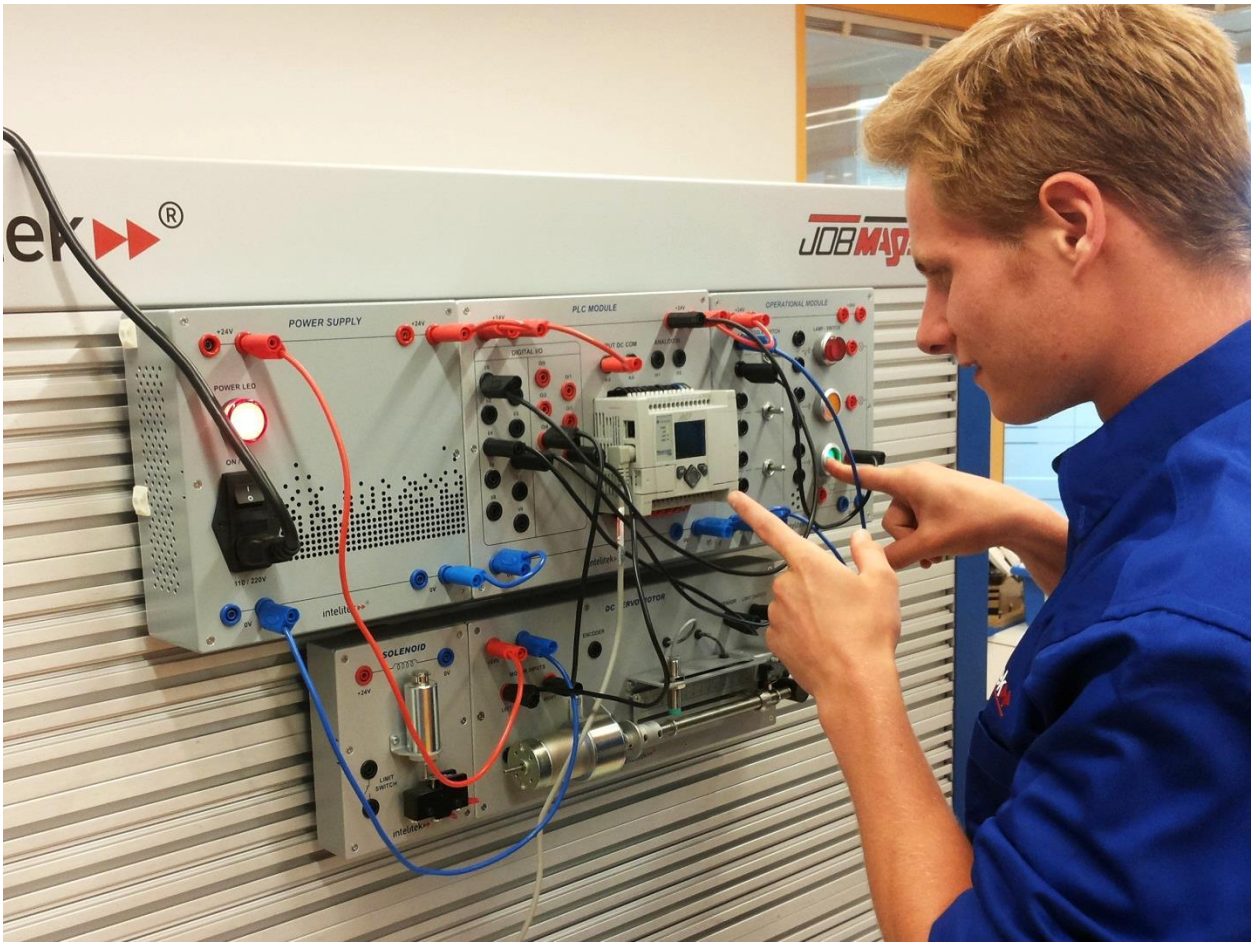
JobMaster® Training Station PLC1 Kit



USER MANUAL

Catalog #34-8000-0002 Rev. B

intelitek

JobMaster® Training Station PLC1 Kit User Manual

Catalog #34-8000-0002 Rev. B

January 2024

Intelitek Inc.

Toll Free: 800-221-2763

Phone: 603-413-2600

Fax: 603-437-2137

Email: info@intelitek.com

Contents

1. About the PLC1 Kit

1.1. OVERVIEW

The JobMaster® Training Station (JMTS) PLC1 Kit is a training set that helps demonstrate the principles of programmable controllers and sequence control systems.

The kit has a number of devices which can be activated and controlled.

The two modules included in the kit have several different types of banana sockets, each of which can be accessed using the electrical connectors.

- Red (+24V) and blue (0V) sockets are voltage inputs.
- Black sockets are outputs or switch connections.

1.2. WARNINGS

Warning: *Avoid damaging the PLC1 Kit:*

- Do not touch or tamper with the DC motor unit, especially when it is in motion.
- Do not tamper with the solenoid or limit switches.

Warning: *To immediately halt all system operation, switch OFF the power supply module.*

Warning: *Make sure you do not short the 24V socket to ground when connecting the wires. It is strongly recommended that you prepare a circuit diagram before making an actual connection.*

1.3. COMPONENTS

1.3.1. In Your Kit

Your PLC1 Kit includes these items:

Qty.	Catalog #	Part Name
1	22-0230-1000	DC servo motor module
1	22-0230-2000	Solenoid module
		Electrical connectors (banana plug cables)
4	411658	Red (200mm)
4	411659	Blue (200mm)
5	411660	Black (200mm)
1	411661	Red (400mm)
1	411662	Blue (400mm)
1	411663	Black (400mm)
2	411664	Red (600mm)
2	411665	Blue (600mm)
2	411666	Black (600mm)
2	411667	Red (1100mm)
2	411668	Blue (1100mm)
2	411669	Black (1100mm)

1.3.2. Prerequisites

The PLC1 Kit requires the following items:

- JMTS mounting panel
- JMTS power supply module
- JMTS operational module

Highly recommended items include:

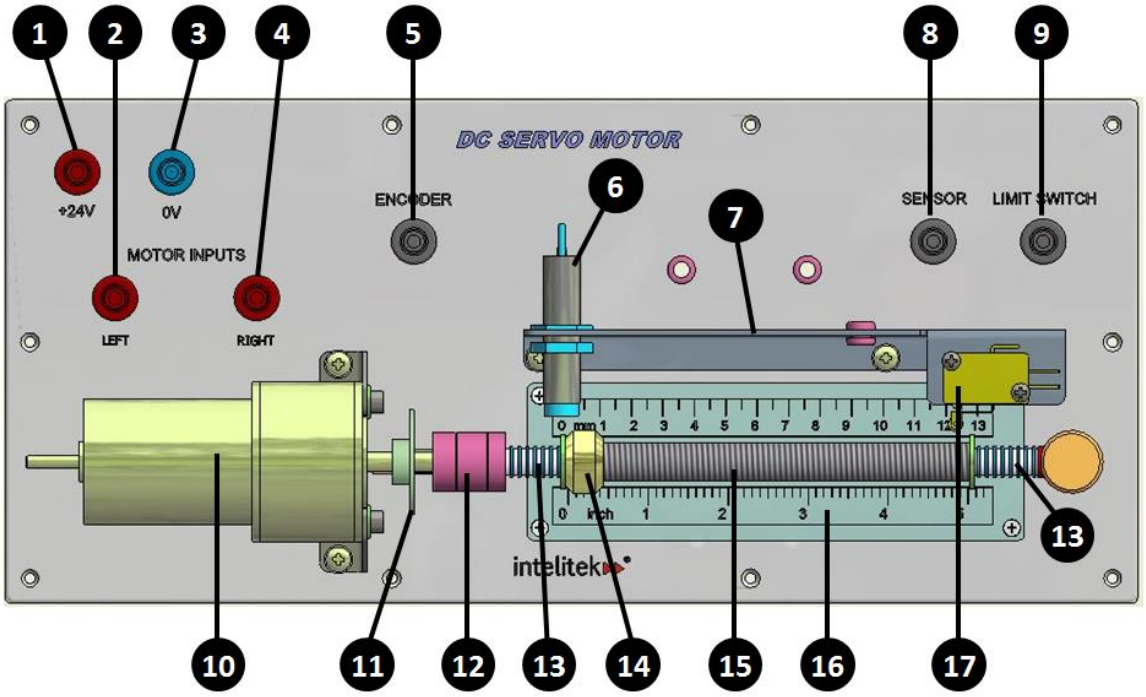
- Allen-Bradley MicroLogix 1100 PLC module with PLCMotion software
- Siemens S7-1200 PLC module with SIMATIC STEP 7 TIA Portal software

Optional items include:

- JMTS relay module
- JMTS HMI module

1.3.3. DC Servo Motor Module

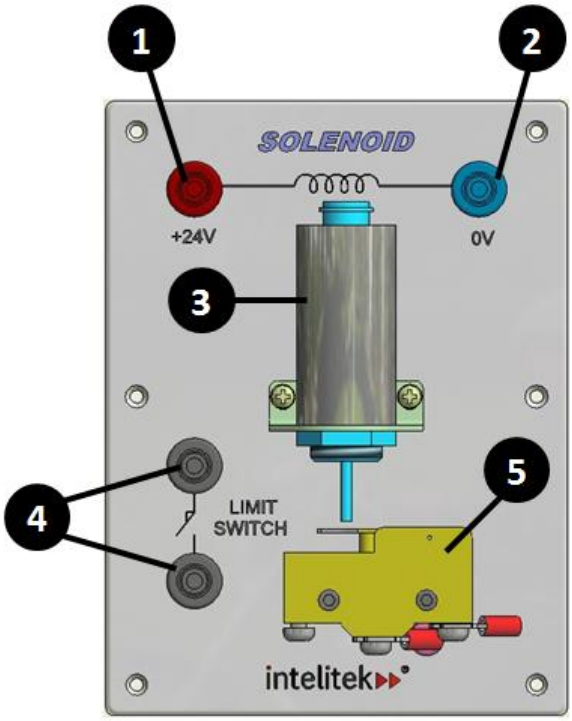
The following diagram shows the DC servo motor module. Numbers in the diagram refer to the component list below.



1. +24V voltage input
2. Leftward motor input
3. 0V voltage input
4. Rightward motor input
5. Encoder output socket
6. Inductive sensor, M12–NPN
7. Bracket for sensor and limit switch
8. Sensor output socket
9. Limit switch output socket
10. DC servo motor, Pittman GM9213
11. Optical encoder with disk (The encoder's LED and photoelectric sensor units are underneath the disk.)
12. Coupling
13. Stopper spring and washer
14. Nut with pointer
15. Lead screw
16. 2 Rulers, 15cm/6"
17. Limit switch

1.3.4. Solenoid Module

The following diagram displays the Solenoid Module. Numbers in the diagram refer to the component list.



1. +24V voltage input
2. 0V voltage input
3. Solenoid, Shindengen's M250 31H
4. Limit switch sockets
5. Limit switch

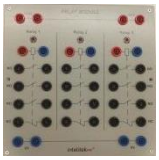
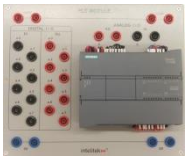
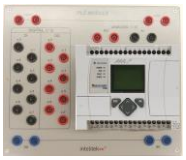
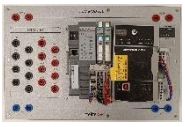
2. Installing the Modules

2.1. MODULE OVERVIEW

The electrical modules (listed in the table below) are optional accessories that can be mounted onto the slots of the JMTS panel. The recommended location of the attachment of these modules is at the top of one of the slotted sides. The power supply module should be placed at the far left side of one of the slotted panels with the HMI module on the far right side. PLC modules should be mounted to the left of the HMI module.

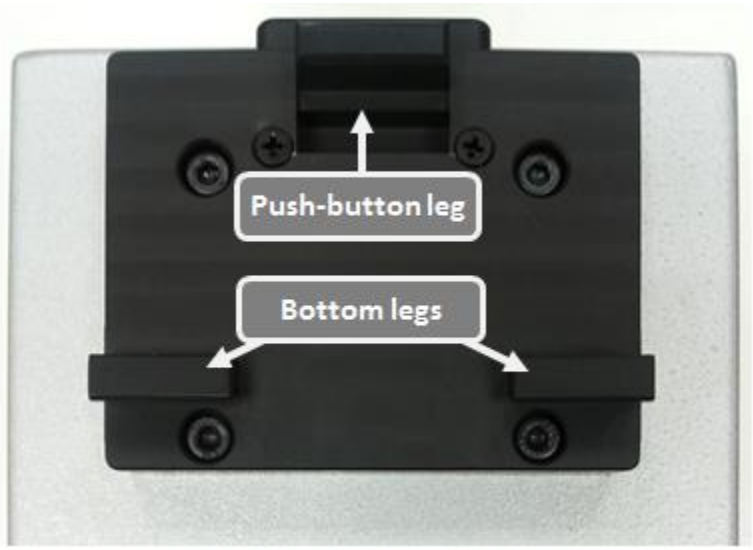
If your JMTS has a swing arm with a monitor, the HMI should be mounted on the side next to the arm.

Tools are not required for the mounting of these modules.

Module	Catalog Number	Recommended Location at the Top of the Slotted Panel	Image
Power Supply Module	10-2550-1000	Far left	
Relay Module	10-2550-2000	Adjacent to Power Supply Module	
Operational Module	10-2550-3000	Center	
Siemens S7-1200 PLC Module	10-2550-4000	Adjacent to the HMI Module	
MicroLogix 1100 PLC Module	10-2550-6000	Adjacent to the Operational Module	
CompactLogix PLC Module	10-2550-7000	Adjacent to the HMI Module	
HMI Module	10-2550-5000 / 10-2550-8000	Far right	

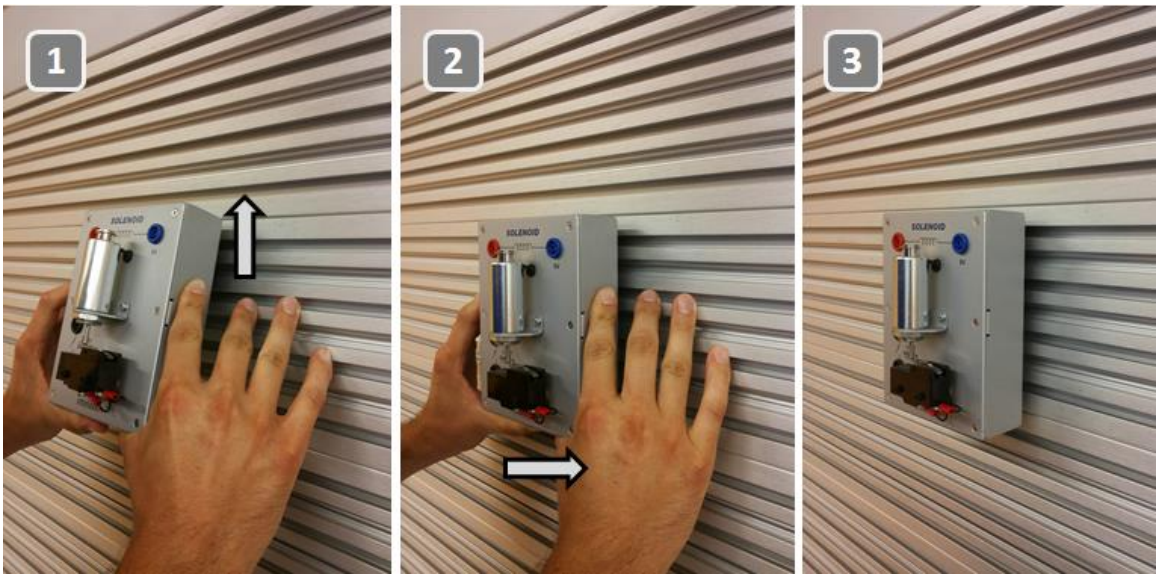
2.2. MOUNTING THE MODULES

The PLC1 Kit modules have several “legs” that allow them to be inserted securely into the slots of the JMTS mounting panel.



To mount a module onto the panel:

1. Insert the module’s top push button leg into one of the thinner slots of the panel.
2. Push the module upwards until the bottom legs are inserted into the slotted panel as well.



To remove a module from the panel:

1. Push the module upwards until the bottom legs are free of the panel.
2. Pull the module outwards and then downwards to remove it.

2.3. MAKING ELECTRICAL CONNECTIONS

Electric connections may be made to a power bar that can be placed in the cabinet of the JMTS Bench. The power bar's cable can be drawn through the hole of the cabinet floor and plugged it into an electrical wall socket.

Draw the Power Supply Module's power cable and any other electrical cables behind or to the side of the JMTS Mounting Panel. Plug the cable into the power bar or directly into a wall socket.

Electric connections may be made to a power bar that can be placed in the cabinet of the JMTS Bench. The power bar's cable can be drawn through the hole of the cabinet floor and plugged it into an electrical wall socket.

Draw the Power Supply Module's power cable and any other electrical cables behind or to the side of the JMTS Mounting Panel. Plug the cable into the power bar or directly into a wall socket.

3. Parts and Specifications

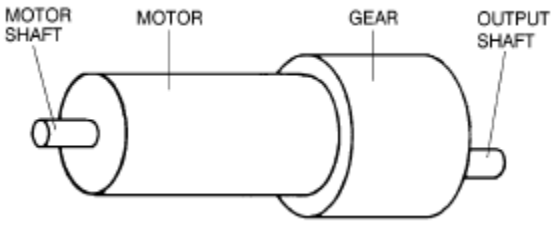
This section describes the individual elements of the two PLC1 Kit modules and the electrical connectors.

Note: The diagrams in this section are for illustrative purposes and do not necessarily represent the actual components of the PLC1 Kit modules.

3.1. DC SERVO MOTOR MODULE

3.1.1. DC Servo Motor

The module's DC servo motor drives a lead screw.



3.1.1.1. Activation

The direction of motor revolution is determined by the polarity of the operating voltage: positive DC voltage turns the motor in one direction, while negative DC voltage turns it in the opposite direction.

- When the **Right** motor input socket is connected to 24VDC, the motor rotates counter-clockwise.
- When the **Left** motor input socket is connected to 24VDC, an internal relay in the panel reverses the polarity, causing the motor to rotate clockwise.

In addition, the motor can be moved by twisting the motor shaft manually.

Specifications: Pittman GM9213 DC Servo Motor

Motor Size Data (25°C)			
Parameter	**Symbol**	**Units**	**Specifications**
Motor Constant	K_M	oz • in√W	3.01
Peak Torque (Stall)	T_P	oz • in	41.3
No Load Speed	S_0	rpm	6151
Motor Friction Torque	T_F	oz • in	0.60
Viscous Damping Factor	D	oz • in/krpm	0.0387
Damping Constant	K_D	oz • in/krpm	6.68
Electrical Time Constant	τ_E	ms	0.85
Mechanical Time Constant	τ_M	ms	9.25
Thermal Time Constant	τ_{TH}	min	12.0

Motor Size Data (25°C)			
Thermal Impedance	R_{TH}	deg C/W	17.1
Maximum Winding Temperature	θ_{MX}	deg C max	5.9×10^{-4}
Motor Inertia	J_M	oz • in • s^2	10.1
Motor Weight	W_M	oz	2.403
Motor Length	L_1	in max	2.354

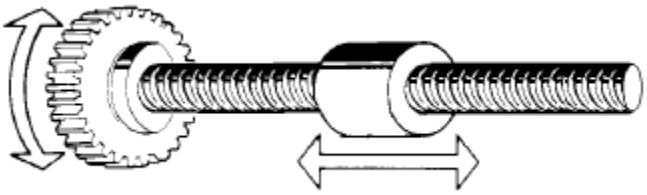
Motor Winding Data (25°C)			
Parameter	**Symbol**	**Units**	**Specifications**
Voltage	E	V	30.3
Torque Constant	KT	oz • in/A	6.50
Back EMF Constant	KE	V/krpm	4.81
Terminal Resistance	RT	ohms	4.62
Inductance	L	mH	3.97
No Load Current	I0	A	0.13
Peak Current (Stall)	IP	A	6.55

Spur Gearmotor Data (25°C) Gear Ratio 127.78			
Parameter	**Symbol**	**Units**	**Output Shaft**
N.L. Speed	S_0	rpm	48.1

3.1.2. Lead Screw and Nut

A lead screw with a nut is connected to the motor output shaft by means of a coupling. The lead screw converts the rotary motion of the DC motor into linear motion of the nut.

3.1.2.1. Activation



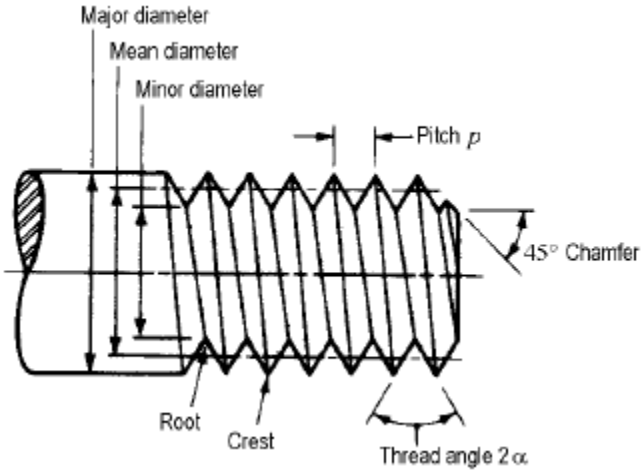
As the motor rotates, a nut travels along the length of the lead screw.

- When the **Right** motor input socket is connected to 24VDC, the nut moves to the right.
- When the **Left** motor input socket is connected to 24VDC, the nut moves to the left.

As the nut moves, the distance traveled can be measured on the rulers by the pointer attached to the nut.

The nut can be detected by two types of sensors: a mechanical limit switch and an inductive proximity sensor.

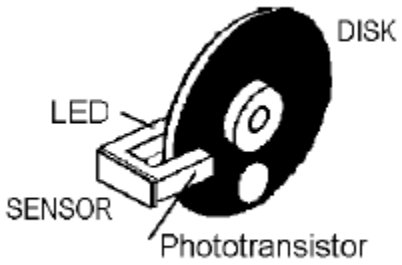
3.1.2.2. Specifications



	Coarse-Pitch Series		
Nominal Major Diameter (d)	**Pitch (p)**	**Tensile-Stress Area (At)**	**Minor-Diameter Area (Ar)**
12	1.75	84.3	76.3

3.1.3. Optical Encoder

The module's encoder has a photoelectric sensor and a one-slot rotating disk.



3.1.3.1. Activation

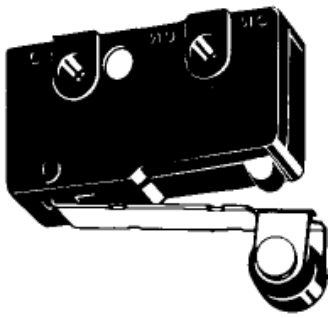
When the disk blocks the light beam from the LED to the phototransistor, an output off (0) signal is sent to the PLC via the **Encoder** output socket.

When the slot allows the light beam to pass from the LED to the phototransistor, an output on (1) signal is sent to the PLC via the **Encoder** output socket.

3.1.3.2. Specifications

Supply voltage	5 to 24 VDC ±10%
Current	100mA
Configuration	NPN, Normally Open (sink)

3.1.4. Limit Switch



3.1.4.1. Activation

When the nut on the lead screw applies force to the limit switch's actuator (the roller lever), the switch is activated.

When the switch is activated, an output on (1) signal is sent to the PLC via the **Limit Switch** output socket.

3.1.4.2. Specifications

Configuration:	Normally open

3.1.5. Inductive Proximity Sensor

This sensor can be moved horizontally within the bracket slot. It can also be adjusted vertically.

3.1.5.1. Activation

The sensor's switch is activated when the sensor detects an electrically conductive material (such as the ferrous nut on the lead screw).

When the switch is activated, an output on (1) signal is sent to the PLC via the **Sensor** output socket. Also, an LED on the sensor is illuminated.

When the electrically conductive material (the nut) is removed from the sensor's field, the switch reverts to its (normally open) initial state. The LED shuts off.

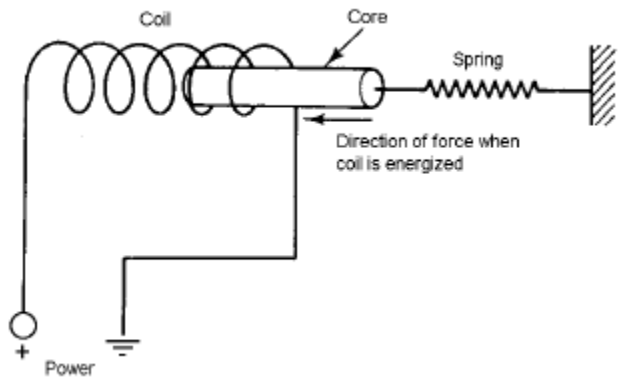
3.1.5.2. Specifications

Supply Voltage	10–30 VDC
Maximum Consumption	200mA
Configuration	NPN, Normally Open (sink)
Thread	M12 thread
Length	50mm
Normal Operating distance	6mm

3.2. SOLENOID MODULE

The solenoid module uses a tubular solenoid housed in a mild steel case.

3.2.1. Solenoid



3.2.1.1. Activation

When the solenoid input socket is connected to 24VDC, the solenoid coil is energized; the magnetic field pulls the core into the coil, and the plunger is pushed into the actuator of the limit switch.

When de-energized, the spring pulls the core out of the coil.

3.2.1.2. Specifications

Duty Cycle (on time / "on time"+"off time") x 100	100% Continuous	50% or less	25% or less	10% or less
Resistance (20°C)	**Volts DC**	**Volts DC**	**Volts DC**	**Volts DC**
57.6	24	34	48	76

3.2.2. Limit Switch

3.2.2.1. Activation

This limit switch is activated when the stroke of the solenoid plunger applies force to the actuator (hinge lever).

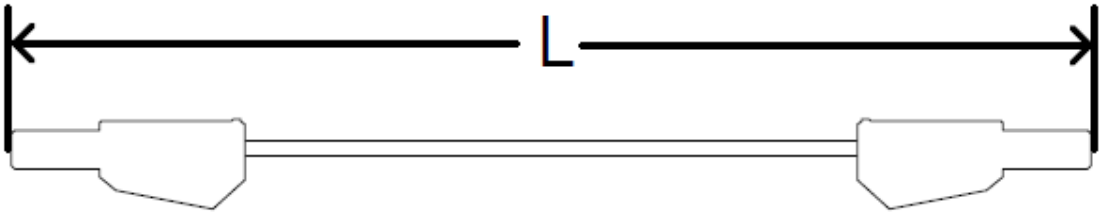
When the switch is activated, an output on (1) signal is sent to the PLC through the Limit Switch socket.

3.2.2.2. Specifications

Configuration	Normally open

3.3. ELECTRICAL CONNECTORS

The PLC1 Kit requires the use of electrical connectors, also known as banana plug cables. These are flexible leads with 4mm insulated stackable plugs.



4. Examples of Use

The following examples are for demonstration purposes only, and are not necessarily recommended for student use.

4.1. EXAMPLE 1: ENERGIZING THE SOLENOID

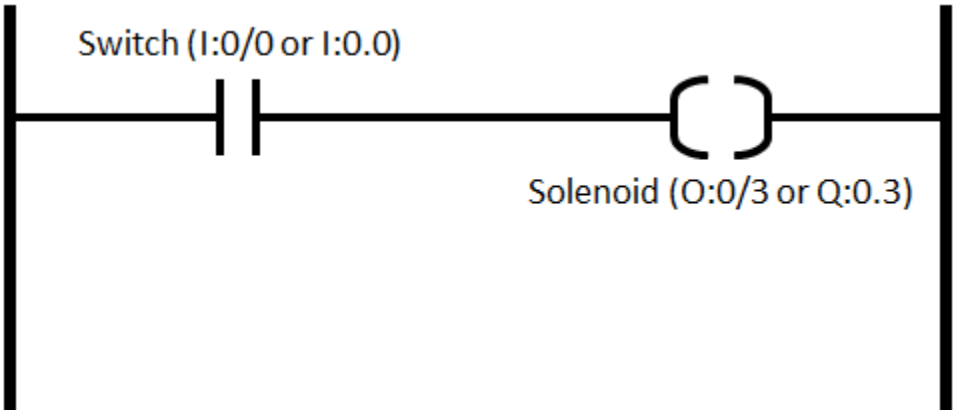
In this application, turning on the operational panel's upper switch energizes the solenoid. The solenoid module's limit switch then closes, allowing power to flow through it and illuminate the red lamp.

4.1.1. Requirements

- PLC1 Kit solenoid module
- Electrical connectors
- JMTS mounting panel
- MicroLogix 1100 PLC module or Siemens S7-1200 PLC module
- Computer with PLCMotion software (for the MicroLogix 1100 PLC module) or SIMATIC STEP 7 TIA Portal software (for the S7-1200 PLC module)
- Power supply module
- Operational module

4.1.2. Programming

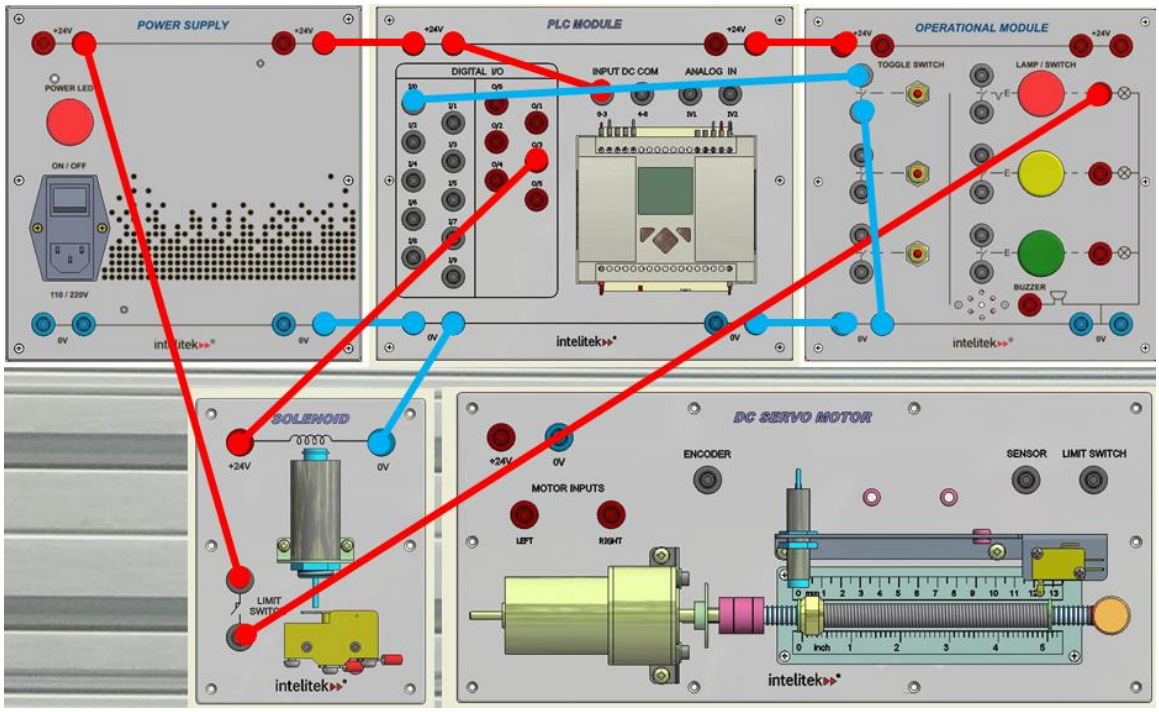
Using PLCMotion (for Allen-Bradley) or TIA Portal (for Siemens), build the ladder diagram and tag the instructions for the I/Os of your controller as shown.



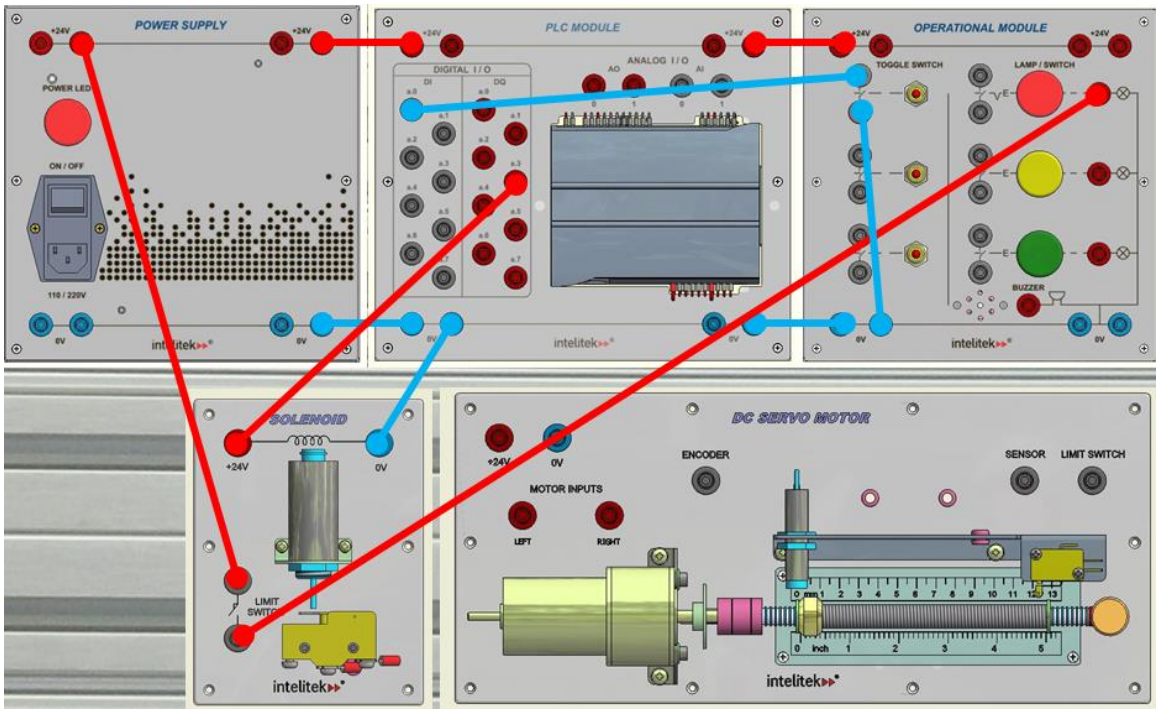
4.1.3. Wiring

Note: The colors of the electrical connectors in the schematic below are for illustrative purposes only. You can use any color or length of connector for any of the connections.

Using the MicroLogix 1100 PLC Module:



Using the Siemens S7-1200 PLC Module:



4.1.4. Procedure

1. Mount all modules to the JMTS mounting panel.
2. Connect the power supply module to an appropriately-rated electrical outlet.
3. Turn on the power supply module.
4. Connect your computer to the PLC.
5. Program the PLC as described above in section 4.1.2.
6. Wire the modules as shown above in section 4.1.3.
7. Turn on the upper switch of the operational module. The solenoid extends and closes the limit switch. The red lamp is illuminated.
8. Turn off the upper switch. The solenoid contracts. The limit switch opens, cutting off power to the red lamp.

4.2. EXAMPLE 2: RUNNING THE MOTOR

In this application, turning on the operational panel's upper switch causes the motor to drive the nut to the right. When the nut reaches the limit switch or if the middle switch is turned on, the motor stops running.

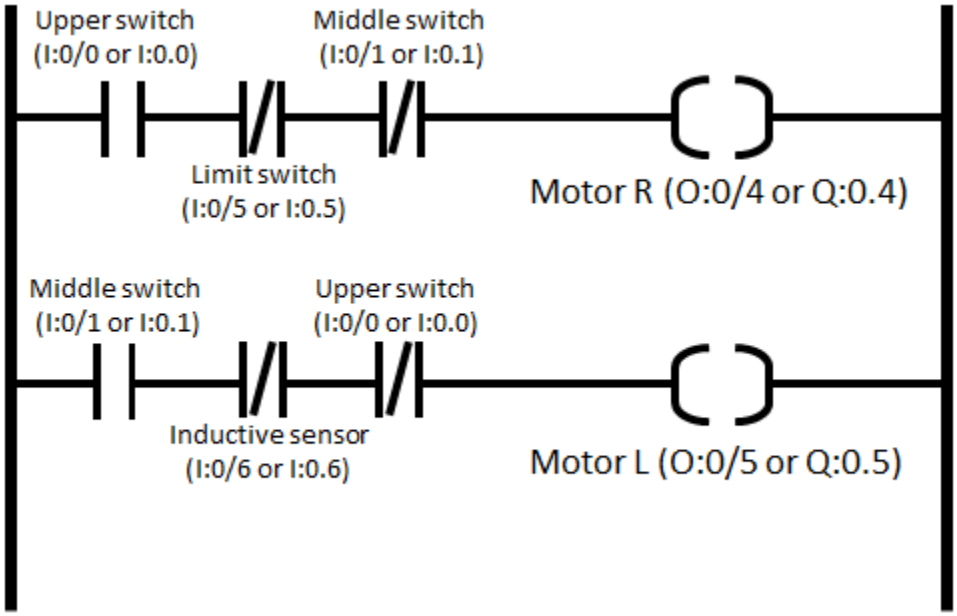
When the upper switch is turned off, turning on the middle switch causes the motor to drive the nut to the left. The motor turns off once the nut reaches the inductive sensor.

4.2.1. Requirements

- PLC1 Kit DC servo motor module
- Electrical connectors
- JMTS mounting panel
- MicroLogix 1100 PLC module or Siemens S7-1200 PLC module
- Computer with PLCMotion software (for the MicroLogix 1100 PLC module) or SIMATIC STEP 7 TIA Portal software (for the S7-1200 PLC module)
- Power supply module
- Operational module

4.2.2. Programming

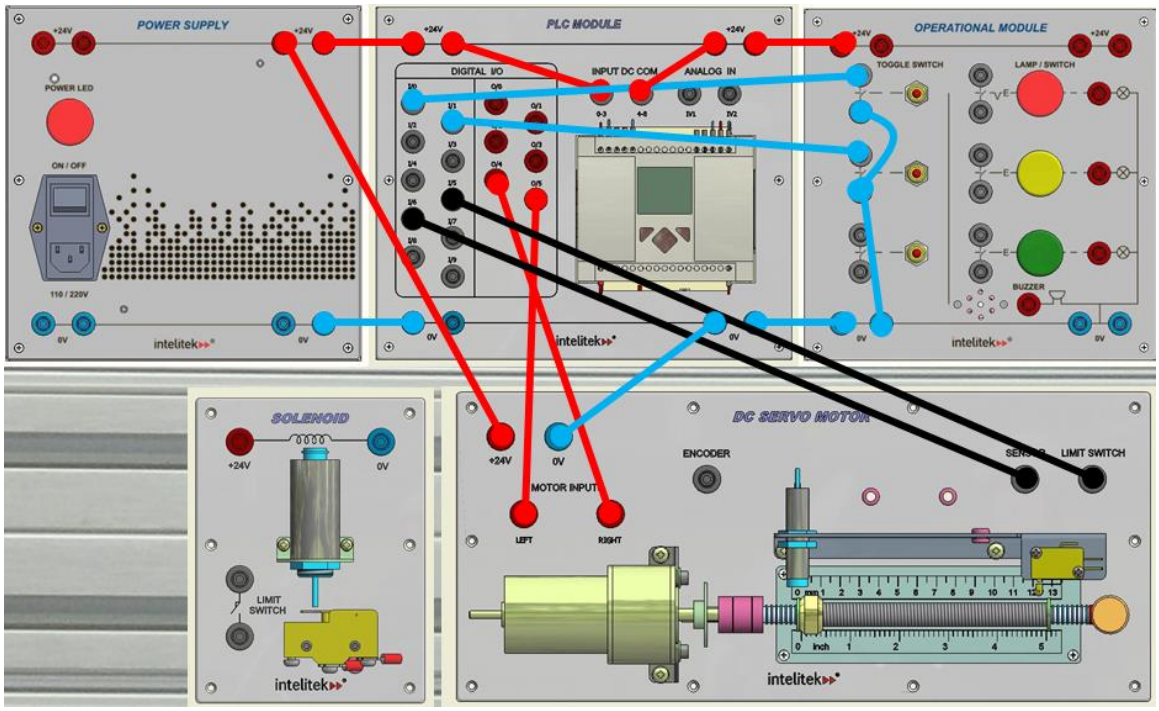
Using PLCMotion (for Allen-Bradley) or TIA Portal (for Siemens), build the ladder diagram and tag the instructions for the I/Os of your controller as shown.



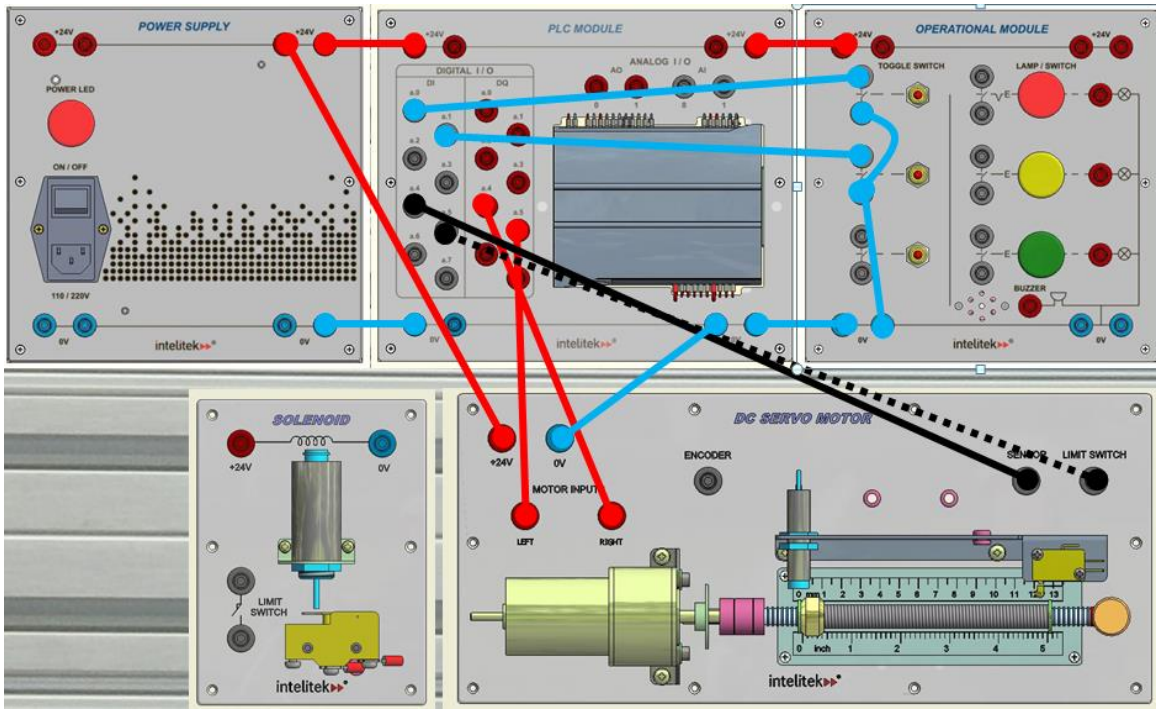
4.2.3. Wiring

Note: The colors of the electrical connectors in the schematic below are for illustrative purposes only. You can use any color or length of connector for any of the connections.

Using the MicroLogix 1100 PLC Module:



Using the Siemens S7-1200 PLC Module:



4.2.4. Procedure

1. Mount all modules to the JMTS mounting panel.
2. Connect the power supply module to an appropriately-rated electrical outlet.
3. Turn on the power supply module.
4. Connect your computer to the PLC.
5. Program the PLC as described above in section 4.2.2.
6. Wire the modules as shown above in section 4.2.3.
7. Turn on the upper switch. The motor turns on. The nut moves to the right until it activates the limit switch. The motor turns off.
8. Turn off the upper switch.
9. Turn on the middle switch. The motor turns on. The nut moves to the left until it activates the inductive sensor. The motor turns off.