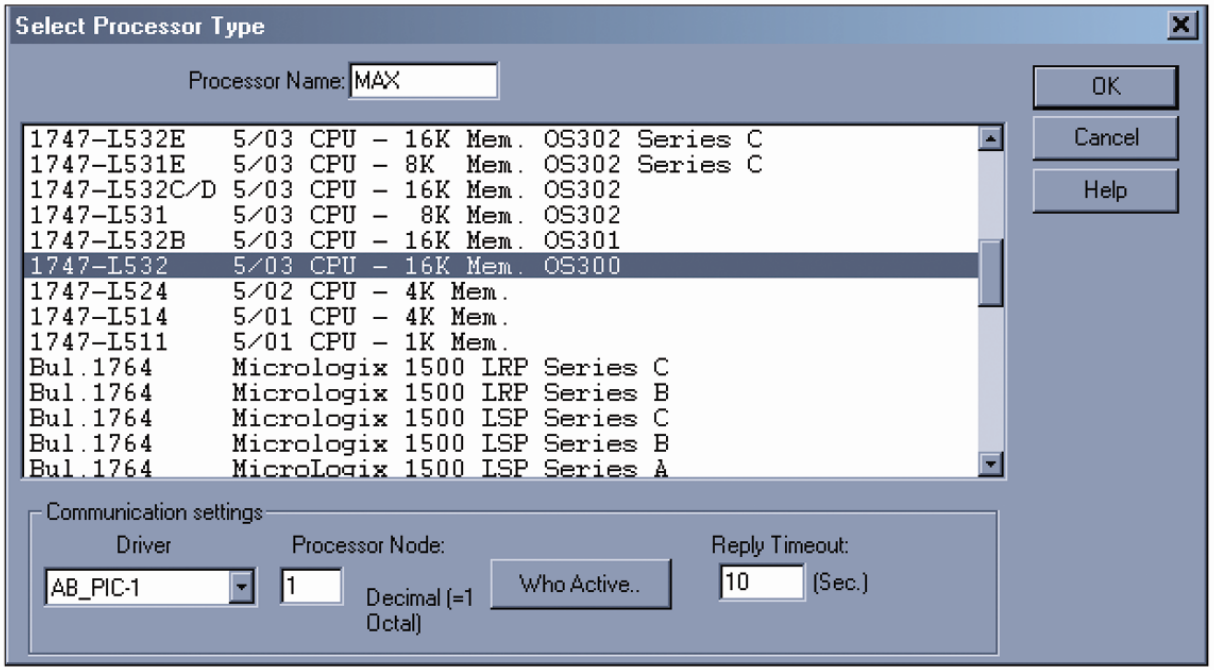
- PLC is in offline programming mode while ladder diagram is created.
- Offline mode:
  - Mode where the PLC ladder logic diagram can be created.

Programming Ladder Logic Diagrams with NO and NC Switches (Cont.)



Programming Ladder Logic Diagrams with NO and NC Contacts

- Software allows set up of the I/O configuration.

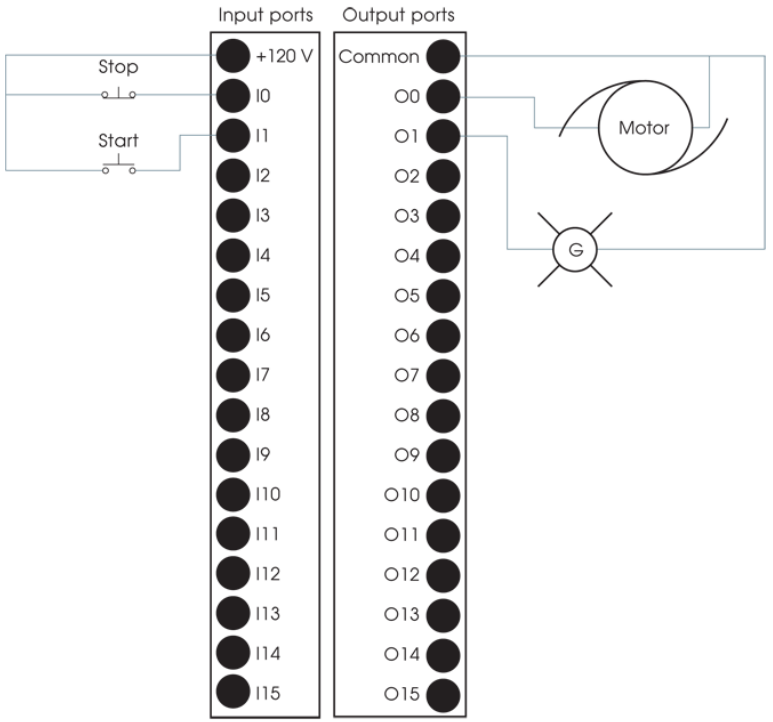


Programming Ladder Logic Diagrams with NO and NC Contacts (Cont.)

- Slot zero:
  - Always reserved for the PLC processor.
- Slot one:
  - Houses a sixteen port 120 VAC input module.
- Slot two:
  - Houses a sixteen port 120 VAC output module.

Programming Ladder Logic Diagrams with NO and NC Contacts (Cont.)

- Input/output connections of the Allen-Bradley Modular SLC 503 PLC.



Program Scan

- PLC program execution flow on each rung is from left to right.
- From the top rung to the bottom rung, moving through the entire PLC ladder logic diagram.
- Operational Scan Rate:
  - Time required to execute the PLC ladder diagram once.

PLC Program Scan Time

- PLC ladder logic diagram instructions:
  - Scanned from the instruction in the upper-left corner.
  - Ends with the instruction on the lower-right corner.
  - After last instruction in the lower-right corner, scanning restarts.

PLC Program Scan Time (Cont.)

- Output energize (OTE):
  - Output port connected to an output device.
- Output latch (OTL) and output unlatch (OTU):
  - Used for latch/unlatch instructions.
- One-shot rising (OSR):
  - One-shot output instruction used to generate a one-shot pulse.

PLC Operational Cycle

- **Input scan:**
  - Processor reads input ports and updates input status table.
- **Program scan:**
  - Processor executes PLC program and updates output status table.
- **Output scan:**
  - Output status table values transferred to output terminals.

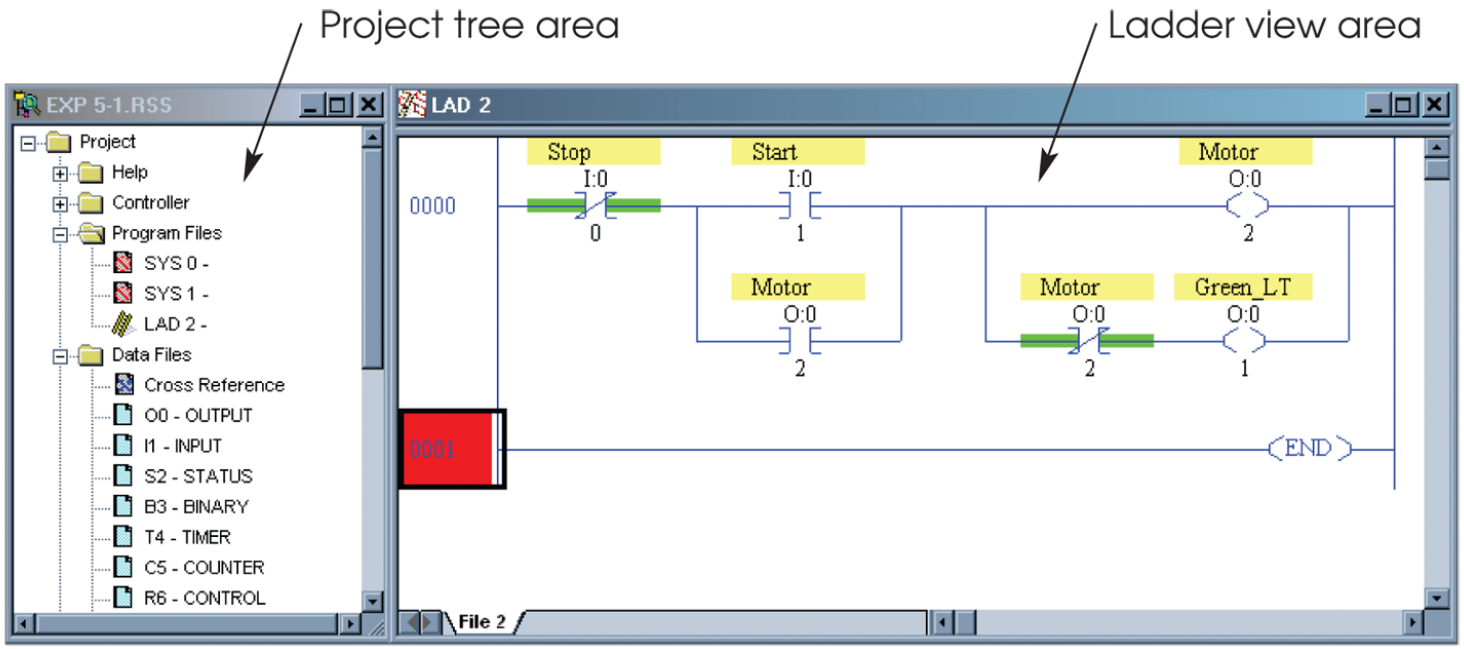
Scanning a Rung

- Input and output addresses are updated.
- Sometimes, specific inputs or outputs may not be updated in time.
- Immediate input with mask (IIM).
- Immediate output with mask (IOM).

Project Tree Area

- Divided into:
  - **Program Files.**
  - **Data Files**.
- Three program file icons in the **Program Files** area.

Project Tree Area (Cont.)



Program Files

- SYS0 program file:
  - Used by PLC processor to keep track of its internal register settings.
  - Not available to RSLogix 500 user.
- SYS1 program file:
  - Reserved.
  - Not available to RSLogix 500 user.

Main Program File (LAD2)

- Holds the main PLC ladder logic diagram.
- PLC project:
  - May be more than one program file.

Subroutine Program Files

- May be several in addition to the main program file.
- Called on or accessed from the main program file.
- Selecting a main program file or a subroutine file in the project tree area:
  - Ladder logic diagram is displayed in ladder view area.

Data Files

- Input (I)
- Output (O)
- Status (S2)
- Timer (T4)
- Counter (C5)
- Control (R6)
- Integer (N7)
- Bit (B3 and B10)

Data Files (Cont.)

- Input (I):
  - Inputs can be ***examine if open (XIO)*** or ***examine if closed (XIC)***.
- Output (O):
  - In the Allen-Bradley Fixed SLC 500 PLCs, eight output ports in module zero.

Status (S2)

- Holds the flag or status bits of the ladder logic diagram.
- If a central processing unit fault is generated in the PLC, click this icon.
- Find fault indicator status bit.
- Read the reason the message was generated.
- Correct the program to solve the fault condition.

Timer (T4)

- Holds information related to the number of timers used in the ladder logic program.
- Depending on the size of the PLC RAM, there could be timers with addresses from T4:0 to T4:255.
  - A PLC ladder diagram can have access to 256 timers.
  - Number of timers is limited due to lack of enough RAM memory in the PLC.

Counter (C5)

- Holds information related to counters that can have any address from C5:0 to C5:255.
- Number limited due to the lack of RAM memory in the PLC.

Control (R6)

- Control file (R6) holds 256 words (R6:0 to R6:255) used as control registers.
- Control registers are used with sequencer and shift register instructions.
- Registers R6:0 to R6:255 can hold valuable information related to the sequencer and shift register instructions.

Integer (N7)

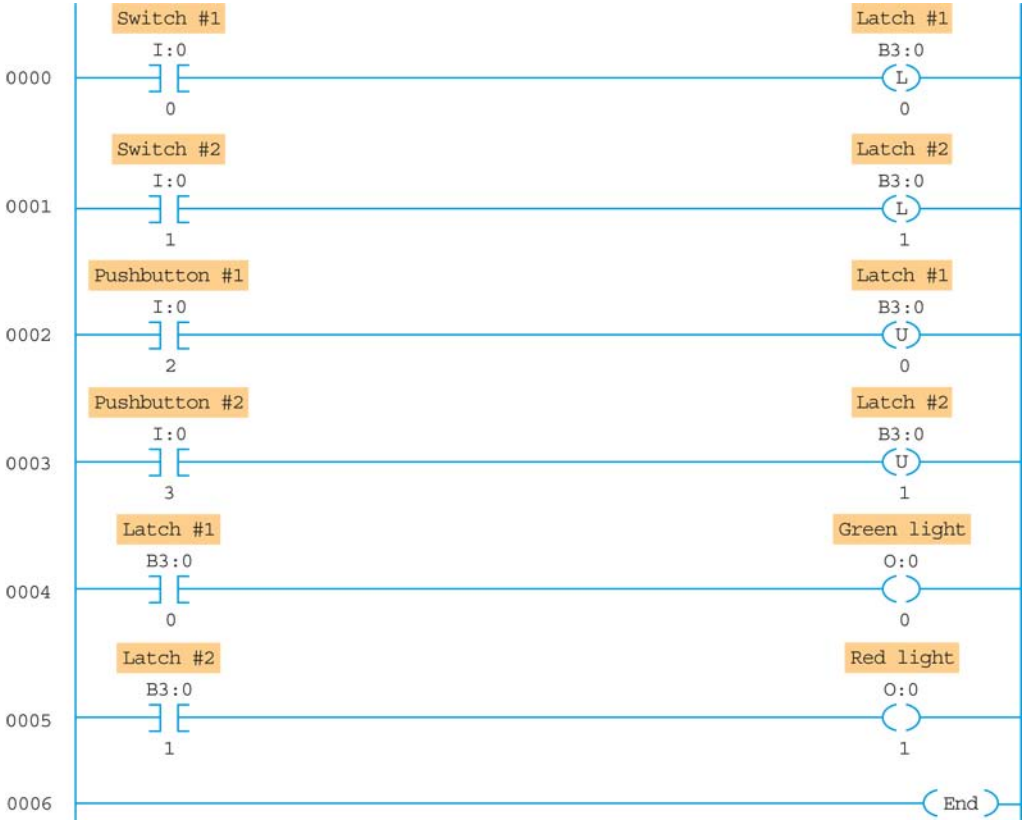
- Holds 256 words (N7:0 to N7:255) that can be used as temporary storage integer registers.

Bit (B3 and B10)

- Each hold 256 words (B3:0 to B3:255 and B10:0 to B10:255).
- Used by advance PLC instructions such as bit shift and sequencer instructions.
- All Allen-Bradley SLC 500 series Programmable Logic Controllers have 16-bit registers.

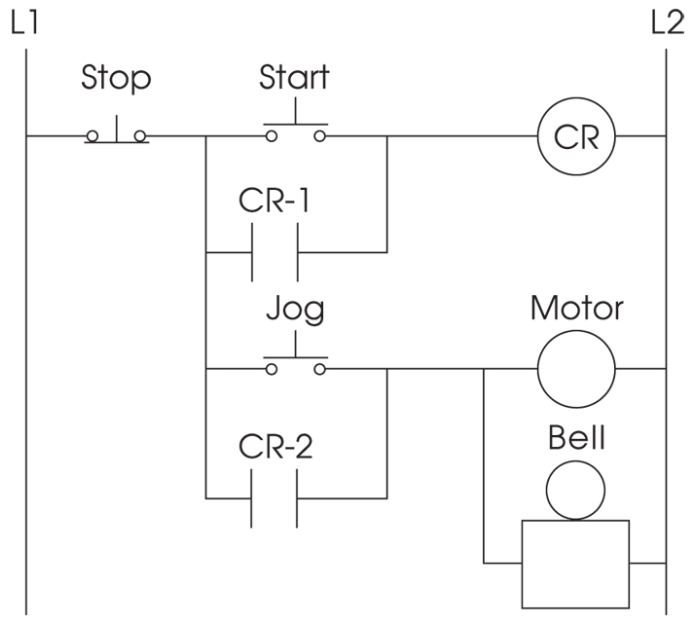
Programming Ladder Logic Diagrams with Latch and Unlatch Instructions

PLC ladder diagram for the relay logic diagram.

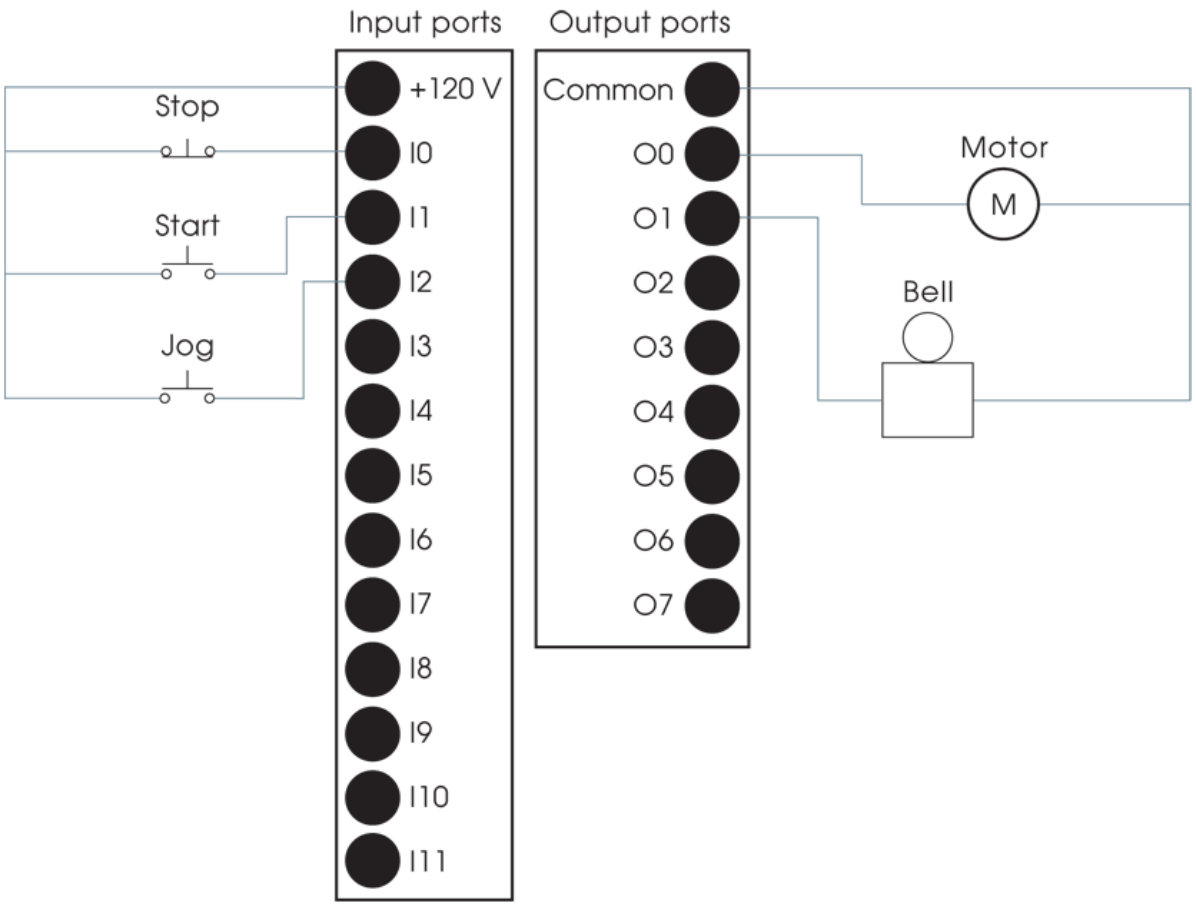


Loading and Troubleshooting PLC Ladder Diagrams in Run Mode

- PLC ladder logic diagram will be loaded into the PLC.
- PLC will be placed in the run mode and online monitor mode.



PLC Device Input/Output Connections



Run Modes

- Offline mode.
- Online mode.

Run Modes (Cont.)

- When PLC is in run and online monitor mode:
  - Run mode icon on the top of the screen will start rotating along its vertical axis.
  - Two vertical rails in the ladder logic diagram will be highlighted.

Forced Condition Mode

- Method of testing the PLC system without actually closing or opening input devices.
- Keys on the computer keyboards are pressed to test the program.
- *Force condition must be used with extreme caution.*
- Allows a programmer to turn outputs on and off without actually touching the input/output devices.

Forced Condition Mode (Cont.)

- Place PLC in the offline mode and create the ladder logic diagram displayed.
- Download program into PLC.
- Place PLC in run/online monitor mode.
- Even though the force instruction is a powerful tool for troubleshooting, using the force instruction in an industrial plant has the potential of causing fatal accidents.

Creating and Printing PLC Program Reports

- Different report options available.
- Configure the printer and its settings.
- Preview reports that are ready to be printed and print them.
- PLC manufacturer’s programming software will have similar report options.

Creating and Printing PLC Program Reports (Cont.)

- Seven commands for creating and printing PLC reports found under the **File** menu:
  - Print View.
  - Print Preview.
  - Report Options.
  - Report Preview.
  - Print Report.
  - Printer Setup.
  - Page Setup.

Report Options

- General.
- Data Files.
- Program Files.
- Special.
- Database.
- Miscellaneous Layout Options.

General Report

- Title Page.
- Processor Information.
- I/O Configuration.
- Channel Configuration.
- Custom Data Monitor.
- Cross Reference.
- Multipoint List.

Title Page Report

- Prints the RSLogix 500 name and the Rockwell software logo.
  - Printing this page requires a lot of ink.
  - Therefore, do not select this option.

Processor Information Report

- Contains the name and type of processor used in the PLC system.
- Know the type of PLC used with your lab station.
- Do not need to select this option either.

I/O Configuration Report

- Number of slots available on the PLC.
- Which slots are configured to be used and how many ports each module in the expansion slot has.
- Printouts of the number of input/output devices used.

Channel Configuration Report

- Lists the controller channel number used for the communication between the PLC and the computer.
- The PLC is assigned to station or node zero.
- Configure the AB_PIC-1 (Allen-Bradley Peripheral Interface Connector) device driver that uses channel one.

Channel One

- RJ-45 connection terminal.
- RJ-45 type terminal looks similar to the RJ-11 telephone jack terminal, except the RJ-45 is larger than the RJ-11 terminal.
- Always used for connecting the 1747-PIC communication interface device to the PLC and the computer.

Channel Zero

- Could also be used for connecting peripheral devices.
- Barcode reader or a printer directly to the SLC 502, SLC 503, SLC 504, and SLC 505 PLC systems.
- Channel zero uses the RS 232C (Recommended Standard 232C) standard channel available on these PLC systems.

Custom Data Monitor Report

- Provides a list of the addresses in the custom data monitor, their symbols, and the current value of the bit or word address.
- For the smaller SLC 500 and SLC 501 programmable logic controller systems, do not print this report.

Cross Reference Report

- Specifies which data files and rungs the addresses in the project are using.
- For smaller ladder logic diagrams with only a few rungs, do not print this report option.

Multipoint List Report

- Contains a list of addresses used in the ladder logic diagram.
- Addresses can be for input/output devices (I/O), contact bits (B3 or B10), timer (T4), counter (C5), control register (R6), or status register (S2).

Multipoint List Report (Cont.)

- Available with Allen-Bradley MicroLogix 1000, SLC 5/03-OS302, and SLC 5/04-OS401 controllers.
- Addresses used and conditions or states while the PLC was operating.
- Occasionally, select this option to review conditions while trouble-shooting your PLC project.

Data Base Section

- **Address/Symbols.**
- **Instruction Comments.**
- **Symbol Groups**.

Address/Symbols Option

- Lists instruction addresses and descriptions.
- Only lists processor addresses used in the ladder logic diagram.

Instruction Comments Option

- Displays the instruction comments.
- On the ladder logic diagram, instruction comments will write over the address comments.
  - If an address has both instruction and address comments, only the instruction comment will be printed.

Symbol Groups Option

- Contains the list and description of the symbol groups.
- PLC programmer can create symbols for each input/output device.
- From then on, the programmer can use the symbol to place the I/O device.

Symbol Groups Option (Cont.)

- For example, create a symbol called PB0 for the input I:0/0.
- Then instead of typing I:0/0, type PB0 to place the input device in the ladder diagram.

Program Files Section

- Report option in the dialog box has two options.
- Options:
  - **Program File List.**
  - **Program Files**.

Program File List

- List of the ladder logic diagrams. It will always list file 0, file 1, and file 2.
  - File 0, or **SYS 0**, is used to hold the status bits or flag bits.
  - These bits are S2, S3, S5, and such. File 1, or **SYS 2**, is reserved.
  - Therefore, file 0 and file 1 are system files. File 2, or **LAD2**, contains the main ladder logic diagram.

Program Files Option

- Displays ladder logic diagrams of the files in the report.
- Select this report option.

Data Files Section

- **Data File List**.
- **Data Files.**
- **Memory Usage**.

Data File Reports

- **Data File List:**
  - Specifies the list of data files available for the PLC project.
- **Data Files** option:
  - Specify which data file to include in report or the range for which data file will be printed.

Saving and Retrieving PLC Programs

- To save the PLC project from the **File** menu, click **Save As**.
- From the **Look In** box, select drive and subdirectory to save the project file.
- Enter name of the file in the **File Name** text box.
- Click **Save**.

Saving and Retrieving PLC Programs (Cont.)

- From **Look In** box, select drive in which the program is residing.
- Select desired PLC project file and click **Open**.
- Change parameters of save instructions.
- From **Tools** menu, click **Options** to open the **System Options** dialog box.

Saving and Retrieving PLC Programs (Cont.)

- In the **Save Time Interval (minutes)** option in the **AutoSave** section:
  - Enter time interval for the program to automatically save the project files.
  - For example, type in “10” to automatically save the project files every 10 minutes.

Number of Backups Text Box

- Enter the desired number.
- Located in the **Program Backup** section.
- Specify the number of copies of the project files for the program to keep.
- Specify that the system keeps only one copy of the project.
  - Copy called the *backup file*.