

UNIT 9 Picking and Placing on Conveyor Belt

OBJECTIVE

After completing this unit, you should be able to:

1. Explain the operation of a pick and place machine.
2. Write PLC programs to control the pickup arm to convey the workpiece from one position to another position on the conveyer belt.

DISCUSSION

Functional Description

This lab controls the pickup arm to pick up the workpiece from where the workpiece presence sensor is activated and place it in the P3 position, and then return to P1 position.

Operating Sequence

The sequence of operations for the entire control system is as follows:

1. Initial state: upper limit sensor (I0.6) ON, left limit sensor (I1.0) ON, vacuum confirm signal (I1.2) OFF.
2. Put a workpiece on the feeding end of the conveyer belt. Activate the Start switch (I1.5), the conveyer belt runs. When the workpiece presence sensor is activated (I0.0=ON), the conveyer belt stops, Z-axis cylinder and pickup arm descend and suction cup holds the workpiece.
3. When the vacuum confirm signal appears (I1.2=ON), the timer starts counting 1 second. After 1 second, Z-axis cylinder and pickup arm ascend.
4. When the upper limit sensor is activated (I0.6=ON), the slide motor rotates CW, the slide table moves to P3 position. When the slide table reaches P3 position, the slide motor stops, the Z-axis cylinder and pickup arm descend and the suction cup releases the workpiece.
5. When the vacuum confirm signal disappears (I1.2=OFF), Z-axis cylinder and pickup arm ascend.
6. When the upper limit sensor is activated (I0.6=ON), the slide motor rotates CCW, the slide table returns to P1 position and stops.

7. The conveyer belt runs again. When the workpiece presence sensor is activated (I0.0=ON), the conveyer belt stops, the Z-axis cylinder and pickup arm descend and suction cup sticks the workpiece.
8. Repeat from step 3 until the Stop switch (I1.4) is pressed. Once Stop switch is activated (I1.4=ON), the pickup arm returns to initial position and stops.

Electrical Connections

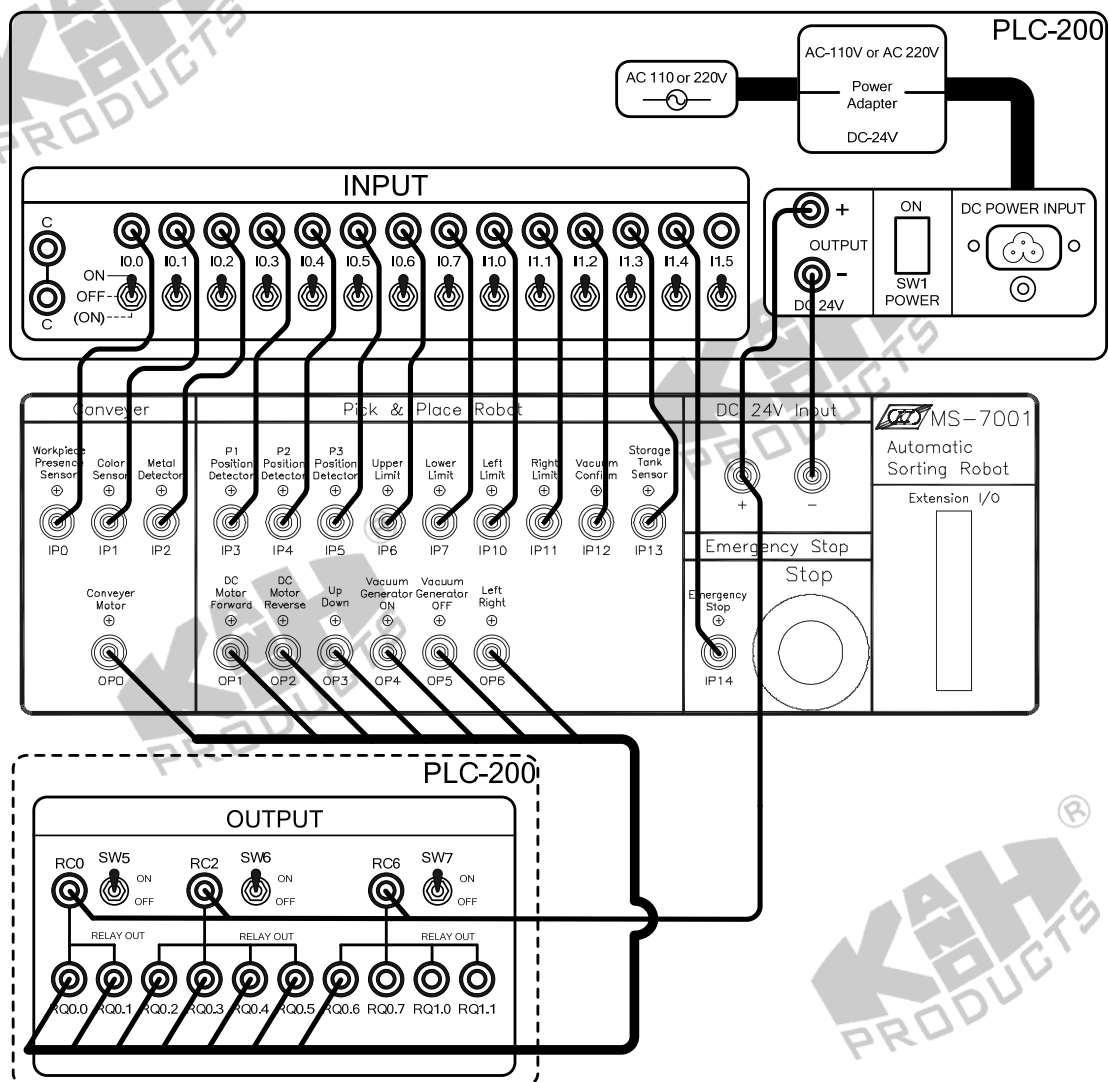


Fig. 9-1 Wiring diagram using safety connecting wires

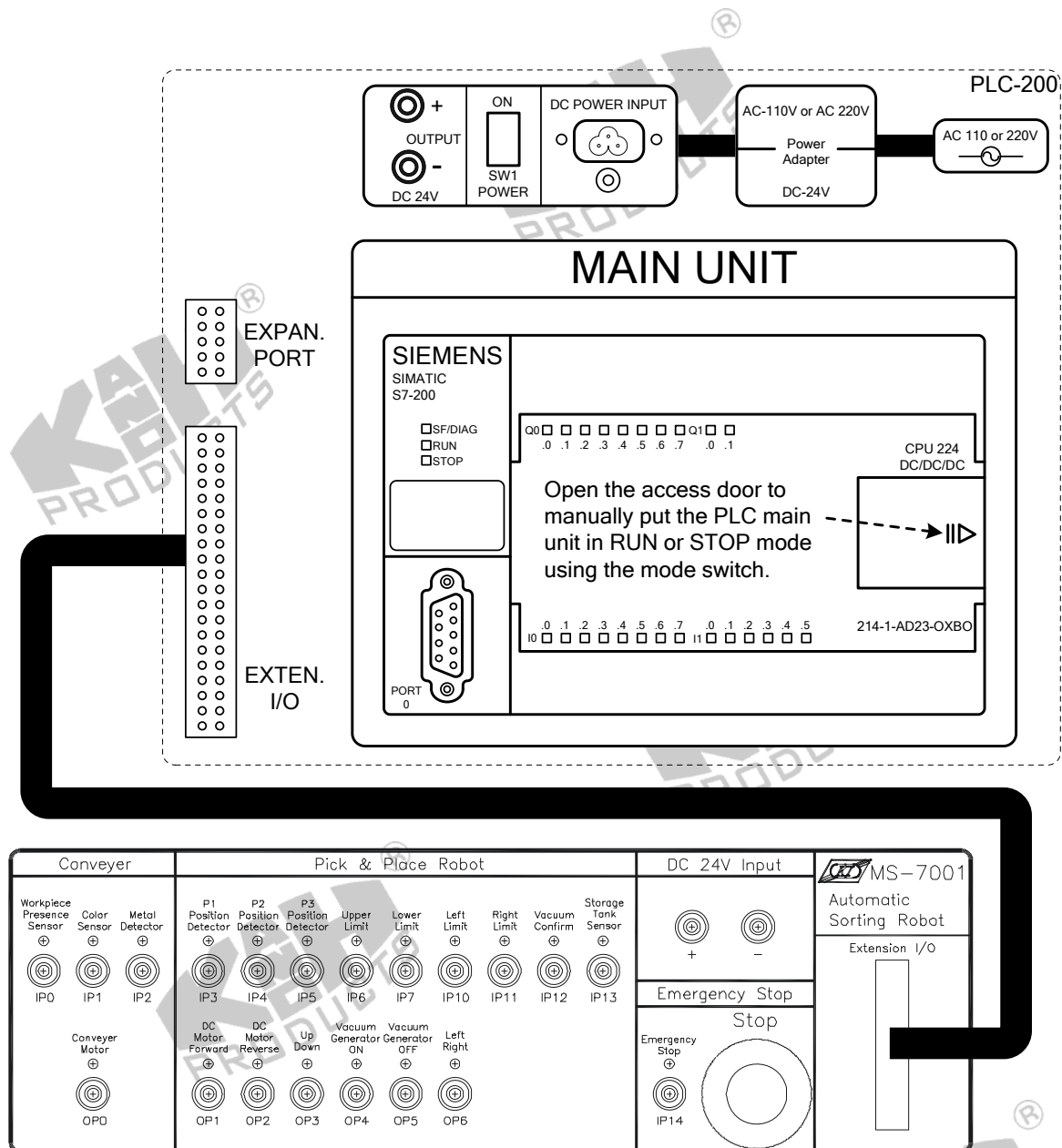


Fig. 9-2 Wiring diagram using flat cable

PLC I/O Connections

Table 9-1 PLC I/O Connections

Input	Description	Output	Description
I0.0	Workpiece presence sensor	Q0.0	Conveyer motor control
I0.3	P1 position detector	Q0.1	Slide motor rotating CW
I0.5	P3 position detector	Q0.2	Slide motor rotating CCW
I0.6	Upper limit sensor	Q0.3	Z-axis cylinder control
I0.7	Lower limit sensor	Q0.4	Vacuum generator ON
I1.0	Left limit sensor	Q0.5	Vacuum generator OFF
I1.2	Vacuum confirm signal	Q0.6	Rotary cylinder control
I1.4	Stop (Emergency Stop)		
I1.5	Start		

Flow Chart

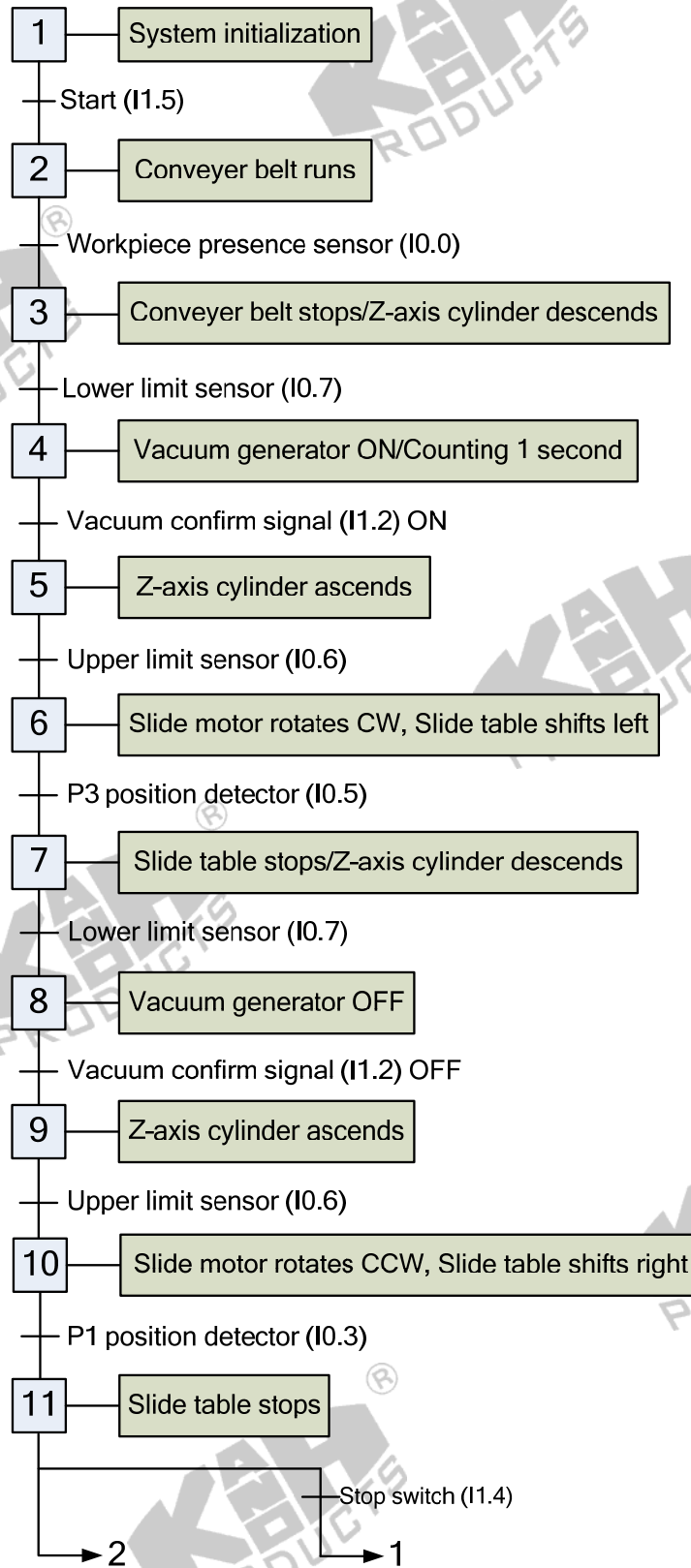


Fig. 9-3 Flow chart

SFC Program

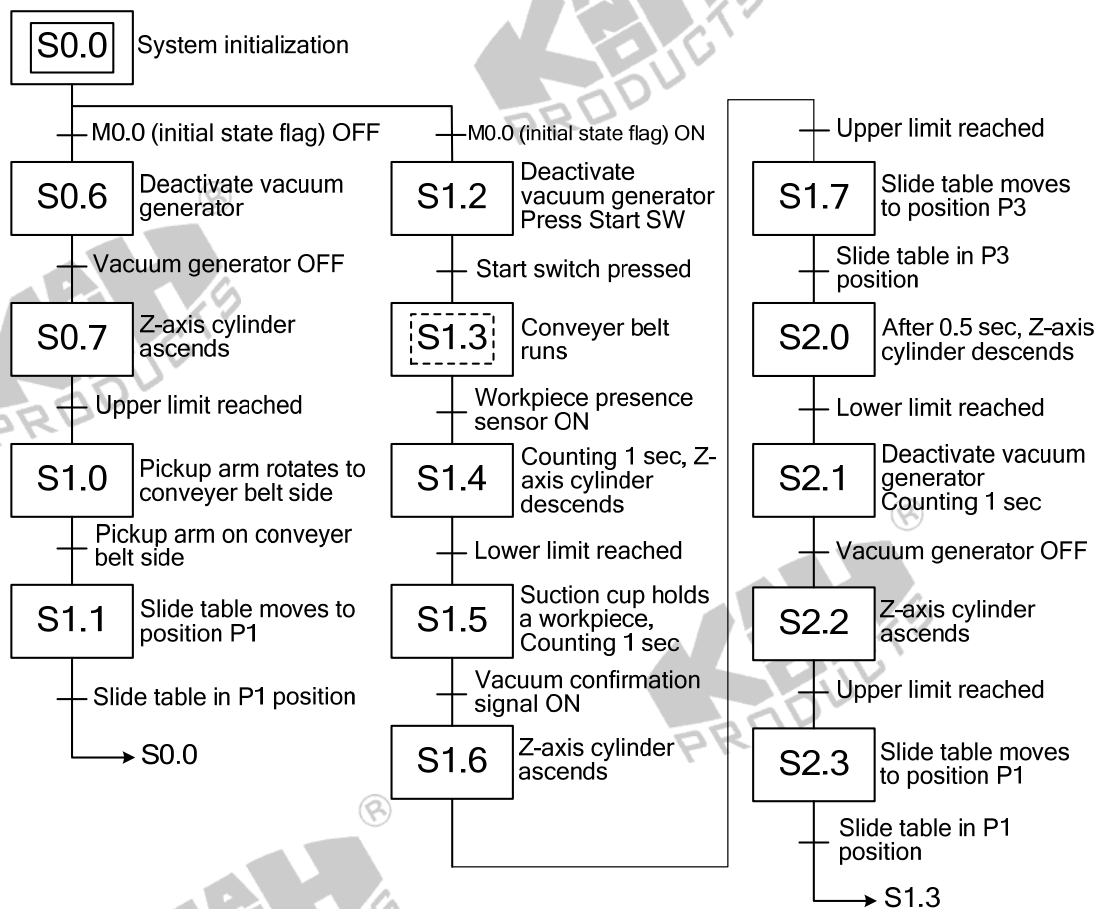
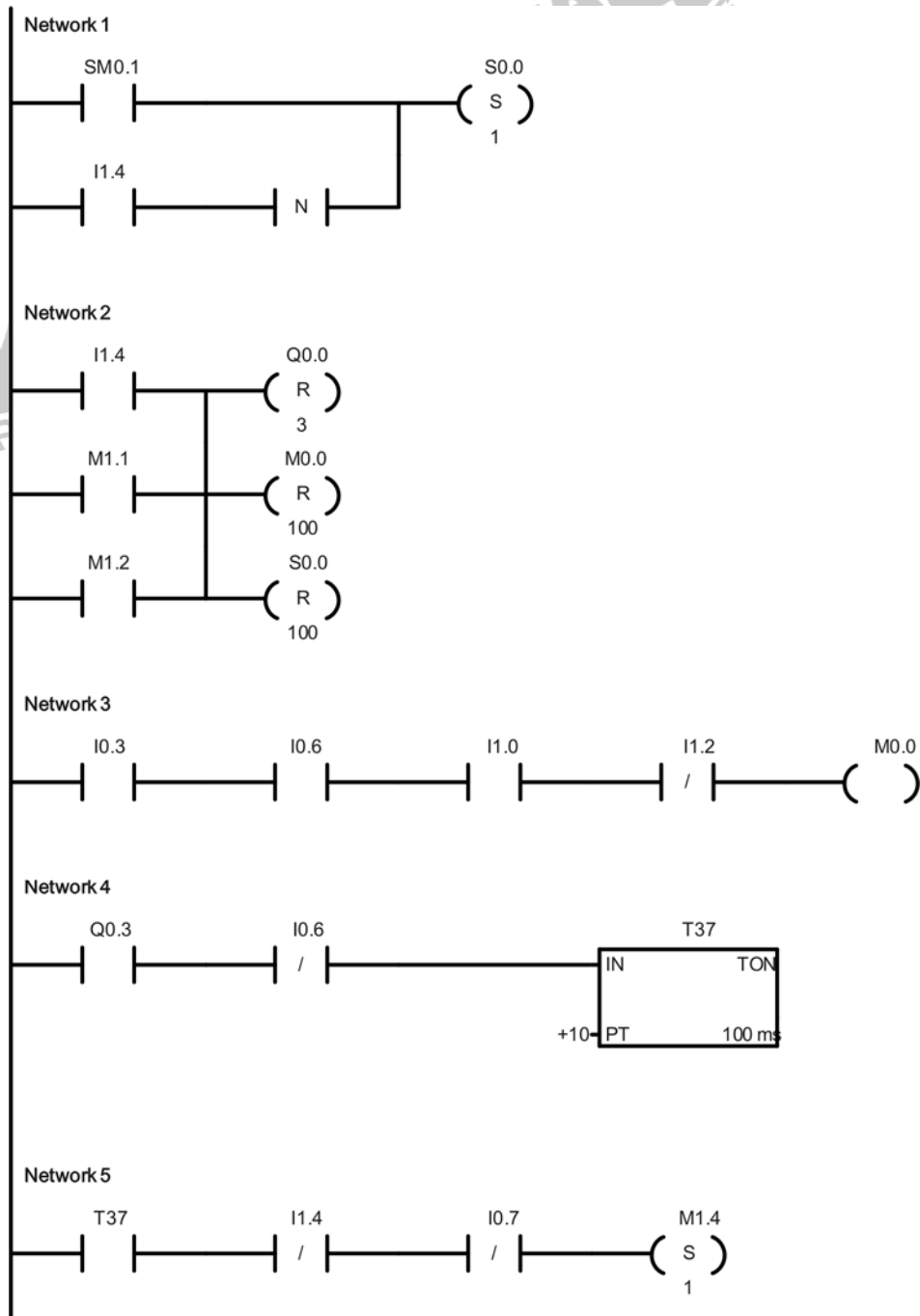
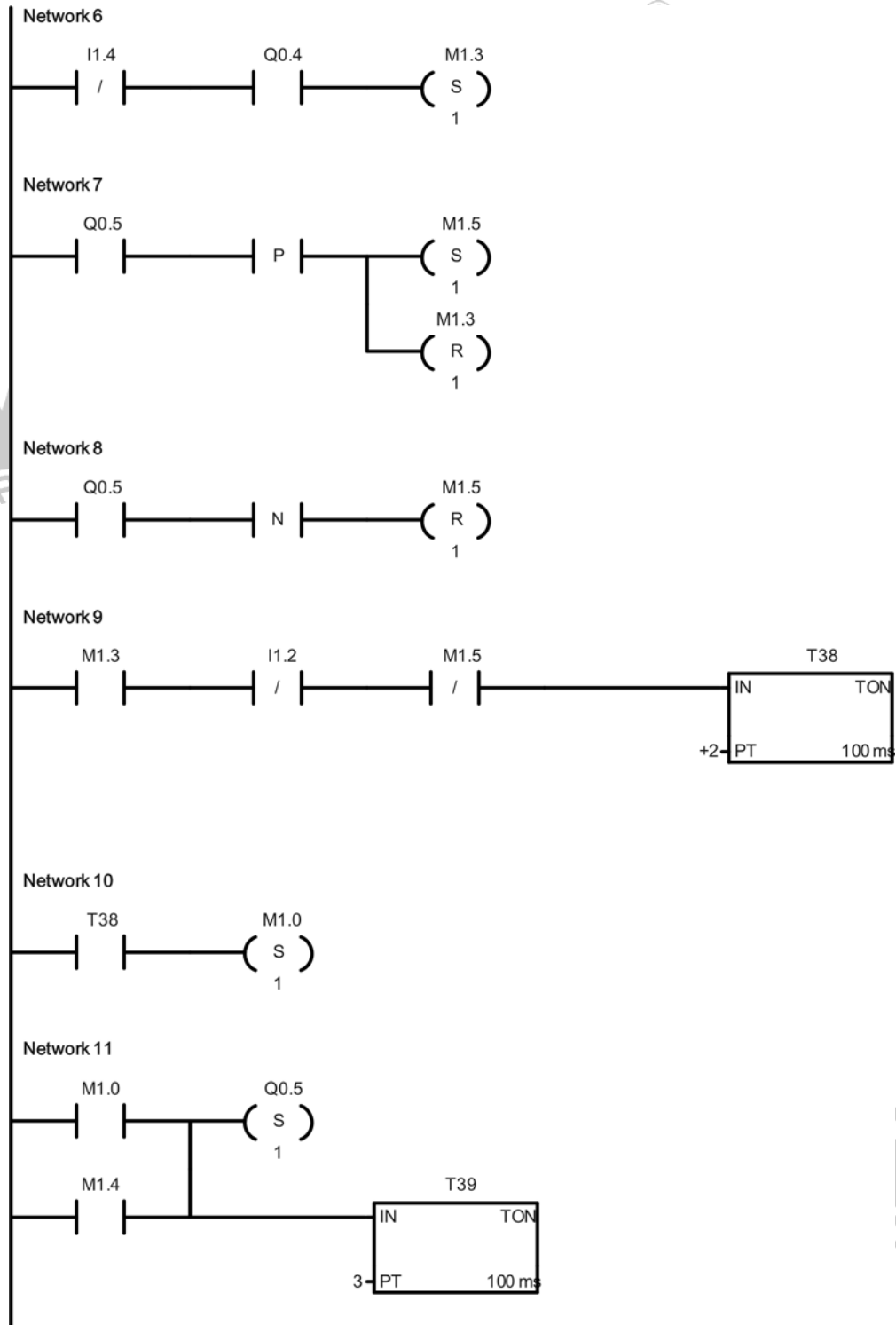
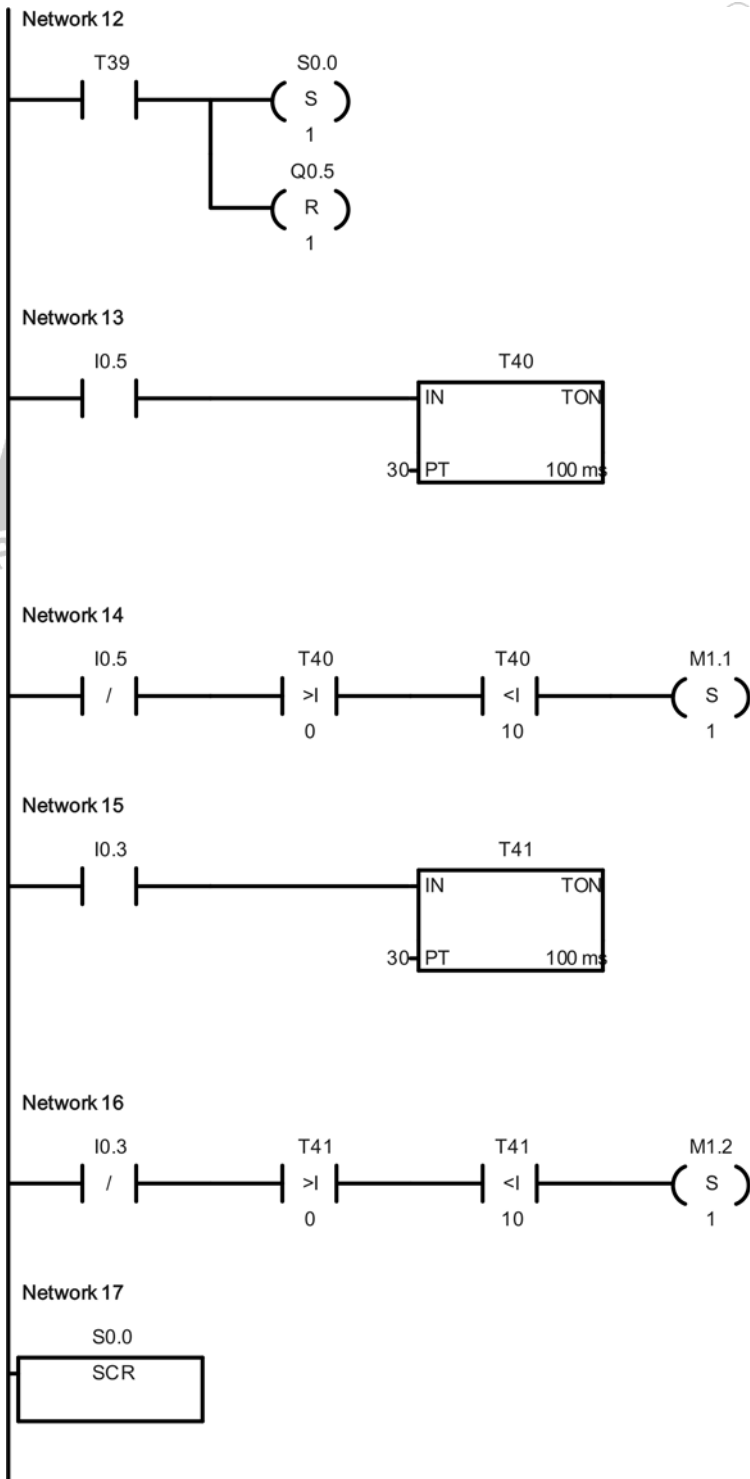


Fig. 9-4 SFC flow chart

Ladder Program



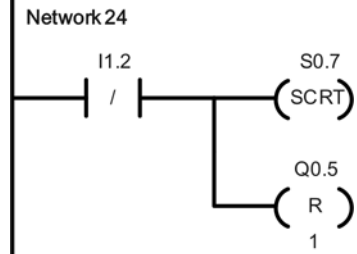
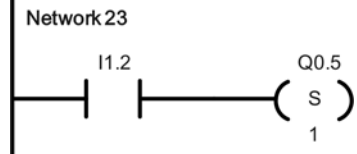
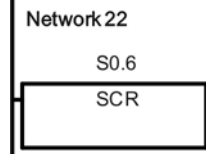
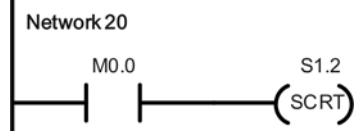
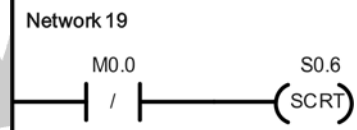
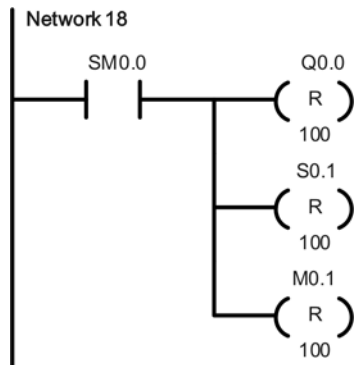


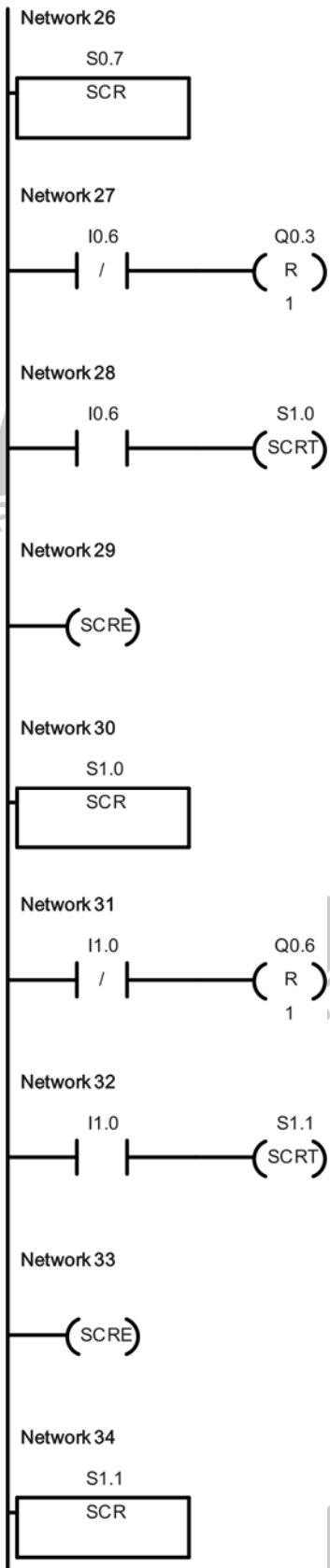


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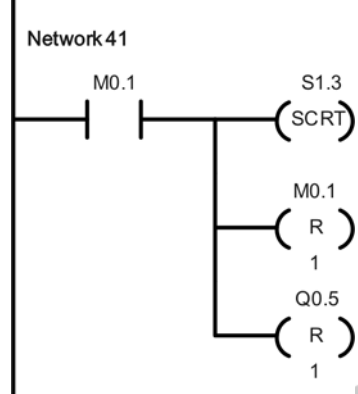
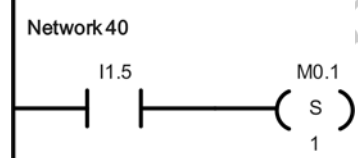
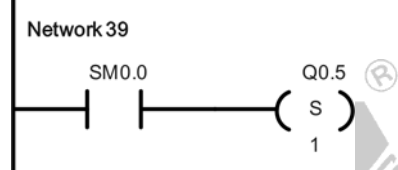
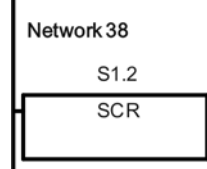
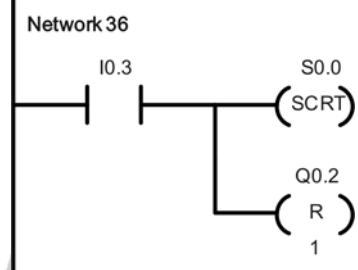
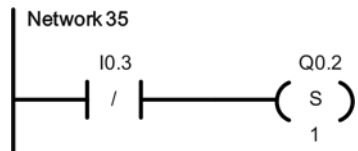


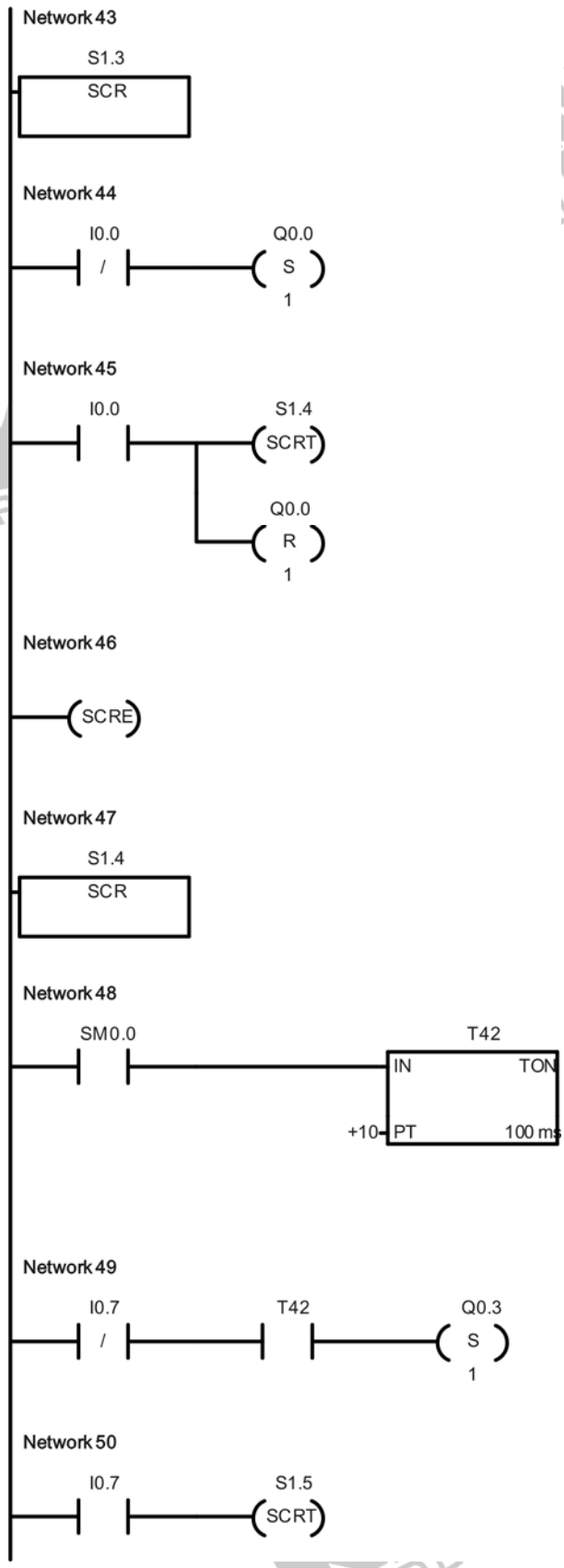
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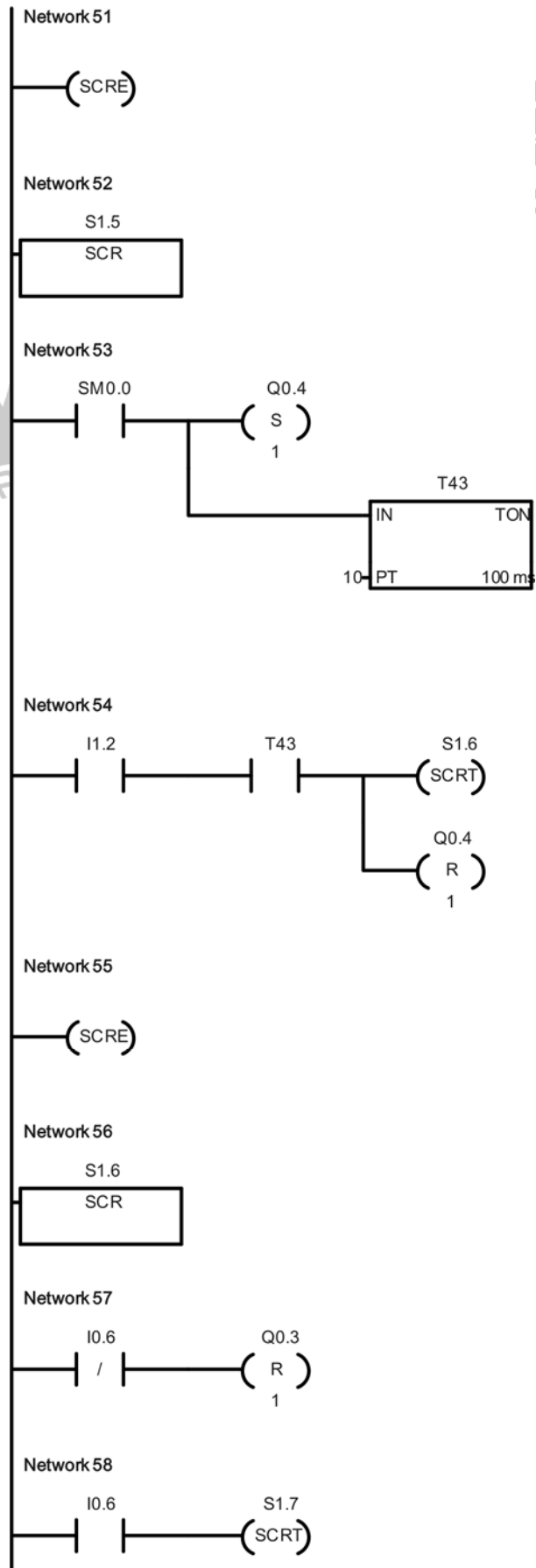
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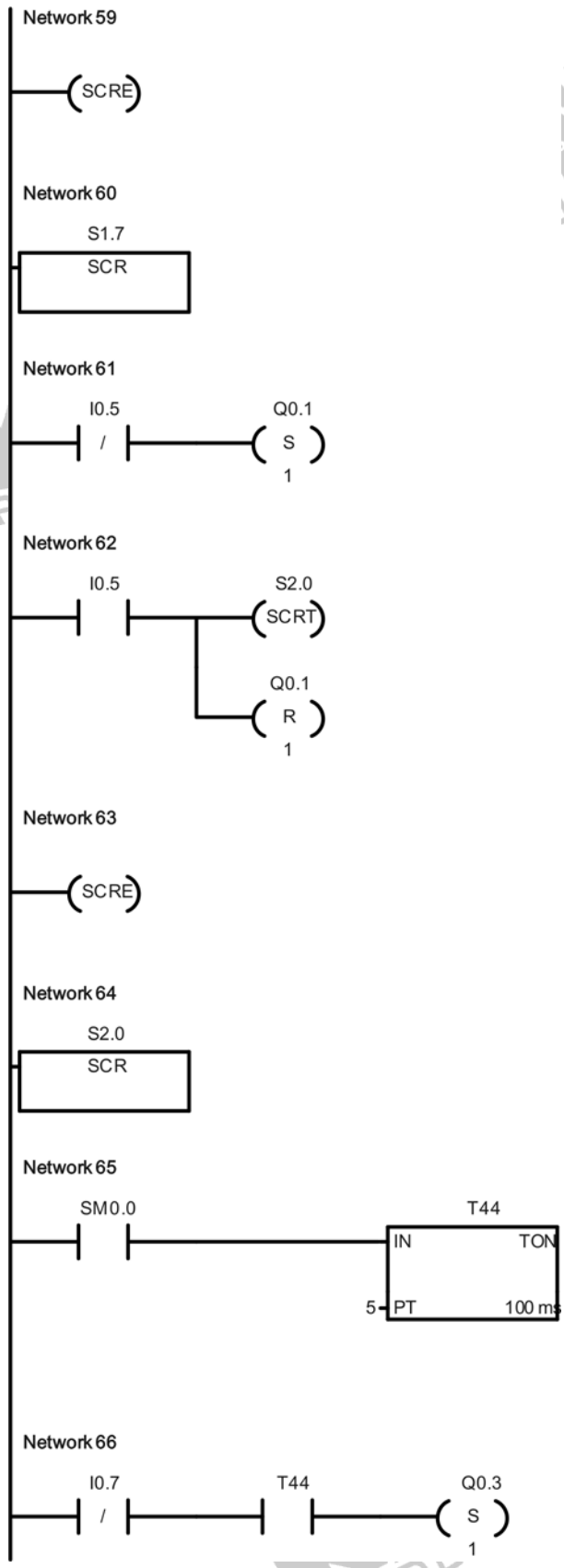
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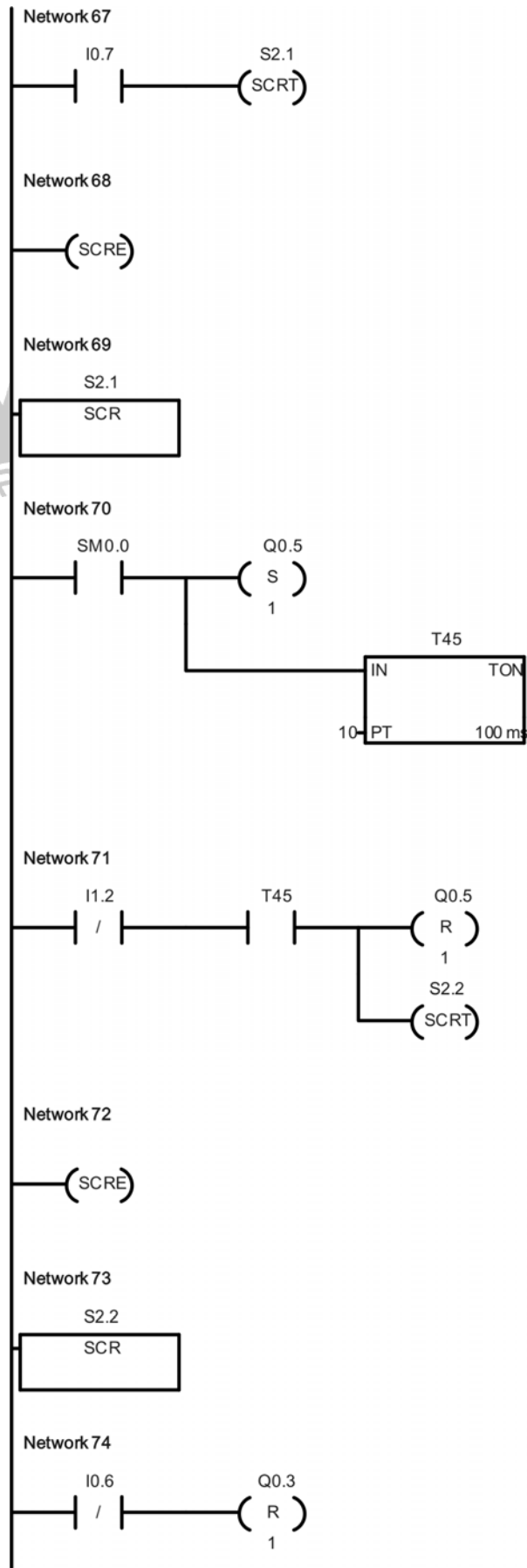
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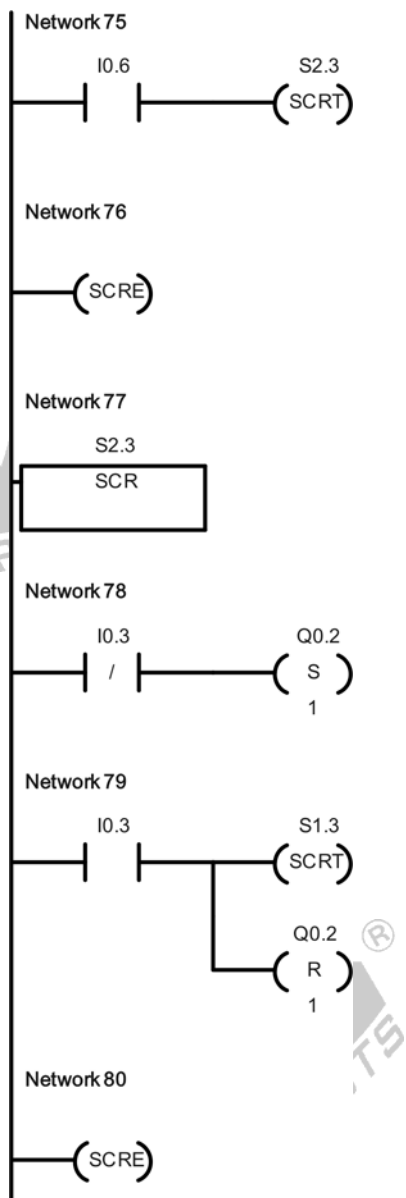


Fig. 9-5 Ladder diagram

Program Description

- Network 1: The status bit SM0.1 is on for the first scan cycle. On the first scan or on the negative edge of the Stop switch (I1.4=ON to OFF), enable State S0.0.
- Network 2: When the Stop switch (I1.4) or M1.1 (motor rotating CW flag) or M1.2 (motor rotating CCW flag) is activated, clear the output points Q0.0-Q0.3, all auxiliary relays and S bits.

- Network 3: When the P1 position detector is activated (I0.3=ON), the upper limit sensor is activated (I0.6=ON), the left limit sensor is activated (I1.0=ON) and the vacuum confirm signal is absent (I1.2=OFF), activate M0.0 (initial state flag).
- Network 4: When the Z-axis cylinder descends (Q0.3=ON) and the upper limit sensor is deactivated (I0.6=OFF), start the 1-second ON-delay timer T37.
- Network 5: After a 1-second delay, if the lower limit sensor is deactivated (I0.7=OFF) and the Stop switch is deactivated (I1.4=OFF), set M1.4 (workpiece in storage flag).
- Network 6: When the Stop switch is deactivated (I1.4=OFF) and the vacuum generator is turned on (Q0.4=ON), set M1.3 (vacuum generator ON flag).
- Network 7: On the positive edge of Q0.5 (vacuum generator OFF), set M1.5 (vacuum generator OFF flag) and reset M1.3 (vacuum generator ON flag).
- Network 8: On the negative edge of Q0.5 (vacuum generator OFF), reset M1.5 (vacuum generator OFF flag).
- Network 9: When M1.3 (vacuum generator ON flag) is on, the vacuum confirm signal disappears (I1.2=OFF) and M1.5 (vacuum generator OFF flag) is off, start the 0.2-second ON-delay timer T38.
- Network 10: After a 0.2-second delay, set M1.0 (workpiece fallen flag).
- Network 11: When M1.0 (workpiece fallen flag) or M1.4 (workpiece in storage flag) is on, turn on Q0.5 so that the vacuum generator is turned off, and start the 0.3-second ON-delay timer T39.
- Network 12: After a 0.3-second delay, transition to State S0.0, turn off Q0.5.
- Network 13: When the P3 position detector is activated (I0.5=ON), start the 3-second ON-delay timer T40.
- Network 14: When the elapsed time of 1 second is not reached and the P3 position sensor is deactivated (I0.5=OFF), set M1.1 (motor rotating CW flag).
- Network 15: When the P1 position detector is activated (I0.3=ON), start the 3-second ON-delay timer T41.
- Network 16: When the elapsed time of 1 second is not reached and the P1 position sensor is deactivated (I0.3=OFF), set M1.2 (motor rotating CCW flag).
- Network 17: Beginning of State S0.0 control region.

- Network 18: The status bit SM0.0 is always on. Clear all output points, auxiliary relays and S bits except S0.0.
- Network 19: When M0.0 (initial state flag) is off, transition to State S0.6.
- Network 20: When M0.0 (initial state flag) is on, transition to State S1.2.
- Network 21: End of SCR region for State S0.0.
- Network 22: Beginning of State S0.6 control region.
- Network 23: When the vacuum confirm signal appears (I1.2=ON), turn on Q0.5 so that the vacuum generator is turned off.
- Network 24: When the vacuum confirm signal is absent (I1.2=OFF), transition to State S0.7, and turn off Q0.5.
- Network 25: End of SCR region for State S0.6.
- Network 26: Beginning of State S0.7 control region.
- Network 27: When the upper limit sensor is deactivated (I0.6=OFF), turn off Q0.3 so that the Z-axis cylinder ascends.
- Network 28: When the upper limit sensor is activated (I0.6=ON), transition to State S1.0.
- Network 29: End of SCR region for State S0.7.
- Network 30: Beginning of State S1.0 control region.
- Network 31: When the left limit sensor is deactivated (I1.0=OFF), turn off Q0.6 so that the rotary cylinder rotates left.
- Network 32: When the left limit sensor is activated (I1.0=ON), transition to State S1.1.
- Network 33: End of SCR region for State S1.0.
- Network 34: Beginning of State S1.1 control region.
- Network 35: When the P1 position detector is deactivated (I0.3=OFF), turn on Q0.2 so that the slide motor rotates CCW and the slide table shifts right.
- Network 36: When the P1 position detector is activated (I0.3=ON), transition to State S0.0, turn off Q0.2 so that the slide motor and the slide table stop.
- Network 37: End of SCR region for State S1.1.
- Network 38: Beginning of State S1.2 control region.
- Network 39: The status bit SM0.0 is always on. Turn on Q0.5 so that the vacuum generator is turned off.
- Network 40: When the Start switch is activated (I1.5=ON), set M0.1 (start flag).
- Network 41: When M0.1 (start flag) is on, transition to State S1.3, reset M0.1 (start flag) and turn off Q0.5.

- Network 42: End of SCR region for State S1.2.
- Network 43: Beginning of State S1.3 control region.
- Network 44: When the workpiece presence sensor is deactivated (I0.0=OFF), turn on Q0.0 so that the conveyer motor rotates and the conveyer belt runs.
- Network 45: When the workpiece presence sensor is activated (I0.0=ON), transition to State S1.4, turn off Q0.0 so that the conveyer motor and the conveyer belt stop.
- Network 46: End of SCR region for State S1.3.
- Network 47: Beginning of State S1.4 control region.
- Network 48: The status bit SM0.0 is always on. Start the 1-second ON-delay timer T42.
- Network 49: After a 1-second delay, if the lower limit sensor is deactivated (I0.7=OFF), turn on Q0.3 so that the Z-axis cylinder descends.
- Network 50: When the lower limit sensor is activated (I0.7=ON), transition to State S1.5.
- Network 51: End of SCR region for State S1.4.
- Network 52: Beginning of State S1.5 control region.
- Network 53: The status bit SM0.0 is always on. Turn on Q0.4 so that the vacuum generator is turned on, and start the 1-second ON-delay timer T43.
- Network 54: After a 1-second delay, if the vacuum confirm signal appears (I1.2=ON), transition to State S1.6, and turn off Q0.4.
- Network 55: End of SCR region for State S1.5.
- Network 56: Beginning of State S1.6 control region.
- Network 57: When the upper limit sensor is deactivated (I0.6=OFF), turn off Q0.3 so that the Z-axis cylinder ascends.
- Network 58: When the upper limit sensor is activated (I0.6=ON), transition to State S1.7.
- Network 59: End of SCR region for State S1.6.
- Network 60: Beginning of State S1.7 control region.
- Network 61: When the P3 position detector is deactivated (I0.5=OFF), turn on Q0.1 so that the slide motor rotates CW and the slide table shifts left.
- Network 62: When the P3 position detector is activated (I0.5=ON), transition to State S2.0, turn off Q0.1 so that the slide motor and the slide table stop.
- Network 63: End of SCR region for State S1.7.
- Network 64: Beginning of State S2.0 control region.

- Network 65: The status bit SM0.0 is always on. Start the 0.5-second ON-delay timer T44.
- Network 66: After a 0.5-second delay, if the lower limit sensor is deactivated (I0.7=OFF), turn on Q0.3 so that the Z-axis cylinder descends.
- Network 67: When the lower limit sensor is activated (I0.7=ON), transition to State S2.1.
- Network 68: End of SCR region for State S2.0.
- Network 69: Beginning of State S2.1 control region.
- Network 70: The status bit SM0.0 is always on. Turn on Q0.5 so that the vacuum generator is turned off, start the 1-second ON-delay timer T45.
- Network 71: After a 1-second delay, if the vacuum confirm signal is absent (I1.2=OFF), turn off Q0.5 and transition to State S2.2.
- Network 72: End of SCR region for State S2.1.
- Network 73: Beginning of State S2.2 control region.
- Network 74: When the upper limit sensor is deactivated (I0.6=OFF), turn off Q0.3 so that the Z-axis cylinder ascends.
- Network 75: When the upper limit sensor is activated (I0.6=ON), transition to State S2.3.
- Network 76: End of SCR region for State S2.2.
- Network 77: Beginning of State S2.3 control region.
- Network 78: When the P1 position detector is deactivated (I0.3=OFF), turn on Q0.2 so that the slide motor rotates CCW and the slide table shifts right.
- Network 79: When the P1 position detector is activated (I0.3=ON), transition to State S1.3, turn off Q0.2 so that the slide motor and the slide table stop.
- Network 80: End of SCR region for State S2.3.

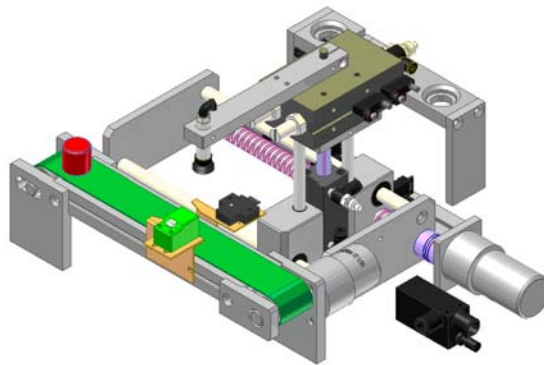
EQUIPMENT REQUIRED

1. Personal Computer
2. PLC-200 PLC Trainer
3. USB/PPI Multi-Master Cable
4. AC Adapter
5. Safety Connecting Wires or Flat Cable
6. MS-7001 Automatic Sorting Robot
7. Cylindrical Workpieces
8. Air Compressor

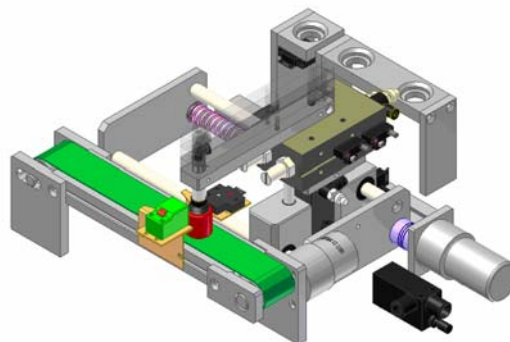
PROCEDURE

1. With the power to the PLC-200 PLC Trainer OFF, place Enable switches SW2 to SW8 in OFF position. Set input switches I0.0 to I1.5 to OFF and Thumbwheel Switches to 0000.
2. Connect PLC Trainer's Port 0 to your PC's USB port using the provided USB/PPI cable.
3. Complete the electrical connections by referring to the wiring diagram shown in Fig. 9-1 or Fig. 9-2. **Note: Do not use the safety connecting wires and the flat cables simultaneously.**
4. Using the pneumatic tubing, connect the air compressor outlet to the Ø6 push-in connector on Pneumatic Module.
5. Start the STEP 7-Micro/WIN.
6. Create a new project by selecting **File >> New** menu command. Complete the Ladder Program shown in Fig. 9-5.
7. Turn the PLC-200 PLC Trainer on. If electrical connections were completed using safety connecting wires, place Enable switches SW5 to SW7 in ON position.

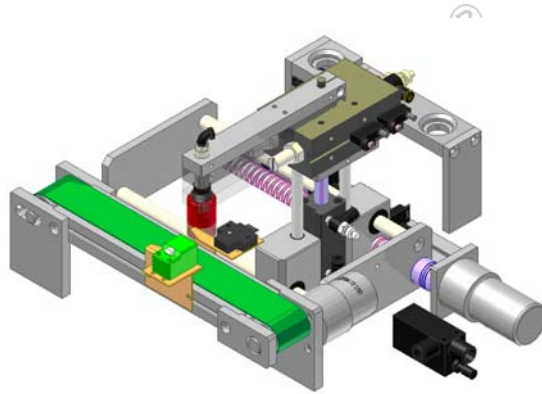
8. Download the ladder program to PLC main unit by selecting **File >> Download** menu command.
9. Run the ladder program by selecting **PLC >> Run** menu command.
10. Make sure the system is in the initial state: upper limit sensor (I0.6) ON, left limit sensor (I1.0) ON, vacuum confirm signal (I1.2) OFF.



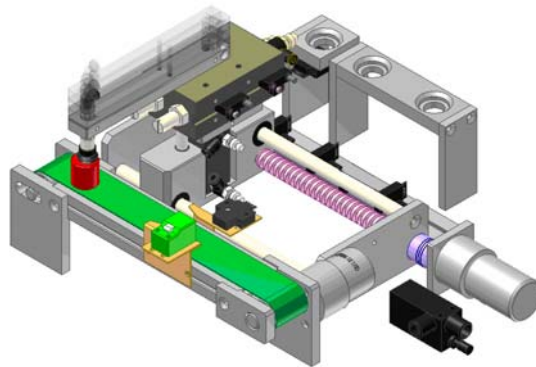
11. Put a workpiece on the feeding end of the conveyer belt. Push the Start switch (I1.5) to begin. The conveyer belt should run. When the workpiece presence sensor is activated (I0.0=ON), the conveyer belt should stop, the pickup arm should descend and the suction cup should stick the workpiece.



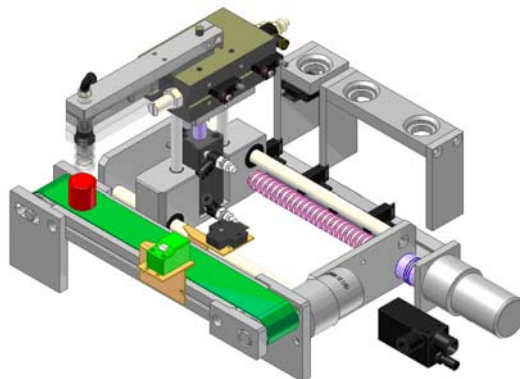
12. When the vacuum confirm signal appears (I1.2=ON), the timer starts counting 1 second. After 1 second, the pickup arm should ascend.



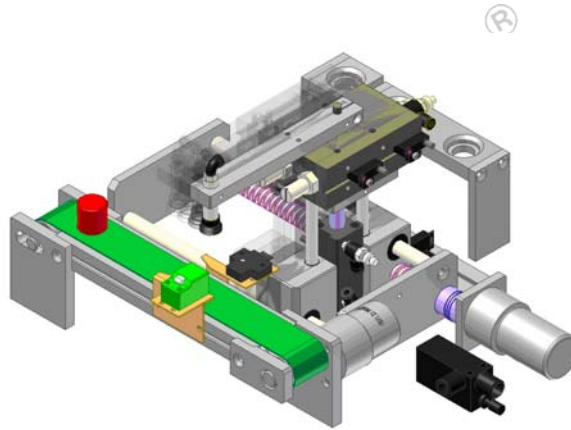
13. When the upper limit sensor is activated (I0.6=ON), the slide table should move to P3 position, the pickup arm should descend and the suction cup should release the workpiece.



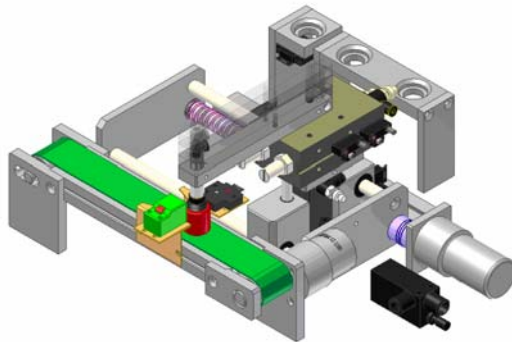
14. When the vacuum confirm signal disappears (I1.2=OFF), the pickup arm should ascend.



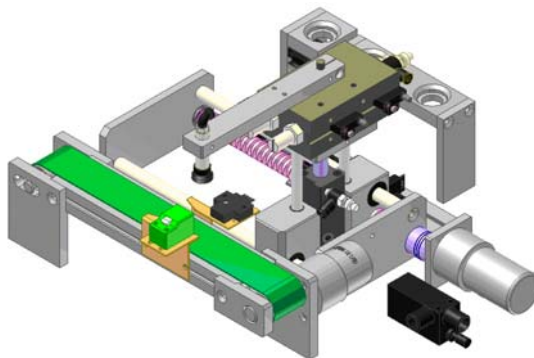
15. When the upper limit sensor is activated (I0.6=ON), the slide table should return to P1 position.



16. The conveyer should run again. Put a workpiece on the feeding end of conveyer belt. Similarly, when the workpiece presence sensor is activated (I0.0=ON), the belt conveyer should stop, the pickup arm should descend and the suction cup should stick the workpiece.



17. Repeat the operation from step 12 until the Stop switch (I1.4) is pressed. In such a case, the pickup arm should return to its initial position.



PROBLEM

1. Rewrite the PLC program to control the pickup arm to do the sequence: picking up the workpiece and placing it in P2 position, returning to P1 position, and picking up the workpiece and placing it in P3 position, and then returning to P1 position. This sequence repeats until the Stop switch is pressed.