



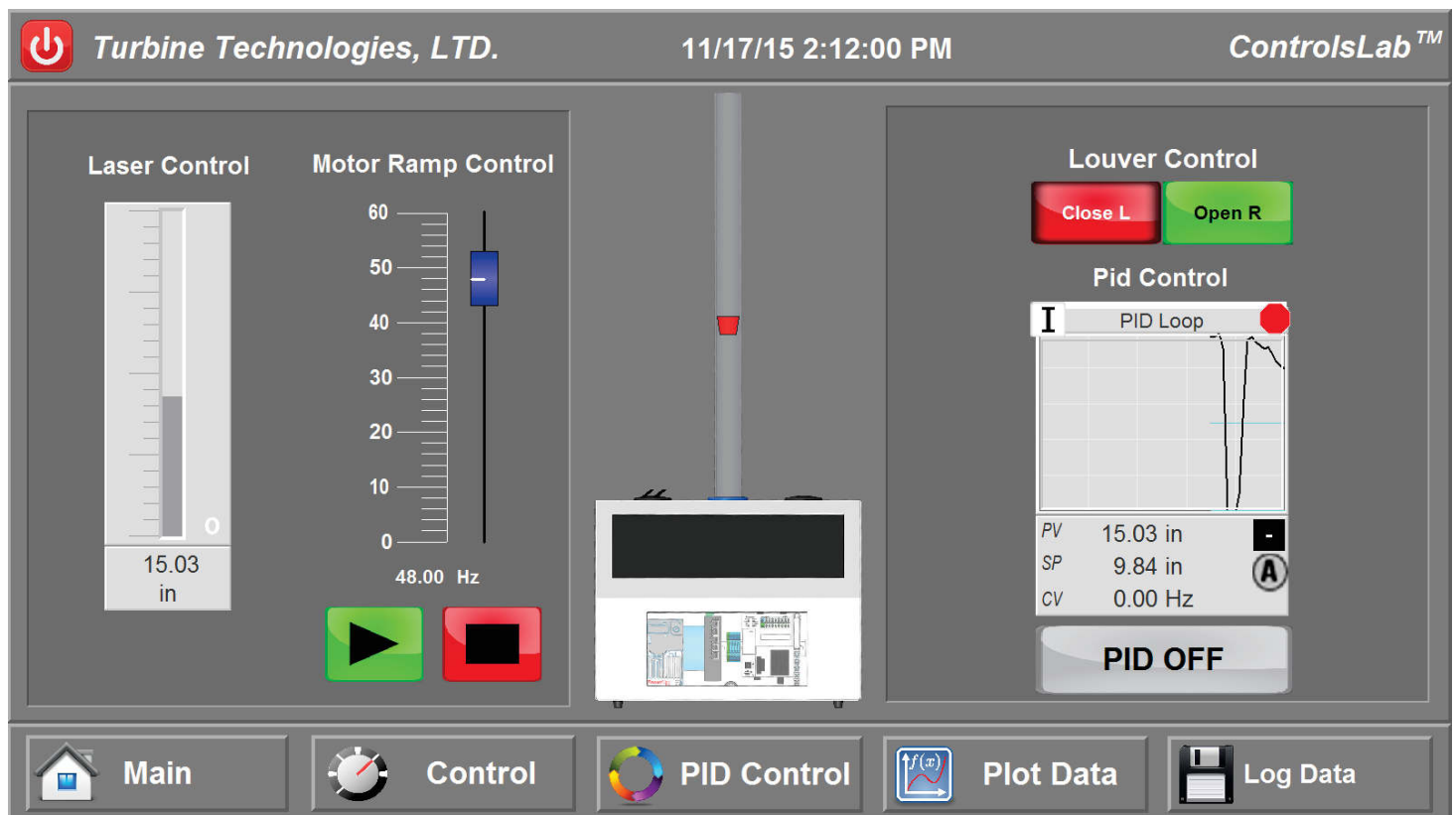
### Product Summary

- Automation & Programmable Logic Controls Learning System
- Portable chassis housing all System Hardware & Software Components
- Onboard, **P**rogrammable **A**utomation **C**ontroller (PAC/PLC)
- Industrial **V**ariable **F**requency **D**rive (VFD) for full PAC Control of Motor/Blower Fan
- Large Format Touchscreen, **H**uman-**M**achine **I**nterface (HMI) Computer
- Solenoid-Actuated Air Louvers for System Airflow Disruptions
- Photoelectric Laser Sensor for Aerodynamic Float Position Sensing
- Ethernet Communications & Wi-Fi Network Enabling Remote Systems Control of Multiple Units
- Curriculum Included- Extensive “Basic Concepts to Advanced Automation Skills Training”

### Description

ControlsLab™ features a programmable automation controller, large format touchscreen, variable frequency drive, and solenoid-operated louvers. Students utilize a blower and a laser distance measuring sensor to control the positioning of an aerodynamic float.

The air blower is driven by an industrial Variable Frequency Drive (VFD), which is controlled by an industrial Programmable Automation Controller (PAC). The PAC features industry standard programming in ladder logic, function block diagram, and structured text. An integrated Human-Machine Interface (HMI) allows an operator to interact with the whole system to program processes and controls, monitor and control processes and react to alarms and tag-out situations. An industrial LAN/WLAN Ethernet System connects all of these elements so they can effectively communicate with each other. It also enables operators to connect with and control the system remotely through wireless devices, versus having to accomplish all communications exclusively through the local HMI. Ethernet also enables multiple systems to be connected together on the same control network, allowing instructor access to each individual system. Furthermore, the connected systems can now operate as one system, significantly expanding possible process scenarios.



**Virtual Instrument Panel, Studio 5000 Logix Designer, and FactoryTalk View ME Software Included**

A complete curriculum allows students to gain hands-on knowledge of subjects that include programmable automation controller operation (PLC/PAC), ladder logic programming, feedback loops, PIDE tuning and many other related topics. ControlsLab™ allows students to devise real-world, custom industrial process scenarios. The curriculum table of contents is provided below:



## Unit 1 - General Overview - pg.10

### Chapter 1 - Overview of ControlsLab™ - pg.11

#### Section 1: Description of System - pg.13

Focus 1: Electrical Schematics

Focus 2: System Schematic

Focus 3: System Parts

Focus 4: System Capabilities

#### Section 2: Basic Pumping - pg.19

Focus 1: Blower

#### Section 4: PID Controls - pg.21

Focus 1 - Height PID Control

Focus 4 - PID Tuning

### Chapter 2 - Introduction to Automation - pg.24

#### Section 1: The History of Automation - pg.25

Focus 1: Manual Control

Focus 2: Relays and Timers

Focus 3: Programmable Relays

#### Section 2: Current Automation Technology - pg.28

Focus 1: Programmable Automation Controller

Focus 2: Communication Networks

### Chapter 3 - Introduction to PAC - pg.30

#### Section 1: Central Processing Unit - pg.31

Focus 1: Microprocessor

Focus 2: Advantages

Focus 3: Execute Instruction (Ladder Logic Basics)

#### Section 2: Scan-Cycle in PAC Operations - pg.33

Focus 1: Parts of the Scan-Cycle

Focus 2: Input Scan

Focus 3: Execute Programs

Focus 4: Output Scan

### Chapter 4 - Introduction to HMI - pg.36

#### Section 1 - History of the HMI - pg.36

Focus 1 - What is an HMI?

Focus 2: How does an HMI Work?

#### Section 2: User Interface Software - pg.39

Focus 1: HMI Interface

Focus 2: HMI Applications

Focus 3: Software Advantages

#### Section 3: User Interface Controls - pg.42

Focus 1: Programmers

Focus 2: Operators

### Chapter 5 - Introduction to VFD - pg.43

#### Section 1: VFD Basic Operation - pg.44

Focus 1: Frequency

Focus 2: Voltage

Focus 3: Pulse Width Modulation (PWM)

#### Section 2: Variable Frequency Drive Benefits - pg.46

Focus 1: Speed Control

Focus 2: Optimized Motor Starts

Focus 3: Constant Torque

### Chapter 6 - Introduction to Communications - pg.48

#### Section 1: Serial Communication - pg.49

Focus 1: The History of RS-232

Focus 2: RS-232 Uses in Automation

#### Section 2: Ethernet Communication - pg.51

Focus 1: History of Ethernet

Focus 2: Types of Ethernet Topology

Focus 3: How Ethernet is Useful

### Chapter 7 - Introduction to Power - pg.54

#### Section 1: Basics of Power - pg.55

Focus 1: What is Power?

Focus 2: What is Voltage

Focus 3: What is Current?

Focus 4: What is Resistance?

Focus 5: Ohm's Law

Focus 4: Electrical Power

#### Section 2: Types of Power Supplies - pg.61

Focus 1: Switched Mode Supplies

Focus 2: Un-interruptible Power Supplies

#### Section 3: Power Supply Requirements - pg.63

Focus 1: Calculating Load

Focus 2: Calculating Inrush

Focus 3: Choosing a Power Supply

## Unit 2 - Centrifugal Pumping - pg.65

### Chapter 1 - Introduction to Centrifugal Pumping - pg.66

#### Section 1: Define Centrifugal Pumping - pg.67

Focus 1: Let's Fling Stones!

#### Section 2: Specific Gravity of a Fluid - pg.72

#### Section 3: Introduction to Suction - pg.74

Focus 1: Suction Lift

Focus 2: Capacity and Suction Lift

#### Section 4: Net Positive Suction Head (NPSH) & Cavitation - pg.80

Focus 1: Net Positive Suction Head Available (NPSHa)

Focus 2: Net Positive Suction Head Required (NPSHr)

### Chapter 2 - Introduction to Process Control - pg.86

#### Section 1: Define Process Control - pg.86

Focus 1: Watering the Lawn

#### Section 2: Electric Motor Operation; a Pump's Driving Force - pg.88

Focus 1: Components of an Electric Motor

Focus 2: What is Electric Frequency

Focus 3: RPM as a Function of Frequency in a Single Phase Motor

Focus 4: Three Phase Motors

#### Section 3: Variable Frequency Drives - pg.94

Focus 1: Rectifier

Focus 2: Direct Current Bus (DC Bus)

Focus 3: Inverter

Focus 4: Output of the Inverter

Focus 5: Effective Voltage

#### Section 4: Variable Speed Applications in Pumping - pg.101

Focus 1: Constant Pressure

Focus 2: Constant Flow

Focus 3: Variable Flow

Focus 4: Soft Start

#### Section 5: Process Control Logic - pg.106

Focus 1: Open Loop Control: A Return to Watering the Lawn

Focus 2: Closed Loop Control: The Heating System

Focus 3: Getting a Better Feel for Controller Logic

#### Section 6: The PID Controller - pg.109

Focus 1: PID Control Overview

Focus 2: Proportional Control (The P in PID)

Focus 3: Integral Control (The I in PID)

Focus 4: Derivative Control (The D in PID)

Focus 5: Putting It All Together: PID Control

#### Section 7: Tuning Methodologies-An introduction to Gain - pg.121

Focus 1: Introduction to Gain

Focus 2: Manual Tuning-Trial and Error

Focus 3: The Ziegler-Nichols Method

Focus 4: PID Tuning Software

## Unit 3 - Ethernet Communication - pg.123

### Chapter 1 - Introduction to Ethernet - pg.124

#### Section 1: What is Ethernet? - pg.125

Focus 1: Types of Ethernet

Focus 2: Types of LAN Technology

Focus 3: IP (Internet Protocol)

Focus 4: TCP (Transmission Control Protocol)

Focus 5: UDP (User Datagram Protocol)

Focus 6: IP Addressing

#### Section 2: Types of Switched Ethernet - pg.131

Focus 1: Basic Switches

Focus 2: Intelligent Switches

Focus 3: Managed Switches

## Chapter 2 - Network Setup - pg.135

### Section 1 - IP Address Classification - pg.135

- Focus 1: Binary Code
- Focus 2: Addressing
- Focus 3: Classes

### Section 2: Subnets - pg.140

- Focus 1: What are Subnets?
- Focus 2: Subnet Benefits

### Section 3: IP Routing - pg.142

- Focus 1: What is IP Routing?
- Focus 2: Routers

## Chapter 3 - Communication Setup - pg.144

### Section 1: PAC Ethernet Setup - pg.145

- Focus 1: IP Address Setup with USB
- Focus 2: Other IP Address Setup Methods

### Section 2: HMI Ethernet Setup - pg.149

### Section 3: VFD Ethernet Setup - pg.151

## Chapter 4 - Ethernet with Wireless Technology - pg.152

### Section 1 - Introduction to WLAN - pg.152

- Focus 1 - What is WLAN?
- Focus 2 - Access Points
- Focus 3 - Security
- Focus 4 - Interference

## Unit 4 - Programmable Automation Controller - pg.157

### Chapter 1 - Introduction to CompactLogix - pg.158

#### Section 1: 1769-L16ER Controller - pg.159

- Focus 1: Memory
- Focus 2: Embedded Inputs / Outputs
- Focus 3: 1734 Series Expansion Cards

#### Section 2: Communication - pg.166

### Chapter 2 - Embedded Input / Output - pg.168

#### Section 1: Inputs - pg.169

- Focus 1: 45LMS Laser

#### Section 2: Outputs - pg.171

- Focus 1: Louvers

#### Section 3: Sports Drink Scenario - pg.173

- Focus 1 - Start the Process
- Focus 2 - Fluid Process
- Focus 3 - Back to the Process Tank

### Chapter 3 - I / O Expansion Modules - pg.178

#### Section 1: 1734 Module Installation - pg.179

- Focus 1 - 1734 Point I/O System
- Focus 2 - 1734 Point I/O Features
- Focus 3 - 1734 Module Installation
- Focus 4 - Wiring the IE2C

#### Section 5: Pharmaceutical Scenario - pg.186

- Focus 1 - Process Plant
- Focus 2 - Buffering and Bottling a Batch of Eyedrops
- Focus 3 - Buffering and Bottling a Batch of Contact Lens Solution

### Chapter 4 - Tag Database - pg.196

#### Section 1: Project Structure - pg.197

- Focus 1 - Project
- Focus 2 - Task
- Focus 3 - Programs
- Focus 4 - Routines
- Focus 1 - Tag Memory
- Focus 2 - Tag Naming Rules
- Focus 3 - I/O Tag Format
- Focus 4 - Tag Locations

#### Section 2: Tag Basics - pg.205

- Focus 5 - ControlsLab™ Tag Library

#### Section 3: Types of Tags - pg.207

- Focus 1: BOOL Tags
- Focus 2: DINT Tags
- Focus 3: REAL Tags
- Focus 4: STRINGS

## Unit 5 - Human Machine Interface - pg.212

### Chapter 1 - Introduction to ControlsLab HMI - pg.213

#### Section 1: ControlsLab HMI Computer - pg.214

- Focus 1: Windows 8.1 Pro Operating System and Features
- Focus 2: 4 GB RAM
- Focus 3: 500 GB Drive
- Focus 4: 1.8 GHz Dual-Core Processor

#### Section 2: Communication I/O - pg.220

- Focus 1: Dual Ethernet Inputs (LAN/WLAN)
- Focus 2: Dual USB 3.0 I/O

### Chapter 2 - HMI Software - pg.222

#### Section 1: Introduction to Studio 5000 Logix Designer - pg.223

- Focus 1: Creating a New Project
- Focus 2: Ladder Logic
- Focus 3: Adding Expansion Modules
- Focus 4: Function Block Diagram
- Focus 5: Structured Text
- Focus 6: I/O Tag Data

#### Section 2: Introduction to FactoryTalk View ME - pg.261

- Focus 1: Creating a New Run-Time
- Focus 2: Communication Setup
- Focus 3: Global Objects
- Focus 4: Displays
- Focus 5: Faceplates
- Focus 6: Tags
- Focus 7: Alarms
- Focus 8: Buttons

### Chapter 4 - VNC Control - pg.343

#### Section 1: VNC Server - pg.344

- Focus 1: Introduction to VNC
- Focus 2: HMI VNC Server

#### Section 2: VNC Client - pg.350

- Focus 1: Connecting to a VNC Server with Client Software

## Unit 6 - Variable Frequency Drive - pg.353

### Chapter 1 - Introduction to PowerFlex 525 - pg.354

#### Section 1: Drive Setup - pg.355

- Focus 1: Drive Wiring
- Focus 2: I/O Features

#### Section 2: Drive Parameters - pg.359

- Focus 1: Parameter Basics
- Focus 2: Ethernet Parameters

### Chapter 2 - VFD Software Control - pg.366

#### Section 1: Basic Control - pg.367

- Focus 1: VFD Software Configuration
- Focus 2: Studio 5000 Control Setup
- Focus 3: FactoryTalk View ME VFD Control

#### Section 2: PID Control - pg.407

- Focus 1: Studio 5000 PID Setup
- Focus 2: FactoryTalk View ME PID Setup

## Unit 7 - Studio 5000 Logix Designer - pg.435

### Chapter 1 - Introduction Studio 5000 Logix Designer - pg.436

#### Section 1: Creating a Project - pg.436

#### Section 2: Connecting Your Computer to the Controller - pg.436

#### Section 3: Downloading Project from the Computer to the Controller - pg.436

#### Section 4: Configuring I/O - pg.436

#### Section 5: Testing Your Logic Program - pg.436

#### Section 6: Adding Logic and Tags Online - pg.436

#### Section 7: Creating and Running a Trend - pg.436

#### Section 8: (Optional) Creating and Using User Defined Types (UDT) - pg.436

#### Section 9: (Optional) Using Studio 5000 Help - pg.436



### Chapter 2 - I/O and Tag Data - pg.437

- Section 1: Communicate with I/O Modules - pg.437
- Section 2: Organize Tags - pg.437
- Section 3: Force I/O - pg.437
- Section 4: Data Access Control - pg.437

### Chapter 3 - Ladder Logic Programming - pg.438

- Section 1: Introduction - pg.438
- Section 2: Write Ladder Logic - pg.438
- Section 3: Enter Ladder Logic - pg.438
- Section 4: Assign Instruction Operands - pg.438
- Section 5: Enter A Rung Comment - pg.438
- Section 6: Verify the Routine - pg.438

### Chapter 4 - Structured Text Programming - pg.439

- Section 1: Introduction - pg.439
- Section 2: Assignments - pg.439
- Section 3: Expressions - pg.439
- Section 4: Instructions - pg.439
- Section 5: Constructs - pg.439
- Section 6: If ... Then - pg.439
- Section 7: Case ... Of - pg.439
- Section 8: For ... Do - pg.439
- Section 9: While ... Do - pg.439
- Section 10: Repeat ... Until - pg.439

### Chapter 5 - Function Block Diagram Programming - pg.440

- Section 1: Introduction - pg.440
- Section 2: Choose the function block - pg.440
- Section 3: Choose a tag name for an element - pg.440
- Section 4: Define the order of execution - pg.440
- Section 5: Identify any connectors - pg.440
- Section 6: Define program/operator control - pg.440
- Section 7: Add a sheet - pg.440
- Section 8: Add a function block element - pg.440
- Section 9: Create a text box - pg.440
- Section 10: Connect elements - pg.440
- Section 11: Assign a tag - pg.440
- Section 12: Assign an immediate value (constant) - pg.440
- Section 13: Connect blocks with an OCON and ICON - pg.440
- Section 14: Verify the routine - pg.440

### Chapter 6 - Plant PAX - pg.441

- Section 1 - PlantPAX Library of Process Objects - pg.441
  - Focus 1: Overview
  - Focus 2: How to Install the Library
  - Focus 3: Common Configuration Considerations
  - Focus 4: Use the Library
- Section 2: P\_RunTime - pg.442
- Section 3: P\_VSD - pg.443
- Section 4: P\_Perm - pg.444
- Section 5: P\_Intlk - pg.445
- Section 6: P\_Alarm - pg.446
- Section 7: P\_Aln - pg.447
- Section 8: P\_Mode - pg.448
- Section 9: P\_PIDE - pg.449

### Unit 8 - FactoryTalk View ME - pg.450

#### Chapter 1 - FactoryTalk View ME User's Guide - pg.451

- Section 1: Getting Started - pg.451
- Section 2: Explore FactoryTalk View Studio - pg.451
- Section 3: Plan applications - pg.451
- Section 4: Work with applications - pg.451
- Section 5: Set up communications - pg.451
- Section 6: Work with tags - pg.451
- Section 7: Use HMI tags - pg.451
- Section 8: Set up global connections - pg.451
- Section 9: Set up alarms - pg.451
- Section 10: Set up FactoryTalk Diagnostics - pg.451
- Section 11: Set up security - pg.451
- Section 12: Set up language switching - pg.451

- Section 13: Set up display navigation - pg.451
- Section 14: Create run-time applications - pg.451
- Section 15: Run applications on a personal computer - pg.451
- Section 16: Transfer applications to a PanelView Plus terminal - pg.451
- Section 17: Use your application - pg.452
- Section 18: Work with components - pg.452
- Section 19: Use graphic displays - pg.452
- Section 20: Use graphic objects - pg.452
- Section 21: Set up graphic objects - pg.452
- Section 22: Animate graphic objects - pg.452
- Section 23: Use expressions - pg.452
- Section 24: Use embedded variables - pg.452
- Section 25: Use parameters and global objects - pg.452
- Section 26: Set up data logging - pg.452
- Section 27: Use information messages - pg.452
- Section 28: Set up trends - pg.452
- Section 29: Set up RecipePlus - pg.452
- Section 30: Use macros - pg.452



To download a curriculum sample go to [www.turbine technologies.com](http://www.turbine technologies.com) , or scan the QR code below:



### System Includes:

- Allen Bradley™ Powerflex 525 0.5HP 0.38kW Variable Frequency Drive (VFD): 25B-A011N104
- Allen Bradley™ Programmable Automation Controller (PAC) :1769-L16ER-BB1B
- Human-Machine Interface (HMI) 20" Touchscreen
- Planet™ Unmanaged Ethernet Industrial Switch - IGS-501T
- Lutze™ 24V Power Supply - DRA-60
- AC Centrifugal Fan/Blower - MB840-T, 1/25 HP
- Allen Bradley™ Laser Sensor - 45LMS
- Solenoid Actuated Louvers
- GracePort HMI Connectivity Interface

### Dimensions

**ControlsLab™:** 20L x 17W x 50H inches  
(51L x 43W x 127H cm)

**As Shipped:** 20L x 20W x 40H inches  
(51L x 51W x 102H cm)

### Weight

**ControlsLab™:** 60 lbs (27 kg)

**As Shipped:** 68 lbs (31 kg)

### Operating Requirements

**Typical Laboratory or Classroom Setting Power:**  
110/220V single-phase 50/60Hz auto switching

### Additional Items

Wireless Keyboard / Mouse  
Spare Aerodynamic Floats

### Operating Conditions / Limitations

Blower Maximum RPM: 3,200 RPM  
Max Air Flow: 63.5 CFM

### Clear-View Float Observation Section

Easy Connect/Disconnect for Transport  
Breakdown  
On-bench eye-level observation design  
Open top for convenient float loading

### Sensors (Preinstalled and Calibrated)

Photoelectric Laser Distance Measuring Device

### Safety

Clear-View Electrical Components  
Compartment Shield



**Solenoid Actuated Louvers**



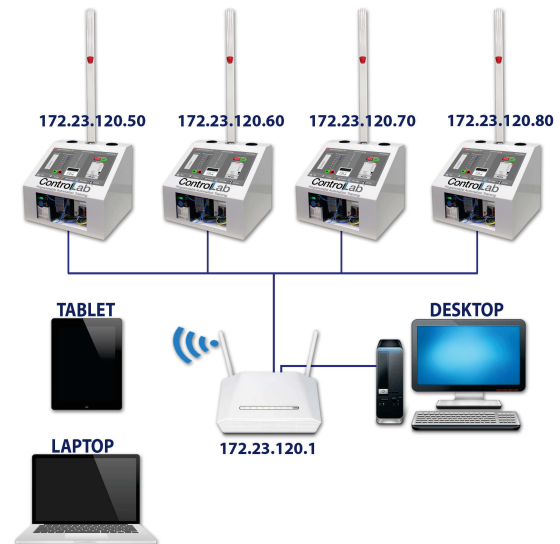
**Clear-View Electrical Components Shield**

Students become familiar with the integrated Ethernet communications system which enables system elements to talk with each other and respond as needed. They also discover that Ethernet enables them to connect with and control the system remotely through the internet and with wireless devices, versus having to accomplish all communications strictly through the local HMI. Multiple systems can be connected together on the same control network, allowing instructor access to each individual system.

Furthermore, the connected systems can now operate as one system, significantly expanding possible process scenarios.



**Remote Control Through Internet and Wireless Devices**



**Multiple System Connectivity**

### Purchase Specifications

A self-contained, portable air flow process automation system with:

- Clear-view aerodynamic float position section, system floats
- Dual Solenoid-Actuated Air Louvers
- Calibrated Photoelectric Laser Sensor
- Industrial Human-Machine Interface with Software
- Industrial Programmable Automation Controller with Software
- Industrial Variable Frequency Drive
- Industrial Ethernet Communications System
- Industrial DC Voltage Controls Power System
- Clear View Electrical Components Compartment Shield
- Comprehensive Curriculum



**ControlsLab™ has a free two year warranty on the entire system**

© 2015

**All ControlsLab™ specifications are subject to change**