

# Lab Exercise 1

## Simple Ladder Logic

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## Objectives

This exercise is designed to provide working knowledge of the Allen Bradley ControlLogix, or MicroLogix/SLC-500 (and the RSLogix software); the Siemens S7 (and the Step 7 Portal software); the Modicon M340/M580 (and the Control Expert software); or the Emerson/GE PACSystems (and the Proficy software). The PLC is programmed for simple logical operations using ladder logic diagrams and the appropriate software tools. Lamp loads and switches are used to simulate input/output conditions and the ladder logic programs are verified for correct operation.

## I. Wiring the Lights and Switches

Connect the lights and switches to the I/O modules. Typical connections to the modules are shown in Figures 1 - 12 (Note: **these are not the actual connections; you need to figure that out**). Use the appropriate figures depending on the PLC (ControlLogix, SLC-500, MicroLogix, S7-300/400, M34/M580 or RX3i). A diagram of the switches and lights is shown in Fig. 13. Use the following connections:

Tag/Symbol/ Variable	Rockwell/Allen-Bradley					S7		
	Slot	Channel	ControlLogix Address	<del>SLC-500</del> <del>Address</del>	<del>MLogix</del> <del>Address</del>	Mod.	Channel	Address
Start_PB	1	00	1:I.Data.0	I:1/00	I:0/00	4	0	%I0.0
Stop_PB	1	01	1:I.Data.1	I:1/01	I:0/01	4	1	%I0.1
SW3	1	02	1:I.Data.2	I:1/02	I:0/02	4	2	%I0.2
SW4	1	03	1:I.Data.3	I:1/03	I:0/03	4	3	%I0.3
LA1	2	00	2:O.Data.0	O:2/00	O:0/00	5	0	%Q4.0
LA2	2	01	2:O.Data.1	O:2/01	O:0/01	5	1	%Q4.1
LA3	2	02	2:O.Data.2	O:2/02	O:0/02	5	2	%Q4.2
LA4	2	03	2:O.Data.3	O:2/03	O:0/03	5	3	%Q4.3
LA5	2	04	2:O.Data.4	O:2/04	O:0/04	5	4	%Q4.4

Tag/Symbol/ Variable	Modicon			GE		
	Mod.	Channel	Address	Mod.	Channel	Address
Start_PB	2	0	%I0.2.0	5	1	%I81
Stop_PB	2	1	%I0.2.1	5	2	%I82
SW3	2	2	%I0.2.2	5	3	%I83
SW4	2	3	%I0.2.3	5	4	%I84
LA1	3	0	%Q0.3.0	6	1	%Q1
LA2	3	1	%Q0.3.1	6	2	%Q2
LA3	3	2	%Q0.3.2	6	3	%Q3
LA4	3	3	%Q0.3.3	6	4	%Q4
LA5	3	4	%Q0.3.4	6	5	%Q5

**Double-check your wiring before you apply power !!**

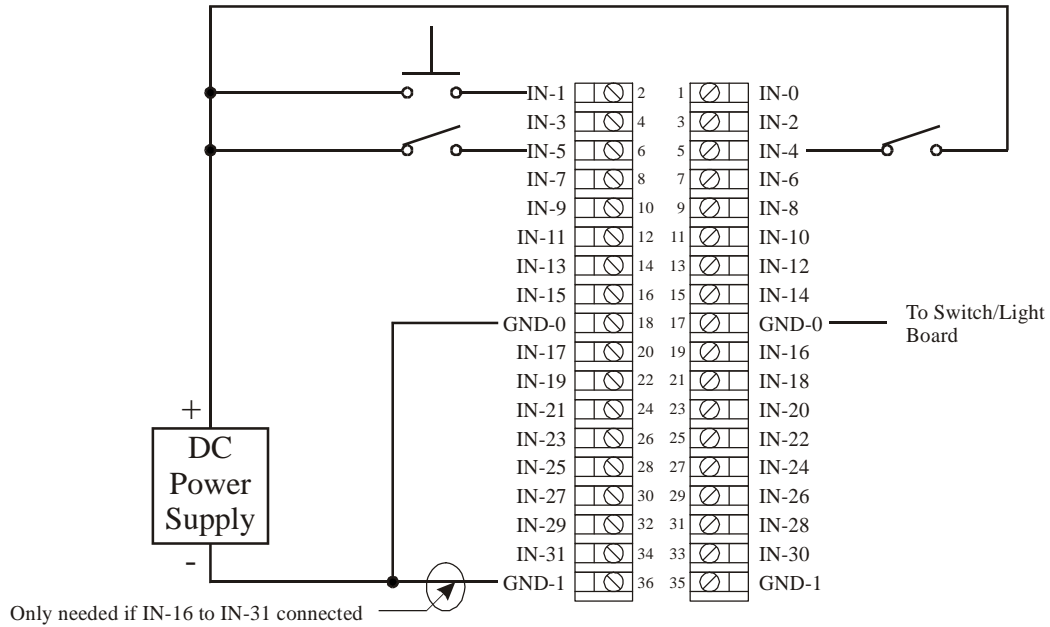


Fig. 1. Example ControlLogix IB32 DC Input Module Connection Diagram.

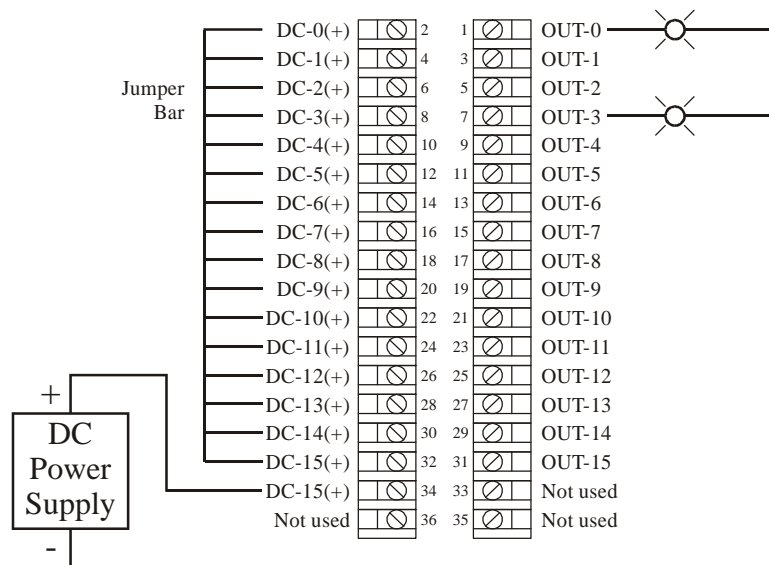


Fig. 2. Example ControlLogix OB16I DC Output Module Connection Diagram.

## 1766-L32BXB/L32BXBA

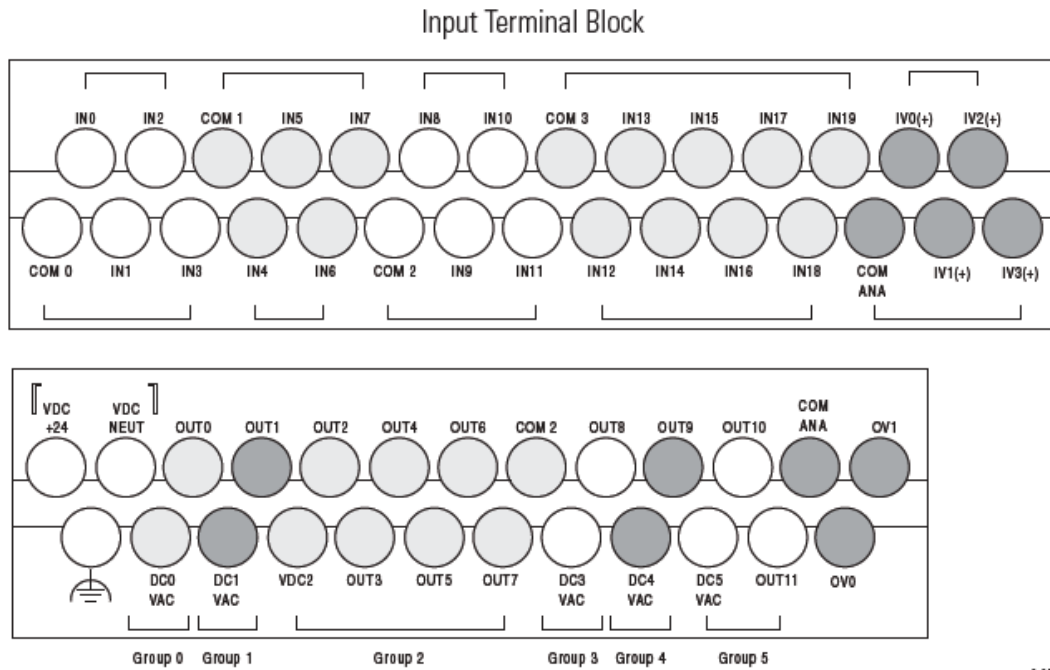


Fig. 3. MicroLogix 1400 terminal block layout (From Rockwell Automation).

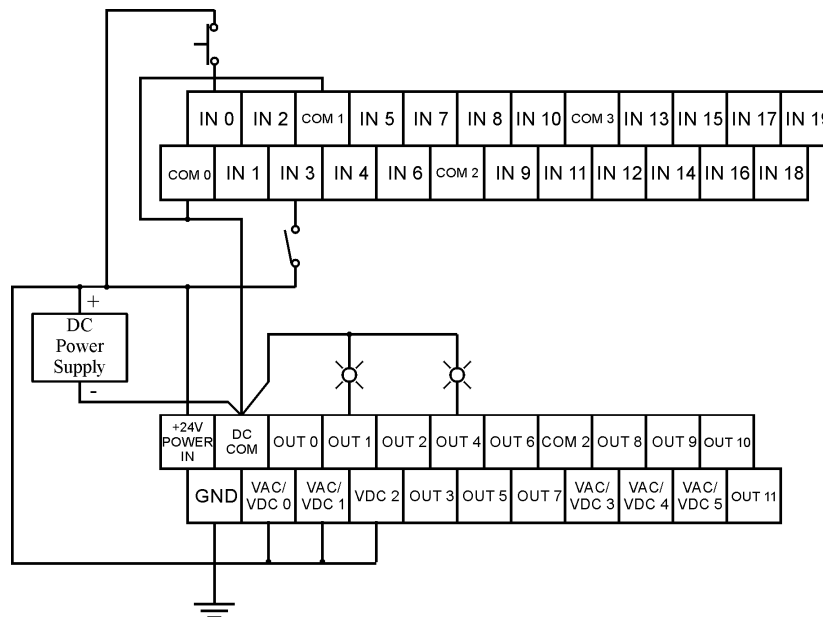


Fig. 4. Example MicroLogix 1400 Connection Diagram.

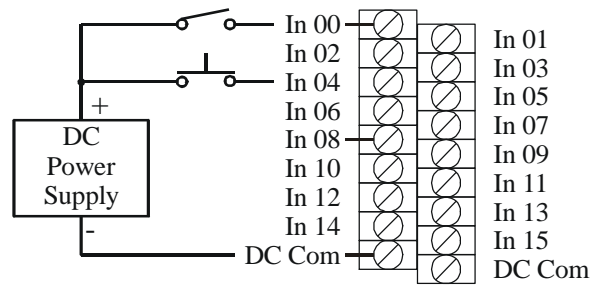


Fig. 5. Example SLC-500 IB16 DC Input Module Connection Diagram.

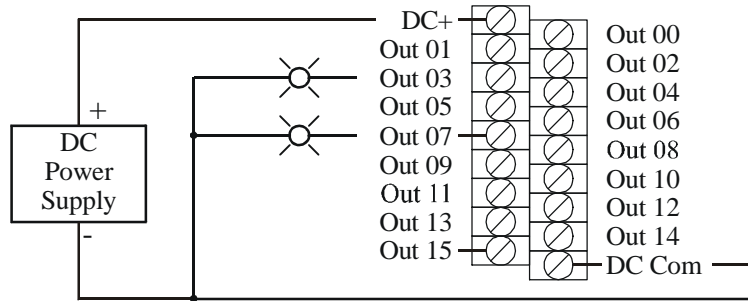


Fig. 6. Example SLC-500 OB16 DC Output Module Connection Diagram

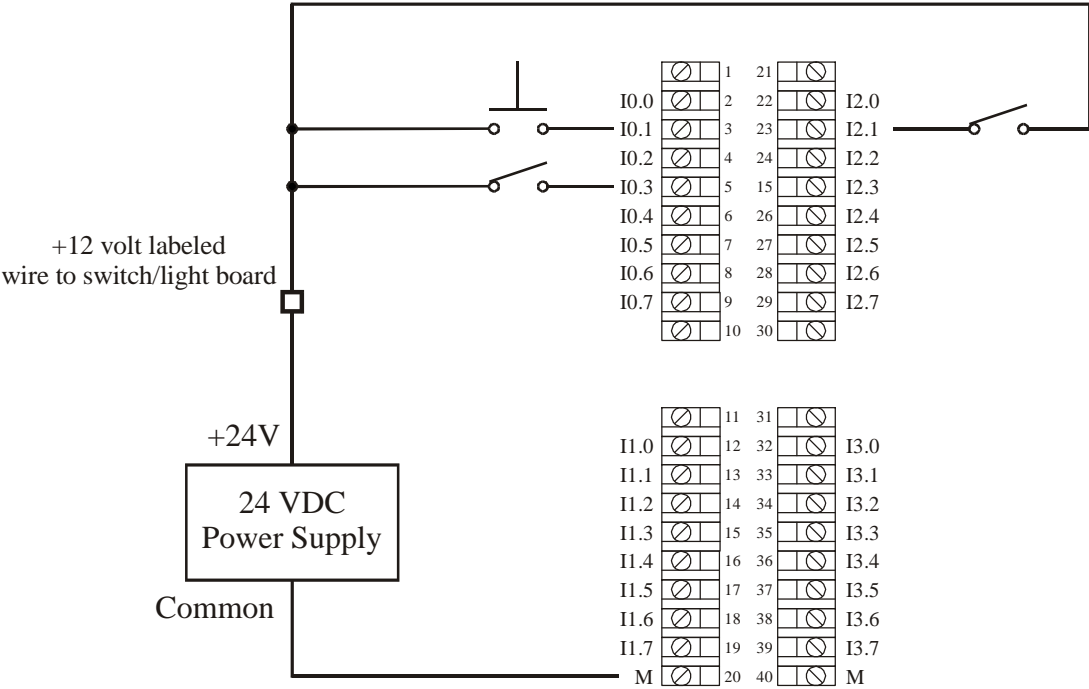


Fig. 7. Example S7 SM321 DI32x24V DC Input Module Connection Diagram.

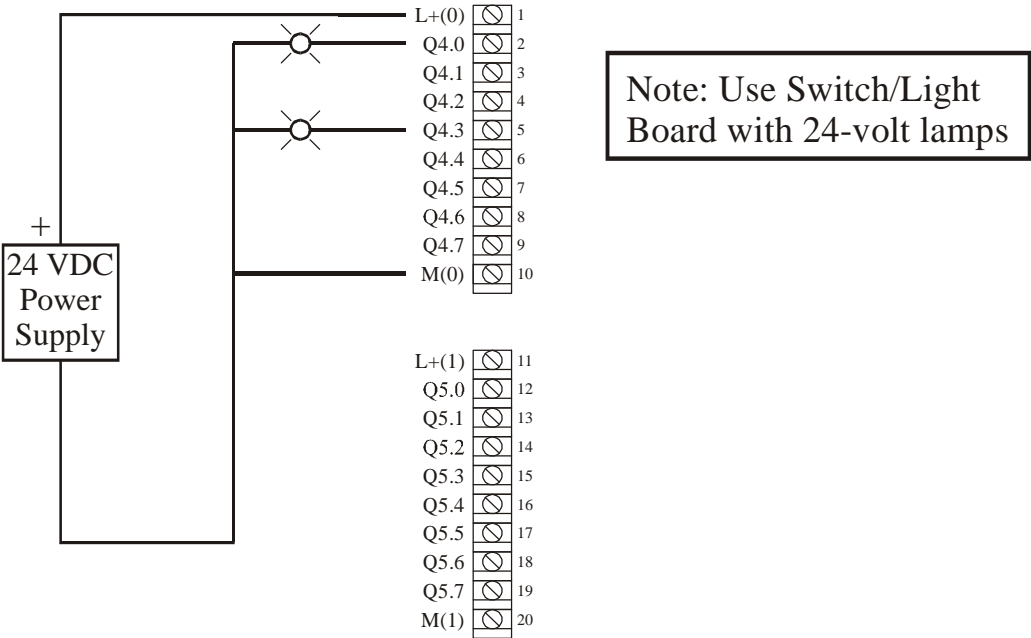


Fig. 8. Example S7 SM322 DO16x24V DC Output Module Connection Diagram.



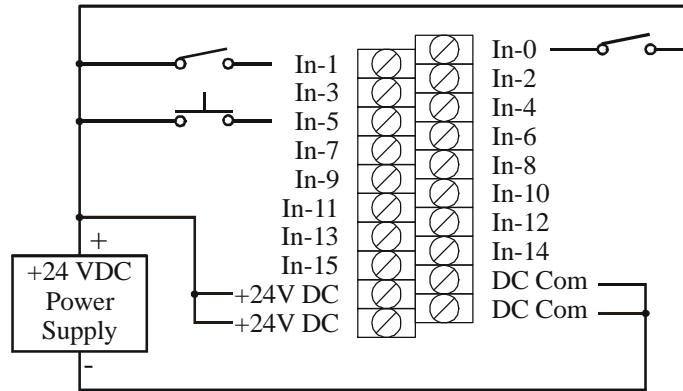


Fig. 9. Example Modicon DDI 1602 24V DC Input Module Connection Diagram.

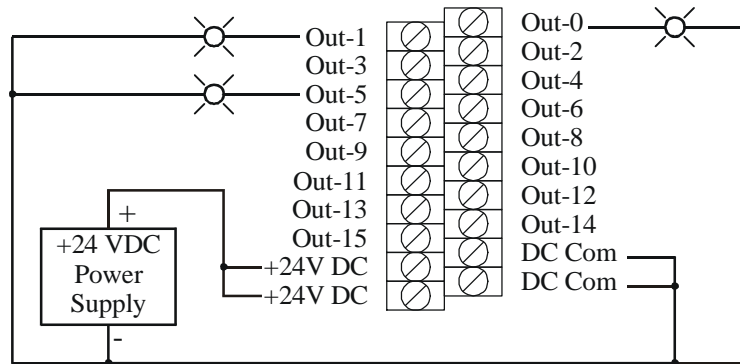


Fig. 10. Example Modicon DDO 1602 24V DC Output Module Connection Diagram.

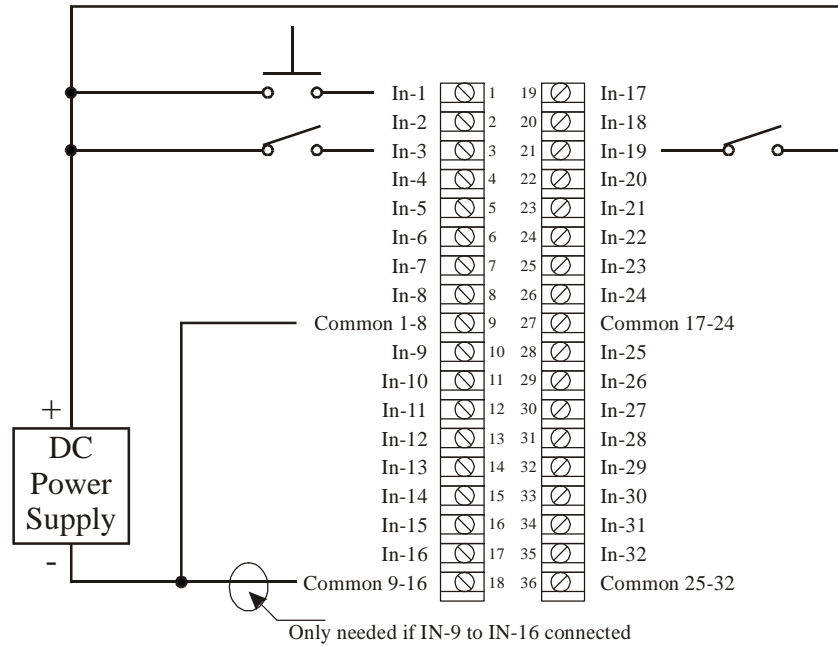


Fig. 11. Example Emerson MDL 660 12/24V DC Input Module Connection Diagram.

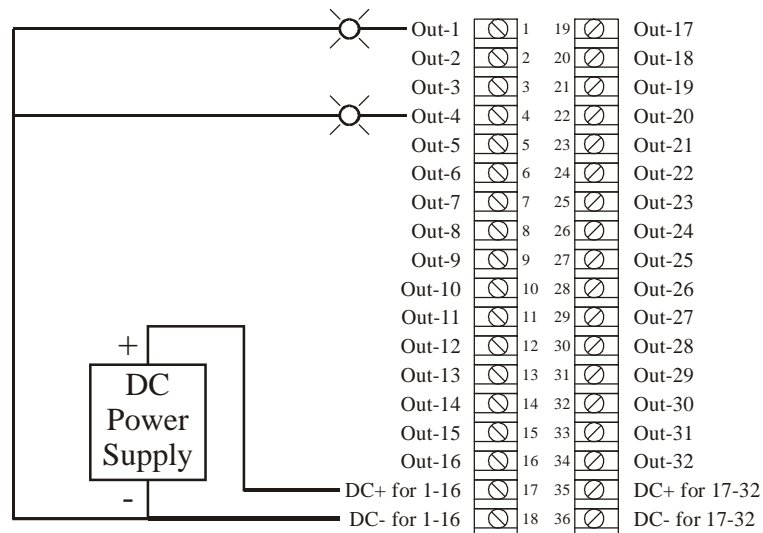


Fig. 12. Example Emerson MDL 754 12/24V DC Output Module Connection Diagram.

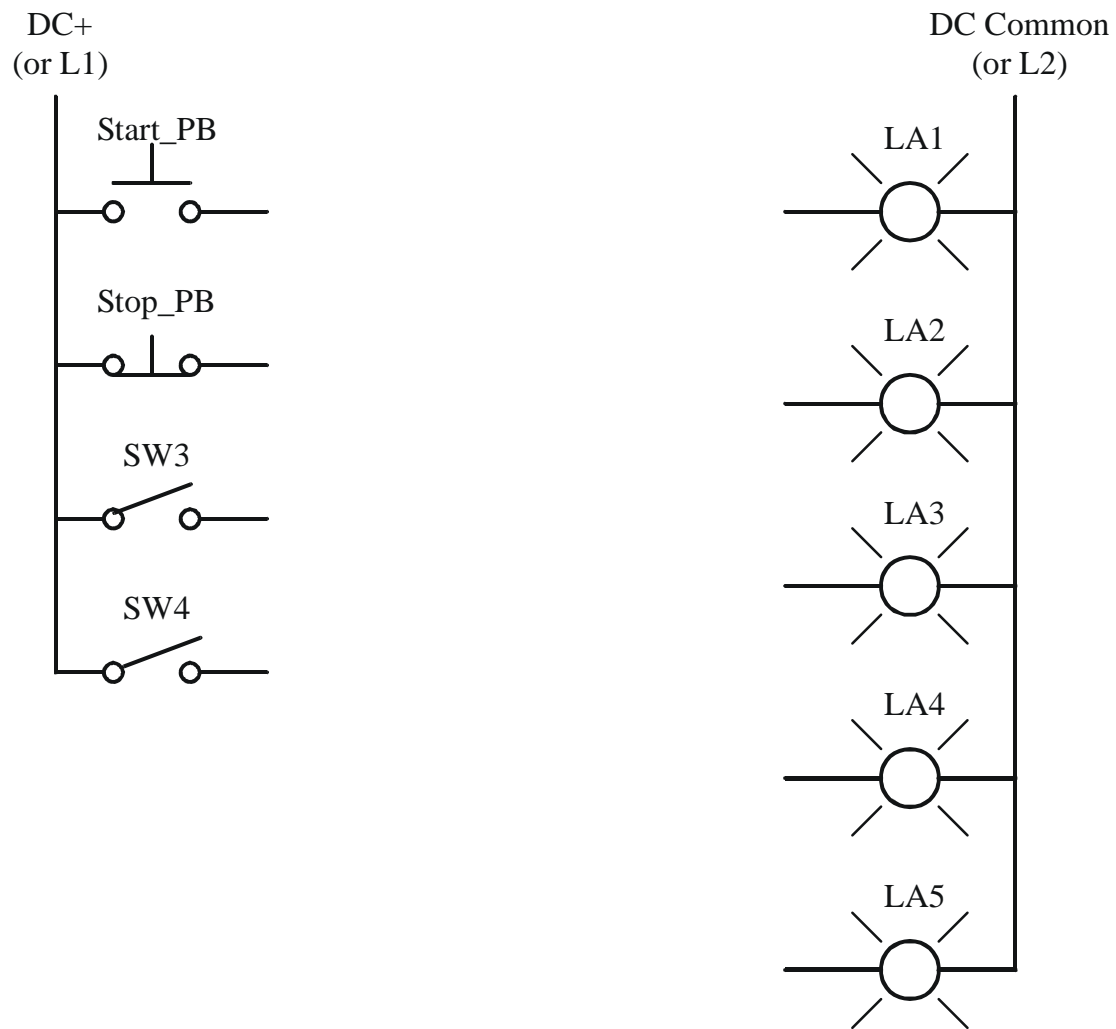


Fig. 13. Switch and light board connections.

## II. Series Operation (Logical AND)

Two switches in series are used to control a lamp load. The circuit and the corresponding ladder logic is shown in Fig. 14. The input and output addresses are shown in the ladder logic. Follow the instructions in part A of the appropriate software programming guide (Studio 5000, RSLogix500, Step7 Portal, Control Expert or Proficy) to set up the processor project. Then follow the procedure in part B.1 to program and test the ladder logic.

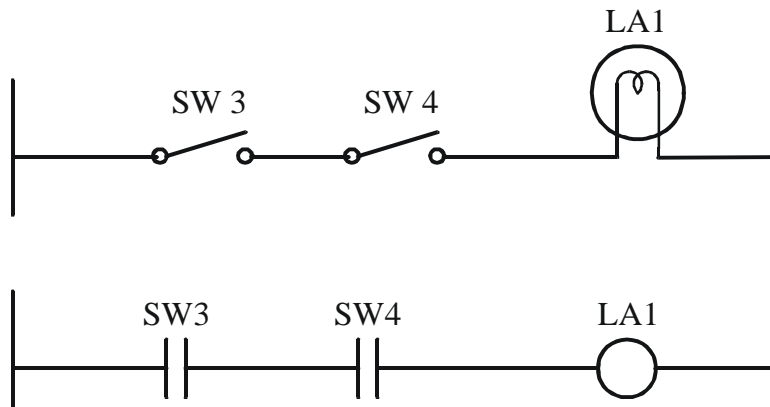


Fig. 14. Series switch circuit and its ladder logic equivalent.

## III. Parallel Operation (Logical OR)

Connect two switches in parallel, as shown in Fig. 15, which is a logical OR condition. The instructions to program the PLC are in part B.2 of the appropriate software programming guide. Demonstrate the PLC operation to the instructor.

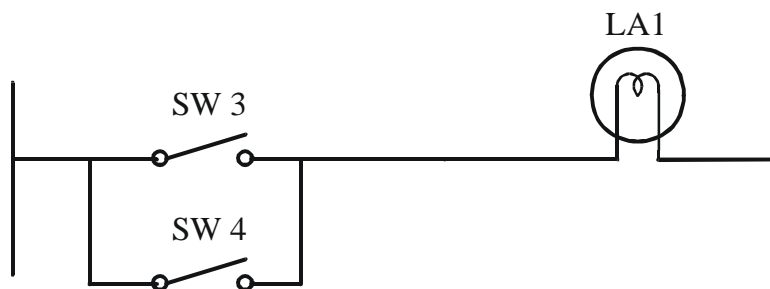


Fig. 15. Parallel switch circuit.

#### **IV. Motor Start/Stop**

Using the Start\_PB and Stop\_PB switches and one lamp, implement a motor start/stop circuit. The start switch is a normally open pushbutton switch and the stop switch is a normally closed pushbutton switch. Demonstrate the PLC operation to the instructor.

#### **V. Timer Operation**

Devise a ladder logic program to do the following:

- a. When a switch is closed, one lamp lights.
- b. Five seconds later, another lamp lights.

The instructions to program the PLC are in part B.3 of the appropriate software programming guide. Demonstrate the PLC operation to the instructor.

#### **VI. Counter Operation**

Devise a ladder logic program to do the following:

When a switch is closed five times, one lamp lights.

The instructions to program the PLC are in part B.4 of the appropriate software programming guide. Demonstrate the PLC operation to the instructor.

## VII. Flashing Lights.

Devise ladder logic using two lamps and two timers to make the two lamps flash alternately. Choose any on/off period. Use one of the switches to turn the flashing lights on and off. Demonstrate the PLC operation to the instructor. You will need to use this ladder logic for anything flashing/beeping/cycling and so it appears in many contexts.

## VIII. Turn Signal.

Devise ladder logic using SW3 and SW4 and timers to produce a turn signal indication (like the old Thunderbirds) with the five lamps. If SW3 is on, the lights should flash to show a left turn. The sequence should be ●●●●○, ●●●○, ●●○○, ●○○○, ○○○○, ●●●● (where ○ means a lamp is on and ● means lamp off). If SW4 is on, the lights should flash to signal a right turn. The right turn sequence should be ○●●●●, ○○●●●, ○○○●●, ○○○○●, ○○○○○, ●●●●●. If both switches are on, then no lamps should flash. The patterns should repeat as long as either switch is on. Each "pattern" in the sequence should be displayed. There should be a time interval for which **no** outputs are on. Choose any reasonable timing intervals. Demonstrate the PLC operation to the instructor.