

Red Level Labs

- Basic Relay Controls Lab
- Electronic Sensors Lab
- Manual Control and Safety Devices Lab
- Intro to PLCs Lab
- Intermediate PLCs Lab
- Advanced PLCs Lab

Basic Relay Controls Lab

Introduction

In these lab exercises the student will build and test relay control circuits. The exercises involve read wiring diagrams, selecting components, laying out the components on a backplane, wiring and then testing the circuits. The student will develop troubleshooting techniques for diagnosing problems with relay control circuits and must complete the task in a timely manner complying with all appropriate safety measures.

Key Learning/ Performance Objectives

- Describe the operation and uses of the various control components
- Read wiring diagram and parts listings accurately
- Mount and wire components on the backplane using accepted practices
- Verify circuit operations using accepted testing procedures
- Demonstrate proper use of Energy Control and Power Lockout procedures

Success Measures

The student will build the relay control circuit using accepted practices with no errors and the circuit must work properly.

Equipment and Special Requirements

- Relays, switches and indicators
- Multimeters
- Wiring tools

Prerequisite Lab

- Motors and Motor Controls Lab

Description of Procedure

The student will select the proper components and assemble the circuits, using the provided wiring diagrams and the instruction sheets. After verifying circuit layout, the student will troubleshoot it and fix any problems, and then demonstrate the circuit operation to the lab instructor.



Basic Relay Controls Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

Always lock and tag out any and all sources of potential energy before working on any project! In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Set up: Prepare the project board	Pass	Fail	Initials
1. Using the relay project board, select the components identified on the schematic and not already installed on the board.			
2. Install and wire the circuit according to the schematic drawing.			

Task II - Basic Relay Control circuit function:	Pass	Fail	Initials
1. Using the schematic drawing and the project board, identify the following components and describe their circuit function.			
a. Master power switch			

Task II - Basic Relay Control circuit function: cont.
Pass
Fail
Initials

b. Emergency stop switch

c. AC control circuit over current protection device

d. DC control circuit over current protection device

e. 3-position switch

f. Solenoid valve

g. Pneumatic power source

h. Pneumatic exhaust

2. Show the extent of power flow when main power switch is activated.

Task II - Basic Relay Control circuit function: cont.
Pass
Fail
Initials

3. Show the extent of power flow when the 3-position switch is turned to the right position.

4. Show the extent of power flow when the 3-position switch is turned to the left position.

5. Describe the difference in connection between an NPN proximity switch and PNP proximity switch.

Task III - Debugging and Troubleshooting
Pass
Fail
Initials

Ensure all switches and breakers are turned off. When approved by lab instructor, remove Lock out/Tag out and apply power to the circuit. Repair and/or replace components as required.

1. Check for proper operation.

2. Verify voltage into each of the breakers and the 24 VDC power supply.

Task III - Debugging and Troubleshooting cont.
Pass
Fail
Initials

3. Verify voltage out of each of the breakers and the 24 VDC power supply.

4. Verify operation of each rung.

5. Verify cylinder extension and retraction.

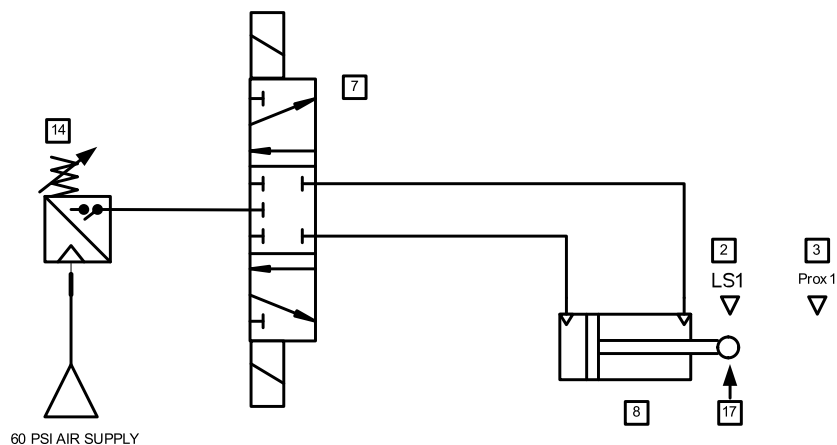
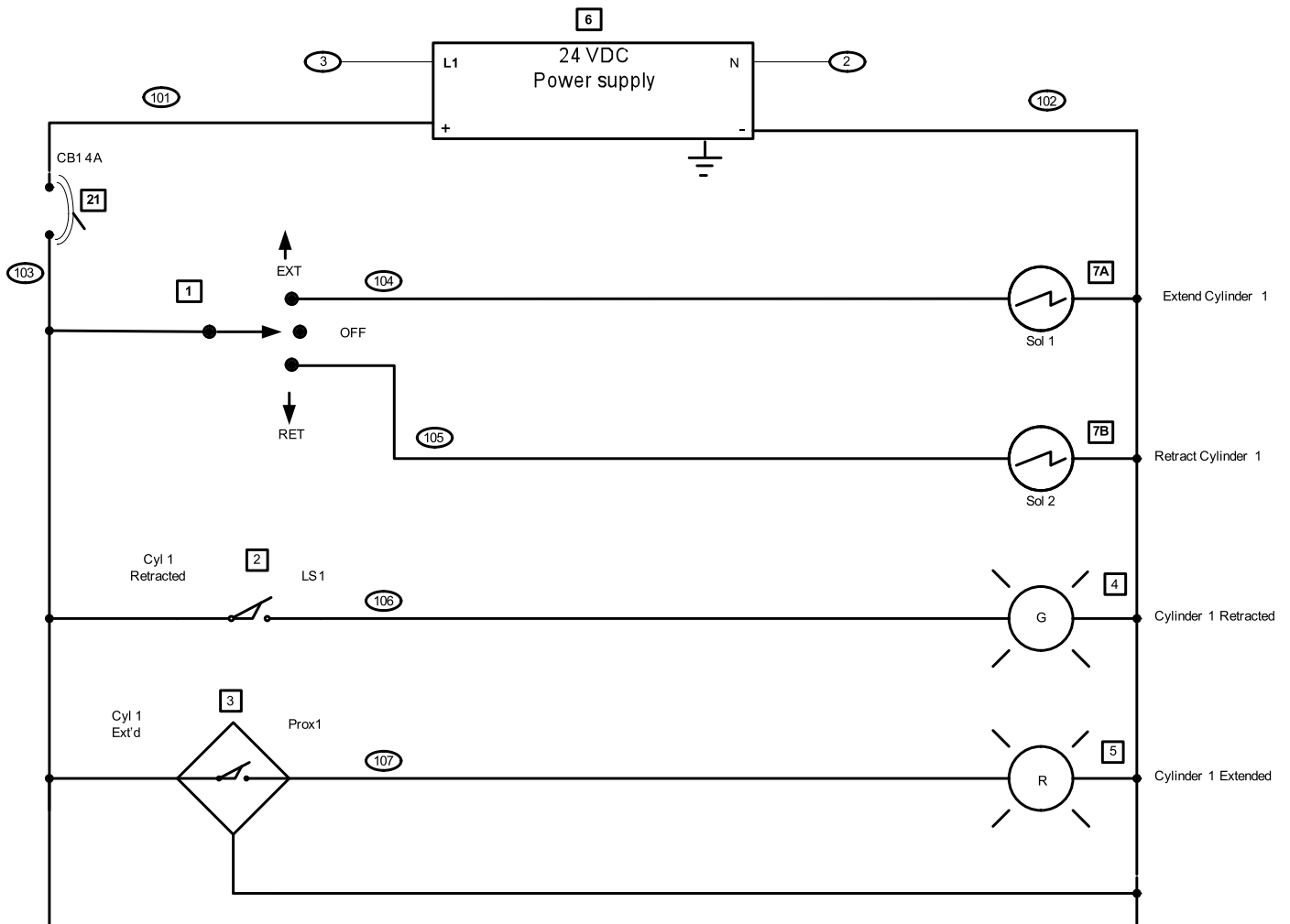
6. Verify operation of proximity switch.

7. Verify operation of limit switch.

8. Demonstrate complete circuit operation to lab instructor.

9. When released by the lab instructor, shut down the circuit and apply energy control procedures. Place wires removed into the wire box and the components back into their respective bin. Clean up work surface and return all tools to their proper storage area. Clean the work area.

Basic Control Circuit Layout



Electronic Sensors Lab

Introduction

In these lab exercises the student will build and test relay control circuits, using electronic sensors such as proximity switches and photoelectric sensors as control circuit inputs. The exercises involve read wiring diagrams, selecting components, laying out the components on a backplane, wiring and then testing the circuits. The student will develop troubleshooting techniques for diagnosing problems with control circuits and must complete the task in a timely manner complying with all appropriate safety measures.

Key Learning/ Performance Objectives

- Describe the operation and uses of the various electronic sensors
- Read wiring diagram and parts listings accurately
- Mount and wire components on the backplane using accepted practices
- Verify circuit operations using accepted testing procedures
- Demonstrate proper use of Energy Control and Power Lockout procedures

Success Measures

The student will build the control circuits using accepted practices with no errors and the circuits must work properly.

Equipment and Special Requirements

- Relays, switches and indicators
- Proximity, photoelectric and other sensors
- Multimeters
- Wiring tools

Prerequisite Lab

- Basic Relay Controls Lab

Description of Procedure

The student will select the proper components and assemble the circuits, using the provided wiring diagrams and the instruction sheets. After verifying circuit layout, the student will troubleshoot it and fix any problems, and then demonstrate the circuit operation to the lab instructor.



Electronic Sensors Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

Always lock and tag out any and all sources of potential energy before working on any project! In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Setup: Prepare the project board	Pass	Fail	Initials
1. Using the relay project board, select the components identified on the schematic and not already installed on the board.			
2. Install and wire the circuit according to the schematic drawing.			

Task II - Vacuum Control circuit function	Pass	Fail	Initials
1. Using the schematic drawing and the project board, identify the following components and describe their circuit function. a. Master power switch			

Task II - Vacuum Control circuit function cont.	Pass	Fail	Initials
b. Emergency stop switch			
c. Cycle stop switch			
d. AC control circuit over current protection device			
e. DC control circuit over current protection device			
f. Start switch			
g. Vacuum sensor switch			
h. Motor controller			
i. Position proximity switch			

Task II - Vacuum Control circuit function cont.
Pass
Fail
Initials

2. Show the extent of power flow when main power switch is activated.

3. Show the extent of power flow when the start button is pushed.

4. Show the extent of power flow when the proximity 1 switch makes.

5. Describe the latching circuit.

6. What is the purpose of VM O/L?

Task III - Debugging & Troubleshooting
Pass
Fail
Initials

Ensure all switches and breakers are turned off. When approved by lab instructor, remove Lock out/Tag out and apply power to the circuit. Repair and/or replace components as required.

1. Check for proper operation.

2. Verify voltage into each of the breakers and the 24 VDC power supply.

3. Verify voltage out of each of the breakers and the 24 VDC power supply.

4. Verify operation of each rung.

5. Verify vacuum.

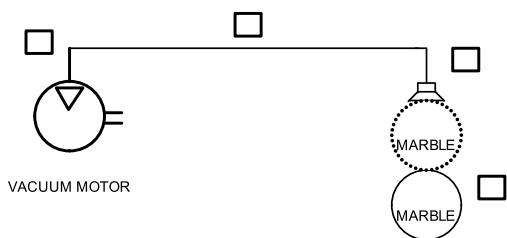
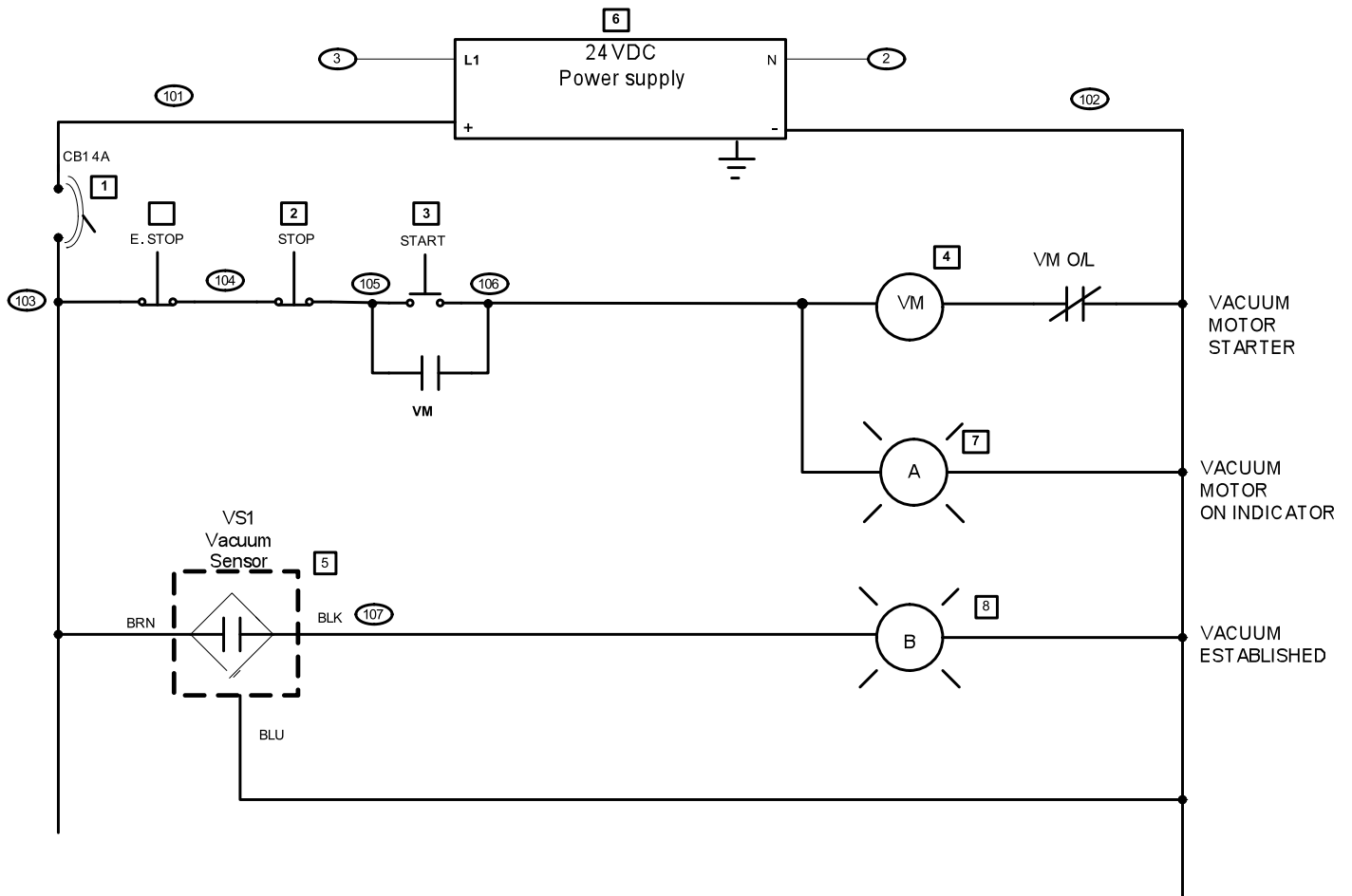
6. Verify operation of proximity switch.

7. Verify operation indicator lights.

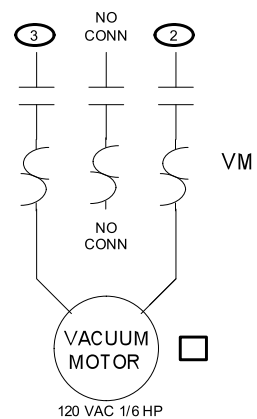
8. Demonstrate complete circuit operation to lab instructor.

9. When released by the lab instructor, shut down the circuit and apply energy control procedures. Place wires removed into the wire box and the components back into their respective bin. Clean up work surface and return all tools to their proper storage area. Clean the work area.

Relay Control Circuit Layout



A VACUUM IS ESTABLISHED
WHEN THE MARBLE IS STUCK
TO THE VACUUM CUP



Manual Control & Safety Devices Lab

Introduction

In these lab exercises the student will build and test relay control circuits, using sensors and safety devices such as proximity and photoelectric sensors, safety relays, limit switches and light curtains as control circuit inputs. The exercises involve read wiring diagrams, selecting components, laying out the components on a backplane, wiring and then testing the circuits. The student will develop troubleshooting techniques for diagnosing problems with control circuits and must complete the task in a timely manner complying with all appropriate safety measures.

Key Learning/ Performance Objectives

- Describe the operation and uses of the various safety devices
- Read wiring diagram and parts listings accurately
- Mount and wire components on the backplane using accepted practices
- Verify circuit operations using accepted testing procedures
- Demonstrate proper use of Energy Control and Power Lockout procedures

Success Measures

The student will build the control circuits using accepted practices with no errors and the circuits must work properly.

Equipment and Special Requirements

- Relays, switches and indicators
- Proximity, photoelectric and other sensors
- Safety devices
- Multimeters
- Wiring tools

Prerequisite Lab

- Electronic Sensors Lab

Description of Procedure

The student will select the proper components and assemble the circuits, using the provided wiring diagrams and the instruction sheets. After verifying circuit layout, the student will troubleshoot it and fix any problems, and then demonstrate the circuit operation to the lab instructor.



Manual Control & Safety Devices Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

Always lock and tag out any and all sources of potential energy before working on any project! In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Set up: Prepare the project board	Pass	Fail	Initials
1. Using the relay project board, select the components identified on the schematic and not already installed on the board.			
2. Install and wire the circuit according to the schematic drawing.			

Task II - Anti-tie down circuit function	Pass	Fail	Initials
1. Using the schematic drawing and the project board, identify the following components and describe their circuit function. a. Master power switch			

Task II - Anti-tie down circuit function cont.	Pass	Fail	Initials
b. Emergency stop switch			
c. Safety relay			
d. Safety gate switch			
e. Control relay 1			
f. Control relay 2			
g. Time delay relay 1			
h. Time delay relay 2			
i. Push button right			
j. Push button left			

Task II - Anti-tie down circuit function cont.

Pass

Fail

Initials

2. Show the extent of power flow when main power switch is activated.

3. Describe what happens when one push button is pressed without the other.

4. Describe what happens when one push button is held open.

Task III - Debugging & Troubleshooting

Pass

Fail

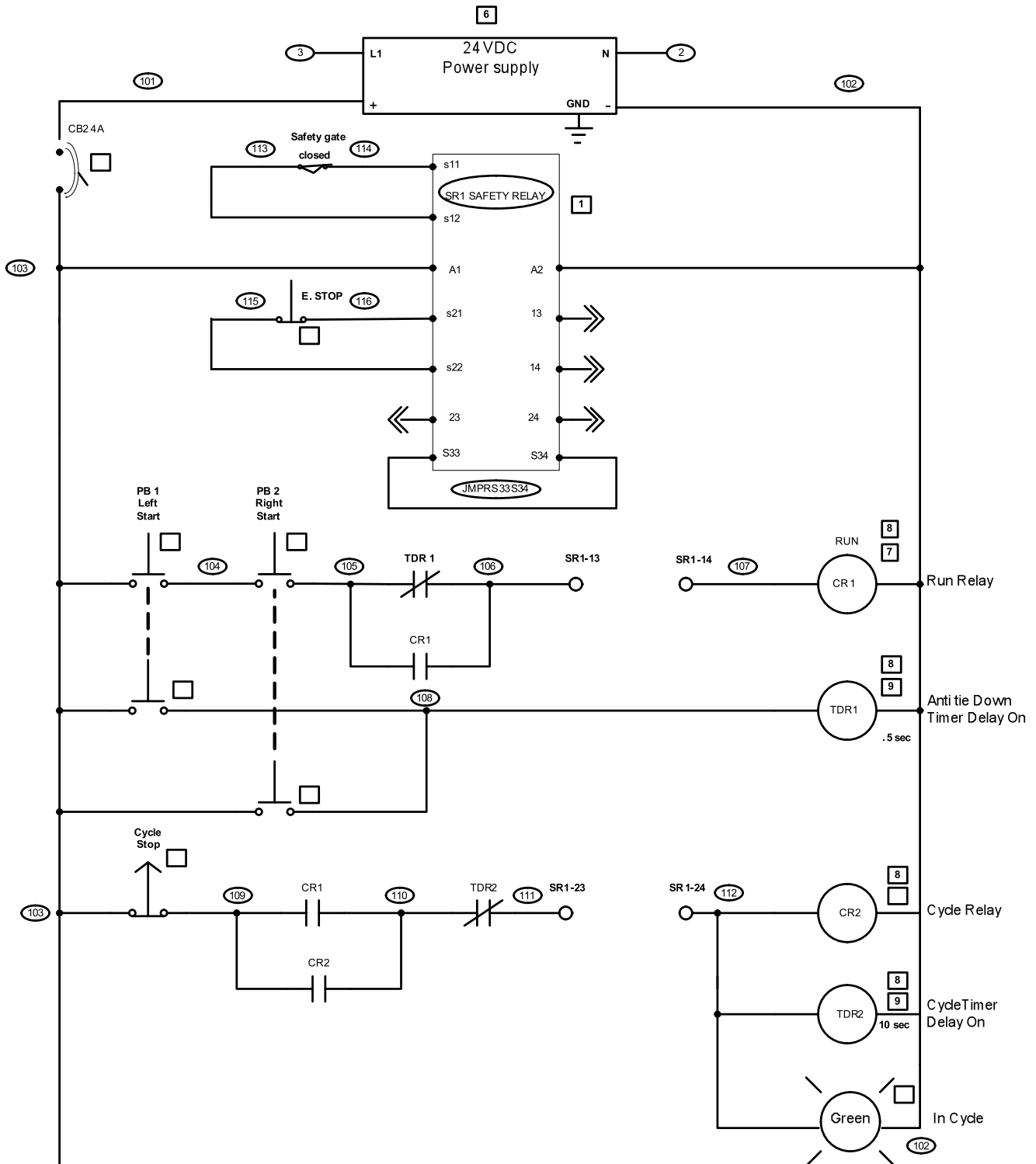
Initials

Ensure all switches and breakers are turned off. When approved by lab instructor, remove Lock out/Tag out and apply power to the circuit. Repair and/or replace components as required.

1. Check for proper operation.

Task III - Debugging & Troubleshooting cont.	Pass	Fail	Initials
2. Verify voltage into each of the breakers and the 24 VDC power supply.			
3. Verify voltage out of each of the breakers and the 24 VDC power supply.			
4. Verify operation of each rung.			
5. Verify the anti-tie down function.			
6. Demonstrate complete circuit operation to lab coordinator.			
7. When released by the lab instructor, shut down the circuit and apply energy control procedures. Place wires removed into the wire box and the components back into their respective bin. Clean up work surface and return all tools to their proper storage area. Clean the work area.			

Manual Control of Safety Devices Circuit Layout



Introduction to Programmable Logic Controllers Lab

Introduction

In these lab exercises the student will be introduced to programmable logic controller hardware and software. The exercises involve identifying the structure of a PLC system and its corresponding components and performing some basic programming tasks. The student will explore the integration of programmable logic control and PLC components into a machine control circuit.

Key Learning/ Performance Objectives

- Identify the structure of a PLC systems and its components
- Identify the function of PLC components
- Describe ladder logic programming symbols and their use in a PLC program
- Demonstrate the use of PLC ladder logic and commands
- Write simple PLC programs using the LogixPro simulation software

Success Measures

The student will accurately identify PLC hardware components and their functions and complete all assigned PLC programming exercises with 100% accuracy.

Equipment and Special Requirements

- Allen-Bradley PLC hardware
- LogixPro simulation software and study guide
- Computer

Prerequisite Lab

- All Relay Control Labs

Description of Procedure

The student will identify PLC hardware components and their functions, and PLC programming structures and commands and their functions. Then the student will complete the assigned programming exercises and demonstrate them to the lab instructor.



Introduction to Programmable Logic Controllers

Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - After viewing the PLC overview session and using the PLC hardware provided, identify and define:

	Pass	Fail	Initials
1. Power Source			
2. Power connections			
3. Input power requirements			
4. Output power requirements			

Task I - After viewing the PLC overview session and using the PLC hardware provided, identify and define: cont.

	Pass	Fail	Initials
5. Programming port and appropriate programming cable(s)			
6. External input and output card			

Task II - Define the following PLC programming structures and commands:

	Pass	Fail	Initials
1. Rungs			
2. Registers			
3. Branches			
4. Basic Commands			
a. XIC			
b. XIO			

Task II - Define the following PLC programming structures and commands: cont.

	Pass	Fail	Initials
c. OTE			
d. OTL			
e. OUT			
f. CTU			
g. CTD			
h. TON			
i. TOF			
j. RTO			
k. RES			

Task III - Using the LogixPRO Study Guide and the I/O Simulator, complete the following exercises

	Pass	Fail	Initials
1. Relay Control			
2. Counters			

Intermediate PLC Lab

Introduction

In these lab exercises the student will convert a relay control circuit with electronic sensors to a programmable logic controller circuit using PLC hardware and the corresponding sensors and writing a PLC program to emulate the control logic. The exercises involve assembling the PLC hardware circuit, writing the program, installing it in the PLC and troubleshooting both the hardware and the program.

Key Learning/ Performance Objectives

- Demonstrate a working knowledge of PLC systems and its components
- Translate a relay control circuit into a corresponding PLC circuit
- Write the PLC program to operate the circuit using RSLogix 500 programming software
- Establish a communications link with the PLC and download the program to it
- Troubleshoot both the PLC hardware circuit and the PLC program to arrive at a fully functioning system

Success Measures

The student will assemble the PLC circuit with no errors and write a successful program to operate the circuit.

Equipment and Special Requirements

- PLC hardware system
- Electronic sensors
- Electrical components needed to complete the circuit
- RSLogix 500 programming software and PC workstation
- Programming cables for connections between the PC and the PLC
- LogixPro Simulation software and computer

Prerequisite Labs

- All Relay Control labs and the Introduction to Programmable Logic Controllers lab

Description of Procedure

The student will assemble the PLC circuit, create the program to operate the circuit, troubleshoot the circuit and program, and demonstrate it to the lab instructor.



Intermediate PLC Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Complete the following LogixPRO study guide exercises:

	Pass	Fail	Initials
1. Timers			
2. Garage Door Program			
3. Word Compare commands			
a. LIM			
b. EQU			
c. GEQ			

Task II - Establishing PLC Communications

	Pass	Fail	Initials
1. Open and RSLinx and configure drivers.			
2. Open RSLogix 500.			
a. Connect to and open the Programmer.			
b. Who Active Go online.			
3. Upload existing program from the PLC.			

Task III - Dual Cylinder Circuit

	Pass	Fail	Initials
1. Convert the Basic Relay Controls Lab circuit to a PLC control circuit. See the circuit diagram below.			
a. This diagram assumes you will be using the relay trainer boards with ML 1000 installed and pre-wired to the terminal blocks. Complete the wiring as you would for the relay lab. Use the two pneumatic valve assemblies or any other 24-Volt, 2-valve block assembly.			
b. Reuse the two-position switch to select automatic/manual control.			
c. Use a momentary pushbutton as the Cycle Start switch.			
d. Add a Cycle Stop switch.			
e. Add a second cylinder at 90 degrees to first cylinder.			

Task III - Dual Cylinder Circuit cont.
Pass
Fail
Initials

f. Add additional proximity switches as necessary.

2. Create the ladder logic program for this project. The program must include the following features:

a. Manual Cycle – 1 cycle per button push

b. Auto Cycle – continuous operation until Cycle Stop is pushed

c. Cylinder 1 will extend until it makes LS1.

d. LS1 will start a dwell timer to hold cylinder 1 open for 10 seconds.

e. When cylinder 1 retracts, cylinder 2 will extend until it makes proximity switch 1.

f. When proximity switch 1 is made, cylinder 2 will retract.

3. Enter program code and download to it to the PLC.

a. Go online and monitor.

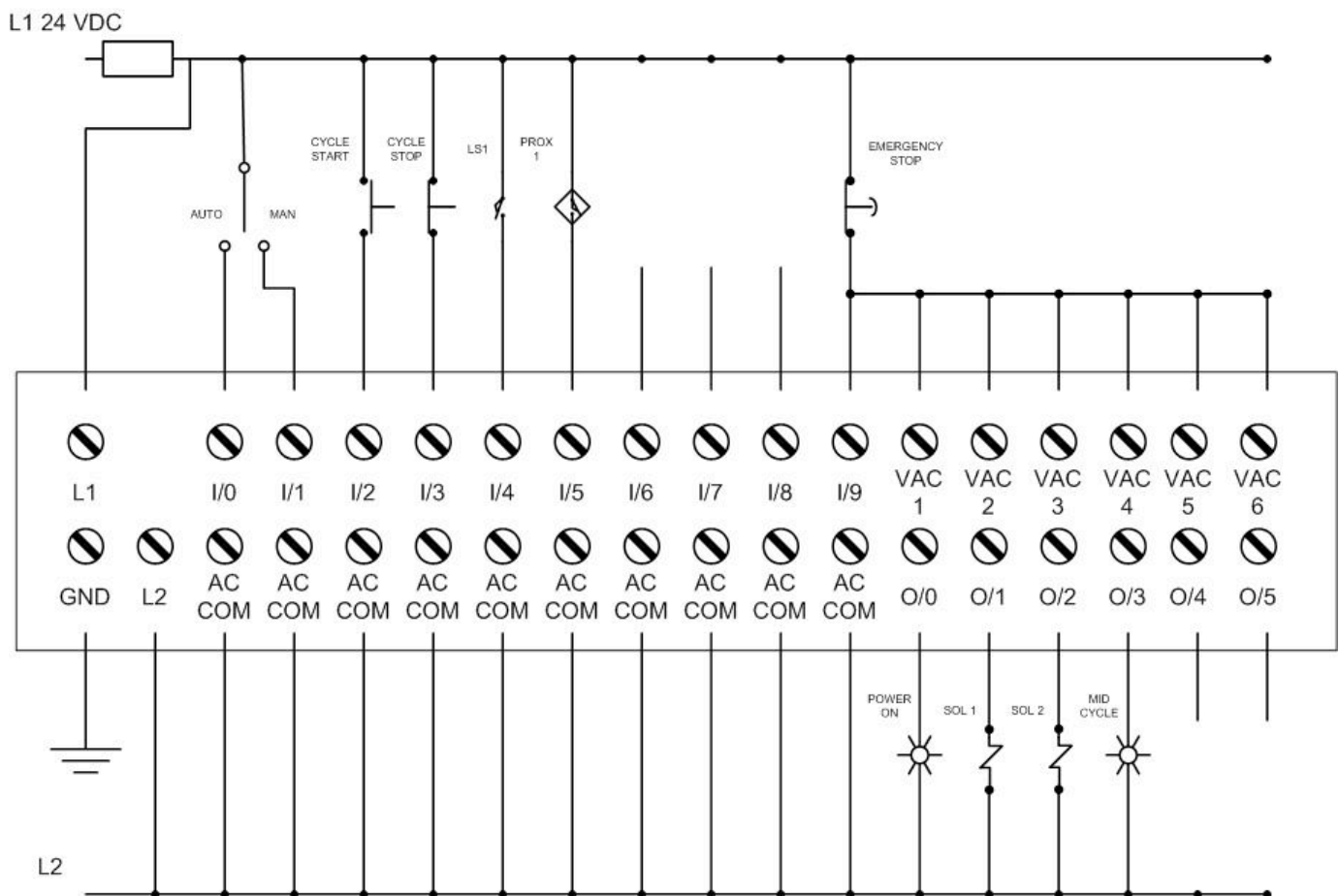
b. Debug as necessary.

c. Modify the program by adding a counter to track full pallets.

d. Add a timer to simulate waiting for new pallet.

e. Add an indicator light to turn on at mid-cycle and stay on until the end of the cycle.

Basic Relay to PLC Conversion ML1000



Advanced PLC Lab

Introduction

In these lab exercises the student will apply the knowledge gained in the previous Programmable Logic Controller Labs and modify an existing program by adding Anti-Tie down features to the control system. The exercises involve modifying the PLC hardware circuit, reviewing the program and rewriting much of it, installing the program in the PLC and troubleshooting both the hardware and the program.

Key Learning/ Performance Objectives

- Translate a anti-tie down function in the relay control circuit into a corresponding PLC circuit
- Assemble and wire the PLC circuit
- Identify the changes required in the PLC program and modify the program accordingly
- Download the program to the PLC
- Troubleshoot both the PLC hardware circuit and the PLC program to arrive at a fully functioning system

Success Measures

The student will assemble the PLC circuit with no errors and write a successful program to operate the circuit.

Equipment and Special Requirements

- PLC hardware system
- Electronic sensors
- Anti-tie down switches
- Electrical components needed to complete the circuit
- RSLogix 500 programming software and PC workstation
- Programming cables for connections between the PC and the PLC

Prerequisite Lab

- All Relay Control and PLC labs

Description of Procedure

The student will modify the PLC circuit, modify the program to operate the circuit, troubleshoot the circuit and program, and demonstrate it to the lab instructor.



Advanced PLC Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Anti-Tie Down Circuit	Pass	Fail	Initials
1. Convert the Manual Control and Safety Devices Lab circuit to a PLC control circuit. See the circuit diagram below. a. Add additional components and controls as required.			
2. Print out listing of existing program.			
3. Get listing for anti-tie down program.			
4. Modify your program to use anti-tie down control instead of a single pushbutton. a. Adjust inputs and outputs, timers and other program code to allow for smooth operation.			

Task I - Anti-Tie Down Circuit cont.

5. Let the lab instructor look over your program listing before you download it and attempt to operate it.

6. Download the program and start the debugging process, when cleared by the lab instructor.

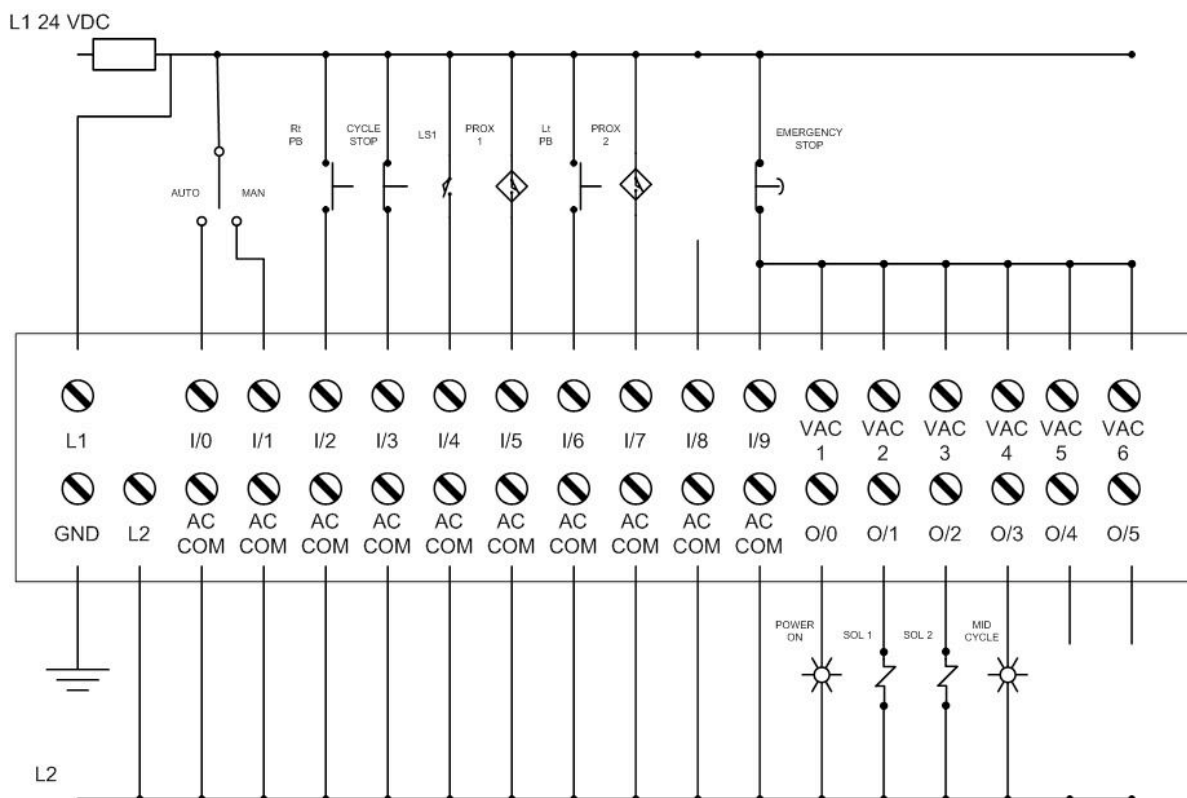
Hint: This program will require you to renumber timers and counters and re-assign input or output addresses. Start the process by writing down what you think each line should do. Then start to modify the program. The only real change to program flow is how the cycle will be started.

Pass

Fail

Initials

Modifications to add Anti Tie Down ML1000





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