EXP 1040-DL1 Introduction to Sequential Circuits, Ladder Diagrams and Relay Logic

PURPOSE

To (i) introduce ladder diagrams and relay logic and (ii) demonstrate a simple pneumatic system.

1.0 INTRODUCTION

Ladder Diagrams (Figure DL2.1) are a graphical representation of sequential control circuits that are widely used in industry. Although originally intended as a way of representing relay logic, ladder diagrams are now the standard means of programming microprocessor based PLCs (Programmable Logic Controllers). They are prevalent in a many engineering fields including automation, process control and manufacturing.

In this lab a sequential logic circuit will be implemented using the pneumatic test board. The pneumatic test board has three pneumatic cylinders that are activated by solenoid valves. The position of each cylinder is monitored by two limit switches. One limit switch is activated when the cylinder is fully extended and the other is activated when the cylinder is fully retracted. By energizing a solenoid you are able to extend a cylinder and by de-energizing the solenoid the cylinder will retract.

2.0 PRELAB

There is no prelab for this session. However, students need to read Unit D2 of the Digital Logic Module before the lab session.

3.0 APPARATUS AND MATERIALS

1 Logic Board
Various banana plug connectors
AC power (from main lab supply)
Compressed air source

4.0 EXPERIMENT

4.1 Limit Switch Familiarization

Limit switches A0 and A1 in Figure DL2.1 are used to sense when cylinder A is retracted and extended respectively. Each switch incorporates both a normally opened and normally closed set of contacts. Cylinders B and C employ switched B0 /B1 and C0/C1 respectively. These six switches are identified on the wiring panel as S1 through S6. An indicator light can be used to verify the operation of the switches. Sketch a circuit that illuminates the green light when cylinder A extends and the red light when cylinder A retracts. Implement the circuit on the pneumatic test board and verify the operation by manually depressing the limit switches. Use the circuit to determine the correspondence between the six limit switches and the wiring terminals S1 through S6.

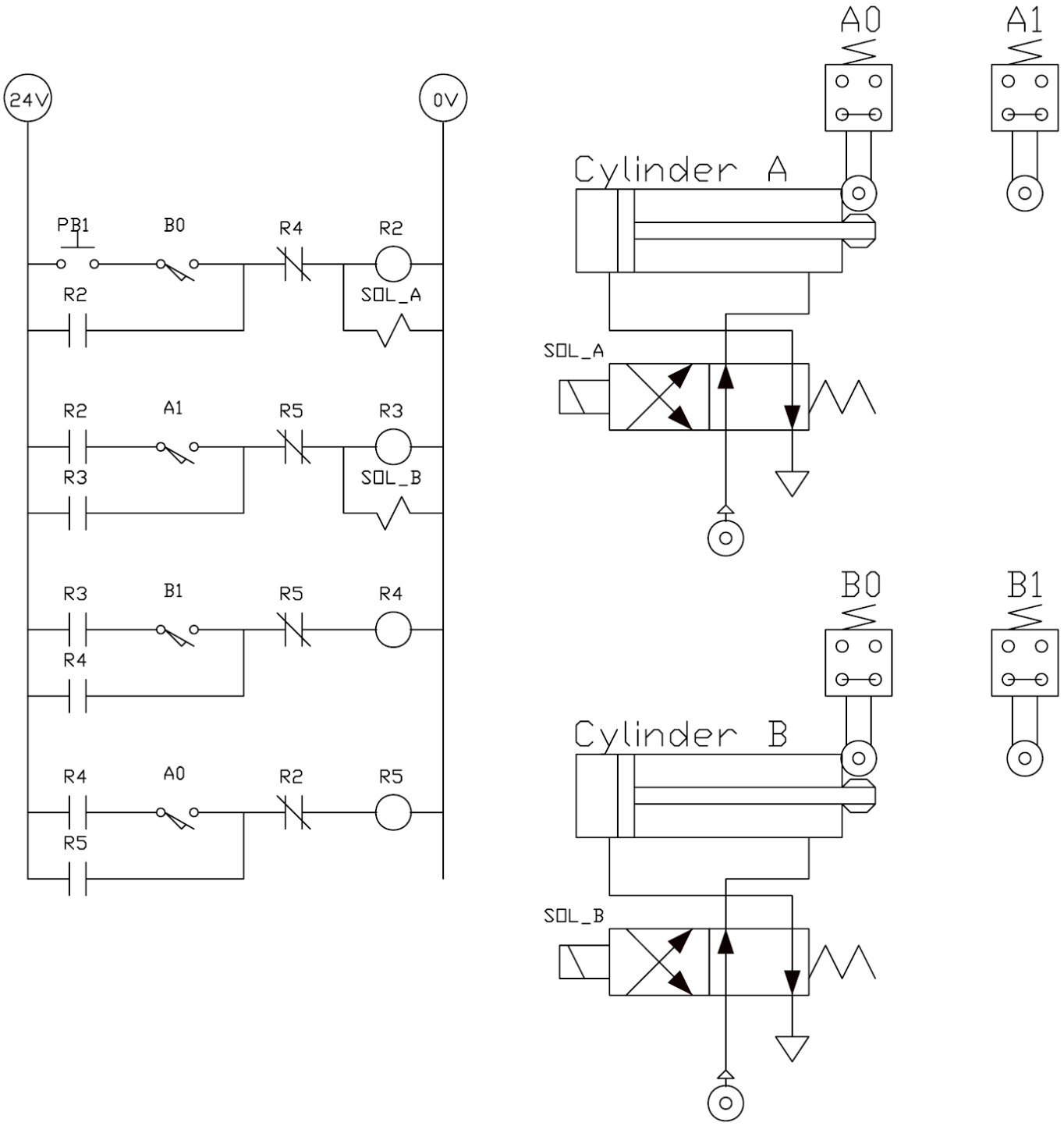

Figure DL2.1 Ladder diagram (left) for controlling two pneumatic cylinders.

4.2 Solenoid Valve Familiarization

Solenoid valves S1, S2 and S3 control the three cylinders A, B and C. As shown in Figure DL2.1, when the solenoid valves are not energized, the cylinders are retracted; i.e., pressure is applied to the rod side of the cylinder. Energizing the solenoid changes the position of the valve such that the cap side of the cylinder is pressurized and the

cylinder extends. Sketch a circuit that extends cylinder A when push button PB1 is depressed and retracts A when the button is released. Implement the circuit on the pneumatic test board and verify the operation. **There are a many "pinch" points on the test board so be sure and keep your fingers away from the cylinders.**

4.3 Implementation of a Simple Latch

Using relay 1 design a circuit that latches the state of push button PB1 such that cylinder A extends when PB1 is depressed and stays extended even if PB1 is released. The cylinder retracts only when push button PB2 is depressed. Implement the circuit on the pneumatic test board and verify the operation.

4.4 Sequential Logic Circuit 1

4.4.1 Familiarization with the Logic Sequence

The ladder diagram shown in Figure DL2.1 is a sequential logic circuit that will make two cylinders follow the sequence:

Cylinder A – extend -> Cylinder B – extend -> Cylinder A – retract -> Cylinder B – retract

The operation of the logic circuit can be described as follows.

- Push button PB1 initiates the start of the sequence; i.e., extend cylinder A by activating solenoid A. Relay 2 is latched when PB1 is depressed if and only if the last step in the sequence (limit switch B0, retract B) has been completed. This also maintains solenoid A energized.
- Once cylinder A has finished extending (i.e., switch A1 is active), the circuit advances to the second "rung" of the ladder which activates solenoid B (cylinder B extends).
- When switch B1 is activated (i.e., B extended), the circuit advances to the third rung in the ladder. Relay 4 is latched which in turn resets relay 2 de-energizing Solenoid A and retracting A.
- In a similar fashion, the fourth rung in the ladder resets relay 3 which retracts B.
- Notice that each rung in the ladder is latched by the completion of the action associated with the previous rung.

4.4.2 Implementation of the Logic Sequence

Implement the circuit described in 4.4.1 and verify the operation.

4.5 Sequential Logic Circuit 2

Modify the circuit in section 4.4 to implement the following sequence:

Cylinder A – extend -> Cylinder B – extend -> Cylinder B – retract -> Cylinder A – retract

5. Lab Report

5.1 Provide a short written lab report that includes ladder diagrams of all the circuits design during the lab.

5.2 Explain the operation of the circuit developed in part 4.5 above.