Anthony Chavez

EEE 174-CpE 185 Summer 2020

Monday, Wednesday

Lab 4

Multism PLC

Dennis Dahlquist

Introduction:

For this lab, we are going to use the Multisim software to simulate ladder logic. First, we will review the "Multisim_PLC.pdf" document provided and become familiar with finding and configuring ladder diagram components. Next, we will use this knowledge to create the ladder logic for a Logical AND, Logical OR, Logical NAND, and Logical NOR. Finally, we will create the logic for an industrial application and demonstrate the working simulation to our lab instructor.

Part 1: Creating a Ladder Diagram

In this section, we learned how to properly configure a Ladder Diagram by following the steps outlined in the "Multisim_PLC.pdf" document under Chapter 4.2. First, we placed four Ladder Rungs on the schematic sheet by clicking on the "Place" button on the taskbar and selecting Ladder Rungs (see Figure 1.1). Second, we added the Normally Open Relay Contact component to the Ladder Rungs by clicking on the "Place" button, selecting "Component", selecting the RELAY_CONTACT_NO under the Ladder Contacts Family (see Figure 1.2), and attaching two to the first two Ladder Rungs. Third, we placed one Lamp on the first two Ladder Rungs (see Figure 1.3). Fourth, we placed one Ladder Relay Coil (see Figure 1.4) and one SPST Switch (see Figure 1.5) to the last two Ladder Rungs. Finally, we changed the value of some of the components to match the diagram shown in the instructions and we successfully replicated the Ladder Diagram (see Figure 1.6).

As for testing our Ladder Diagram, we simply press the green triangle on the toolbar to start the simulation and click on the switches to understand the difference between the AND rung and the OR rung. When we close the either Key 1 or Key 2 and leave one switch open, we noticed the OR rung's Lamp becomes energized. Only one switch needs to be close in order to complete the OR rung's circuit (see Figures 1.7 and 1.8). As for the AND rung's Lamp, the circuit is only completed when both Key 1 and Key 2 are closed (see Figure 1.9).

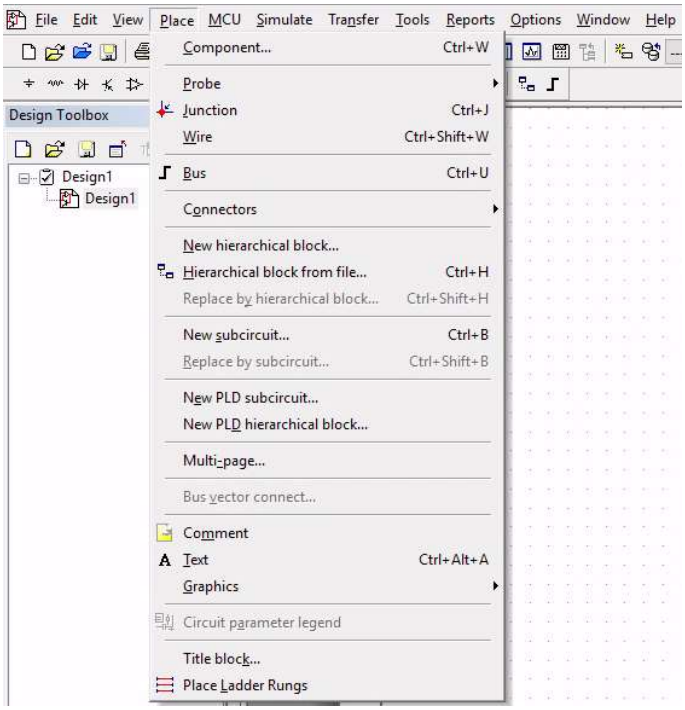


Figure 1.1: Placing Ladder Rungs

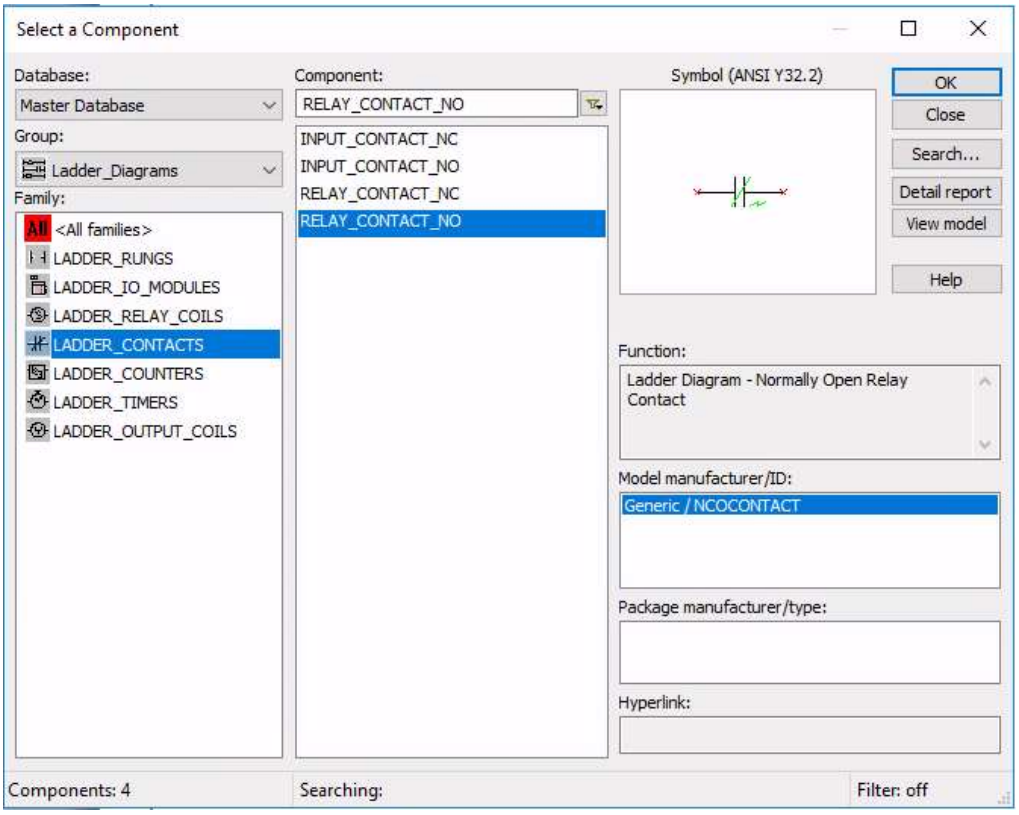


Figure 1.2: Placing Normally Open Relay Contact

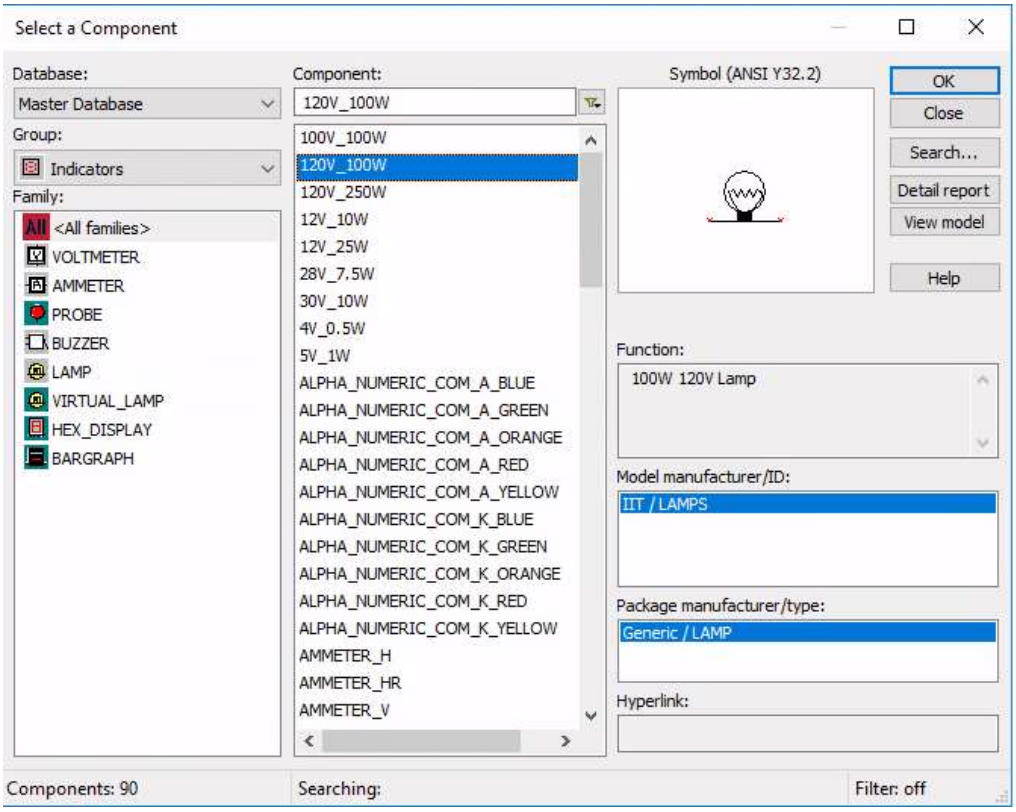


Figure 1.3: Placing Lamp

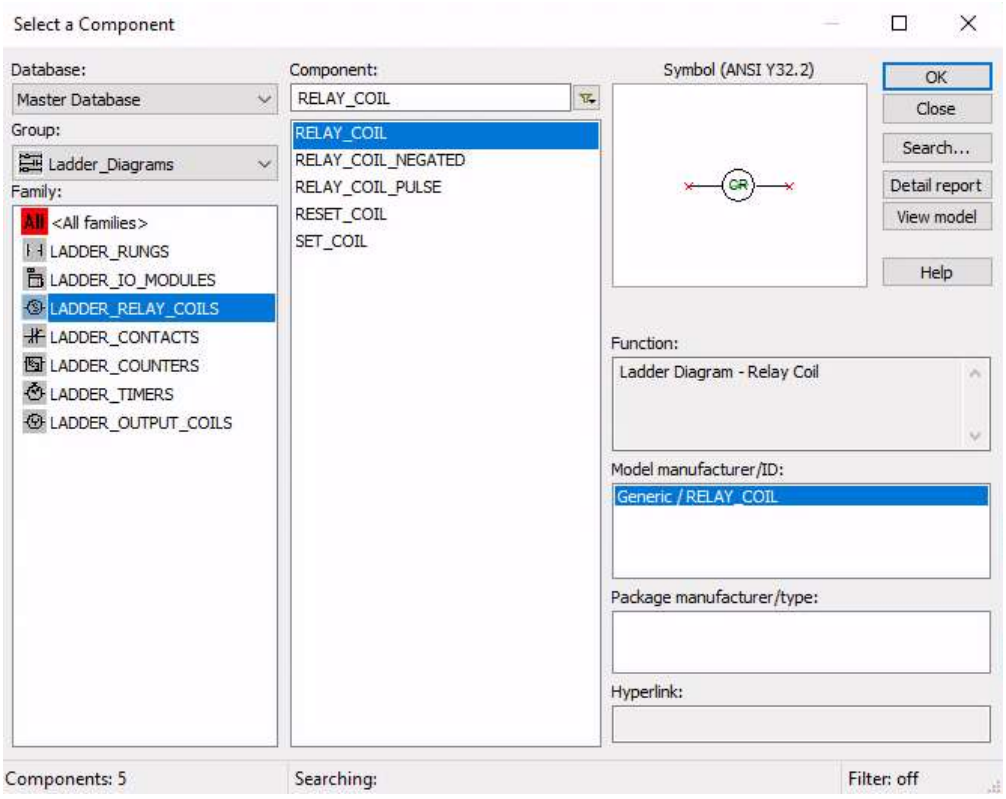


Figure 1.4: Placing Ladder Relay Coils

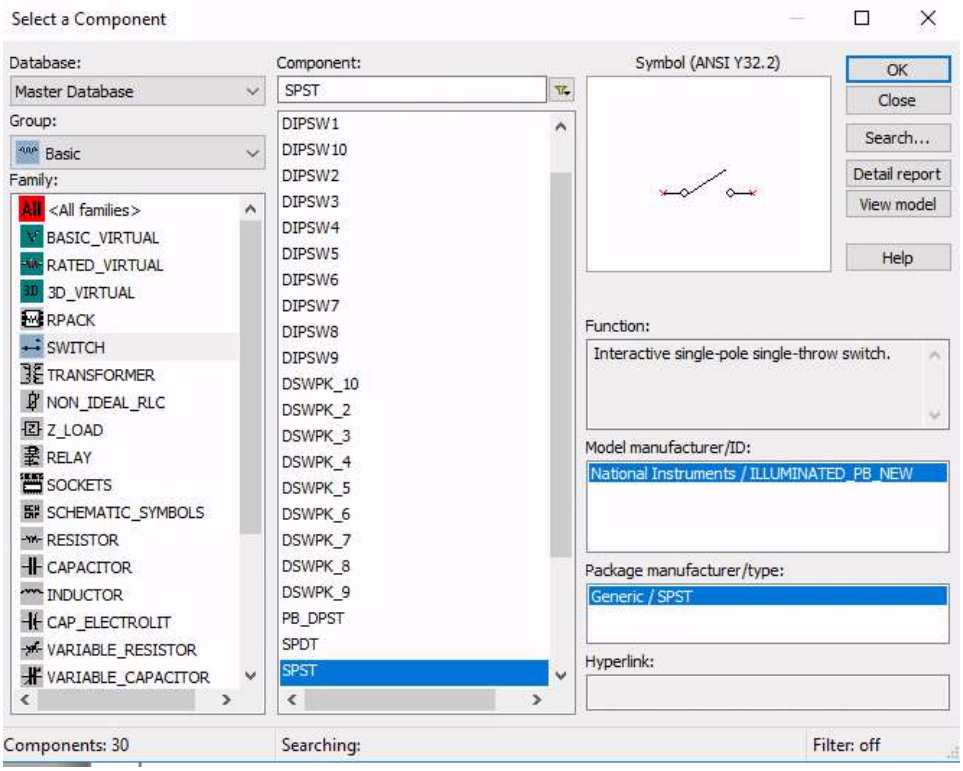


Figure 1.5: Placing SPST Switches

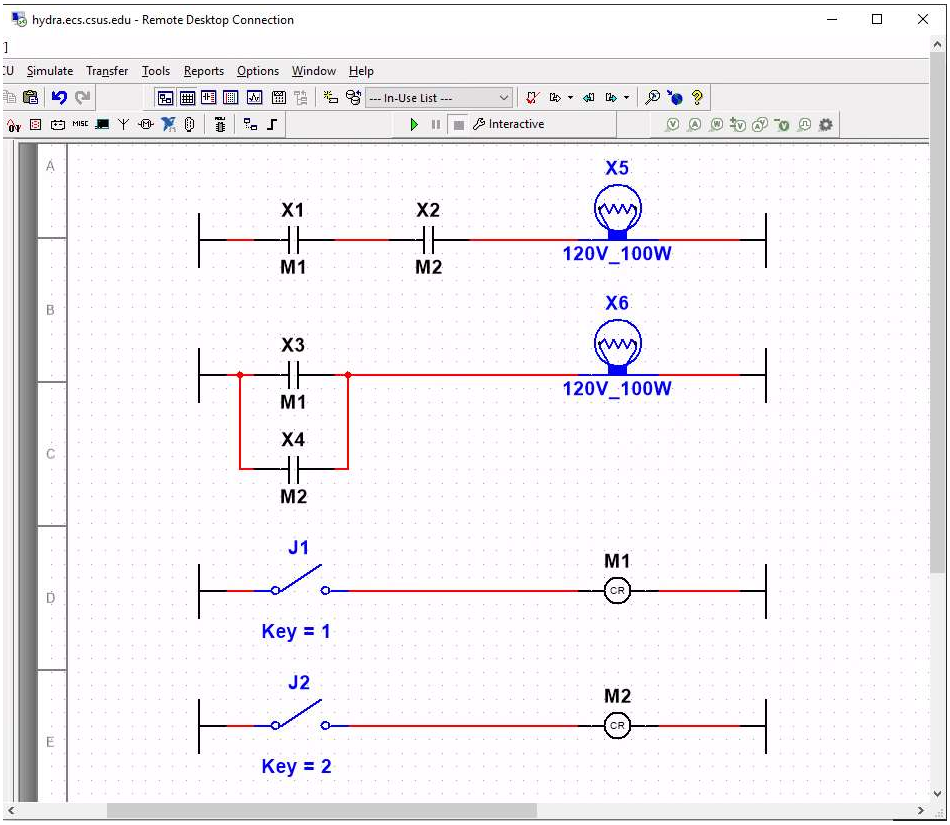


Figure 1.6: Final Result

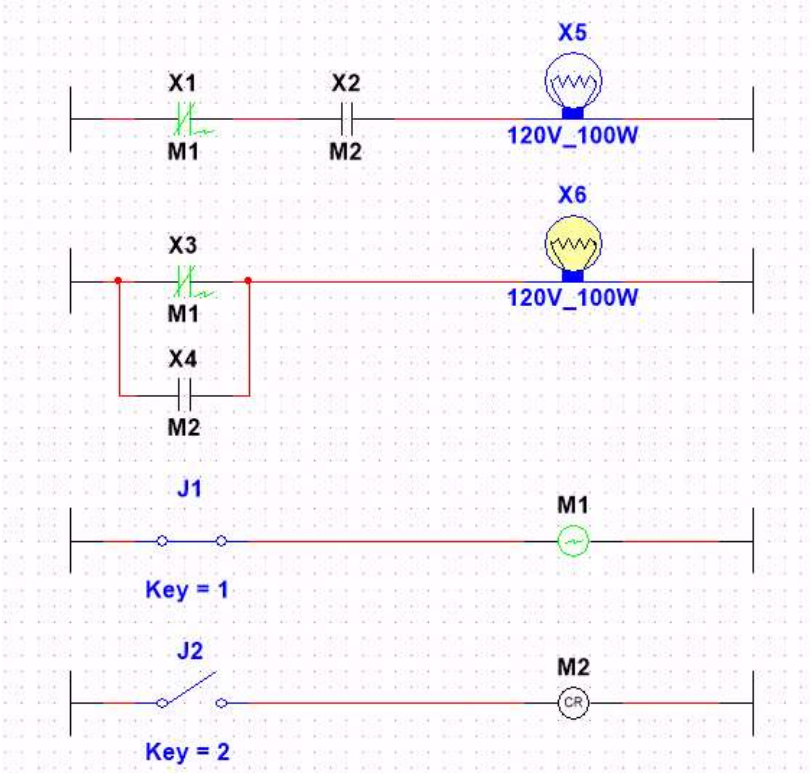


Figure 1.7: Key 1 is closed, OR rung's Lamp is ON

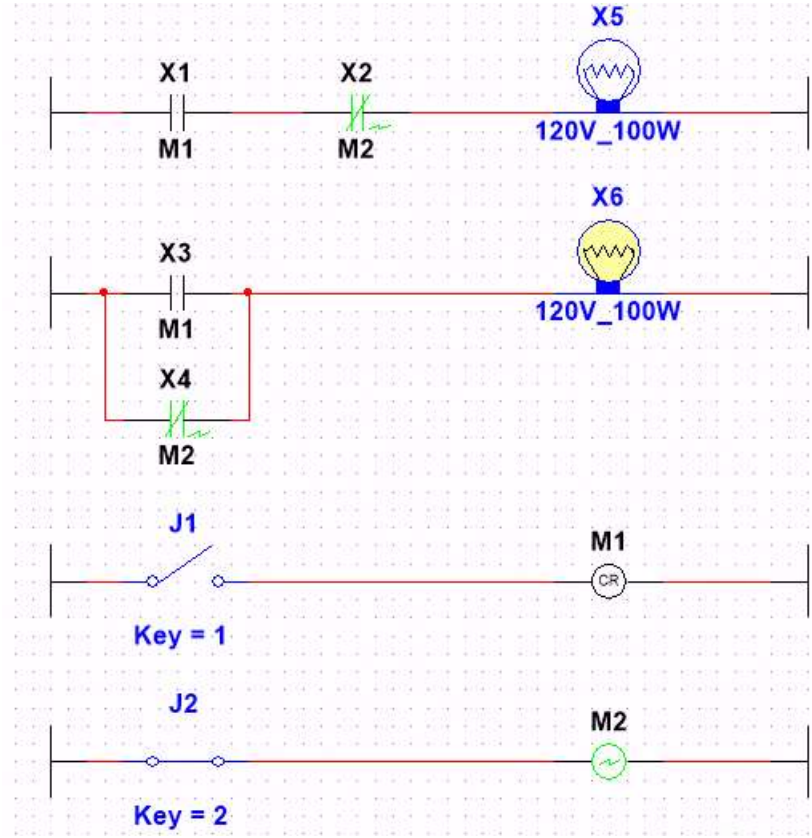


Figure 1.8: Key 2 is closed, OR rung's Lamp is ON

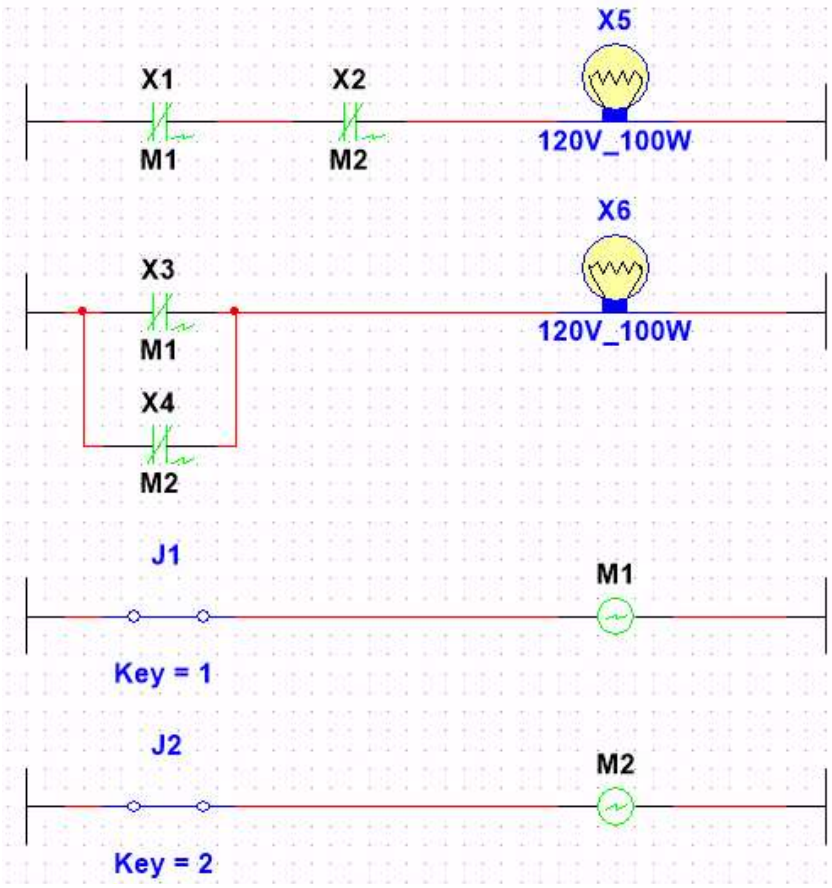


Figure 1.9: Key 1 and Key 2 are closed, AND and OR rung's Lamp is ON

Part 2: AND, OR, NAND, NOR Logical Ladders

For this portion of the lab we created the Ladder Logic for a Logical AND, Logical OR, Logical NAND, and Logical NOR. First, we created the AND Ladder Diagram as shown in Figure 2.2. The Logical AND circuit will only energize the Lamp when both switches are closed as can be seen in Figure 2.3. Second, we created the OR Ladder Diagram as shown in Figure 2.5. The Logical OR circuit will energize the Lamp when either switch is closed or if both are closed as shown in Figure 2.6. Both the AND and OR circuit use Normally Open Relay Contacts to perform the correct outputs shown by the Truth Table in Figures 2.1 and 2.4. Third, we created the NAND Ladder Diagram as shown in Figure 2.8. The NAND circuit will energize the Lamp when both switches remain closed or if one switch is opened as shown in Figure 2.9. Fourth, we created the NOR Ladder Diagram as shown in Figure 2.11. The NOR circuit will energize the Lamp only when both switches remain closed as shown in Figure 2.12. Both the NAND and NOR circuit use Normally Closed Rely Contacts to perform the correct outputs shown by the Truth Table in Figures 2.7 and 2.10.

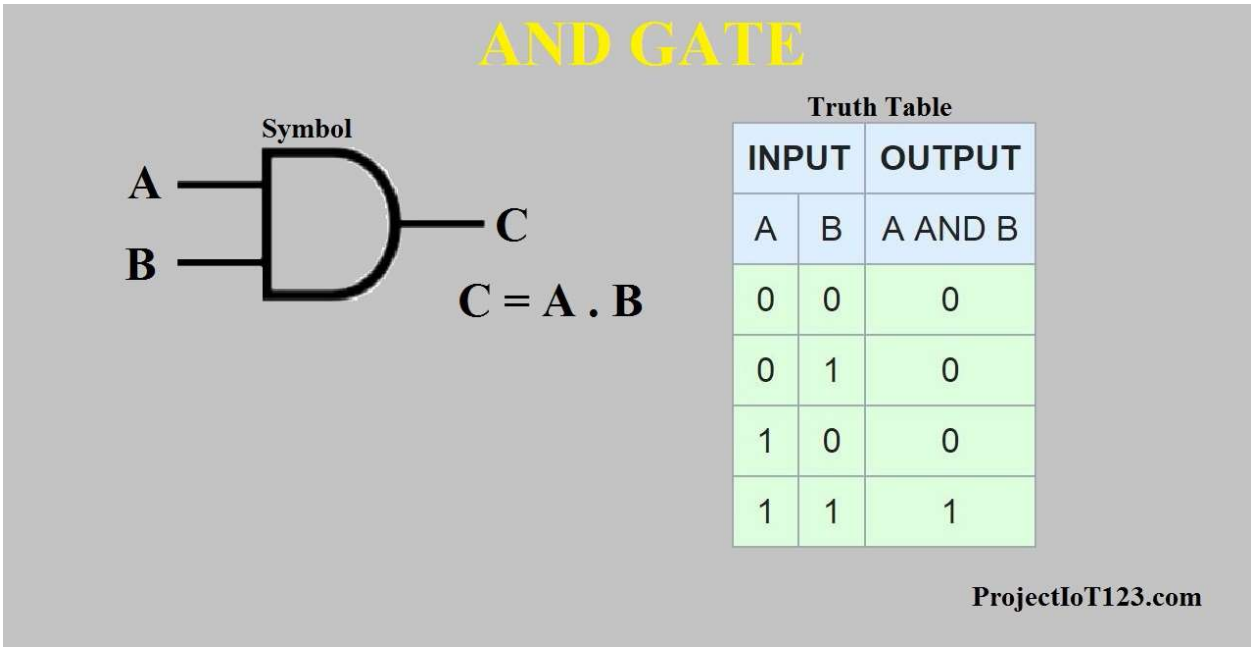


Figure 2.1: AND Gate Logic

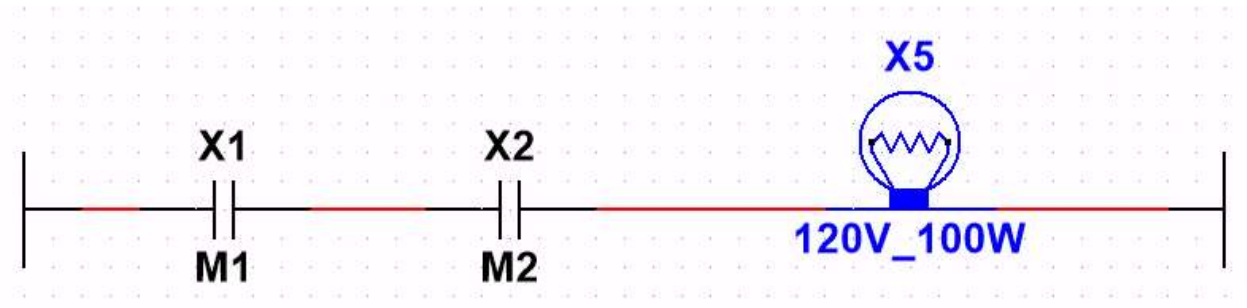
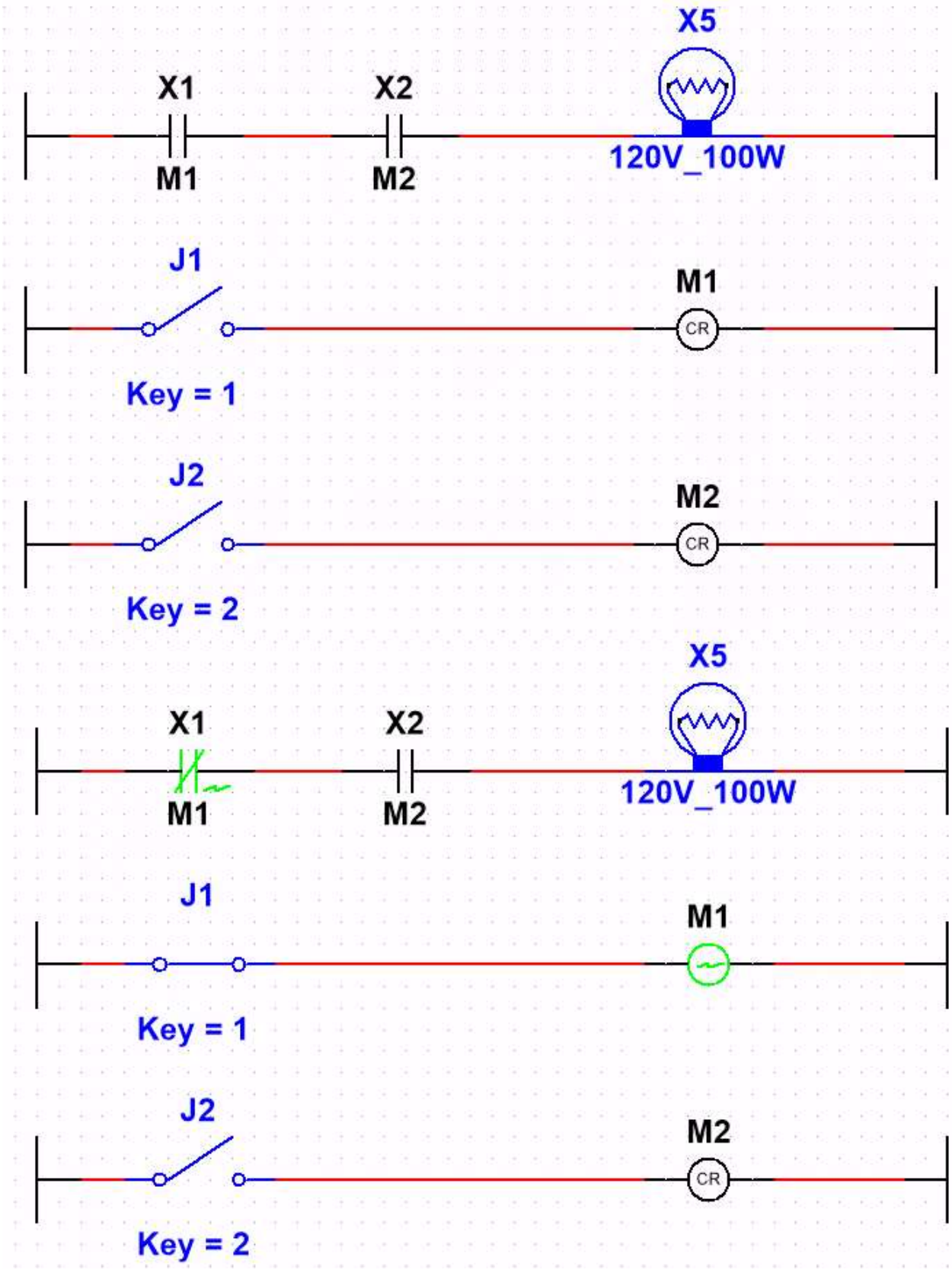


Figure 2.2: AND Gate Ladder Diagram


X5
X1
X2
M1
M2
120V_100W
J1
M1
CR
Key = 1
J2
M2
CR
Key = 2
X5
X1
X2
M1
M2
120V_100W
J1
M1
Key = 1
J2
M2
CR
Key = 2

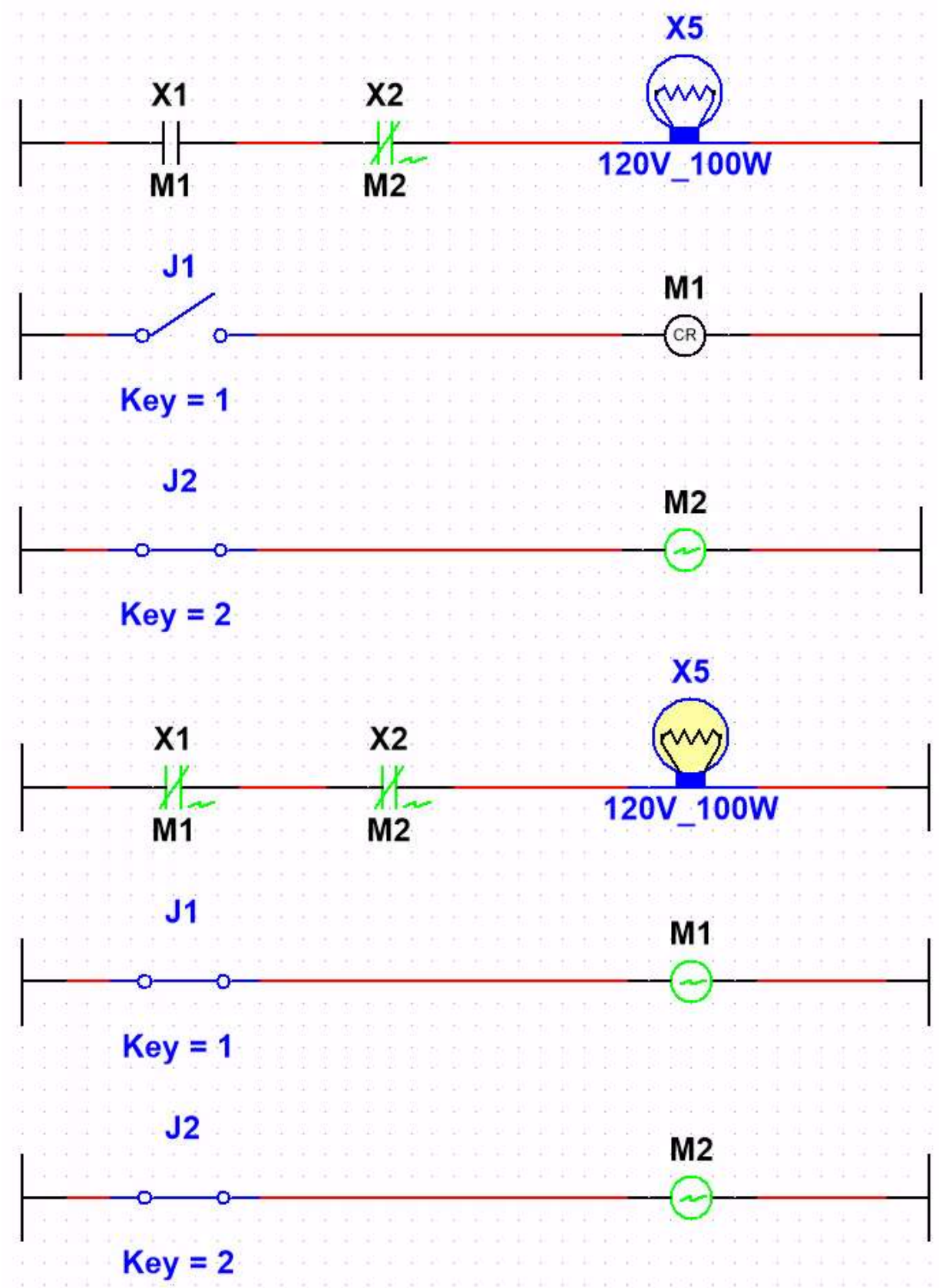


Figure 2.3: AND Gate Outputs

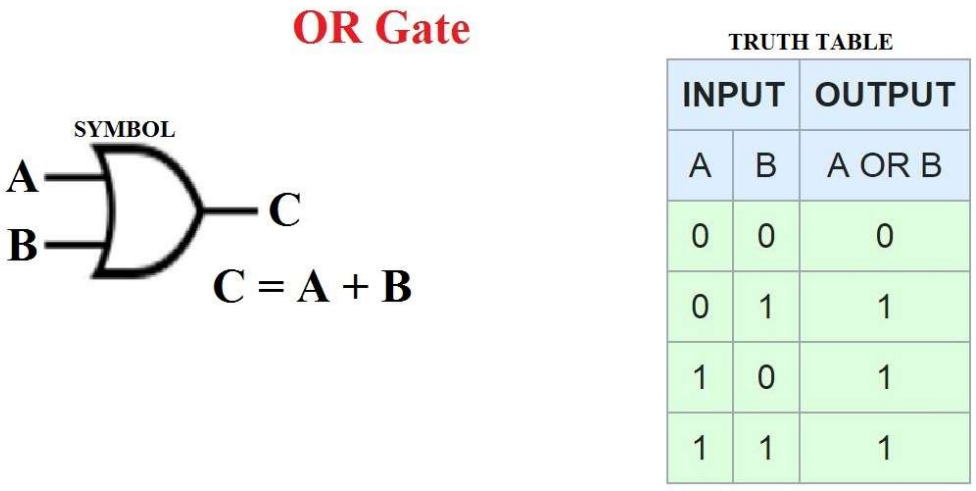


Figure 2.4: OR Gate Logic

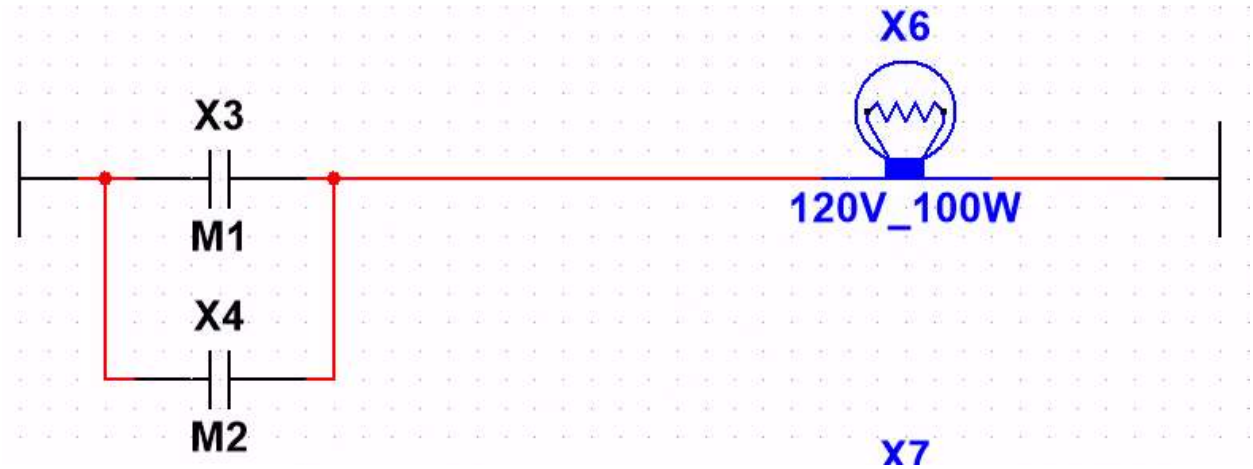
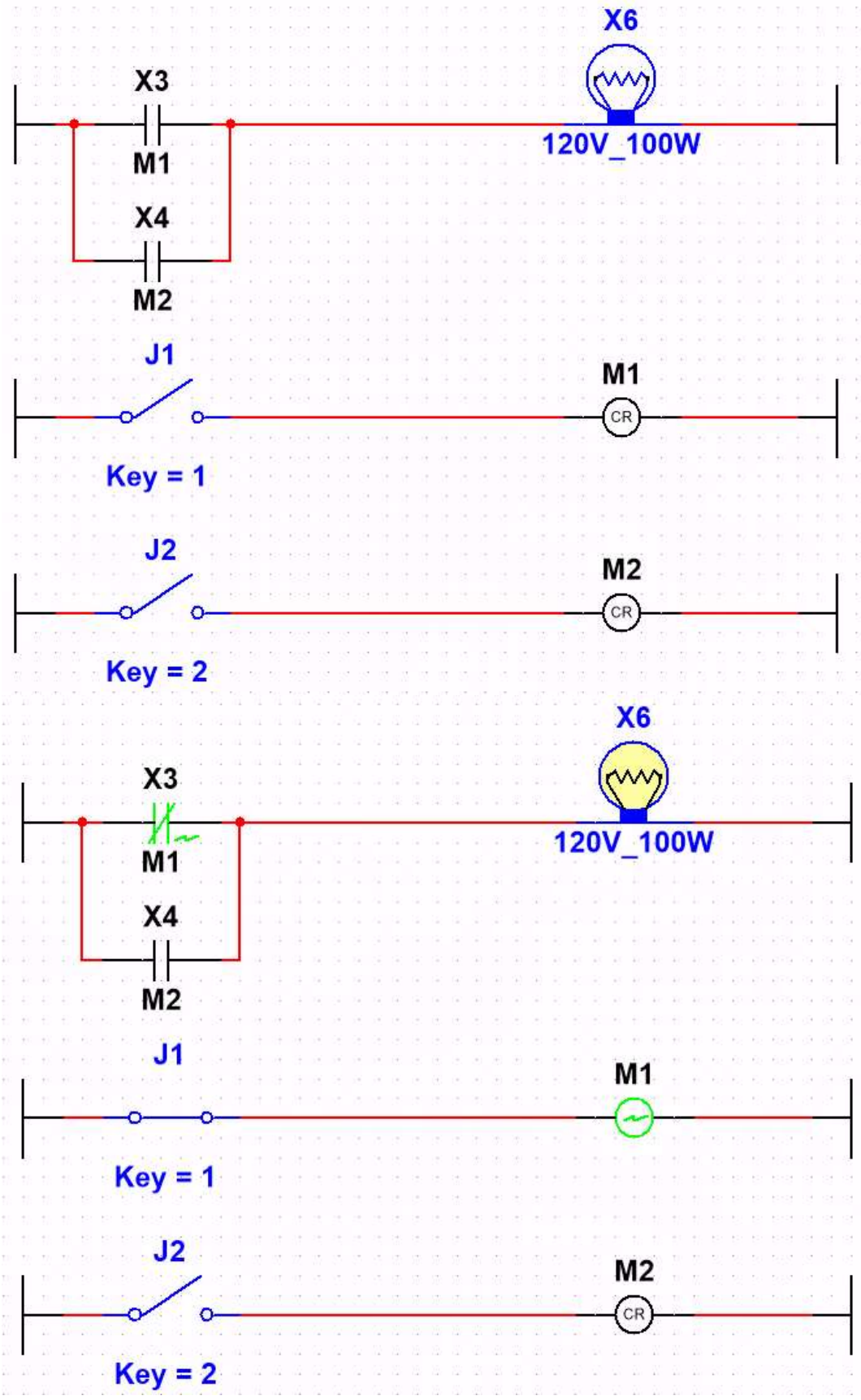


Figure 2.5: OR Gate Ladder Diagram


X6
X3
M1
120V_100W
X4
M2
J1
M1
CR
Key = 1
J2
M2
CR
Key = 2
X6
X3
M1
120V_100W
X4
M2
J1
M1
Key = 1
J2
M2
CR
Key = 2

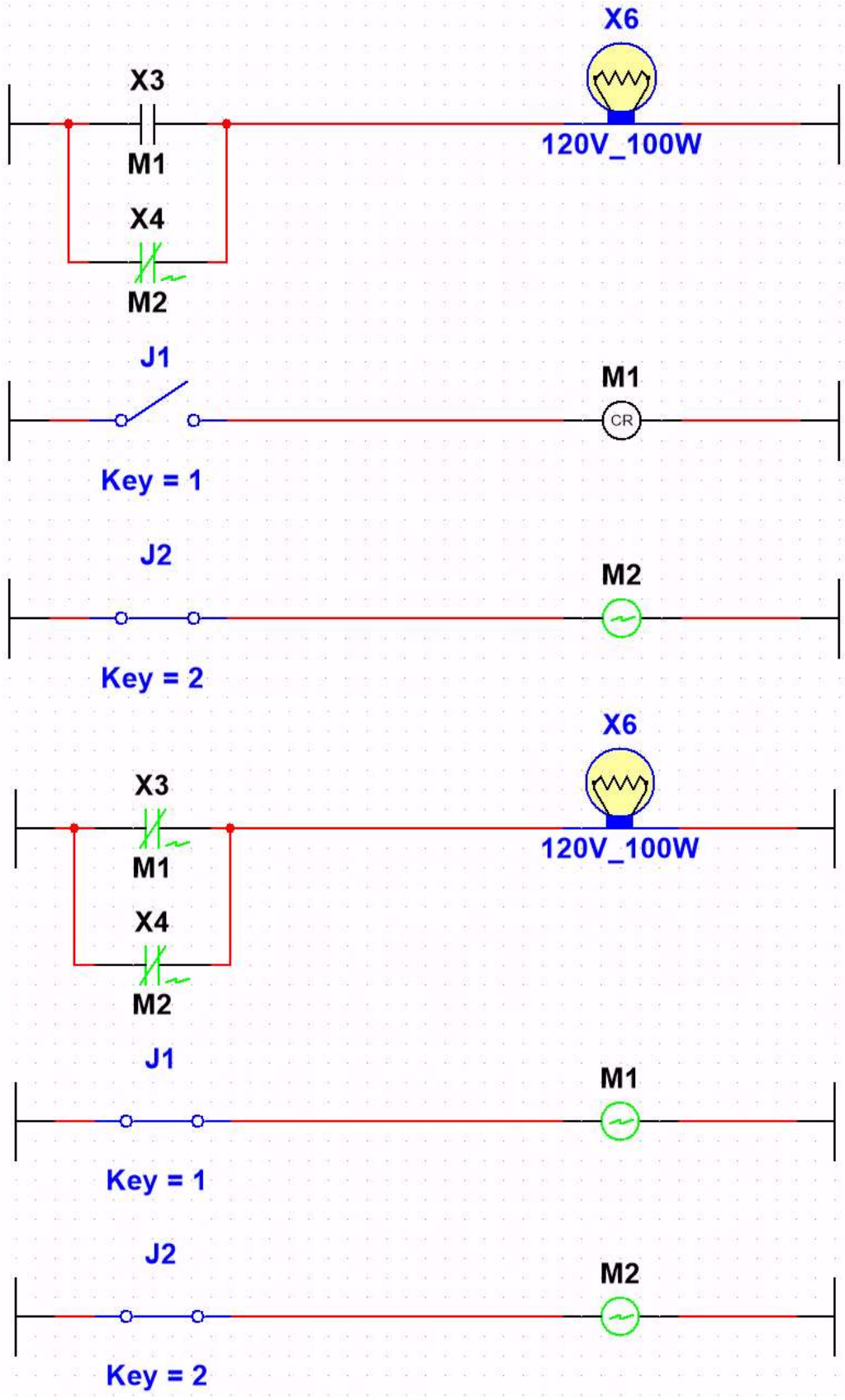
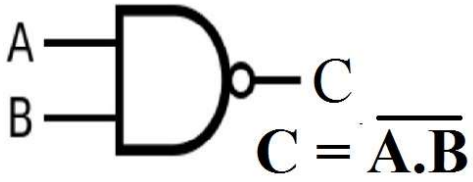


Figure 2.6: OR Gate Outputs

NAND GATE



Truth Table

INPUT		OUTPUT
A	B	A NAND B
0	0	1
0	1	1
1	0	1
1	1	0

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Figure 2.7: NAND Gate Logic

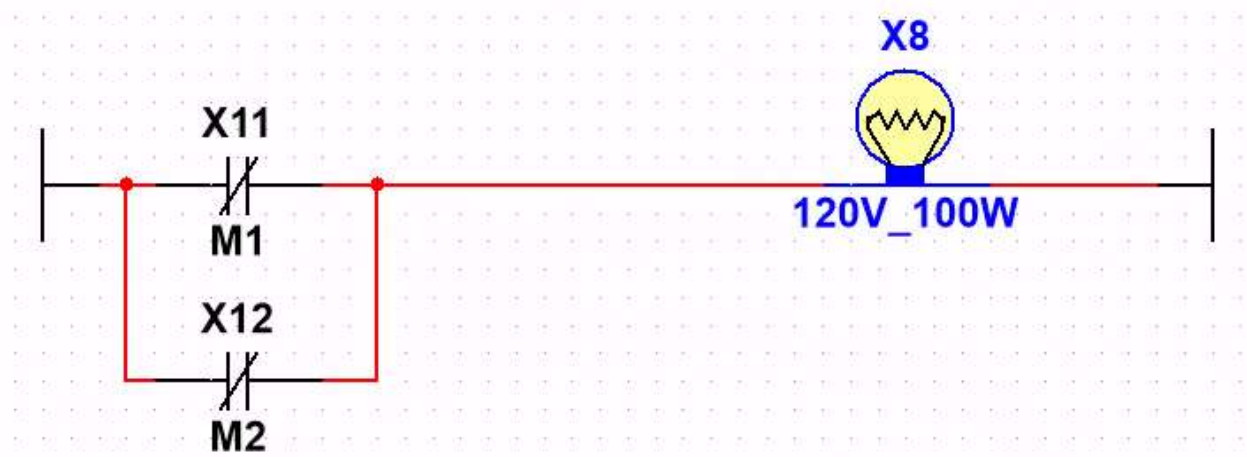
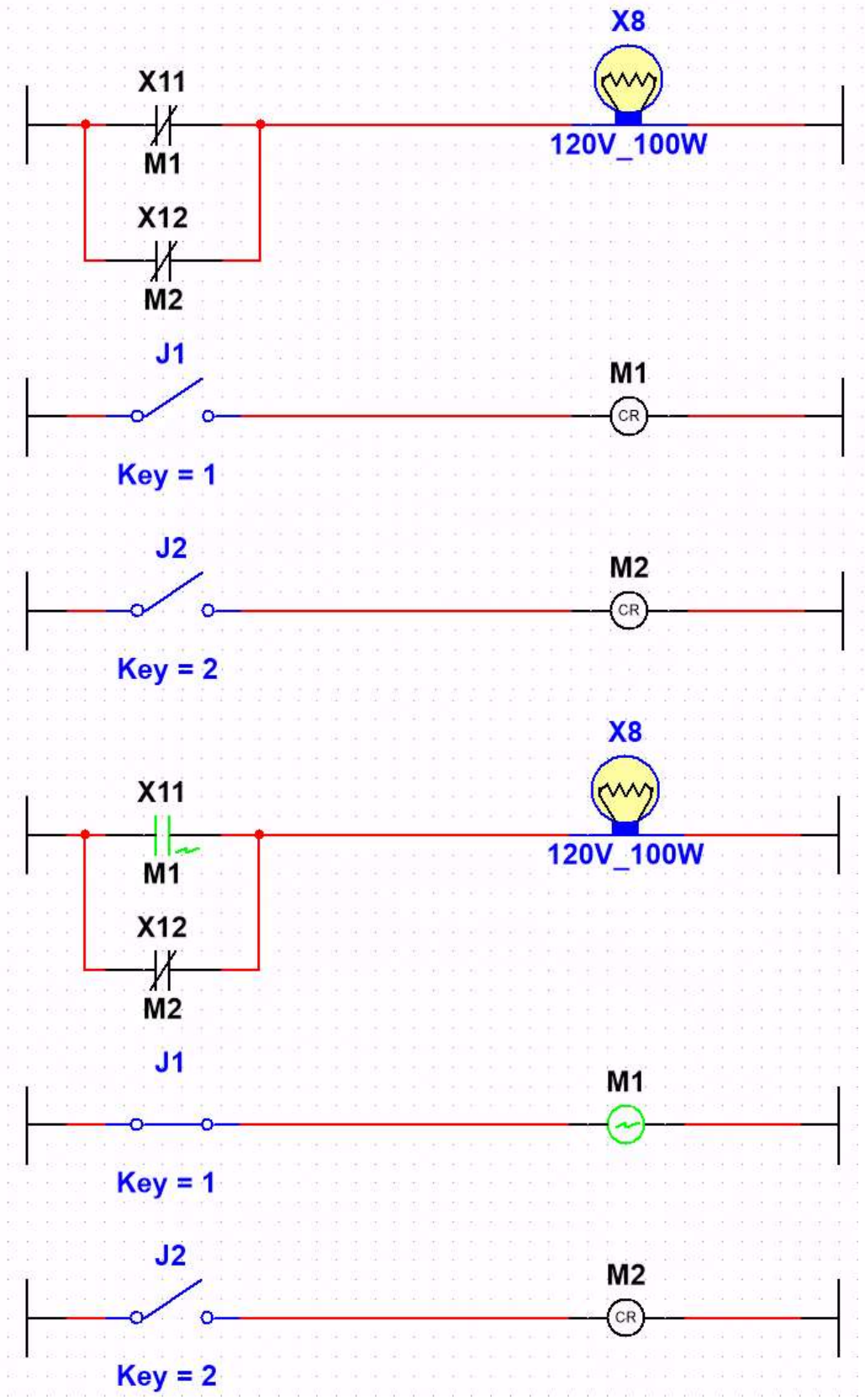


Figure 2.8: NAND Gate Ladder Diagram


X8
X11
M1
120V_100W
X12
M2
J1
M1
CR
Key = 1
J2
M2
CR
Key = 2
X8
X11
M1
120V_100W
X12
M2
J1
M1
Key = 1
J2
M2
CR
Key = 2

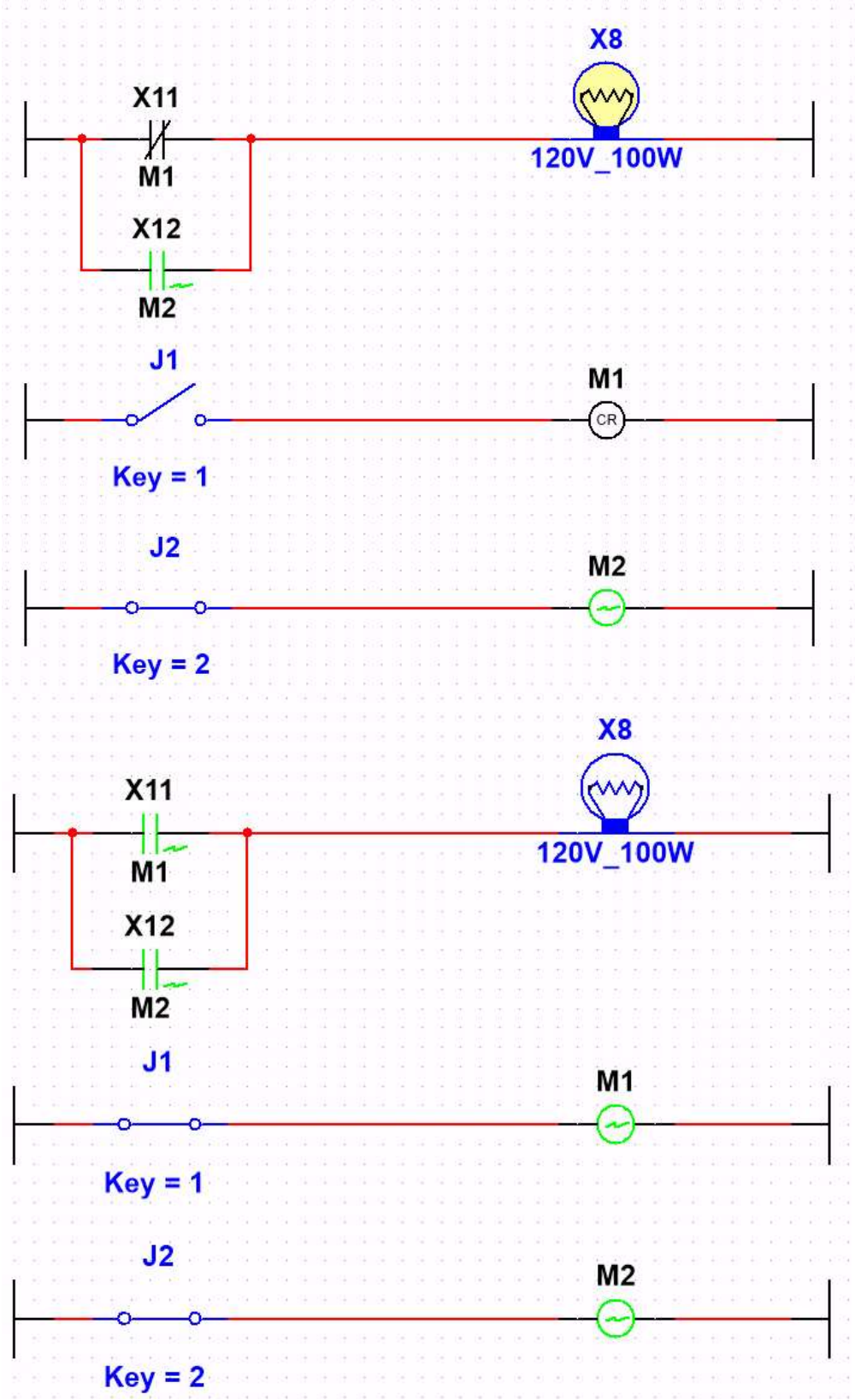
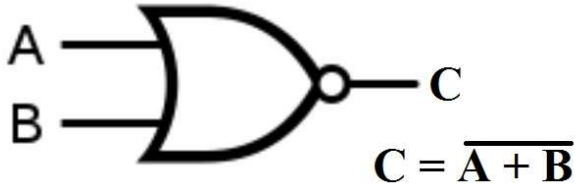


Figure 2.9: NAND Gate Outputs

NOR GATE



TRUTH TABLE

INPUT		OUTPUT
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

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Figure 2.10: NOR Gate Logic

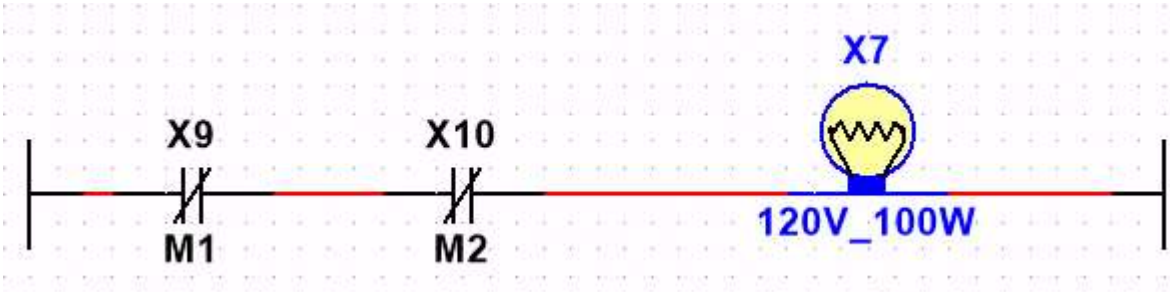
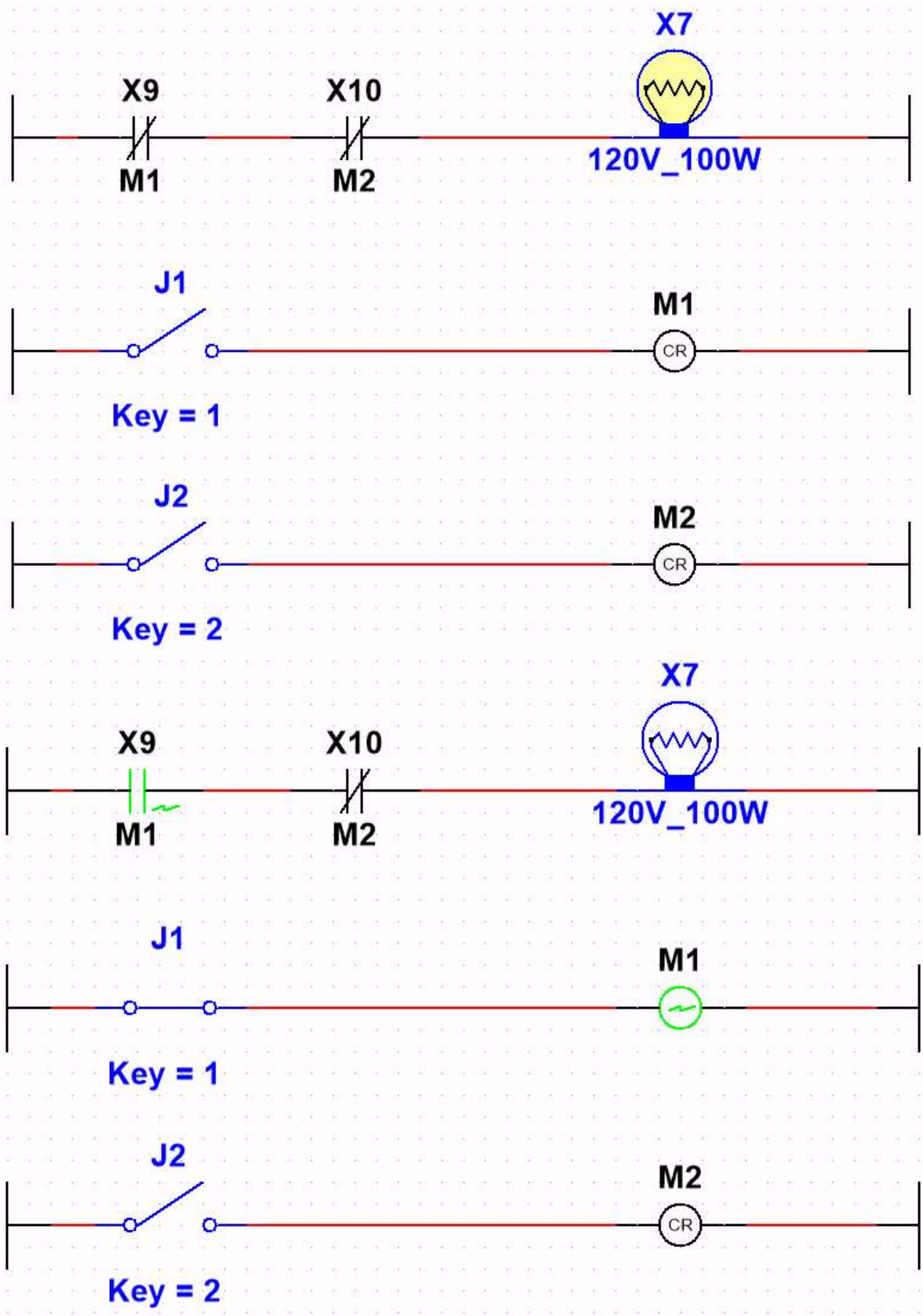


Figure 2.11: NOR Gate Ladder Diagram


X7
X9
X10
M1
M2
120V_100W
J1
M1
CR
Key = 1
J2
M2
CR
Key = 2
X7
X9
X10
M1
M2
120V_100W
J1
M1
Key = 1
J2
M2
CR
Key = 2

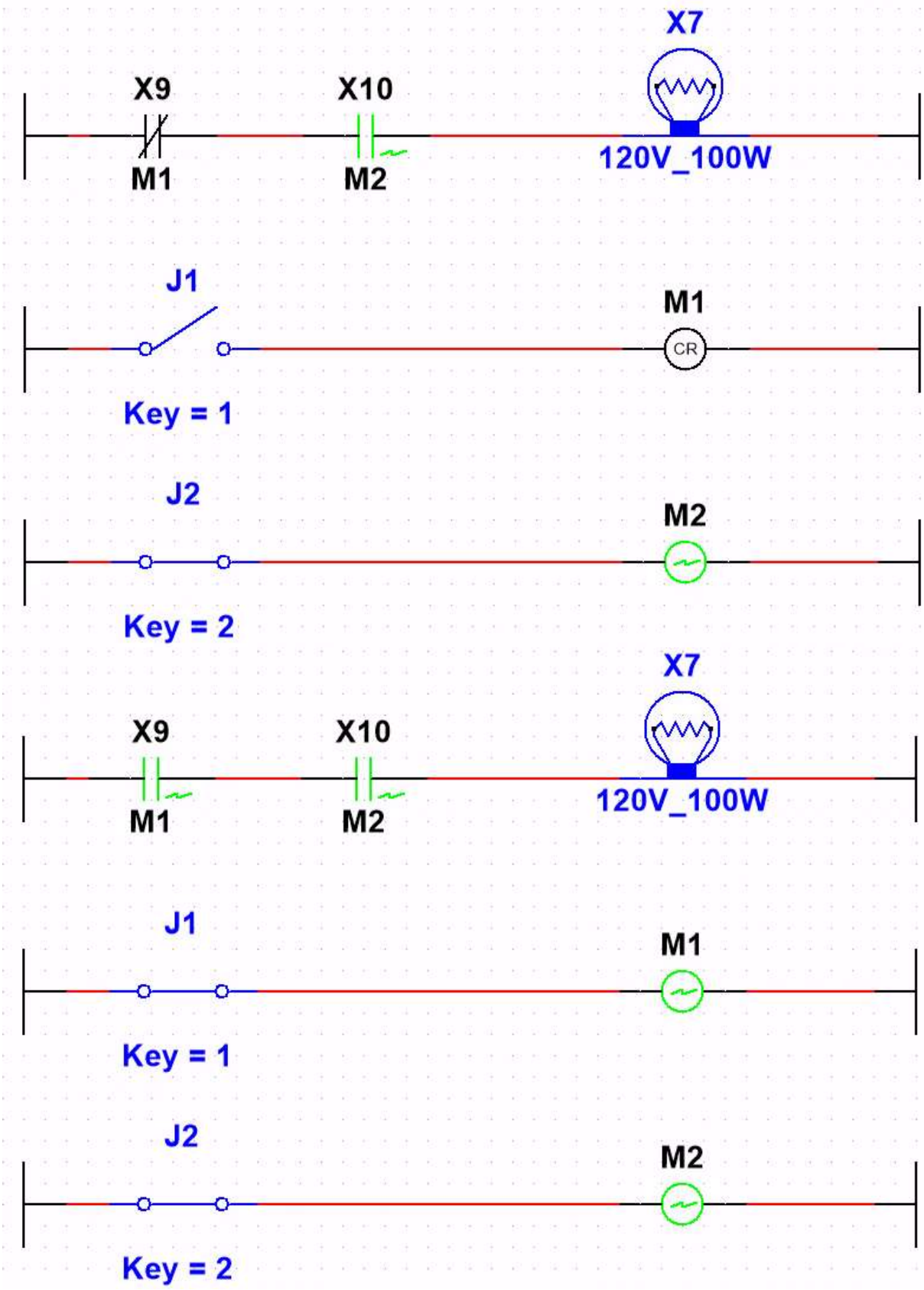


Figure 2.12: NOR Gate Outputs

Part 3: PLC Application

For this portion of the lab, we had to create our own PLC application and we decided to implement a car alarm/notification system. In order to keep the diagram simple, only three components were created (see Figure 3.1). When the car is locked and the alarm is armed the trunk, hood, and camera detection will set off the alarm as well as send a notification to the owner. First, the trunk and hood will only sound if the “Locked” switch is closed. If only the trunk or the hood is opened, the alarm will still sound and/or notify the owner (see Figure 3.2). Second, the car has two cameras and both must detect an object in their field of vision. If both cameras detect an object, the alarm will notify the owner and allow a livestream (see Figure 3.3). Finally, the Tire Pressure Low component does not require the car to be locked to function. When a tire reaches a certain level, the switch corresponding to that tire will be closed and notify the owner the tire pressure is low (see Figure 3.4).

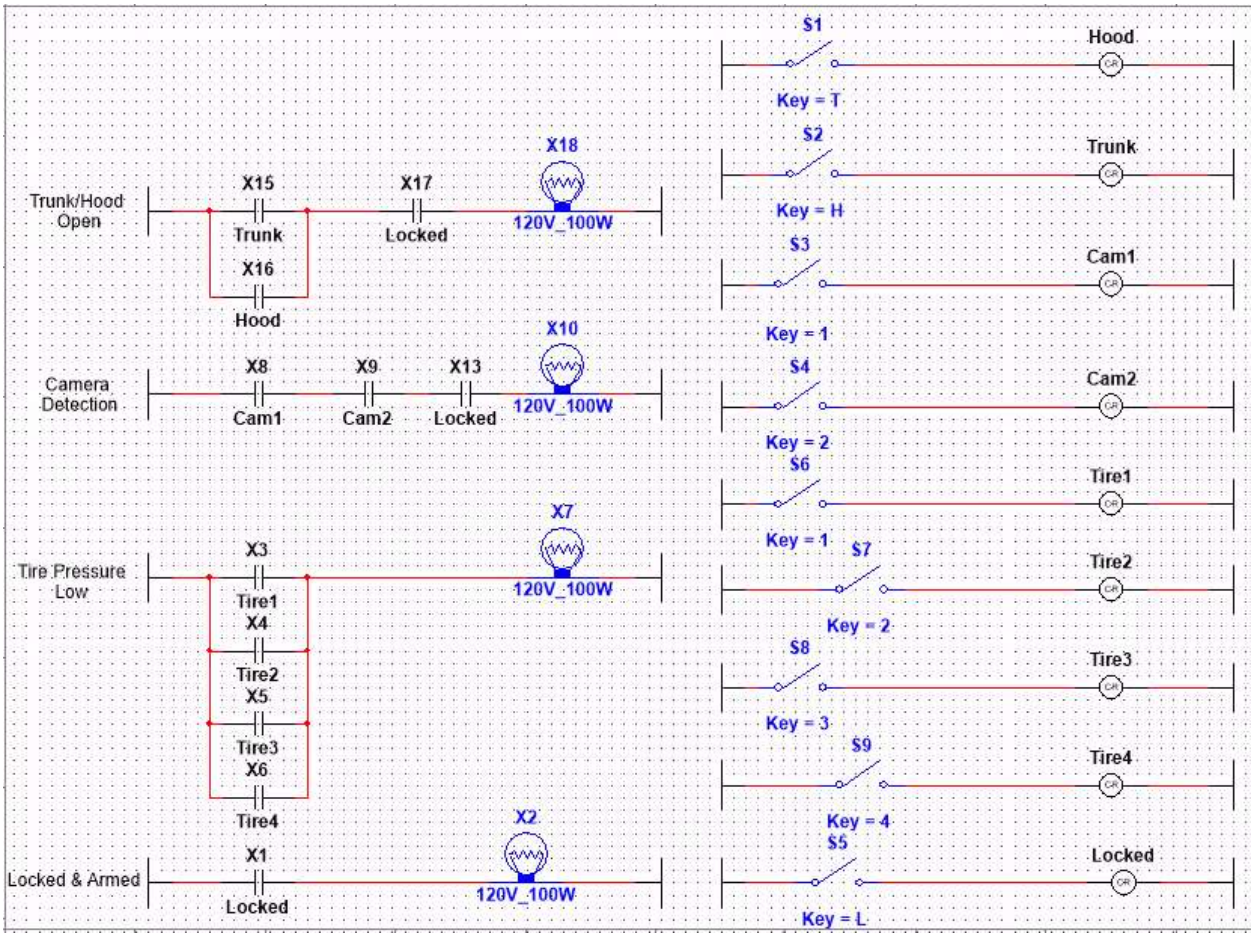
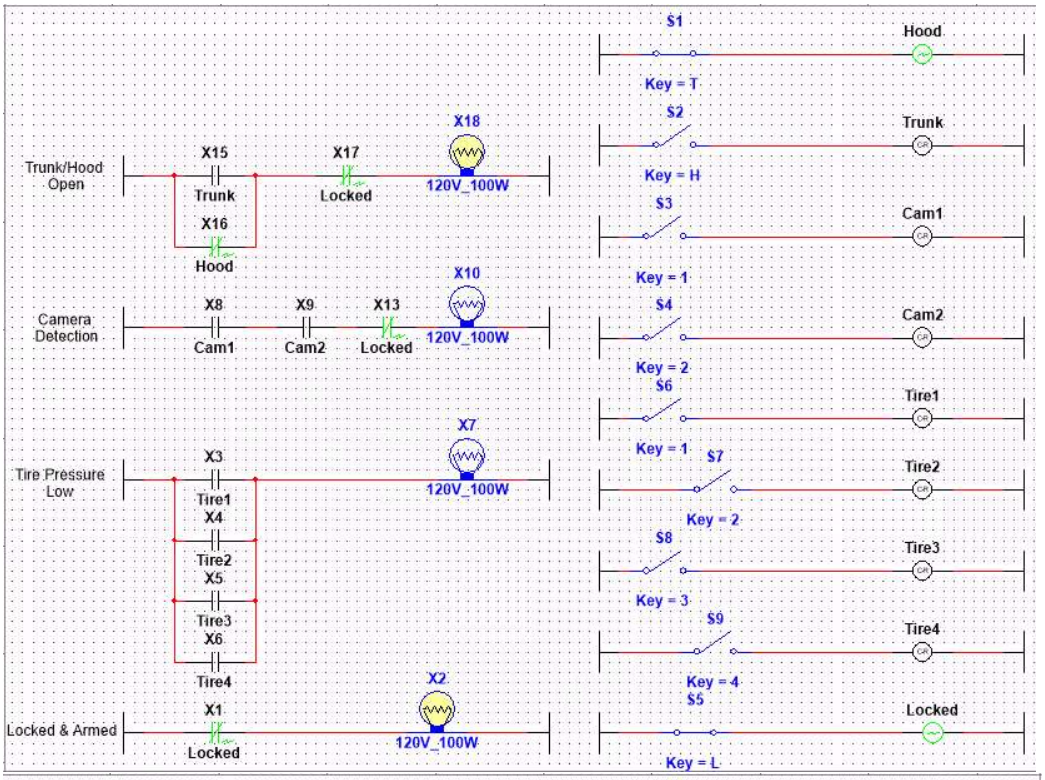
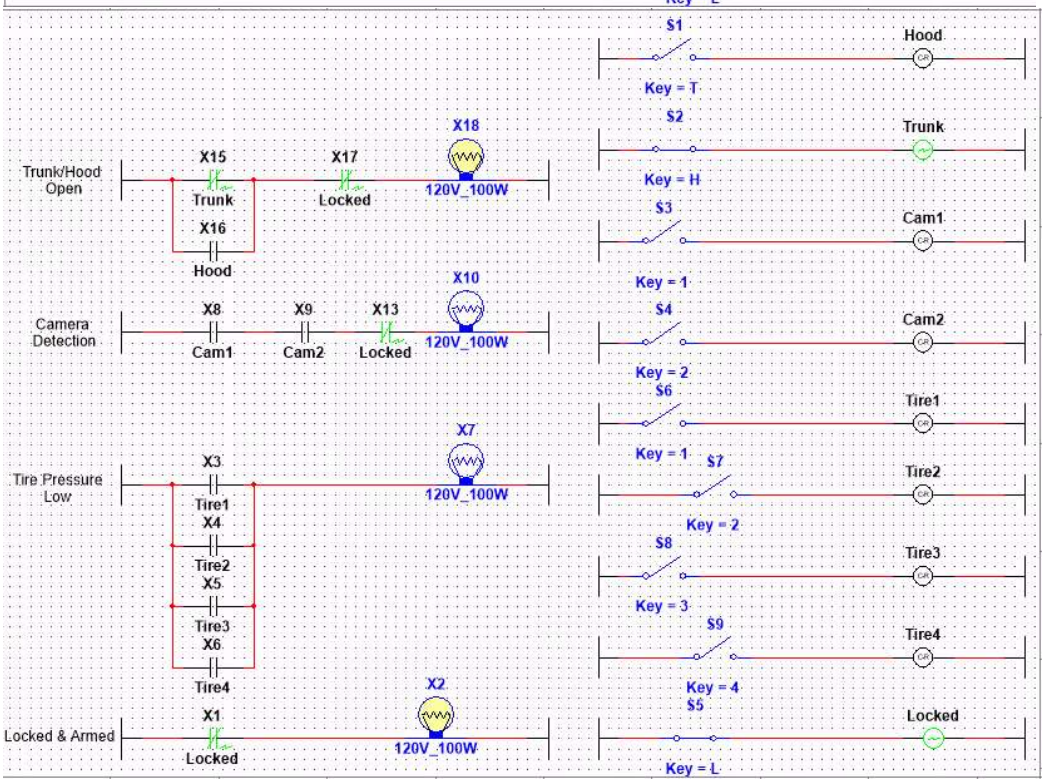


Figure 3.1: PLC Application


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked

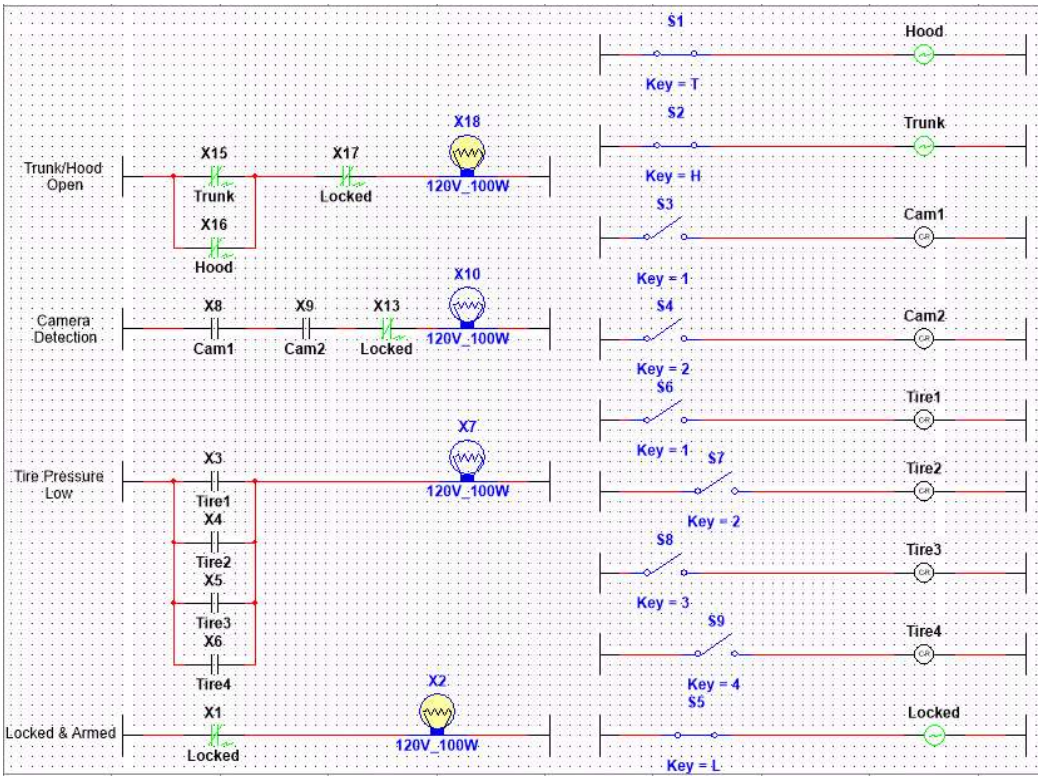
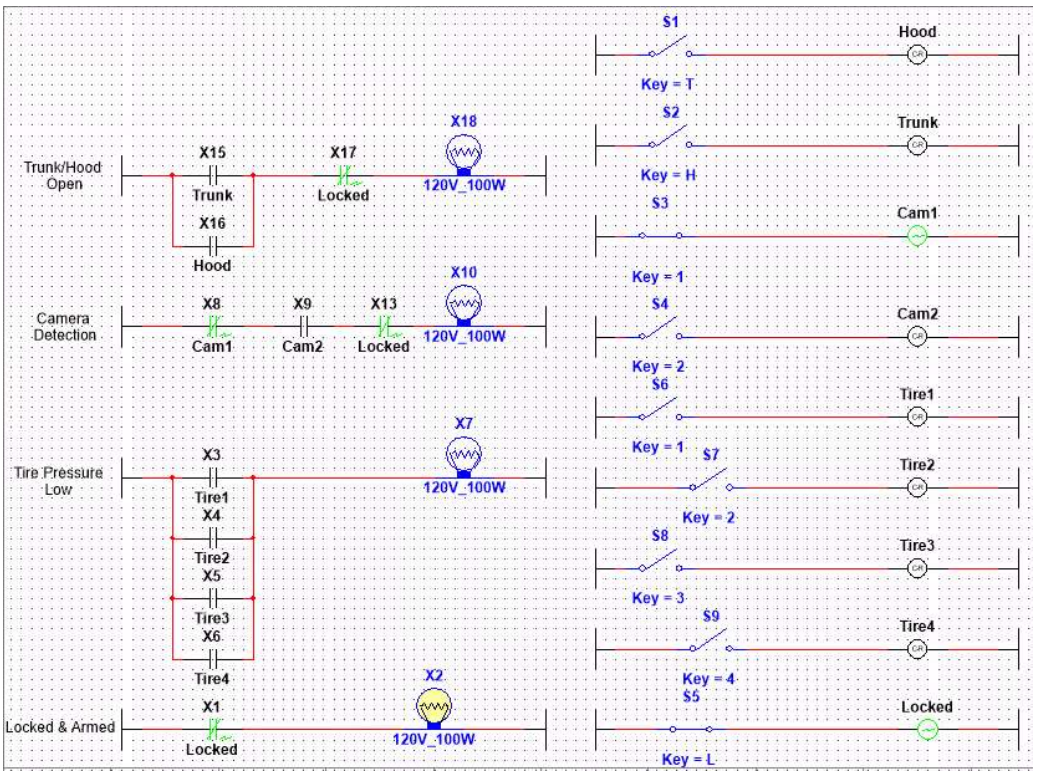


Figure 3.2: Trunk or/and Hood Opened



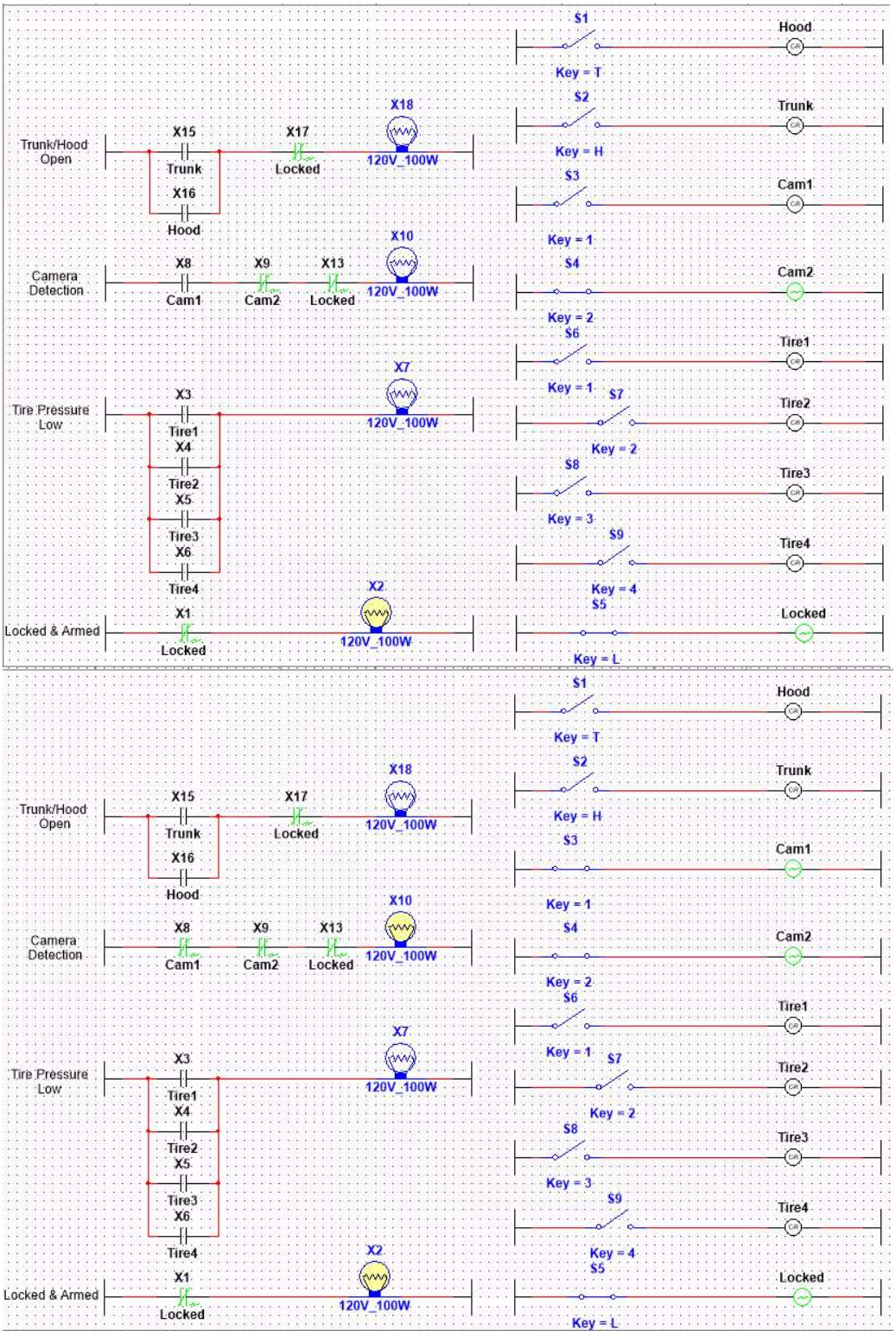
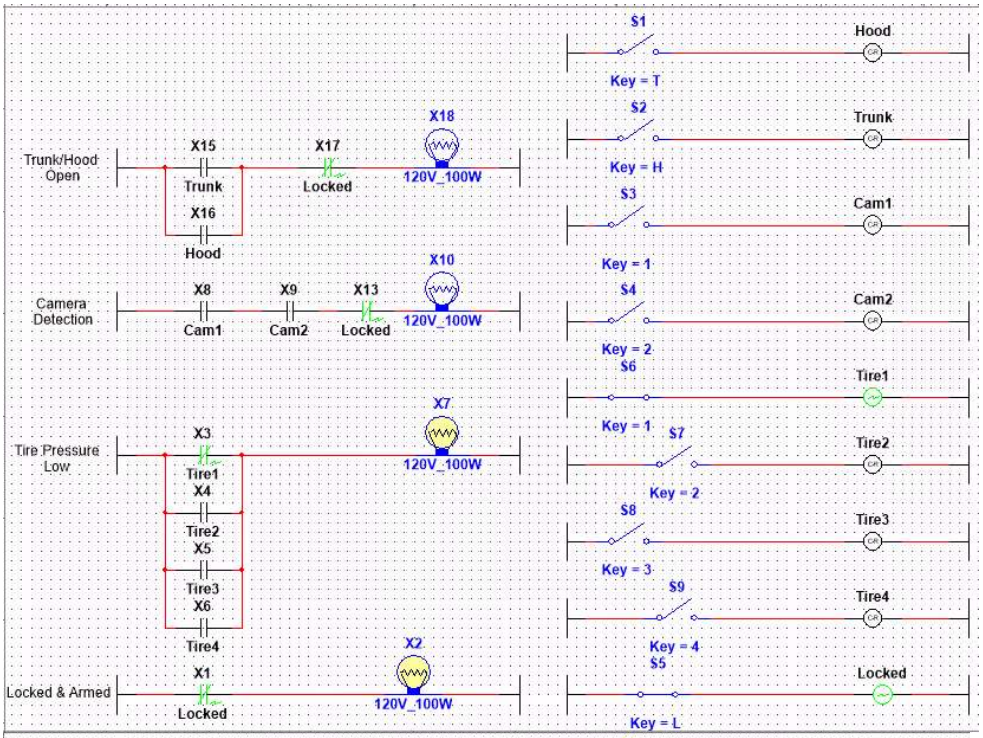
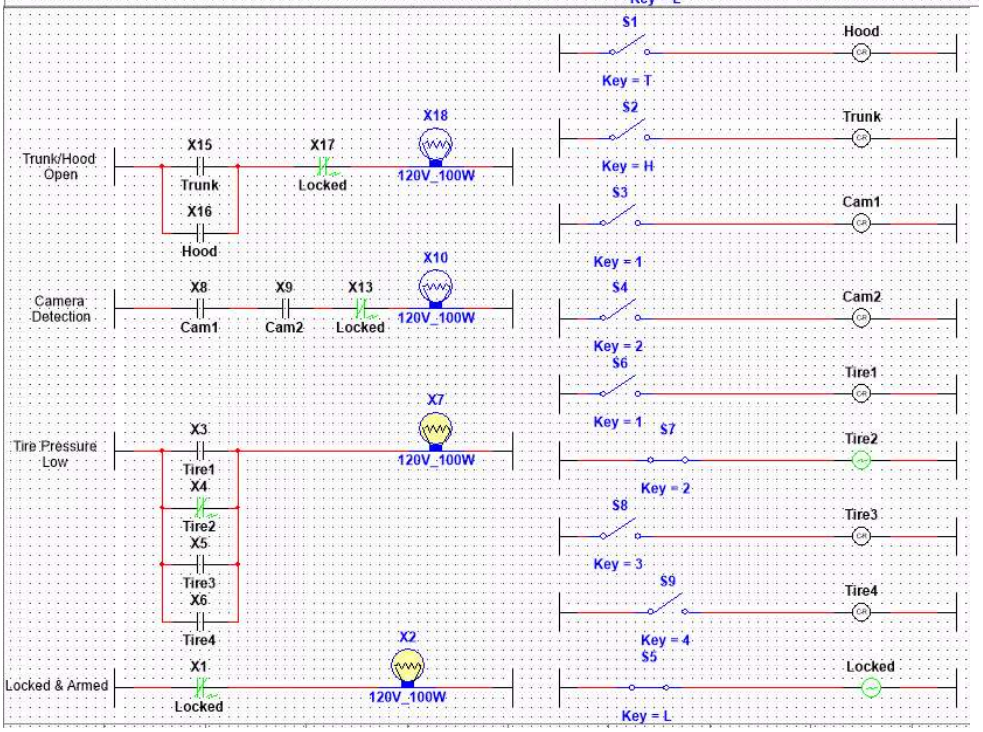
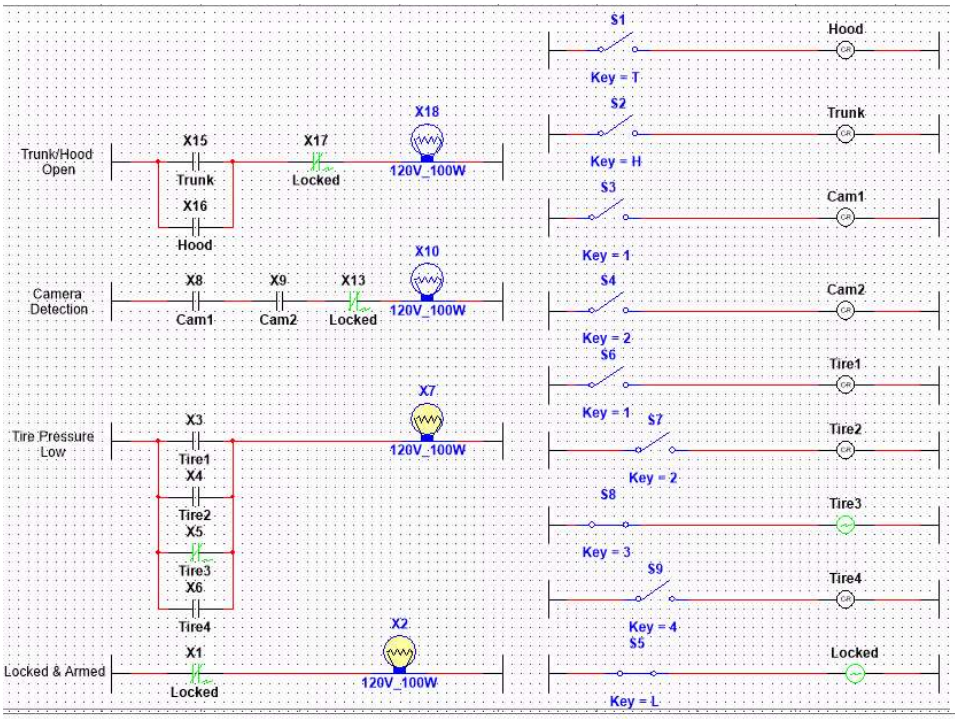
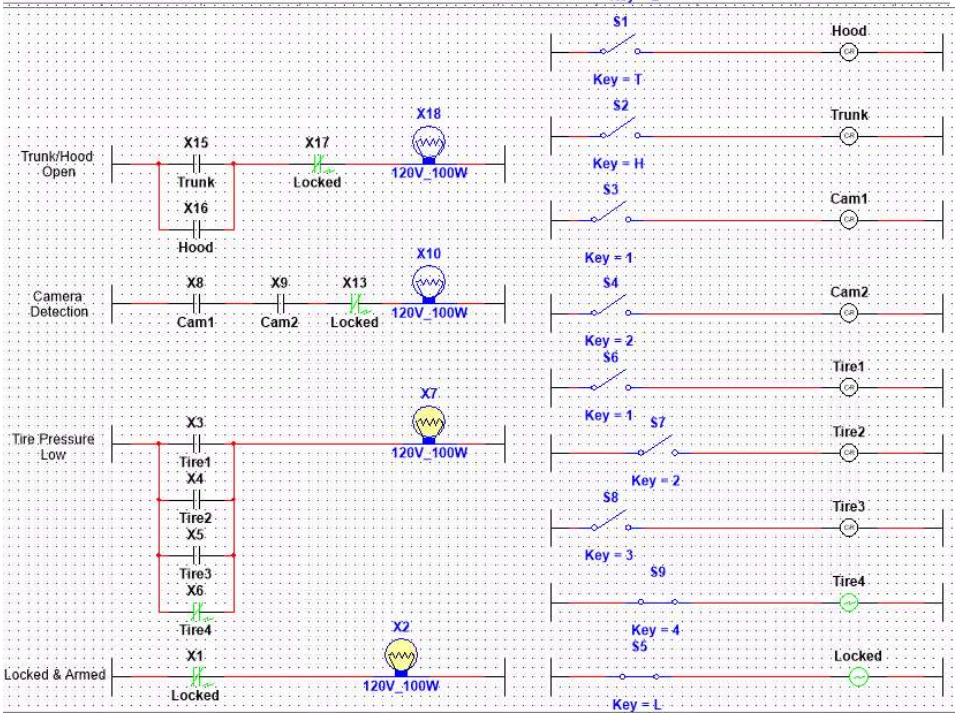


Figure 3.3: Cameras Detect Something


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked


Trunk/Hood Open
X15
Trunk
X16
Hood
X17
Locked
X18
120V_100W
Camera Detection
X8
Cam1
X9
Cam2
X13
Locked
X10
120V_100W
Tire Pressure Low
X3
Tire1
X4
Tire2
X5
Tire3
X6
Tire4
X7
120V_100W
Locked & Armed
X1
Locked
X2
120V_100W
S1
Key = T
Hood
S2
Key = H
Trunk
S3
Key = 1
Cam1
S4
Key = 2
Cam2
S6
Key = 1
Tire1
S7
Key = 2
Tire2
S8
Key = 3
Tire3
S9
Key = 4
Tire4
S5
Key = L
Locked

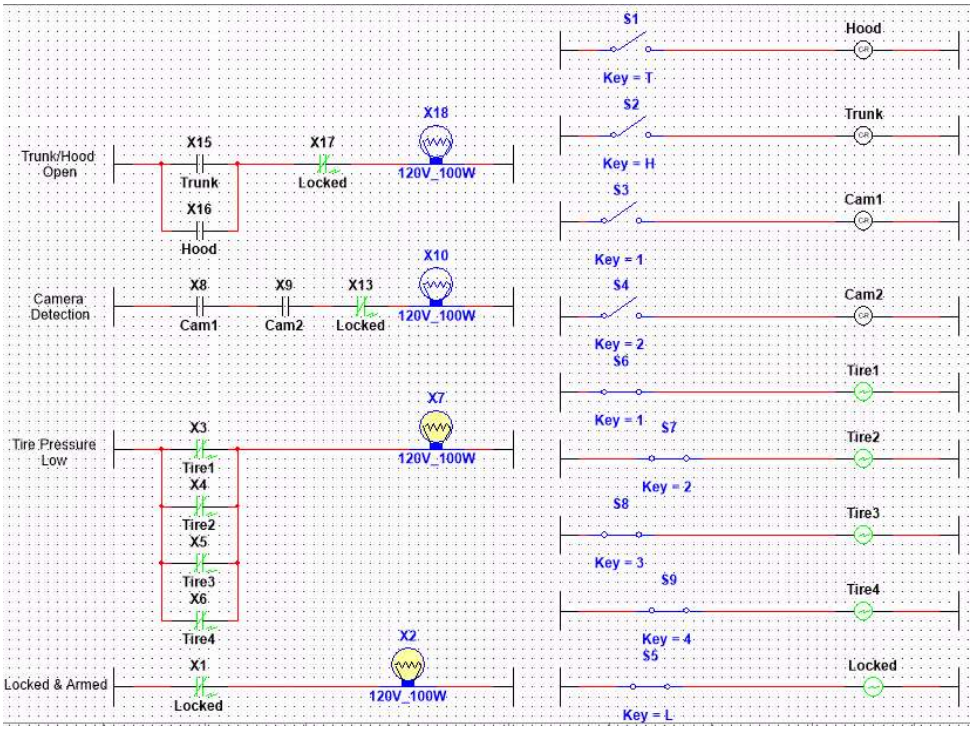


Figure 3.4: Tire Pressure Low

Conclusion:

This lab was quite easy to complete and may be helpful with the design process of our final project. However, I did run into a problem with the remote desktop in which the color of the screen became glitched with different colored pixels appearing when simulating and taking snippets of the logic ladders. I simply had to disconnect and reconnect into the remote control application and the problem would go away, but would reappear when taking snippets. Overall, I think the lab was helpful in learning about logic ladders.