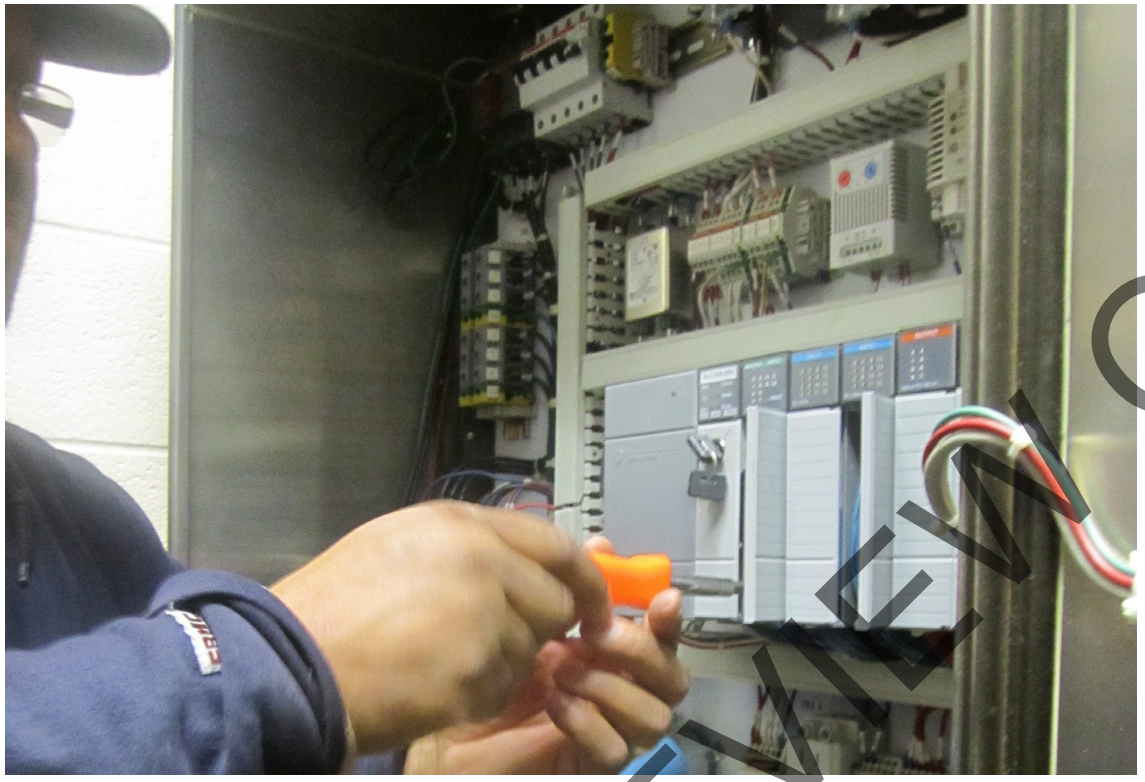
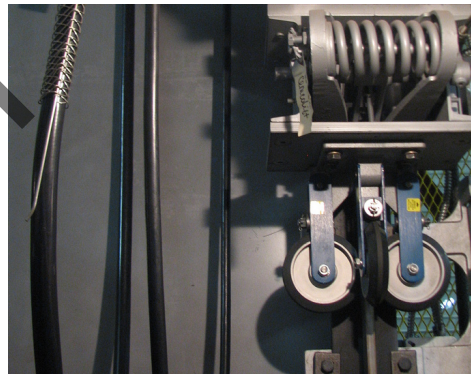
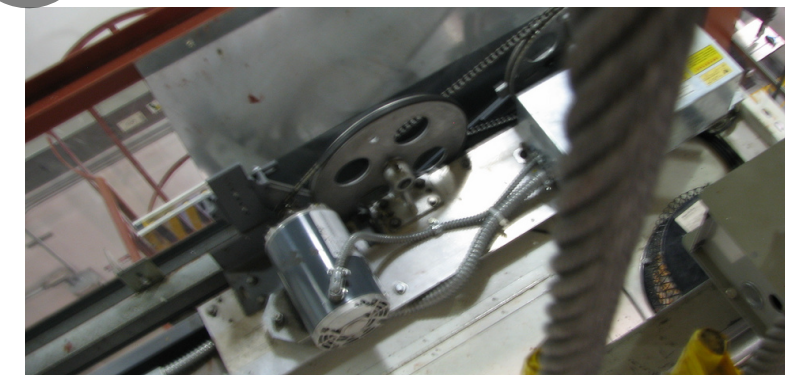
Instructor Guide







301: Electrical/Electronic Systems
Module 1: Electronic Drive Systems

TRANSIT ELEVATOR/ESCALATOR CONSORTIUM

Table of Contents

Icons Used In This Guide

REVIEW slides

INDIVIDUAL ACTIVITY

ASK

WRITE

CLASSROOM ACTIVITY

Multimedia

SMALL GROUP ACTIVITY

REFER participants to

Agenda

Topic #	Topic Title	Duration
1	Overview	30 Minutes
2	Safety	20 Minutes
3	Variable Frequency Drives	40 Minutes
4	Testing VFDs	20 Minutes
5	Field Trip	100 Minutes
6	Summary	30 Minutes
	Total Time:	Minutes

Overview

Purpose The purpose of this module is to:

Build on previous knowledge on variable frequency drives for transit elevators and escalators including how it works with the PLC and what areas should be tested.

Objectives

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

- List common safety precautions when dealing with electrical/electronic systems
- Describe how a VF drive works
- Identify different areas of a VF drive
- Identify areas of a VF drive that can be tested
- Explain how the internal electronic drive controls regulate the drive
- Explain the role of the PLC to electrical/electronic drive systems

Materials

Mandatory Make sure you have the following

- PowerPoint Presentation
- Coursebook
- Quizzes
- Pencils
- Masking tape
- Handouts: Sequence op Operation (cut apart steps)

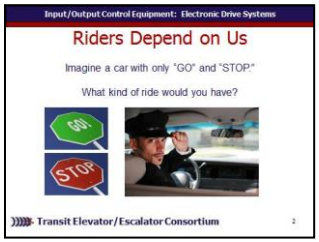
Optional You may also want the following for optional activities:

- Chalk board with chalk, large paper with marker, etc.
- Internet connection
- Lab, simulator or out of service elevator

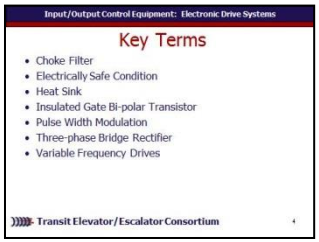
Elevator-Escalator – Electronic Drive Systems

Instructor's Guide

Module Length: 240 min | Time remaining: 240 min | This section: 30 min (6 slides) | *Section start time: _____* | *Section End Time: _____*

DO	SAY	Materials Needed
REVIEW introduction slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Welcome to the course on Electronic Drive Systems. The purpose of this module is to build on previous knowledge on variable frequency drives for transit elevators and escalators including how it works with the PLC and what areas should be tested. ***Advance*** Riders depend on us. ***Advance*** Imagine a car with only "Go" and "Stop." ***Advance*** What kind of ride would you have? ***Allow participants to discuss thoughts.*** Without a variable frequency drive, the ride in an elevator would be similar to a ride in a car with only go and stop. ***Advance***	✓PPT slides 1, 2  

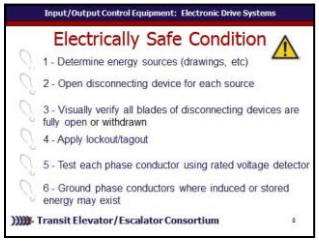
Module Length: 240 min | Time remaining: 240 min | This section: 30 min (6 slides) | *Section start time:* _____ | *Section End Time:* _____

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: • Choke Filter • Electrically Safe Condition • Heat Sink • Insulated Gate Bi-polar Transistors • Pulse Width Modulation • Three-phase Bridge Rectifier • Variable Frequency Drives ***Advance***	✓PPT slide 4 

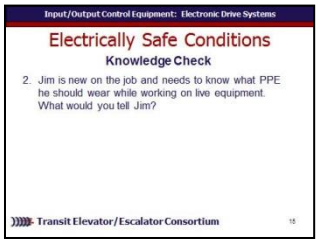
Module Length: 240 min | Time remaining: 240 min | This section: 30 min (6 slides) | *Section start time: _____* | *Section End Time: _____*

DO	SAY	Materials Needed
REVIEW slide **INDIVIDUAL ACTIVITY** **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Before we begin exploring variable frequency drives, lets review a typical sequence of operation. In reviewing the assumptions, we know that: The elevator is in service and fully automatic operation. The car is stopped at the first floor and there are no other calls. The doors are close, the safety circuit and door lock circuit are made. So with that, lets practice. ***Advance*** Close your course books. With the cards you have, place them in order to show the sequence of operation. ***Continued***	✓PPT slide 6  ✓Handout: Sequence of Operation Activity

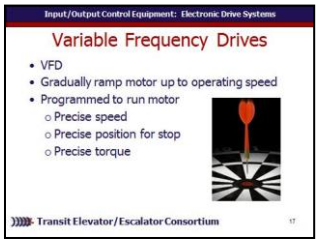
Module Length: 240 min Time remaining: 210 min This section: 20 min (10 slides) *Section start time:* _____ *Section End Time:* _____

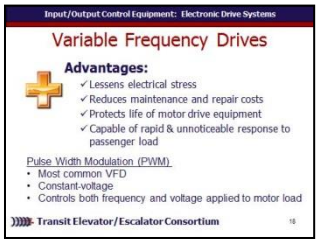
DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** An **Electrically Safe Condition** shall be achieved by completing all of the following six steps: ***Advance*** **Step 1** - Determine all sources of electrical supply (Drawings, diagrams). ***Advance*** **Step 2** - Open disconnecting device for each source. ***Advance*** **Step 3** - Visually verify all blades of disconnecting devices are fully open or withdrawn. ***Advance*** **Step 4** - Apply lockout/tagout devices in accordance with policy. ***Advance*** **Step 5** - Test each phase conductor using adequately rated voltage detector. ***Advance***	✓PPT slide 8 

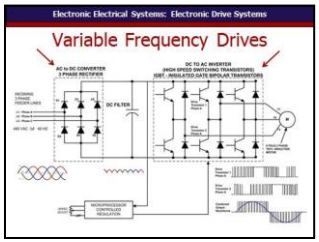
Module Length: 240 min Time remaining: 210 min This section: 20 min (10 slides) *Section start time: _____* *Section End Time: _____*

DO	SAY	Materials Needed
ASK **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Jim is new on the job and needs to know what PPE he should wear while working on live equipment. What would you tell Jim? ***Call on participants for answer.*** ***Advance for correct answer.*** Answer: • Long-sleeved natural-fiber or FR-rated shirts and pants, long-sleeved FR-rated coveralls or other company-approved arc-flash-hazard protection • Nonconductive safety glasses • EH-rated footwear or rubber mats • Clean leather gloves ***Advance***	✓PPT slide 15 

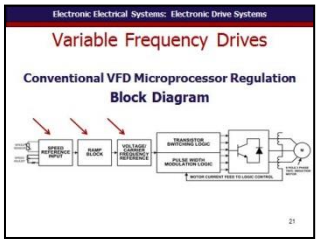
Module Length: 240 min Time remaining: 190 min This section: 40 min (16 slides) *Section start time:* _____ *Section End Time:* _____

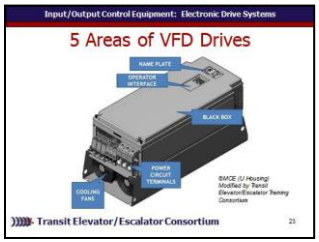
DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** As discussed in previous courses, single-speed starting methods start motors abruptly, subjecting the motor to a high starting torque and to current surges that are up to ten times the full-load current. **Variable Frequency Drives** (VFDs), on the other hand, gradually ramp the motor up to operating speed. Full-voltage (across the line) starters can only run the motor at full speed, and reduced voltage soft starters can only gradually ramp the motor up to full speed, and back down to shutdown. Variable speed drives can be programmed to run the motor at a precise speed, to stop at a precise position, or to apply a specific amount of torque. ***Advance***	✓PPT slide 17 

DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Advantages of the VFD: lessen electrical stress, reduce maintenance and repair costs, and protect the life of the motor drive equipment. Full-voltage (across the line) starters can only run the motor at full speed, and reduced voltage soft starters can only gradually ramp the motor up to full speed, and back down to shutdown. Variable speed drives can be programmed to run the motor at a precise speed, to stop at a precise position, or to apply a specific amount of torque. Through the use of its internal processor and programming, the VFD drive is capable of rapidly responding to changes in passenger load making the change imperceptible to the passengers. ***Continued***	✓PPT slide 18 

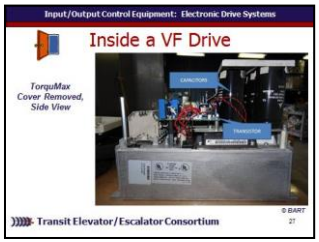
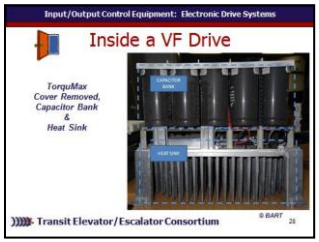
DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** In the VFD Power Conversion diagram (Figure 2), the **three-phase bridge rectifier** converts the three-phase incoming line feed to a fixed level DC voltage. ***Advance*** The next stage in the drive is the filter (capacitor) removes variations in the rectified DC waveform. The set of six drive transistors with diodes in the switching (inverter) section of the drive are controlled by the microprocessor. It is in the switching section where the DC power is converted to a "synthesized AC power" which is then fed to the induction motor. The transistors used in this application are typically **Insulated Gate Bi-polar Transistors (IGBTs)**. These devices are capable of switching on and off at high frequency while controlling high levels of current. ***Advance***	✓PPT slide 20 

Module Length: 240 min Time remaining: 190 min This section: 40 min (16 slides) *Section start time:* _____ *Section End Time:* _____

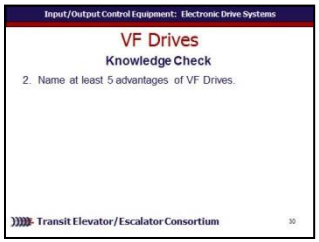
DO	SAY	Materials Needed
REVIEW slide **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** The signal moves to a section that sets both the rate of change (frequency) and strength of the magnetic field of the motor. The single speed control commands both of these variables in a VFD drive. It is by controlling both the frequency and the voltage that the drive is capable of slowly ramping up and ramping down the speed of the escalator drive motor(s). ***Advance***	✓PPT slide 21 

DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** **Areas of a VFD** The five main areas of a VFD shown here are: • Name Plate - contains information on model, make, serial number, motor specifications and input and output power • Operator Interface • Cooling Fans (where applicable) • Power Circuit Terminals • "Black Box" - contains components which are not repaired by transit elevator/escalator technicians and is rarely opened in the field. ***Advance***	✓PPT slide 23 

Module Length: 240 min Time remaining: 190 min This section: 40 min (16 slides) *Section start time:* _____ *Section End Time:* _____

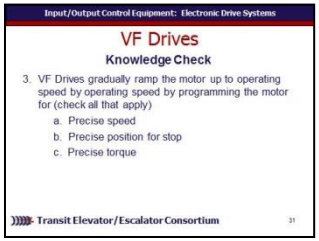
DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Here is another side view where we can again see the capacitors as well as the transistor. ***Advance*** And here we can see the capacitor bank and heat sink. The heat sink, which is a protective device that stops the drive from overloading and burning up. ***Advance***	✓PPT slides 27, 28  

Module Length: 240 min Time remaining: 190 min This section: 40 min (16 slides) *Section start time: _____* *Section End Time: _____*

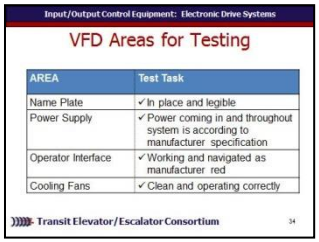
DO	SAY	Materials Needed
ASK **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Name at least 5 advantages of VF Drives. ***Call on participants for answer.*** ***Advance for the correct answer.*** ***Answers:*** Possible Answers: • Lessens electrical stress • Reduces maintenance and repair costs • Protects life of motor drive equipment • Capable of rapid & unnoticeable response to passenger load • Permits use of "standard" low cost induction motors • High input displacement power factor for lower cost output power v. power consumption • "Inherent" ability to "hold back" loads through power regeneration when used with external circuitry • High speed capability • Variable frequency control/variable speed control ***Advance***	✓PPT slide 30 

Module Length: 240 min Time remaining: 190 min This section: 40 min (16 slides) *Section start time:* _____ *Section End Time:* _____

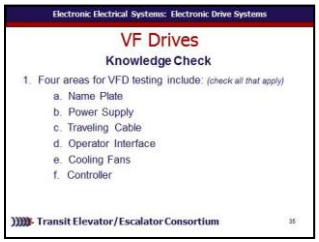
DO	SAY	Materials Needed
ASK **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** VF Drives gradually ramp the motor up to operating speed by operating speed by programming the motor for (check all that apply) a. Precise speed b. Precise position for stop c. Precise torque ***Call on participants for answer.*** ***Advance for the correct answer.*** ***Answers: a., b., c.*** ***Advance***	✓PPT slide 31



Module Length: 240 min | Time remaining: 150 min | This section: 20 min (4 slides) | *Section start time:* _____ | *Section End Time:* _____

DO	SAY	Materials Needed
REVIEW slides **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** All of the areas outlined above should be checked in one way or another under preventative maintenance. As always, follow your authorities' requirements for frequency of inspection and testing. Note that further directions on how these tests/inspections should be completed can be found in module 3 of this course: ***Advance*** Here is a brief list of areas to be tested and/or inspected. ***Continued***	✓PPT slides 33, 34  

Module Length: 240 min | Time remaining: 150 min | This section: 20 min (4 slides) | *Section start time: _____* | *Section End Time: _____*

DO	SAY	Materials Needed
ASK **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** Lets see what we have learned so far: Four areas for VFD testing include: *(check all that apply)* a. Name Plate b. Power Supply c. Traveling Cable d. Operator Interface e. Cooling Fans f. Controller ***Ask participants to name each part. Advance through the numbers to reveal answers.*** ***Answers: a., b., d., e.*** ***Advance***	✓PPT slide 35 

Module Length: 240 min | Time remaining: 30 min | This section: 30 min (3 slides) | *Section start time: _____* | *Section End Time: _____*

DO	SAY	Materials Needed
CLASSROOM ACTIVITY **Instructor's Notes** _____ _____ _____ _____ _____	**In your own words:** ***Read slide.*** ***For each objective, briefly review what was learned in this module or ask participants to share what they have learned for each learning objective and briefly discuss as a class.*** ***Advance*** Lets take a look at some of the key words we have defined as moved through this module. ***Read slide. Discuss definitions as a group.*** ***Advance***	✓PPT slides 38, 39