Instructor Guide

401: Programmable Logic Controllers
Module 1: Controller Functions and Components

SIGNALS TRAINING CONSORTIUM

Elevator – Escalator Programmable Logic Controllers
Instructor's Guide

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Icons Used In This Guide

REVIEW slides

ASK

CLASSROOM ACTIVITY

SMALL GROUP ACTIVITY

INDIVIDUAL ACTIVITY

WRITE

Multimedia

REFER participants to

Agenda

Topic #	Topic Title	Duration
1	Overview	20 Minutes
2	Principles of Electronic Safety	20 Minutes
3	SIL for Control Devices	30 Minutes
4	Relay (Ladder) Logic	30 Minutes
5	Components of PLCs	60 minutes
6	Principles of PLCs	60 minutes
7	Summary	20 minutes
	Total Time:	240 Minutes

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Overview

Purpose   The purpose of this module is to:

Provide the participant with a conceptual understanding of programmable logic controllers (PLC) for elevator and elevators.

Objectives
At the end of this lesson, the transit elevator/escalator trainee will be able to:

- Discuss safety and authority-specific procedures
- Discuss the safety integrity levels for control devices
- Describe ladder logic
- Identify the main components of a PLC
- Identify the principles of programming a PLC

Materials

Mandatory   Make sure you have the following

- PowerPoint Presentation
- Lesson Plan
- Quizzes
- Pencils

Optional   You may also want the following for optional activities:

- Chalk board with chalk, large paper with marker, etc.
- Internet connection
- Lab, simulator or out of service elevator
- Specific transit authority related procedures and guidelines

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Module Length:210 min   Time remaining: 210 min   This section: 20 min (4 slides)   *Section start time: _____*   *Section End Time: _____*

DO	SAY	Materials Needed
REVIEW introduction slides	**In your own words:** Welcome to the course on Programmable Logic Controllers ***Advance***	✓PPT slides 1 Programmable Logic Controllers **Programmable Logic Controllers:** Understanding the Magic in the Black Box)))))- Transit Elevator/Escalator Consortium
Instructor's Notes _____ _____ _____ _____ _____		

PREVIEW ONLY

Module Length:210 min	Time remaining: 210 min	This section: 20 min (4 slides)	*Section start time:* _____	*Section End Time:* _____

DO	SAY	Materials Needed
REVIEW key terms **Instructor's Notes** _____ _____ _____ _____	**In your own words:** Lets take a look at some of the key words we will be defining as move through this module: -Antistatic straps, mats, gloves -ASME A17.1, ASME 17.2, ASME 17.3, & NEC code -Elevator Industry Employees" Field Safety Handbook -Function Block Diagram -Input/Output Modules -Math/Comparison/Move Instructions -Nomenclature Instructions -Personal Protective Equipment -Program Control Instructions -Programmable Logic Controller -Programming Instructions -Relay (Ladder) Logic -Solid state PLCs ***Advance***	✓PPT slide 3 **Programmable Logic Controllers** **Key Terms** • Antistatic straps, mats, gloves • ASME A17.1, ASME 17.2, ASME 17.3, & NEC code • Elevator Industry Employees' Field Safety Handbook • Function Block Diagram • Input/Output Modules • Math/Comparison/Move Instructions • Nomenclature Instruction • Personal Protective Equipment • Program Control Instructions • Programmable Logic Controller • Programming Instructions • Relay (Ladder) Logic • Solid State PLCs))))) Transit Elevator/Escalator Consortium 3

Module Length: 210 min	Time remaining: 190 min	This section: 20 min (1 slides)	*Section start time:* _____	*Section End Time:* _____

DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes** _____ _____ _____ _____	**In your own words:** Safety is always the most important thing when dealing with electrical components. Lets talk about the precautions that you must take when handling a Programmable Logic Controller. **Handling Precautions –** •Remember to Power Down which includes removing the electrical power at the main power disconnect/switch panel. Follow your properties lockout/tagout procedures before removing any electrical/electronic components. •Unplug all power cords or Turn Off all circuits. Turn off and/or disconnect all peripheral power sources •Before disconnection, label where the connector goes and in what position it was installed.	✓PPT slide 5 **Programmable Logic Controllers** **Principles of Electronic Safety** • Handling precautions • Installing Modules Precautions • Electrostatic Damage (ESD) Precautions • Latch-up • Precautions for Package Mounting – Lead insertion type – Surface Mount type • Storage of Semiconductor Devices • Humidity • Precautions for Use Environment)))) Transit Elevator/Escalator Consortium 5

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DO	SAY	Materials Needed

REVIEW slide
 	
Instructor's Notes
 	
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	In your own words:
	•If you do not have a wrist strap, touch and maintain contact with an unpainted metal part of the chassis
	•To protect electronic components from ESD, place components on an antistatic surface, such as an antistatic discharge mat, an antistatic bag, or a disposable antistatic mat.
	
	Additional safety rules include
	•*Select a suitable work space*
	    •Avoid carpets in cool dry areas
	    •When working on carpet, be sure to take anti-static measures beforehand
	    •Place ESD-sensitive components on an antistatic mat
	    •When servicing or removing server components, attach antistatic strap to your wrist and then to a metal area on chassis
		✓PPT slide 5
		
		Programmable Logic Controllers
		Principles of Electronic Safety
		• Handling precautions
		• Installing Modules Precautions
		• Electrostatic Damage (ESD) Precautions
		• Latch-up
		• Precautions for Package Mounting
		  – Lead insertion type
		  – Surface Mount type
		• Storage of Semiconductor Devices
		• Humidity
		• Precautions for Use Environment
		
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DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes** _____ _____ _____ _____	**In your own words:** •Unused Input pins should be connected through an appropriate resistance to a power supply or ground pin. When semiconductors are subjected to abnormally high voltages, PNPN (Positive/Negative/Positive/Negative) junctions (called thruster (TRIAC) structures) may be formed, causing large current levels in excess of several hundred amps to flow continuously at the power supply pin. This condition is called a latch up. A latch up not only causes loss of reliability in the semiconductor device but can cause injury or damage from high heat. To prevent this: 1. Be sure that the voltage applied to pins doesn't exceed the absolute max ratings 2. Be sure that abnormal current flows do not occur during power on sequence.	✓PPT slide 5 **Programmable Logic Controllers** **Principles of Electronic Safety** • Handling precautions • Installing Modules Precautions • Electrostatic Damage (ESD) Precautions • Latch-up • Precautions for Package Mounting – Lead insertion type – Surface Mount type • Storage of Semiconductor Devices • Humidity • Precautions for Use Environment)))))- Transit Elevator/Escalator Consortium 5

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DO	SAY	Materials Needed

REVIEW slide
 	
Instructor's Notes
 	
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	In your own words:
	Surface Mount type – Use appropriate mounting techniques (specified by the manufacturer).
	
	Storage of Semiconductor Devices – To prevent heat moisture that can cause storage packages to peel and crack:
	1. Avoid exposure to rapid temperature changes which cause moisture to condense inside the product. Store products where temperature changes are slight.
	2. Use dry boxes for product storage. Products should be stored below 70% relative humidity, and at temperatures between 5C and 30C (41F-85F).
		✓PPT slide 5
		
		Programmable Logic Controllers
		Principles of Electronic Safety
		• Handling precautions
		• Installing Modules Precautions
		• Electrostatic Damage (ESD) Precautions
		• Latch-up
		• Precautions for Package Mounting
		  – Lead insertion type
		  – Surface Mount type
		• Storage of Semiconductor Devices
		• Humidity
		• Precautions for Use Environment
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| Module Length: 210 min | Time remaining: 170 min | This section: 15 min (1 slides) | *Section start time: _____* | *Section End Time: _____* |

DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes** _____ _____ _____ _____	**In your own words:** The standard referred to in the ASME reads: EN 12016:2013:EMC-Product Family Standard for Lifts, Escalators. And Moving Walks – Immunity 01/08/2014 from the European Committee for Standardization: This European standards specifies the immunity performance criteria and test levels for apparatus used in lifts, escalators, and moving walks which are intended to be permanently installed in buildings including the basic safety requirements in regard to their electromagnetic environment. Note: "This standard is n ot applicable to apparatus that manufactured before the date of its publication of EN 12016. " This standard does not apply to railway and metros-subway systems in Europe. *Advance*	✓ PPT slide 6 **Programmable Logic Controllers** **Safety Integrity Level Ratings for Control Devices** • SIL stands for Safety Integrity Level • Measure of safety system performance, or probability of failure on demand • Refer to ASME Code A17.1-2010 – 2.26.4.4 SIL rating for equipment) • Refer to EN 12016:2013: EMC – Product Family Standard for Lifts, Escalators, and Moving Walks from the European Committee for Standardization. Note: This standard does not apply to railway and metros-subway systems in Europe.)))) Transit Elevator/Escalator Consortium

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Module Length: 210 min | Time remaining: 65 min | This section: 60 min (4 slides) | *Section start time: _____* | *Section End Time: _____*

DO	SAY	Materials Needed

REVIEW slide
 	
Instructor's Notes
	In your own words:
	Be extremely careful before changing the status of any part of memory allocated to I/O units, Dedicated I/O units, and other boards. Any changes to the data allocated to any part of the PLC system mat result in erroneous operation of the loads connected to the PLC. Changes in the following may result in changes to the memory status:
	• Transferring I/O memory data to the CPU Unit from a programming device
	•Changing present values in memory from a programming device
	•Force – setting /resetting bits from a programming device
	•Transferring I/O memory from a host computer or from another PC on a network
	
	Caution: Execute online edits only after confirming no adverse effects will be caused.
		✓PPT slide 17
		
		Programmable Logic Controllers
		Principles of Programmable Logic Controller
		• Overall Precautions for programming (safety precautions)
		• PLC Programming Design
		• Programming Basics
		  – Algorithms
		  – I/O assignment table
		  – Internal address assignment table
		  – Register address assignment table
		
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DO	SAY	Materials Needed

REVIEW slide
 	
 ASK
 	
 Instructor's Notes
 	
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	In your own words:
	 The three documents used to state the arrangement of the PLC system are the:
	 • I/O assignment table – documents the names, descriptions, and locations of the input and outputs
	 • the internal address assignment table – provides the descriptions/locations of internal outputs, registers, timers, counters, and other devices.
	 •and the register address assignment table – provides all of the available addresses within the PLC.
	
	 Ask:
	 Does anyone know how you would translate logic or a relay diagram into PLC ladder program form?
	
	 Answer: Program coding
		✓PPT slide 17
		
		 Programmable Logic Controllers
		 Principles of Programmable Logic Controller
		 • Overall Precautions for programming (safety precautions)
		 • PLC Programming Design
		 • Programming Basics
		   – Algorithms
		   – I/O assignment table
		   – Internal address assignment table
		   – Register address assignment table
		
		)))))- Transit Elevator/Escalator Consortium 17

Module Length: 210 min   Time remaining: 65 min   This section: 60 min (4 slides)   *Section start time: _____*   *Section End Time: _____*

DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes**	**In your own words:** Latching Relays •OTL – OuTput Latch •OUT – OuTput Unlatch Normally the unlatch operator takes precedence. (If the unlatch instruction is true then the relay output is false). In Allen Bradley ladder logic, ladder logic, latch and unlatch relays are separate operators. Jump to Subroutine (JSR). For jumping one rung to another the JSR command is used. *Advance*	✓PPT slide 18 Programmable Logic Controllers **Principles of Programmable Logic Controller** • Nomenclature Instructions – Positive Logic/Negative Logic – Normally Open/Normally Closed – Output Enable – On Timer/Off Timer/Retentive Timer – Latching Relays – Jump to Subroutine))))) Transit Elevator/Escalator Consortium

| Module Length: 210 min | Time remaining: 65 min | This section: 60 min (4 slides) | *Section start time:* _____ | *Section End Time:* _____ |

DO	SAY	Materials Needed

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REVIEW slide

Instructor's Notes

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In your own words:

Function Block Diagrams are similar to ladder logic diagrams but the elements appear as blocks. The function block takes one or more signals from input devices, calculates a decision, and ten sends signals to one or more output devices. It consists of four basic elements: function blocks, references, wire connectors, and wires.

Advance

Materials Needed

✓ PPT slide 20

Programmable Logic Controllers

Principles of Programmable Logic Controller

- Elements in Programming for Controllogix Controllers (Allen Bradley)
  - Program Control Instructions
  - Math Instructions
  - Comparison Instructions
  - Move Instructions
  - Function Block Diagram

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Module Length: 210 min   Time remaining: 5 min   This section: 5 min (3 slides)   *Section start time:* _____   *Section End Time:* _____

DO	SAY	Materials Needed
? **ASK** **Instructor's Notes** _____ _____ _____ _____	**In your own words:** Block #5 of the PLC diagram represents a. memory b. power supply module c. input module d. output module ***Call on participants for answer*** ***Advance for correct answer*** Answer: d. output module ***Advance***	✓PPT slide 22