Motion Workshop

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E and M

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Workshop Objectives

- Motion Control 101
- Introduce EandM's **NEW** Motion Control Training course
- Hardware overview of EandM's Motion Trainer Unit (MTU)
- Motion Lab
  - Examine communication configuration
  - Examine TO configuration
  - Examine MC block configuration
  - Download to PLC and to S210 drives
  - Tune S210 drives
  - Control each axis using TO control panel
  - Test functionality of drives using KP8F
  - Test functionality of E-Stop and Door Limit Switch

Motion 101

What is Motion Control?

Motion control, a subfield of industrial automation, refers to the methods used to automate tasks that require precise and repeatable movements. It focuses on regulating the position, speed, acceleration and even force of moving components in a mechanical system. Motion control systems can use either pneumatic, hydraulic, or electromechanical actuation technology.

Motion 101

Examples of Industrial Motion Control

Robotic Assembly:

Motion control allows robotic arms to perform tasks like assembling components on an automotive production line or installing battery packs in an electric vehicle.

Motion 101

Examples of Industrial Motion Control

CNC machining:

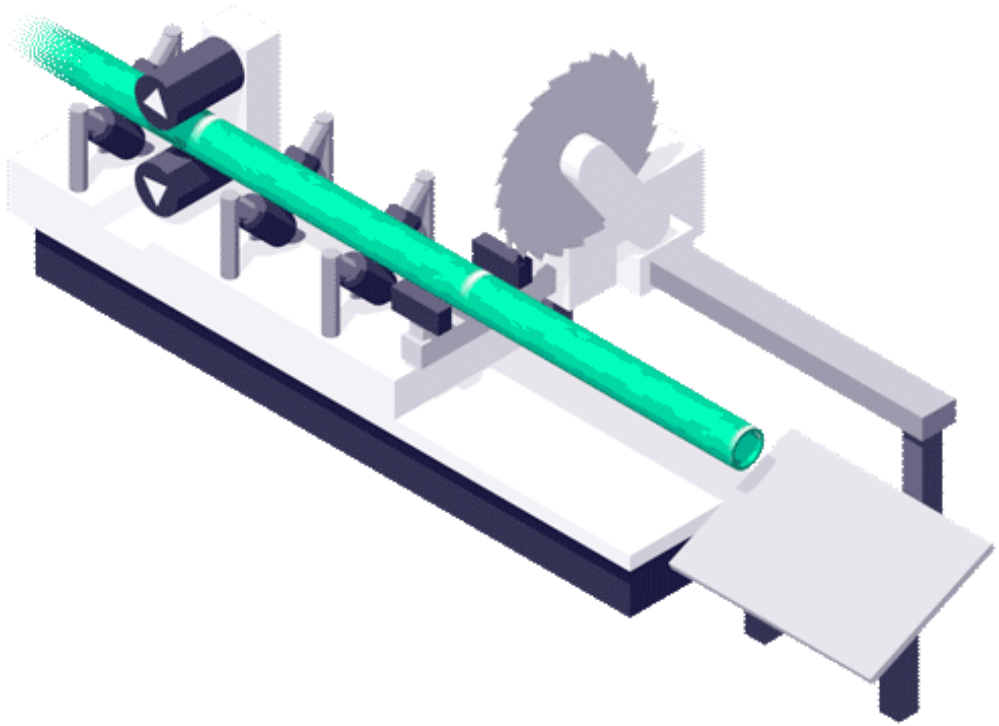
Provides precise control over cutting, drilling, and other fabrication processes to produce intricate and exact parts.

Motion 101

Examples of Industrial Motion Control

Cutting:

Precisely cut moving materials into fixed lengths in a continuous production line. It achieves this by synchronizing the speed of the saw's blade with the moving material. This allows for highly accurate and efficient cutting of items like steel pipes, wood, sheet metal, and paper without stopping the production line.

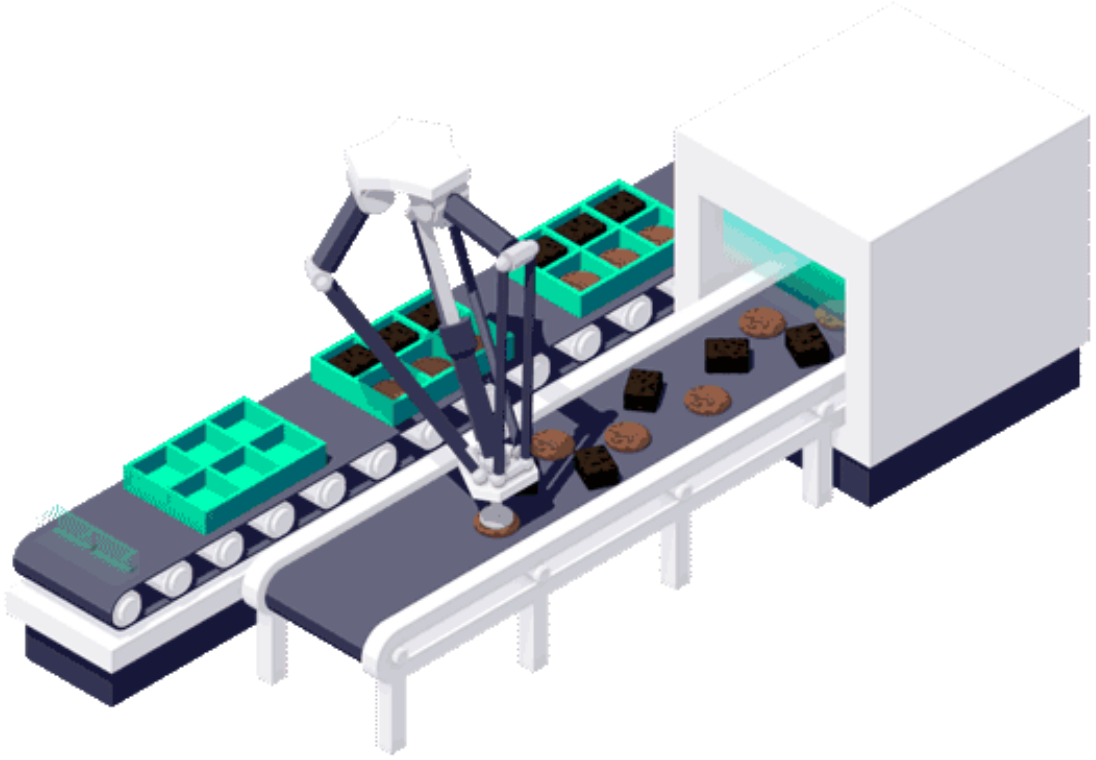


Motion 101

Examples of Industrial Motion Control

Pick-and-Place:

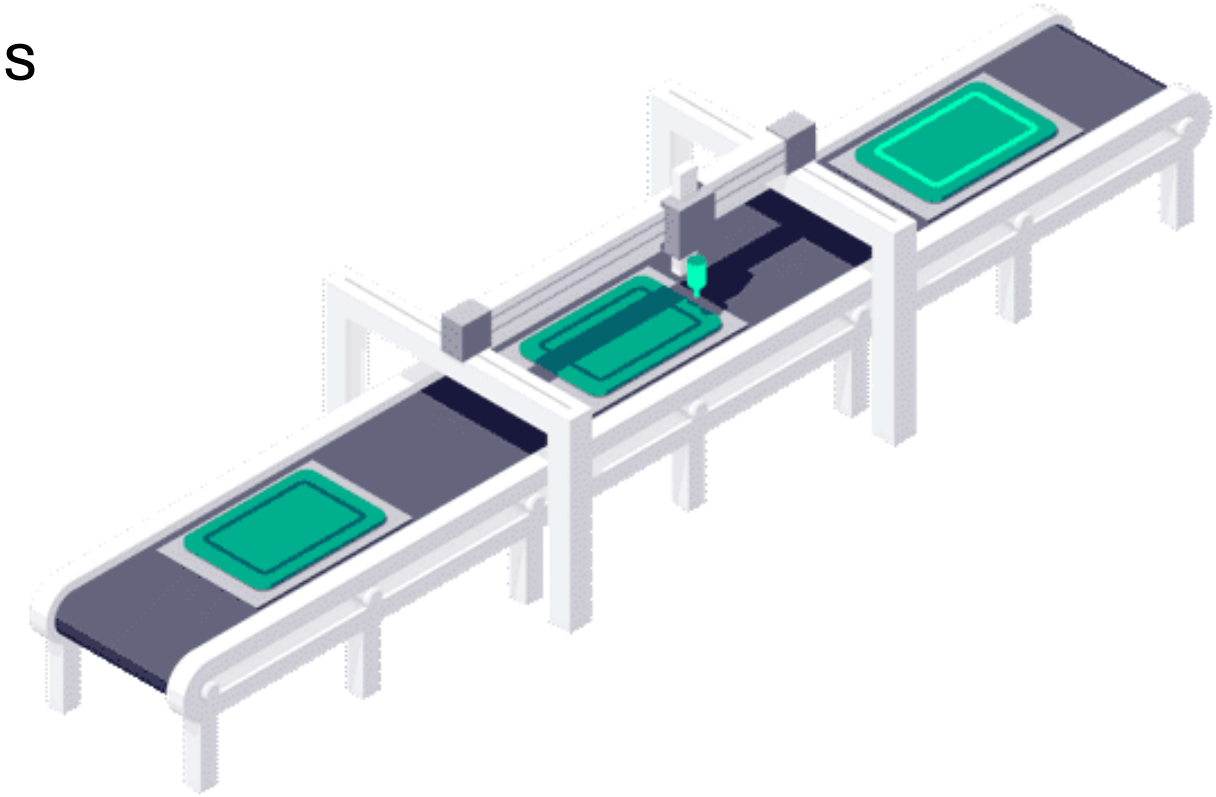
Automated systems, usually robotic arms, that automatically pick up items from one location and precisely place them onto another. In logistics and packaging, pick-and-place robots pick items from shelves or conveyors to place them into boxes, containers, or other downstream processes.



Examples of Industrial Motion Control

Assembly Lines:

Synchronized motion control ensures components are moved, positioned, and placed accurately in sequence, such as in the automotive or semiconductor industries.

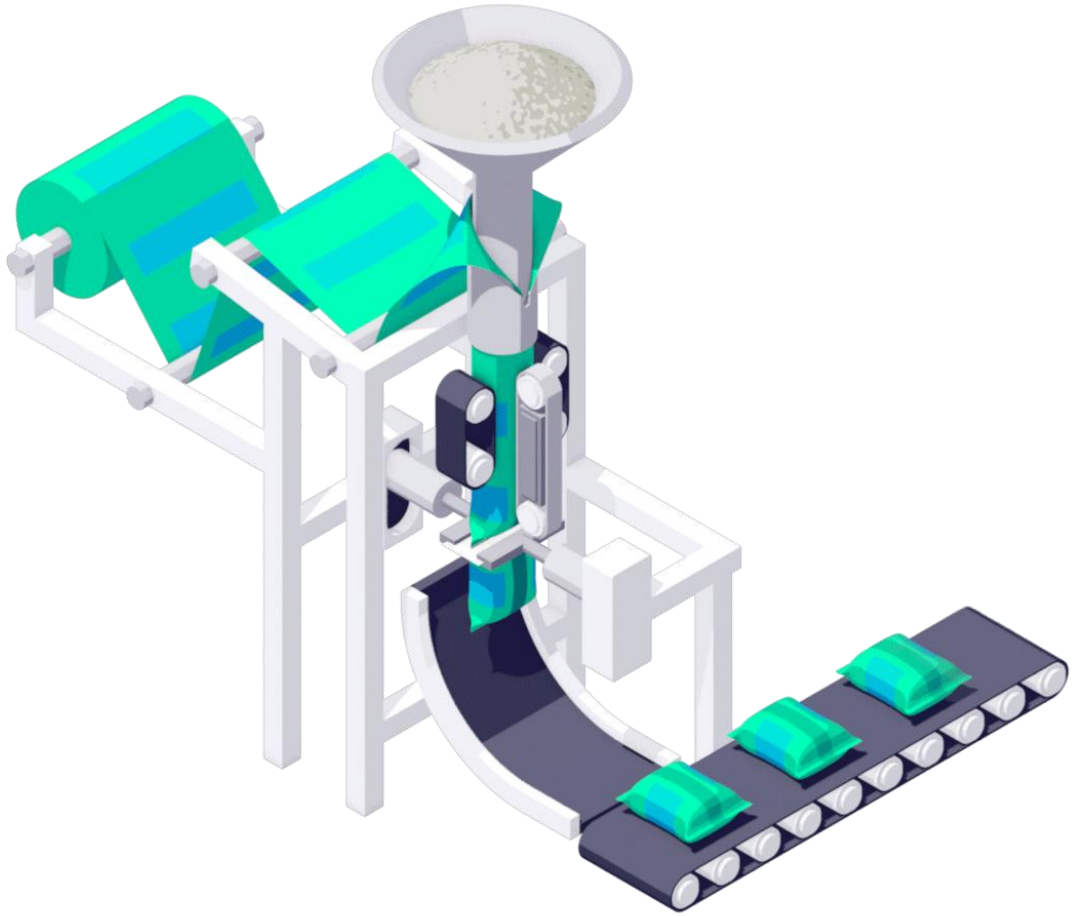


Motion 101

Examples of Industrial Motion Control

Packaging Machines:

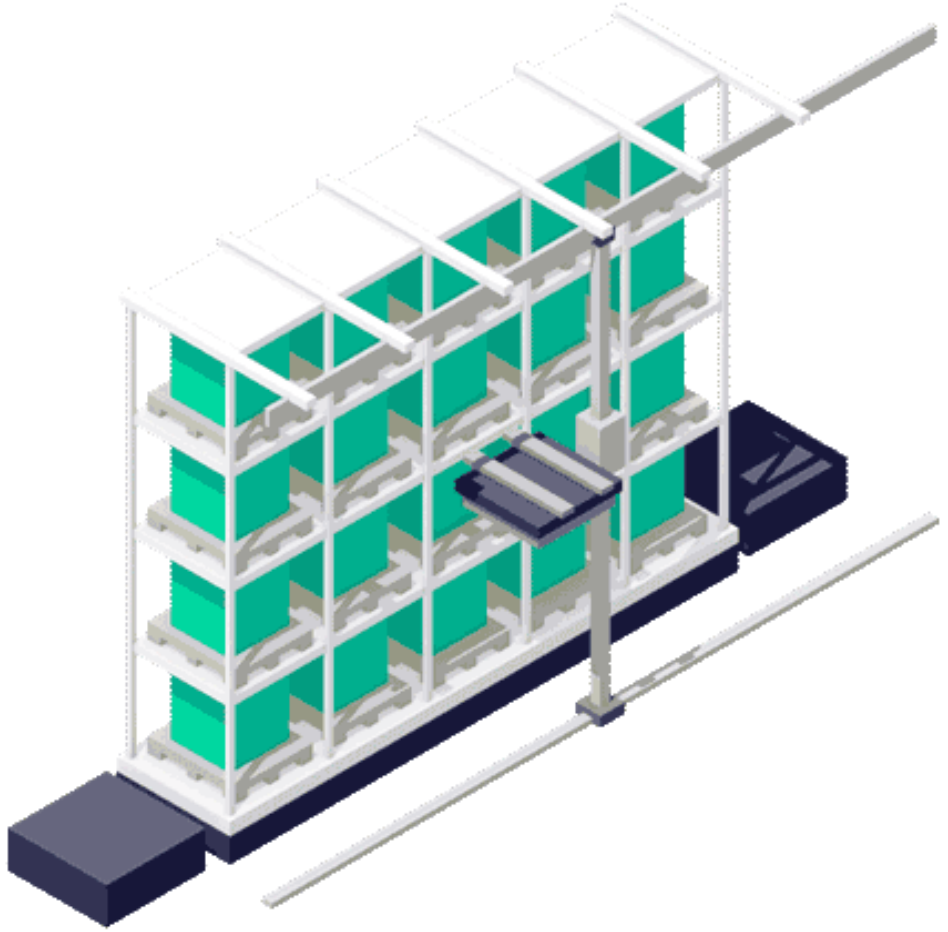
Precise movements are critical for dosing, filling, sealing, and labeling products, ensuring efficiency and minimizing waste.



Examples of Industrial Motion Control

Storage and Retrieval:

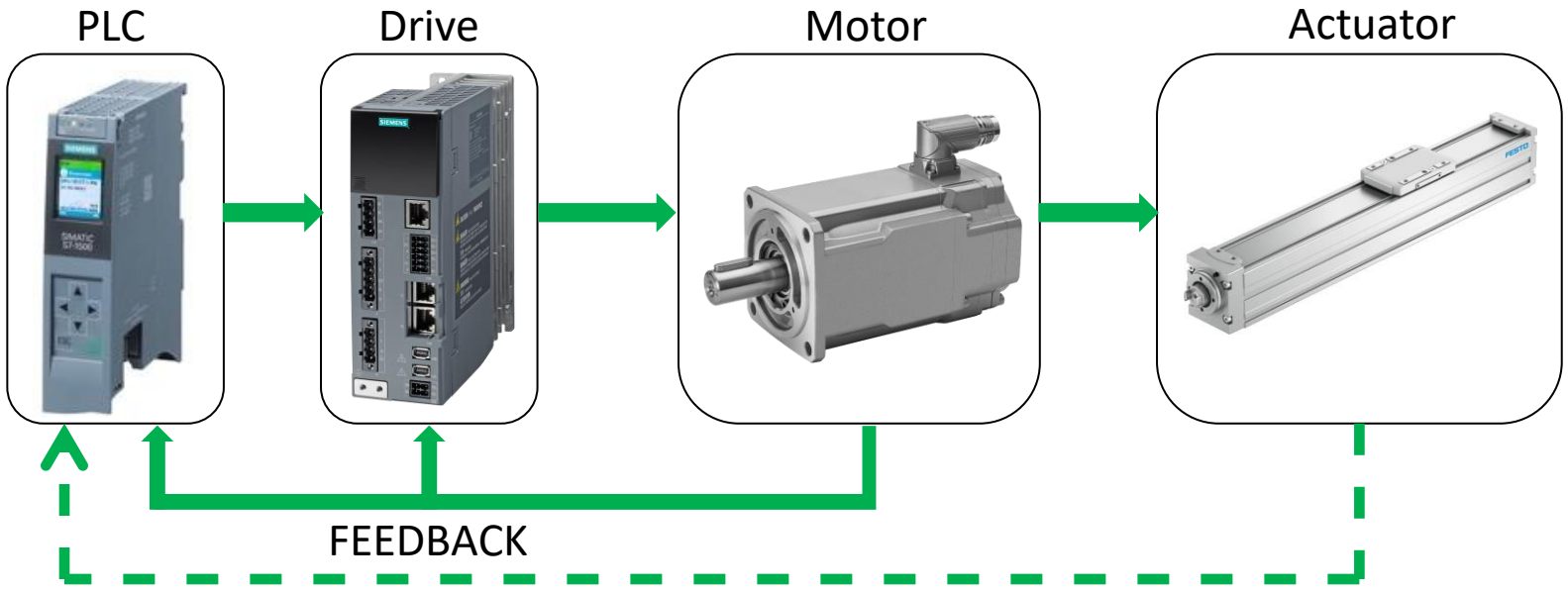
Automated storage and retrieval systems (ASRS) automates the storage and retrieval of goods in a warehouse, using robotic devices and automated structures to place and remove items from defined locations. These systems save space, improve picking accuracy and speed, provide tighter inventory control, reduce labor costs, and enhance overall warehouse efficiency and safety.



How Does Motion Control Work?

The four essential components of a motion control system are:

- Controller/PLC
- Driver/amplifier
- Sensing/feedback devices
- Motors/Actuator



Motion 101

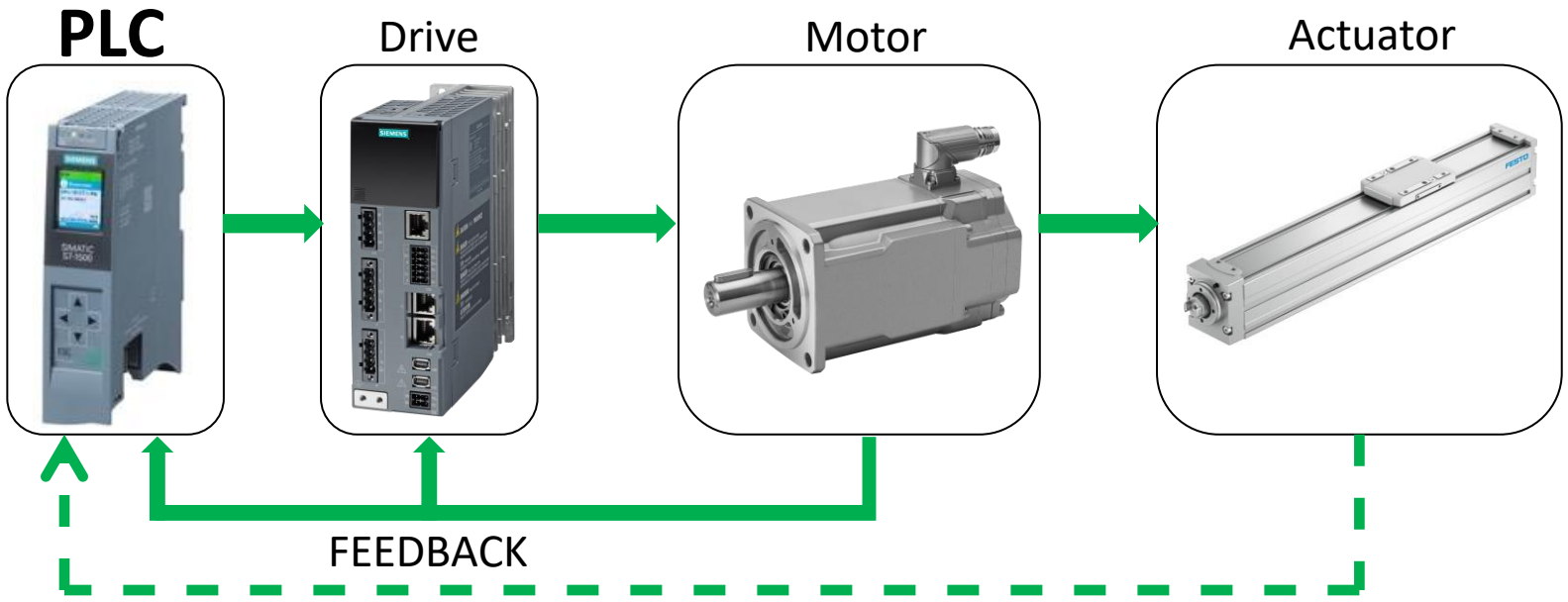
The **controller** is the "brains" of a servo system. It is responsible for generating the motion paths and for reacting to changes in the outside environment. Controllers can be something as simple as an ON/OFF switch, or a dial controlled by an operator.

They can also be as complex as a computer with the ability to actively control multiple servo axes as well as monitor I/O and maintain all the programming for the machine.

Typically, the controller sends a signal to the drive; the drive provides power to the motor; and the feedback from the motor is sent back to the controller and drive. Feedback from the load is also routed to the controller. The controller analyzes the feedback and corrects for errors by updating the signal to the amplifier. The controller is considered to be the intelligent part of the servo, closing the velocity and/or position loops while the amplifier closes the current loop.

However, many amplifiers will close the velocity and/or position loops reducing computational demands from the controller.

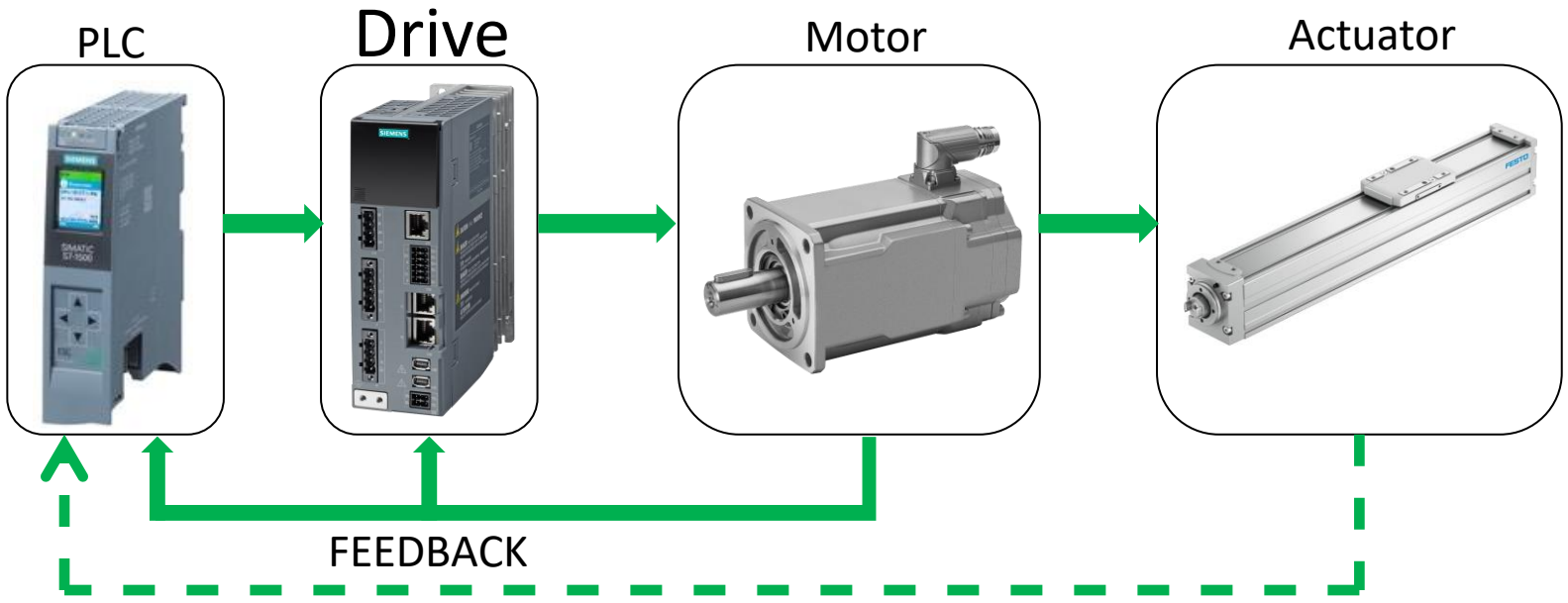
Controllers come in a variety of forms which people choose based on cost, performance, convenience, and ease of use. Most controllers fall into the category of Microcontrollers, **PLCs**, and Motion Controllers.



Motion 101

The **SERVO DRIVE** is the link between the controller and motor. Also referred to as servo controller or servo amplifiers, their job is to translate the low energy reference signals from the controller into high energy power signals to control a motor's precise speed, position, and torque. It uses feedback from an encoder (and/or other sensors) to constantly monitor the motor's output and make real-time adjustments to the voltage and current it supplies, ensuring accurate and predictable motion for tasks like robotics and machine positioning.

The current trend is to add more features and abilities to drives. Today drives can be expected to handle all the system feedback including encoders, resolvers and tachometers, as well as limit switches and other sensors. Drives are also being asked to close the torque loop, velocity loop and position loop and being given the responsibility of path generation. As the line between controller and drive blurs, the drive will take on many of the more complex control functions that used to be the sole domain of the controller.



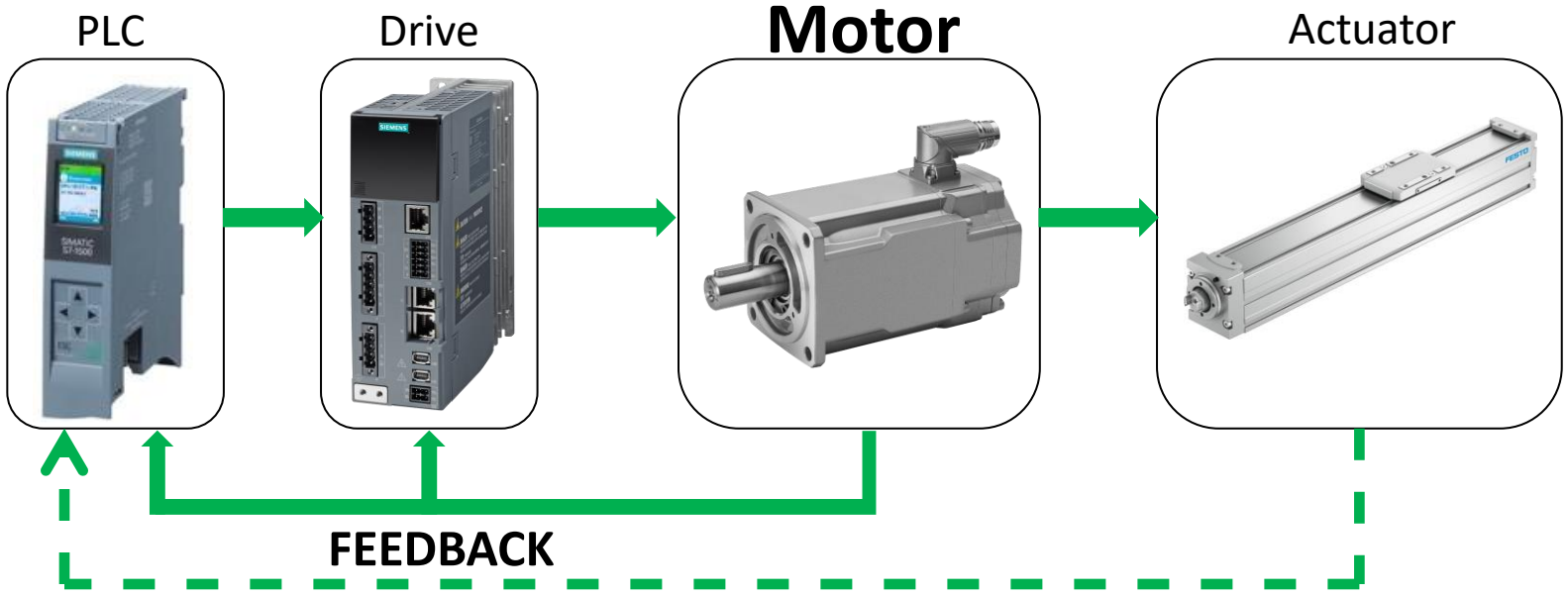
Motion 101

The main types of **motors** used in motion control are servo motors, stepper motors, DC brushed motors, and DC brushless motors (BLDC). Servo motors offer high precision and incorporate feedback for accurate positioning. Stepper motors move in precise, repeatable steps for controlled positioning. DC motors include brushed versions for lower cost and brushless versions for higher efficiency and longevity, often used in battery-powered systems. The choice of motor depends on the application's precision, speed, torque, and cost requirements.

In modern control systems, **feedback** devices are used to ensure that the motor or load reaches the commanded position or velocity. Servo amplifiers and controllers use this feedback to determine how much current to deliver to the motor at any time, based on its present position and velocity versus where it needs to be. There are two main types of feedback, absolute and relative (also known as 'incremental'). Typical feedback devices are encoders placed on the motor shaft.

Absolute Feedback
Absolute devices provide definitive position within a specified range upon power up (i.e. without a homing routine).

Relative Feedback (incremental)
These devices provide only incremental position updates. In order to know the motor or load's position, incremental feedback needs to be used in conjunction with some type of absolute feedback (a limit switch, for example) to determine the initial position. Once the initial position is known, relative feedback can provide position information throughout the range of motion.

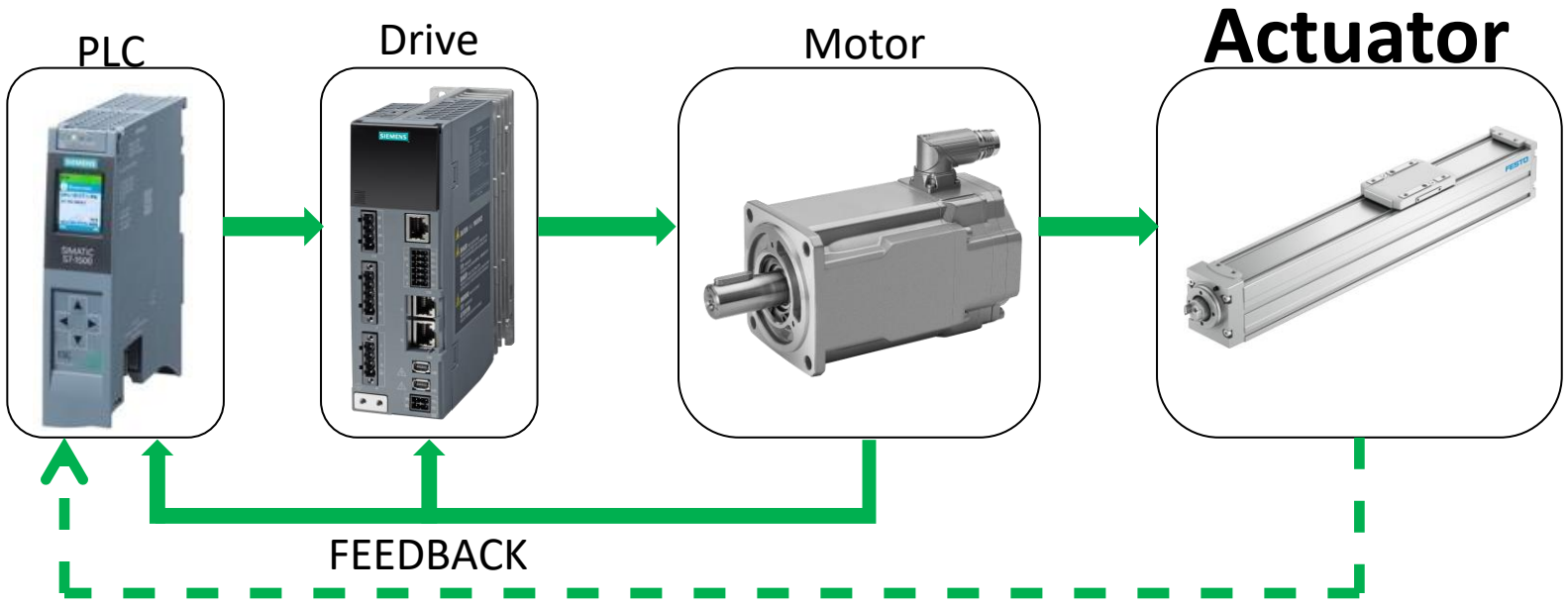


Motion 101

An **actuator** is a device in an automated system that makes something move or operate, such as linear or rotary movement. It serves as the "mover" of the system, physically executing commands to produce the desired force, torque, or displacement by receiving energy from electrical, hydraulic, or pneumatic sources. Examples include electric motors (like servo and stepper motors), hydraulic cylinders, and pneumatic devices.

Common Types of Actuators

- Electric Actuators: These use electric motors, such as servo motors or stepper motors, to generate motion.
- Hydraulic Actuators: These use pressurized hydraulic fluid to produce movement.
- Pneumatic Actuators: These utilize compressed air to create mechanical motion.



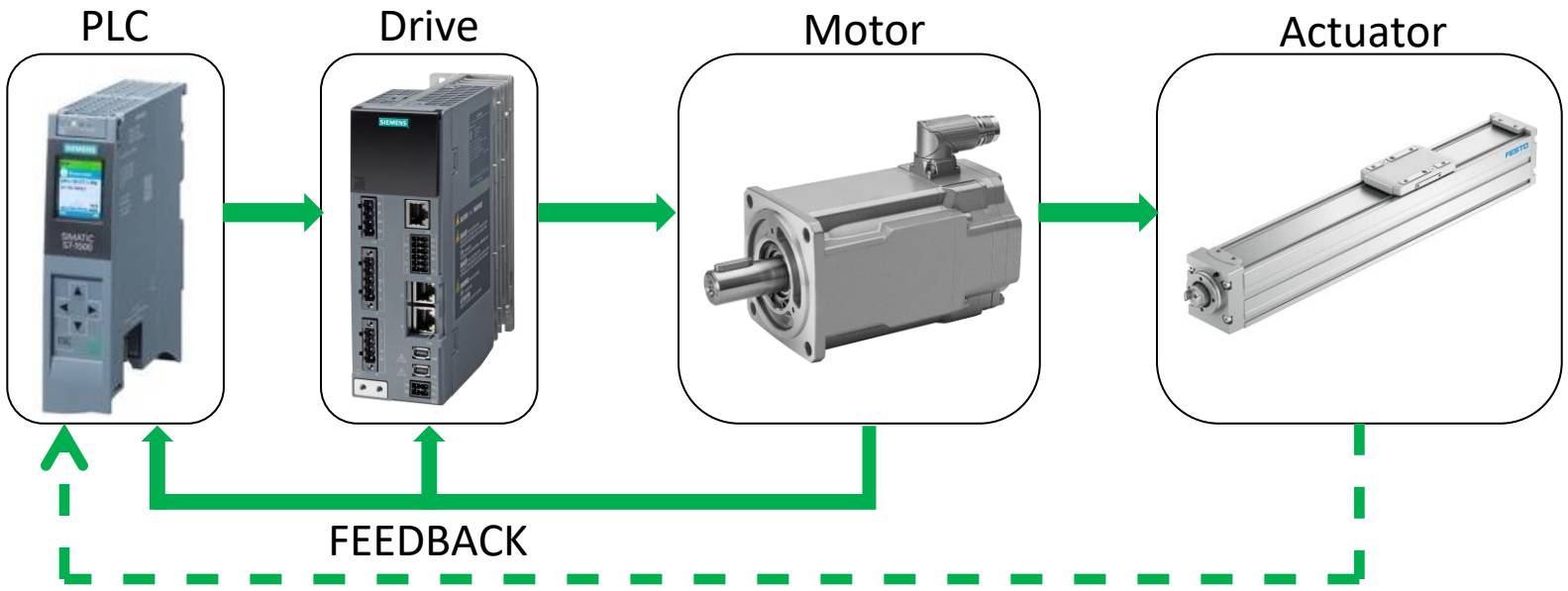
Motion 101

When we put it all together, it forms the Control Loop. The feedback from the motor encoder and sensors informs the controller of the actuator position. The controller compares the actual position with the desired target position.

The controller performs rapid calculations based on preset conditions and provides corrective action to the servo drive. The motor moves the actuator to the desired position.

As you can imagine, this action needs to be precise and occur in the blink of an eye. Having the actuator in the right position is essential, and any deviation from the target position could result in defects or worse.

Servo-drive logic can include up to three types of servo loops – current, velocity, and position. These servo loops use feedback signals to adjust the output of the loop to produce the desired result.



EandM Motion Training Course

- Deep dive into the fundamentals of Motion Control systems
- Overview of Motion Control functions
  - Speed
  - Position
  - Gearing
  - Camming
  - Kinematics
- Overview of Motion Control hardware/software offerings from Siemens and Festo
- Hardware overview of EandM's Motion Trainer Unit (MTU)
- All programming and configuration done in the latest version of Siemens TIA Portal
- Parameterization and tuning of Siemens S210 servo drives
- Deep drive into PLC Technology Objects (TO) and configuration
- Deep drive into PLC Motion Control blocks (MC) and programming of blocks
- Configuration of a HMI runtime for user control of motion system
- Configuration of Siemens KP8F touch button HMI
- Safety configuration and programming for safe motion control
- Testing and Diagnostic tools
- Plus more!

SIGN UP NOW!

Motion Equipment

1. Siemens S7-1511TF-1 PN PLC
2. Axis A
   - Siemens Sinamics S210 Servo Drive
   - Siemens 1FT2 Servo Motor
   - Festo ELGC linear actuator
   - Festo proximity sensors
3. Axis B
   - Siemens Sinamics S210 Servo Drive
   - Siemens 1FT2 Servo Motor
   - Festo ELGC linear actuator
   - Festo proximity sensors
4. Siemens KP8F
5. SICK REI Door Safety Switch
6. Siemens E-STOP Pushbutton
7. Disconnect Switch

Engineered
with TIA Portal

SIMATIC S7-1500 T-CPU

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Advanced Controller – SIMATIC S7-1500 T-CPU

Extended Motion Control functions with TIA Portal V18 and firmware V3.0 [1)]

Additional Motion Control functions

- Gearing and camming
  - Synchronization with specifying the synchro-nous pos. of the leading and following axes
  - Setpoint value coupling
  - Actual value coupling with extrapolation
  - Leading-value-coupled correction profiles on the following axis
  - **Velocity gearing** — New
- Cam profiles (1,000 points / 10,000 points)
- Cross-PLC synchronous operation
  - Synchronisation between axes on different CPUs
- Kinematic functions
  - **Control of kinematics with up to 6 interpolating axes** — New
- SIMATIC Safe Kinematics V2.0
  - Optional fee-based system library for safe motion monitoring in the cartesian space

Integrated editors and viewers

- Kinematics configuration
- Kinematics trace
- Cam profile editor with extended diagnostics
- Coordination of traces in different CPUs
- **Long-Term traces** — New

Hardware innovations

- SIMATIC S7-1500 T-CPUs
  - **CPU 1511T, CPU 1511TF** — Upd
  - **CPU 1515T, CPU 1515TF** — Upd
  - CPU 1516T, CPU 1516TF
  - CPU 1517T, CPU 1517TF
  - CPU 1518T, CPU 1518TF
  - **CPU 1514SP T, CPU 1514SP TF** — New
  - CPU 1515SP PC2 T/TF
  - CPU 1504D TF, CPU 1507D TF
- Standard-, Safety-plc and Motion Control on one controller

Programming

Consistent and seamless extension of S7-1500 by S7-1500 T-CPU

Web server

Diagnostic pages for Motion Control

[1)] Compared to the standard CPU

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Overview
Motion Control functions and typical applications

S7-1200

S7-1500

S7-1500 T-CPU

Kinematics functions (with up to 6 interpolating axes, conveyor tracking)

- Cartesian portals
- Roller pickers
- Delta pickers
- SCARA robots
- Articulated arms, …

Coordination (synchronous operation, cams)

- Machines with a very high number of axes
- Synchronized axes (also cross-PLC)
- Cross cutters
- Flying shears, ...

Positioning
Speed setpoint

- Palletizers, ...
- Hoisting + vertical conveyors
- Feeder + door control systems
- Conveyor belts
- Auxiliary drives, ...

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Advanced Controller – SIMATIC S7-1500
Overview Motion Control functionalities (extract)

S7-1500

S7-1500 T-CPU

Kinematics functions

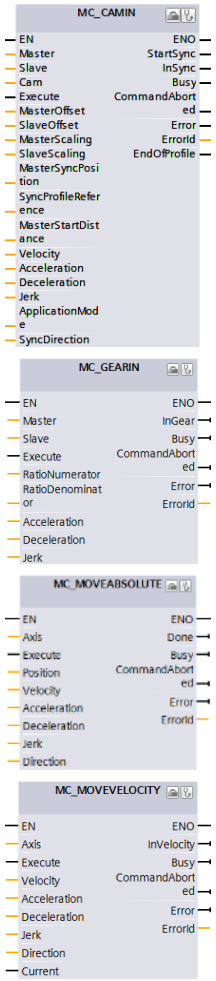
Camming
Gearing

Positioning

Speed setpoint

Output cams
Measuring input

- Kinematics with conveyor tracking (T-CPU only)
- **Kinematics with up to 6 interpolating axes** (T-CPU only) **New**
- Cross-PLC synchronous operation (T-CPU only)
- Leading value coupled correction profiles on the following axis (T-CPU only)
- Camming (T-CPU only)
- Coupling onto actual values (T-CPU only)
- Gearing - With synchronous position (T-CPU only)
- Gearing - Without synchronous position
- **Velocity gearing** (T-CPU only) **New**
- Encoder switch over to 2nd – 4th encoder (T-CPU only)
- Specification of motion vector from application (T-CPU only)
- Move axis to relative/absolute position or superimposed during active motion
- Cyclic interface for torque data
- Moving an axis with torque limiting
- Homing absolute and on the fly, Setting a position
- Traversing an axis with speed setpoint
- Enabling/disabling an axis
- Activating output cams and cam tracks and measuring inputs
- …



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Advanced Controller – SIMATIC S7-1500 T-CPU
Overview in comparison to standard controllers

Performance (TIA Portal V18)			SIMATIC S7-1500 Controller							Distributed Controller		Drive Controller	
					Upd.					New	Upd.	Upd.	
			CPU 1511	CPU 1513	CPU 1515	CPU 1516	CPU 1516T	CPU 1517	CPU 1518	CPU 1514SP	CPU 1515 SP PC2 (*)	CPU 1504D TF	CPU 1507D TF
Number Positioning axes	Typical [3]		11		11		55	70	140	11	30	12	55
	Maximum [4]		14		30		80	128	192	30	30	40	160
Motion Control functionality	Cross-PLC synchronous operation	Technology											
	Kinematics functions	Technology											
	Camming	Technology											
	Gearing[1] (with synchronous position)	Technology											
	Gearing[2] (without synchronous position)	Standard											
	Output cam / Measuring input	Standard											
	Positioning	Standard											
	Open-loop speed control	Standard											

[1] Synchronization with specification of the synchronous position, Velocity gearing

[2] Synchronization without specification of the synchronous position

[3] At 4 ms Servo/IPO cycle time and 35 % CPU load due to Motion Control. Estimated values are subject to implementation of use case.

[4] No further TO's applicable

(*) With TIA V18 (planned Q2/2023)

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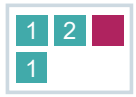
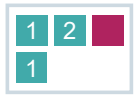
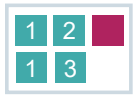
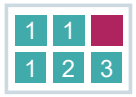
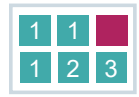
Advanced Controller – SIMATIC S7-1500
Expansion of the CPU portfolio with Technology CPUs

	Upd.	Upd.	Upd.[6]			New	Upd.[6]	Upd.[6]	Upd.[6]
	Technology CPU					Distributed Controller		Drive Controller CPU	
CPU types	**1511T/TF-1 PN**	**1515T/TF-2 PN**	**1516T/TF-3 PN/DP**	**1517T/TF-3 PN/DP**	**1518T/TF-4 PN/DP**	**1514SP T/TF-2 PN**	**1515SP PC2 T/TF PN (*)**	**1504D TF**	**1507D TF**
Interfaces									
Program memory **Data memory**	450 kB 1,5 MB	1,5 MB 4,5 MB	3 MB 7,5 MB	3 MB 8 MB	9 MB 60 MB	900 kB 3,5 MB	3 MB 7,5 MB	4 MB 6 MB	15 MB 40 MB
Bit performance	25 ns	6 ns	6 ns	2 ns	1 ns	6 ns	10 ns	Scale with Motion Control performance	
Functions	Display, S7-1500 backplane bus					ET 200SP backplane bus (no isochronous mode)		• SINAMICS S120 Integrated (incl. 12 DI, 8 DI/DQ) • PLC technology I/Os (8 DI/DQ)	
Positioning axes ▪ **Typical[1]** ▪ **Maximum[2]**	 11 14	 11 30	 55 80	 70 128	 140 192	 11 30	 30 30	 12 40	 55 160
Motion Control Resources[3]	1.120	2.400	6.400	10.240	15.360	2.400	2.400	3.200	12.800
Extended Motion Control Resources[4, 5]	90	120	192	256	512	120	120	160	420

1 At 4 ms Servo/IPO cycle time and 35 % CPU load due to Motion Control. Estimated values are subject to implementation of use case.
2 No further TO´s applicable
3 Resources for Motion Control technology objects:
Speed axis = 40 | Positioning axis = 80 | Synchr. Axis = 160 | Output cam= 20 | Output cam track = 160 | Measuring input = 40 | Ext. Encoder = 20
4 Resources for Extended Motion Control technology objects:
Cams (1.000 points and 50 segments) = 2 | Cams (10.000 points and 50 segments) = 20 | Kinematic objects= 30 | Leading axis proxy = 3
5 1514 T/TF, 1515 T/TF: Maximum 1 kinematic object is recommended
6 Enhanced functionality for existing CPUs through FW upgrade

(*) With TIA V18 (planned Q2/2023)

1 PROFINET IO with IRT 2 PROFINET IO with RT 3 PROFINET Basic communication (1 Gbit) PROFIBUS

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Advanced Controller – SIMATIC S7-1500 Technology-CPU
Scalable Motion Control in the advanced controller portfolio

SIMATIC S7-1500 T-CPU

Feature / Function	Benefits
Extended Motion Control functions: • Speed-, positioning axis • Gearing • Camming • Kinematics with up to 6 interpolating axis	**Simple programming of sophisticated Motion Control functions:** • In the well known SIMATIC environment • For a high machine flexibility • E.g. assembly or handling tasks based on PLCopen
Kinematics configurator and trace • Path recording • Kinematics control panel	**Simple 3D visualization and diagnosis** of movements as well as **commissioning** of the kinematics
Cam editor integrated in the TIA Portal • Simple definition of non-linear dependencies between leading and following axes	**High engineering efficiency** through • Graphic-based and tabular configuration • Optimization of cams
Consistent functionality and programming of S7-1500 throughout to S7-1500 T-CPU	**Seamless extension** of the Motion Control functionality of a standard CPU in TIA Portal
Failsafe PLC • With extended Motion Control functions	Standard automation, Motion Control and safety functions **inside one CPU**

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SINAMICS S210
SIMOTICS S-1FK2

Servo drive system for medium-complexity higher-dynamic motion control

usa.siemens.com/cnc

SINAMICS S210 servo drive
Top-10 specs

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Format		Component drive paired with synchronous servo motor		
Supply voltages / power range		**Power**	**Torque**	
	1AC 200 – 240V	0.13 – 1 Hp (100 – 750 W)	0.16 Nm - 2.4 Nm	
	3AC 380 – 480V	In development		
Control		Servo		
Communication		PROFINET IRT, PROFIsafe, PROFIenergy		
Features		• Auto-configuration • One-button tuning • One cable connection with SPEED-CONNECT quick-lock fastener and compact, rotatable plug • Allowed cable length: up to 165 ft. (50 m) • Internal braking resistor		
Motor compatibility		Synchronous – SIMOTICS S-1FK2		
Degree of Protection		IP20		
Commissioning / Configuration Tools		Web server, Startdrive		
Safety Technology		• Safe Torque Off	• Safe Stop 1	Safe Brake Control
Standards Compliance		CE, UL		

SIMOTICS S-1FK2 synchronous servo motor
Highlights

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Format		Synchronous servo motor	
Supply voltages / power range		**Power**	**Torque**
	1AC 200 – 240V	0.13 – 1 Hp (100 – 750 W)	0.16 Nm - 2.4 Nm
Configuration		• Low rotor inertia (High dynamic) in shaft height 20 to 40 mm • Medium rotor inertia (compact) in shaft height 30 mm	
Cabling		• One cable connection with SPEED-CONNECT quick-lock fastener and compact, rotatable plug • Allowed cable length: up to 165 ft. (50 m)	
Encoder		• 20 Bit Abs. single or multiturn	
Options		• High Dynamic (HD) or Compact (CT) • Plain or feather key shaft • With or without holding brake • Plain or feather key shaft, rotary shaft seal	
Degree of Protection		IP64; IP65 option	
Standards Compliance		cURus	

SINAMICS S210 servo drive system
Overview

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The SINAMICS S210 Servo Drive System is a single-axis AC/AC drive with enhanced features, connectivity and performance for high-dynamic midrange motion control applications – such as those found in the packaging, medical instrument manufacturing and material handling areas

Comprised of the SINAMICS S210 servo drive and the SIMOTICS S-1FK2 servo motor, this servo drive system features compact or high-dynamic versions and a dedicated “One-Cable-Connection” between motor and drive

It works perfectly together with the Siemens SIMATIC S7 controllers like S7-1500 or S7-1500T to perform motion control tasks such as positioning, synchronous axis, gearing and more

Highlights

- PN IRT communications
- Safety Integrated: Basic and Extended functions via PROFIsafe
- Dedicated S-1FK2 motors (compact and high dynamic) with One-Cable-Connection

- Integrated webserver and “One-Button Tuning”
- UL Certification
- Integrated category C2 EMC-filter

SINAMICS S210 servo drive system
Features

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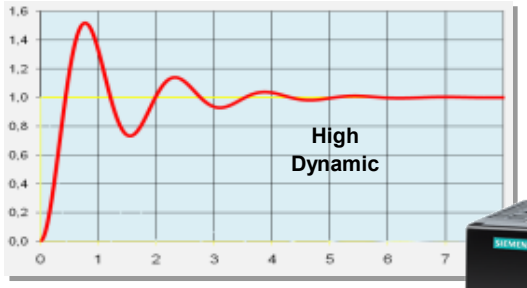
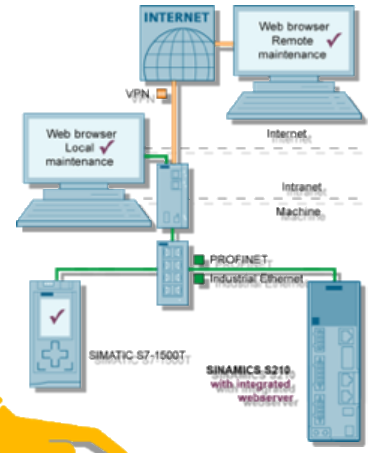
Compact design / high performance

- 1AC 230V
- 0.05 - 0.75kW



Optimal integration with SIMATIC controller



Simple installation with one-cable motor connection

Integrated safety functionality

Easy commissioning with integrated webserver and one-button tuning

Ready for worldwide markets

SINAMICS S210 servo drive system
One-cable connection

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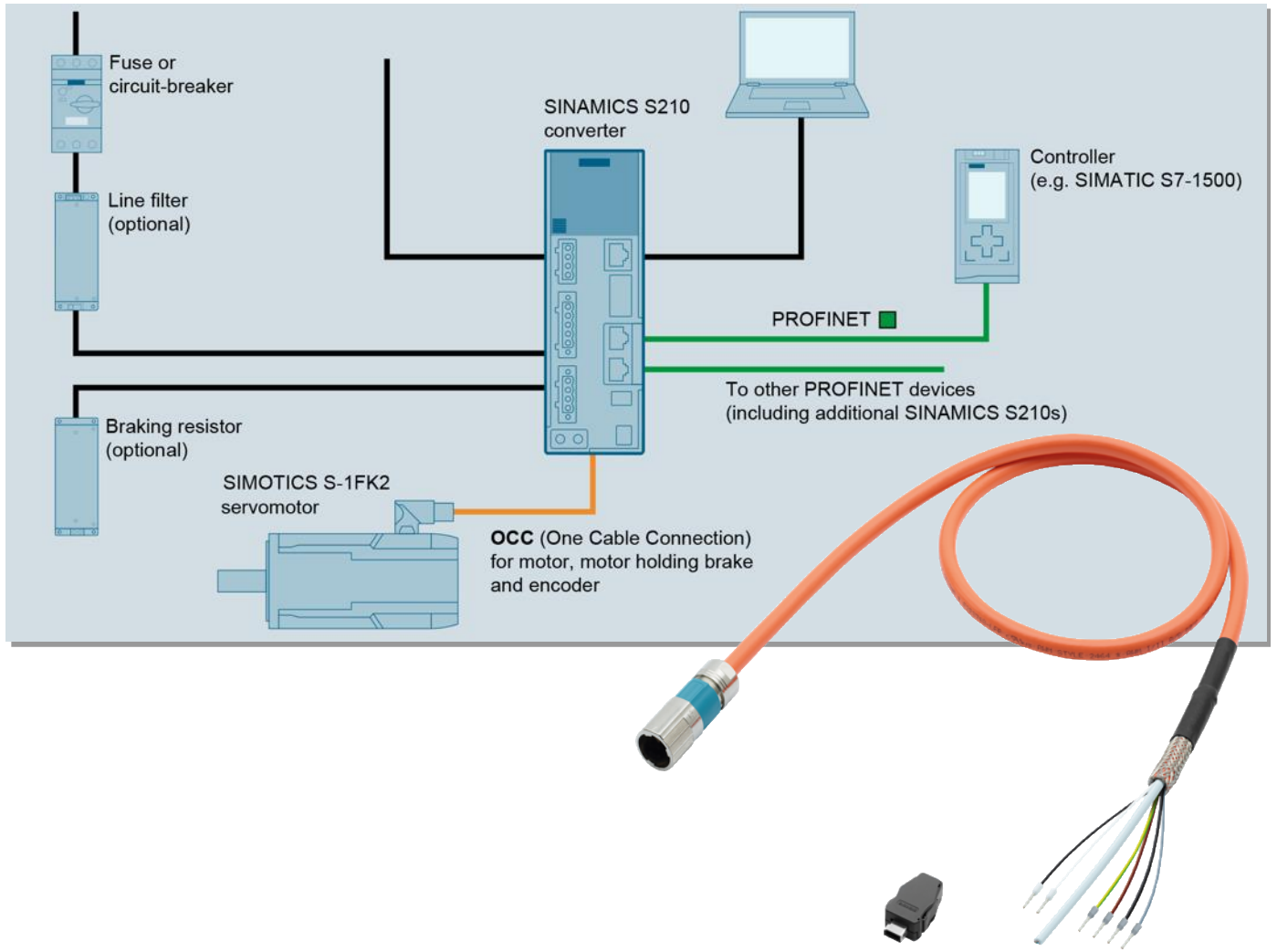
Ingenuity for life

- Individual cable lengths up to 50m (165 ft.) may be ordered
- SPEED- CONNECT fast connection system with rotatable motor connector
- Flexible cables with small bending radii
- Trailing cable version available
- Small and compact M12 connector for motor SH20/30mm – only 25mm in height
- Extension cables and mounting flange available



SINAMICS S210 servo drive system
Optimizing via web server

The SINAMICS S210 web server offers easy

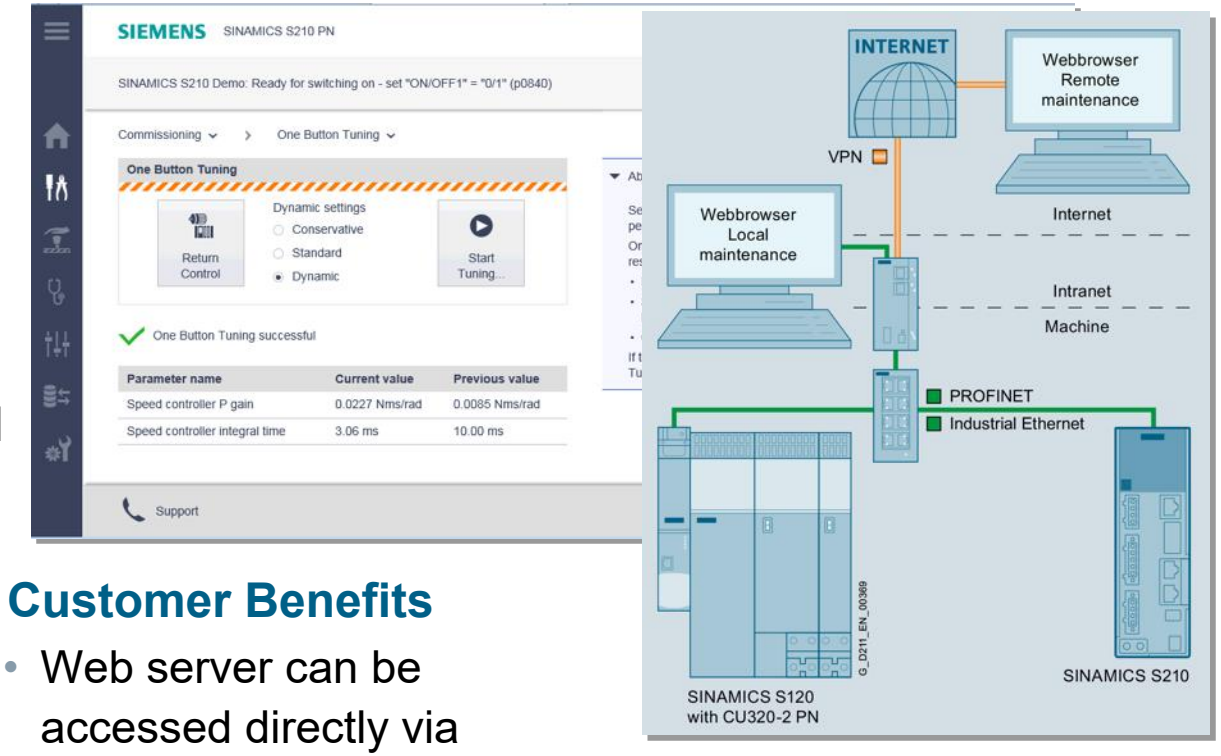
- Parameter assignment
- Commissioning purely oriented to the functionality of the drive
- Bringing drive into operation with a few clicks

By reading the electronic type plate of the connected SIMOTICS S-1FK2 servomotor, only a few operator actions are needed – such as One-Button tuning

- Motor and encoder are automatically detected
- Controller parameters are automatically optimized

Three selectable dynamic levels of controller can optimally consider the desired behavior of the connected mechanics

Axis motion can take place directly via the control panel during commissioning



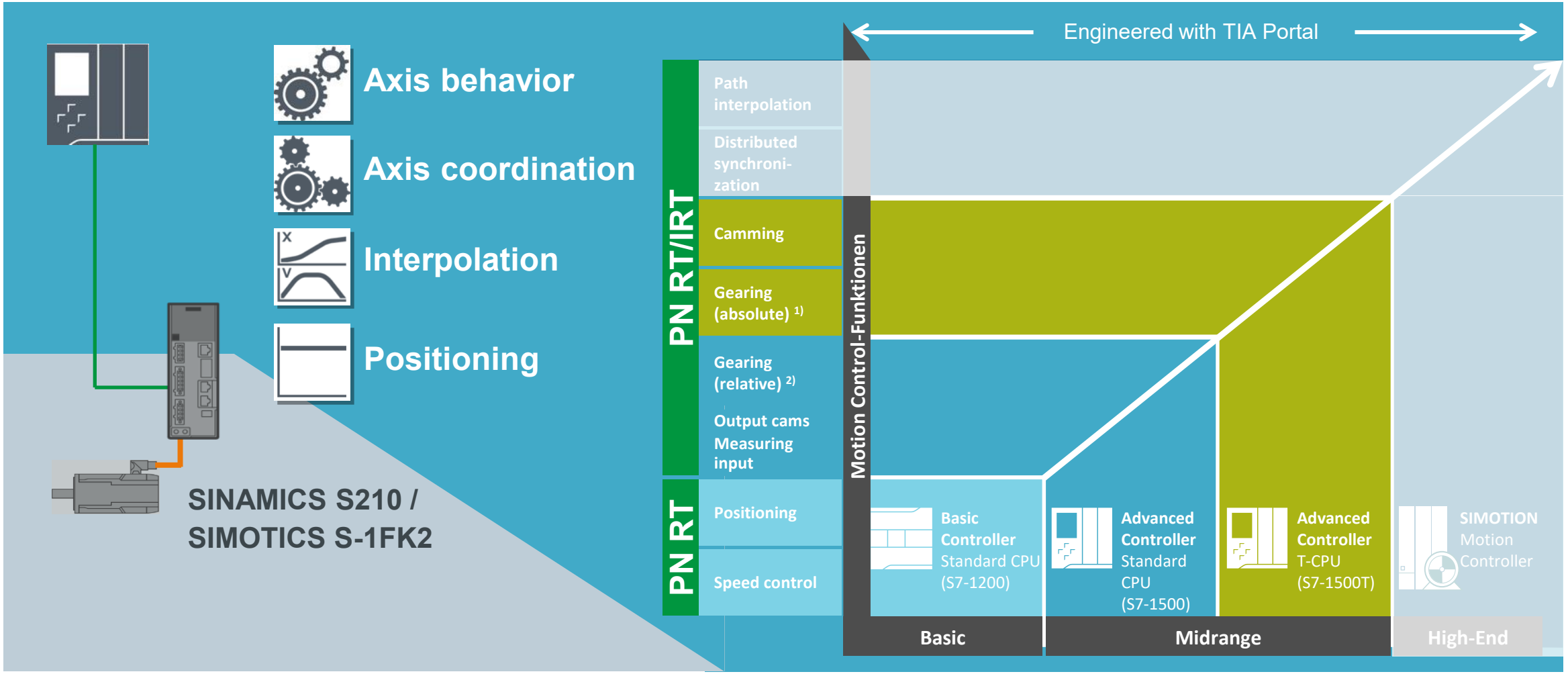
Customer Benefits

- Web server can be accessed directly via PROFINET – commissioning for hard-to-get-to places
- Full diagnostic capability – no need for additional software
- Commissioning and diagnostics via computer and mobile devices
- Intuitive user interface

SINAMICS S210 servo drive system

Motion control via SIMATIC S7, SIMOTION and PROFINET

SIEMENS
Ingenuity for life



1) Synchronization with specification of the synchronous position

2) Synchronization without specification of the synchronous position

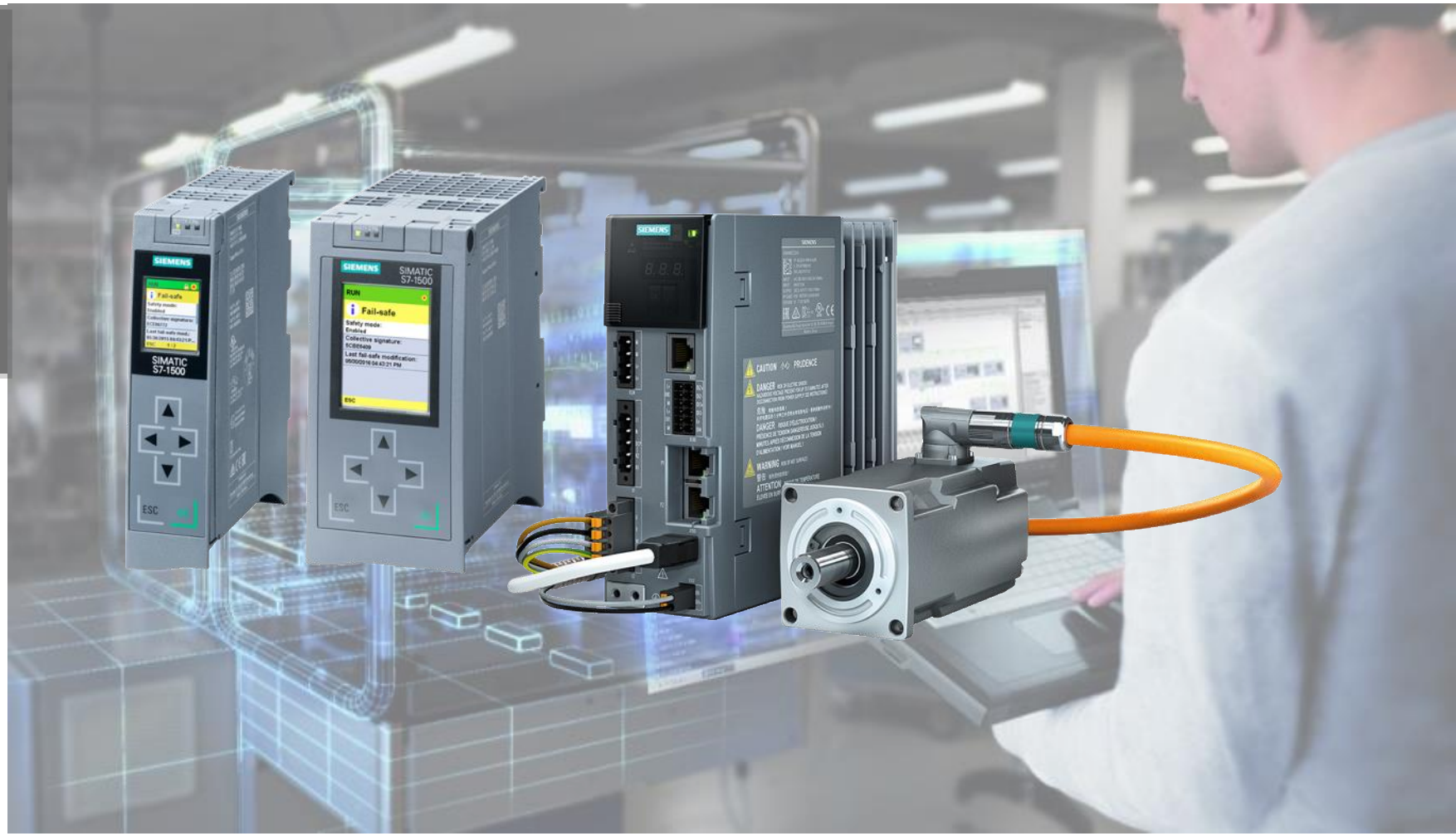
SINAMICS S210 servo drive system

With SIMATIC S7-1500, SIMATIC S7-1500 T-CPU, PROFINET

SIEMENS
Ingenuity for life

TIA Portal usability

- Easy to program
- System simulation
- Integrated safety
- Built-in diagnostics



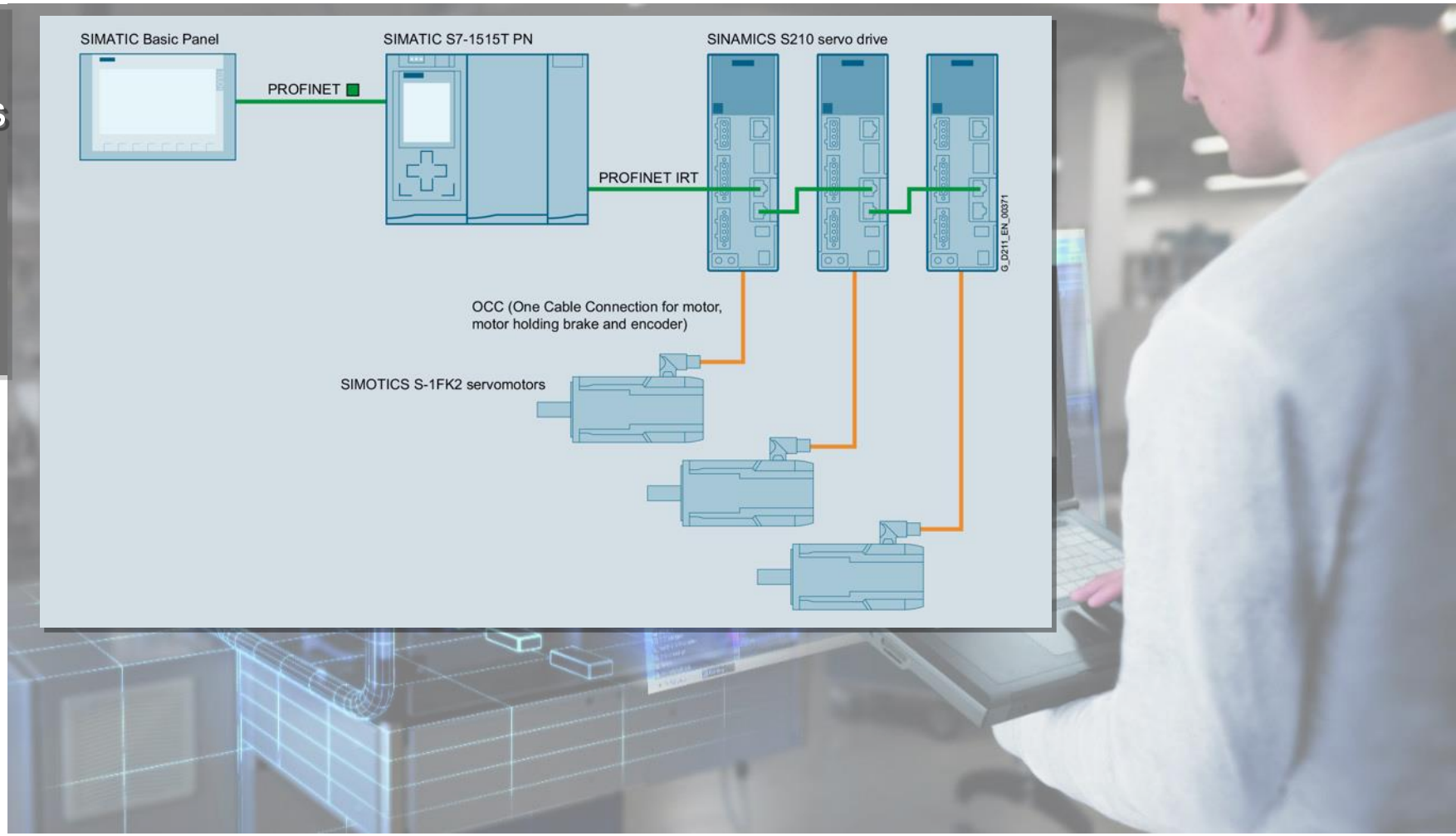
SINAMICS S210 servo drive system

With SIMATIC S7-1500, SIMATIC S7-1500 T-CPU, PROFINET

SIEMENS
Ingenuity for life

TIA Portal usability

- Wide range of applications
- High dynamics
- Cost efficient results



SINAMICS S210
Components

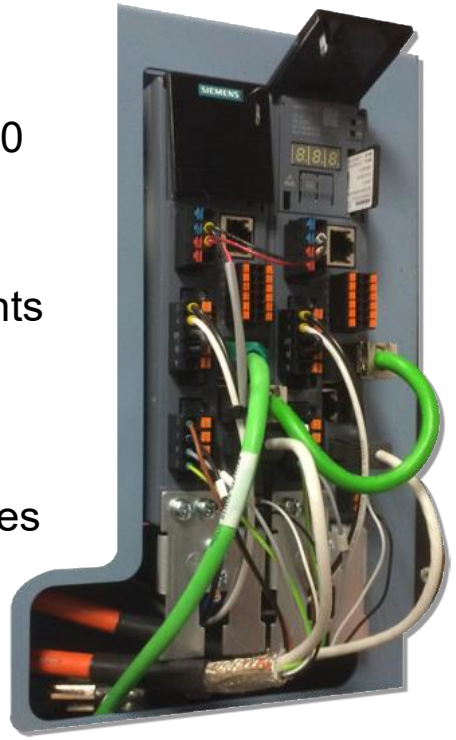
SIEMENS
Ingenuity for life

Line filter

- Filters are already integrated in the SINAMICS S210 in order to achieve category C2 (for motor cable lengths up to 33 ft./10 m) or category C3 (for motor cable lengths up to 82 ft./25 m). Further requirements can be achieved using an external line filter

Overcurrent protective devices

- Siemens offers a comprehensive selection of devices to meet IEC and UL regulations for a broad range of applications



Braking resistor

- Integrated into the SINAMICS S210
- Together with the generously dimensioned DC link capacities, an external braking resistor is not normally required

Memory card

- Drive parameters may be stored on the memory card (optional)
- In the event of drive replacement, insert memory card in the new SINAMICS S210 and the system is ready to run

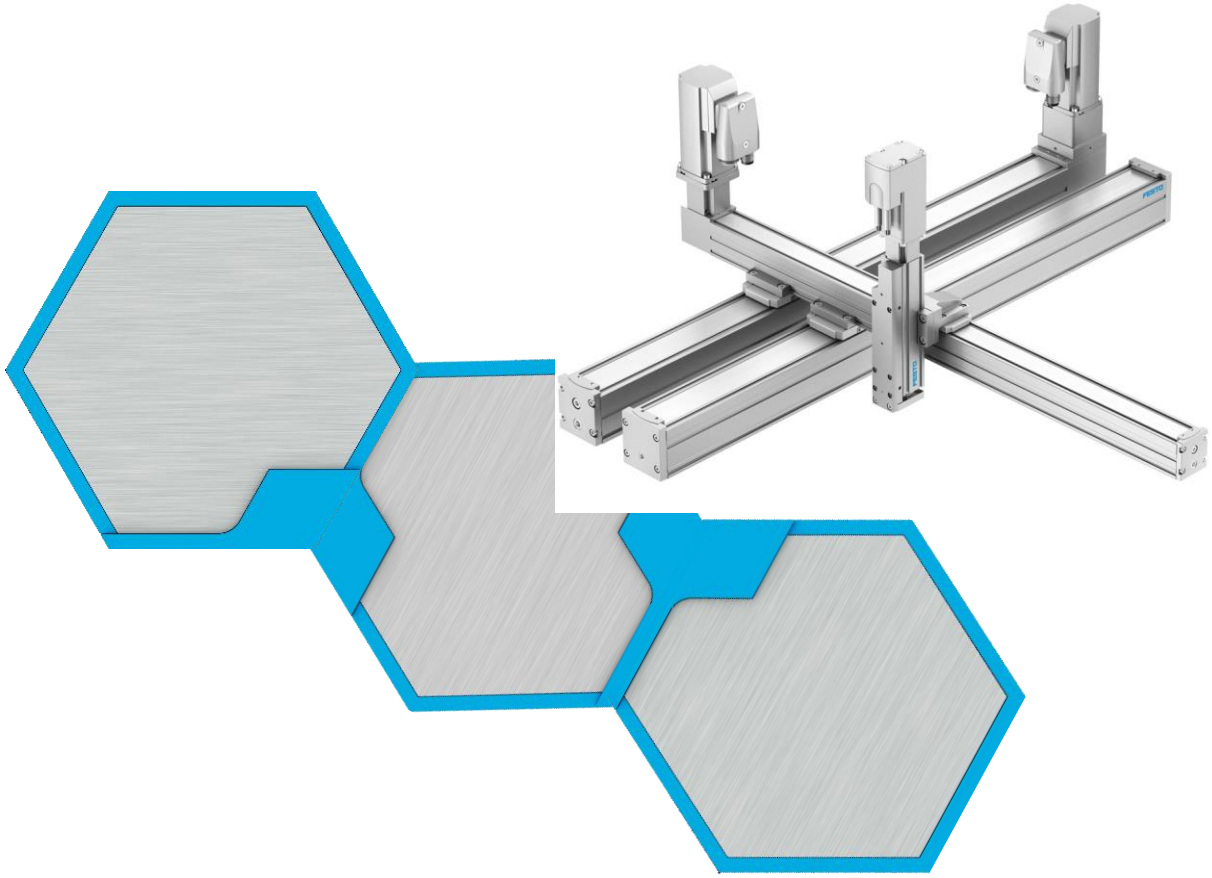
SINAMICS S210 / SIMOTICS S-1FK2

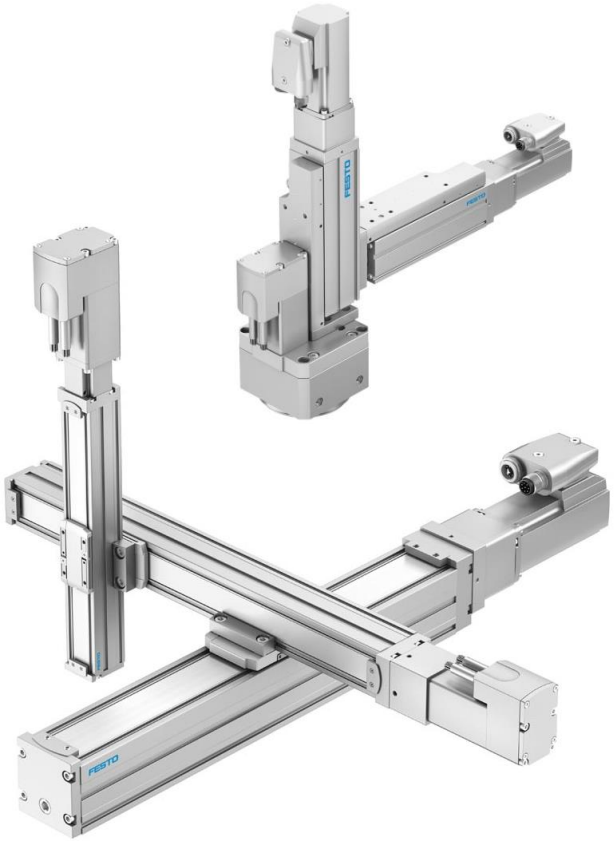
Midrange high-dynamic servo drive system

SIEMENS
Ingenuity for life

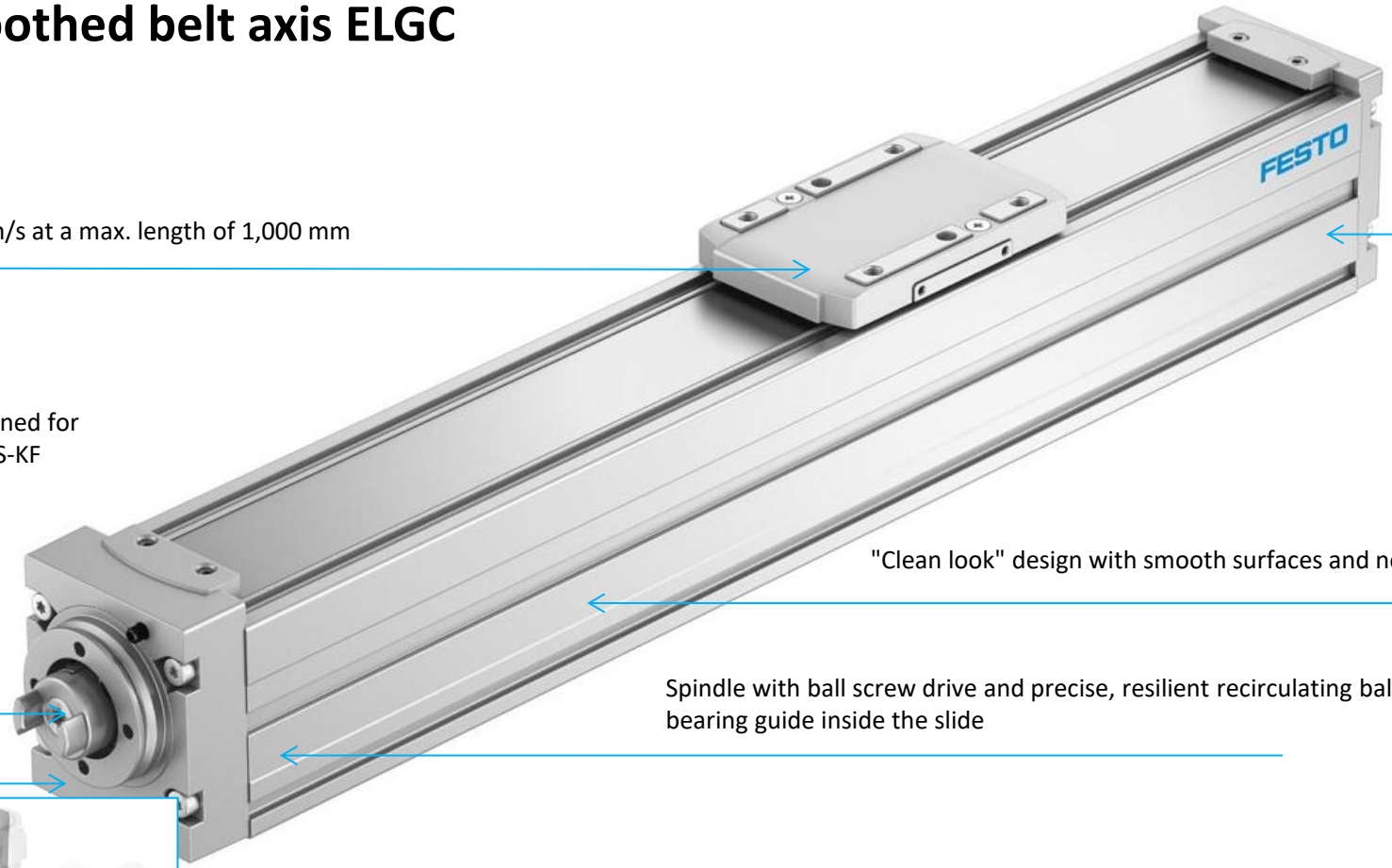
Performance / Purpose	Continuous Motion – Basic	Continuous Motion – Medium	Continuous Motion – High	Discontinuous Motion – Basic	Discontinuous Motion – Medium	Discontinuous Motion – High
Pumping Ventilating Compressing	• Centrifugal pumps • Radial/axial fans • Compressors		• Eccentric worm pumps	• Hydraulic pumps • Dosing pumps		• Descaling pumps • Hydraulic pumps
Moving	• Belt conveyors • Roller conveyors • Chain conveyors	• Belt conveyors • Roller conveyors • Chain conveyors • Vert./horiz. handling • Elevators • Escalators • Gantry cranes • Ship drives • Cable railways	• Elevators • Container cranes • Mine hoists • Open cast mine excavators • Test stands	• Accelerating conveyors • Rack feeders	• Accelerating conveyors • Rack feeders • Crosscutters • Roll changers **SINAMICS S210**	• Rack feeders • Robotics • Pick & place • Indexing tables • Crosscutters • Roller feeds • Engaging / disengaging
Processing	• Mills • Mixers • Kneaders • Crushers • Agitators • Centrifuges	• Mills • Mixers • Kneaders • Crushers • Agitators • Centrifuges • Extruders • Rotary furnaces	• Extruders • Winders / unwinders • Leading / Following drives • Calenders • Mechanical presses • Printing machines	• Tubular bagging machines • Single-axis motion control – positioning, path profiles		• Servo presses • Rolling mills • Multi-axis motion control – multi-axis positioning, cam discs, interpolation
Machining	Main drives for • Turning • Milling • Drilling	Main drives for • Drilling • Sawing **SINAMICS S210**	Main drives for • Turning • Milling • Drilling • Gear cutting • Grinding	Axis drives for • Turning • Milling • Drilling	Axis drives for • Drilling • Sawing	Axis drives for • Turning • Milling • Drilling • Laser machining • Gear cutting • Grinding • Nibbling / punching

ELGC/EGSC – Drives for compact handling solutions





Spindle axis and toothed belt axis ELGC



Four sizes for movements up to 1 m/s at a max. length of 1,000 mm

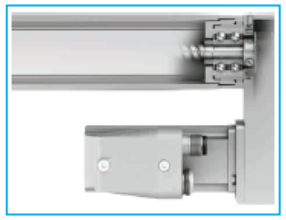
Vacuum connection; increased protection of the system due to reduced particle emissions

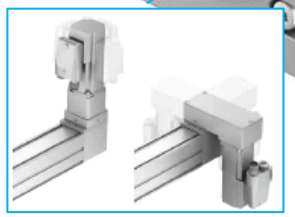
Integrated coupling - optimally designed for the performance data of the ELGC-BS-KF

"Clean look" design with smooth surfaces and no sensor slots

High-performance, double ball bearing integrated in the axis

Spindle with ball screw drive and precise, resilient recirculating ball bearing guide inside the slide





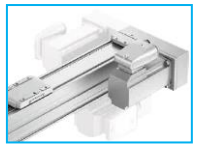
Flexible motor mounting

Compact and simple: the system at a glance

An optimally coordinated and modular system for unlimited expansion

- Direct combination with next smaller size
- Scalable modular system kit comprising linear axes and mini slides
- ELGC/EGSC – a unique system, making the Cartesian system simpler than ever before

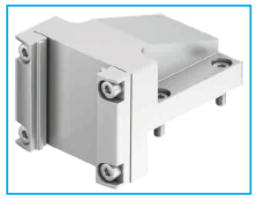
Free choice of motor position with toothed belt axis



Free choice of motor position with spindle axes and mini slides

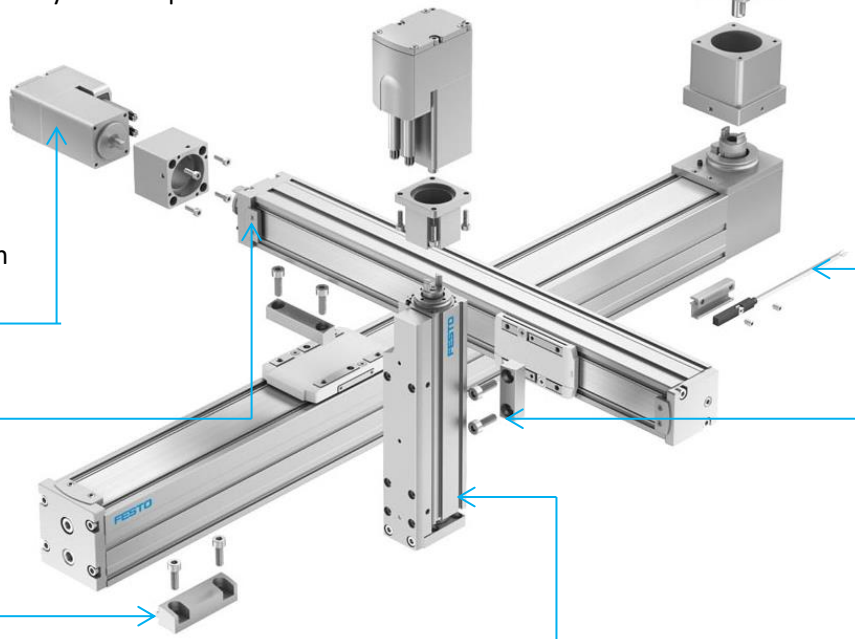
Cost-effective position sensing with magneto-resistive proximity sensor SMT-8M

Integrated coupling



Angle kit for direct mounting of vertical axes

"One-size-down" mounting system with standard profile mounting



Uniform profile mounting is used to mount the axes and mini slides

Yoke plate with a standardised interface for electric rotary drive ERMO

From individual axes to a complete handling system

Single-axis system

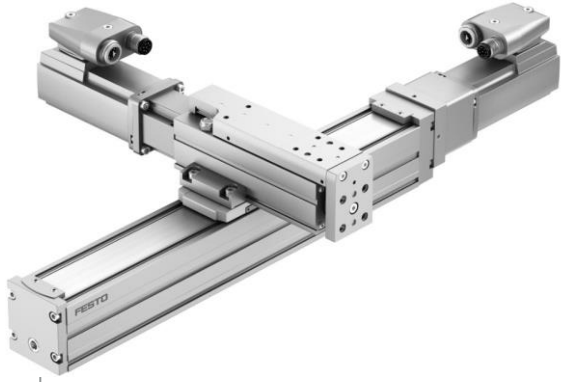
Precisely positioning and aligning workpieces also at high loads:

- Adapterless direct mounting of mini slides and rotary drives
- Also available as linear-rotary Z-axis in 2D and 3D systems

Pick & place solution

Compact response to simple requirements:

- Adapterless, cost effective direct mounting of mini slides and rotary drives
- Mechanically rigid and sturdy design with precision positioning



Linear gantry

Vertical 2D movements for simple handling tasks can be realised at low cost:

- Spindle or toothed belt axes combined with mini slides for vertical 2D working space
- Space-optimised and easy to assemble

3D gantry

Extremely compact 3D system with attractive price/performance ratio

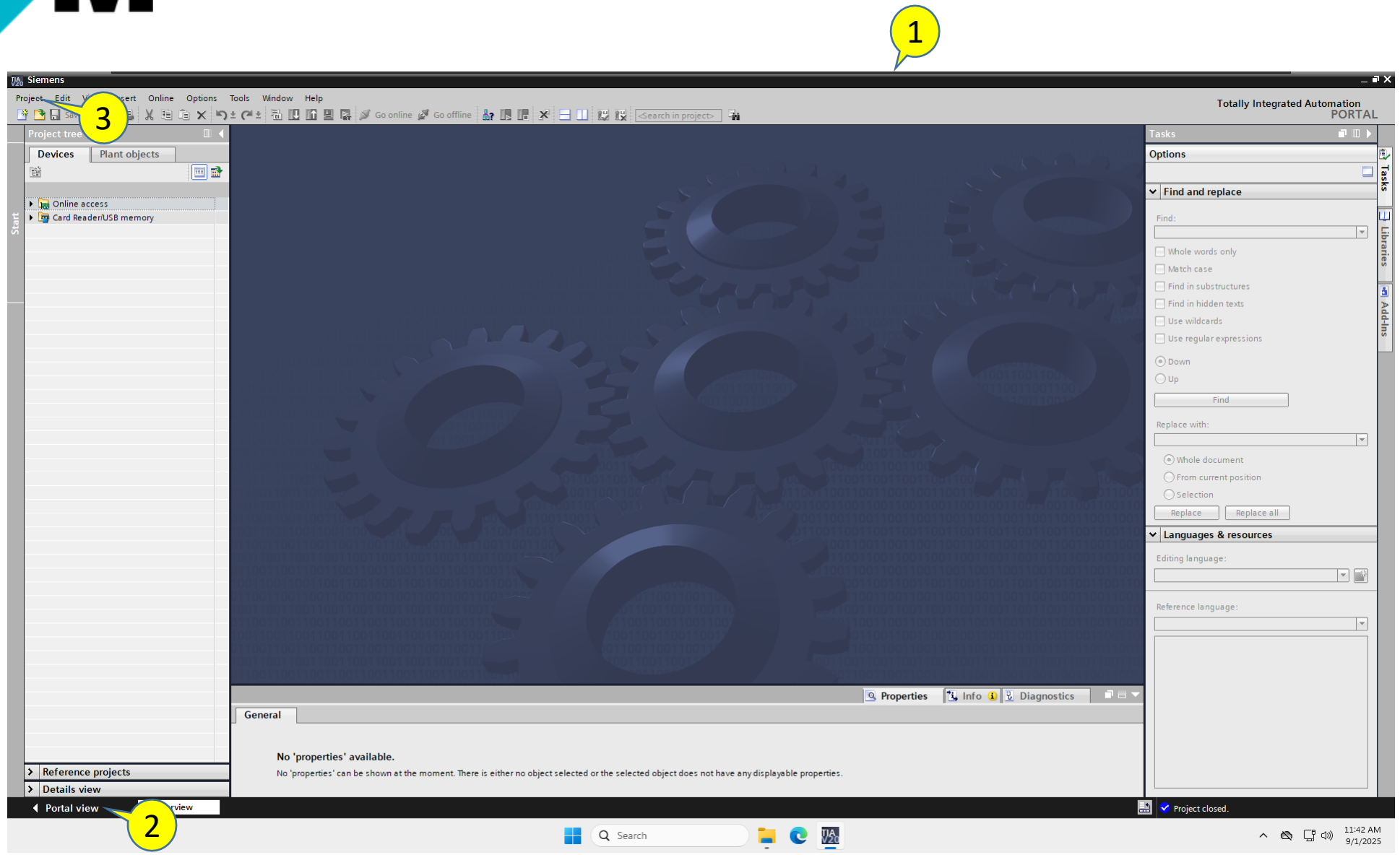
- Maximum workspace coverage by combining the small-scale gantry EXCM and mini-slide for the Z-axis
- Configurable length and width and with different Z strokes

E and M

SIEMENS
FESTO
SICK

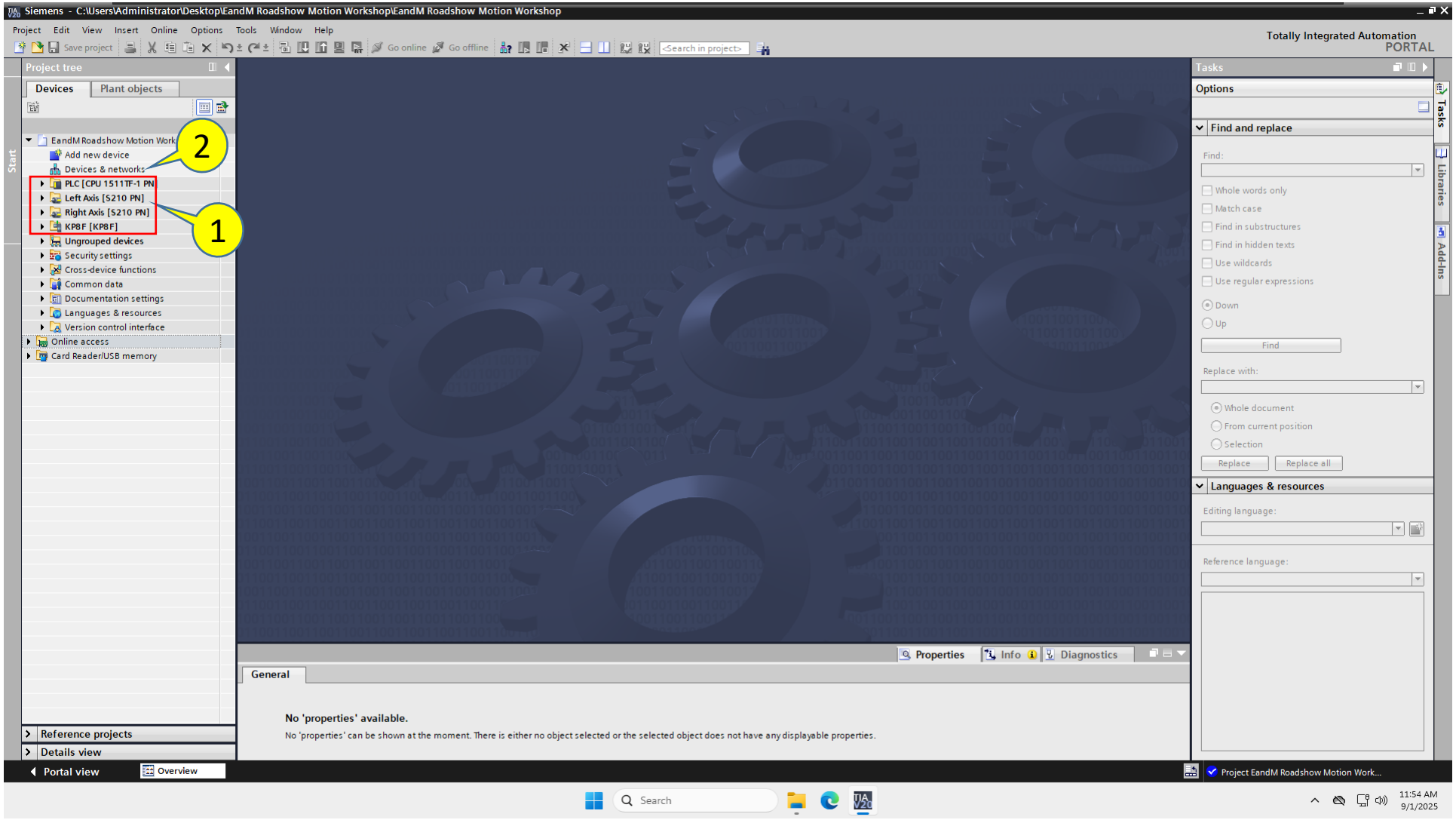
Motion LAB

Motion Lab



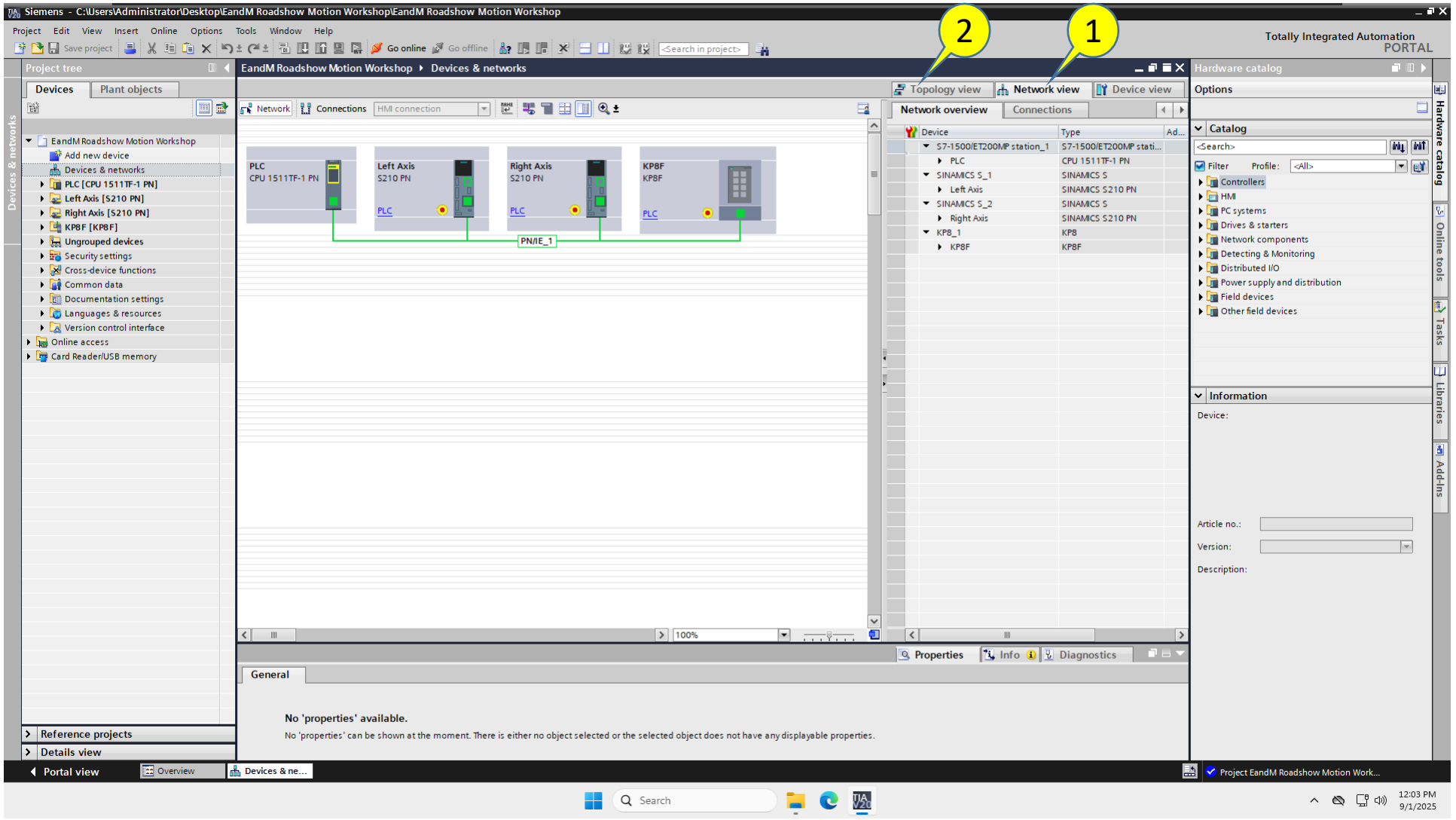
1. Open TIA Portal
2. Make sure you're in the project view
3. Go to the Project menu and select "Open…"
4. Open the "Eand Roadshow Motion Workshop" project located on the desktop

Motion Lab



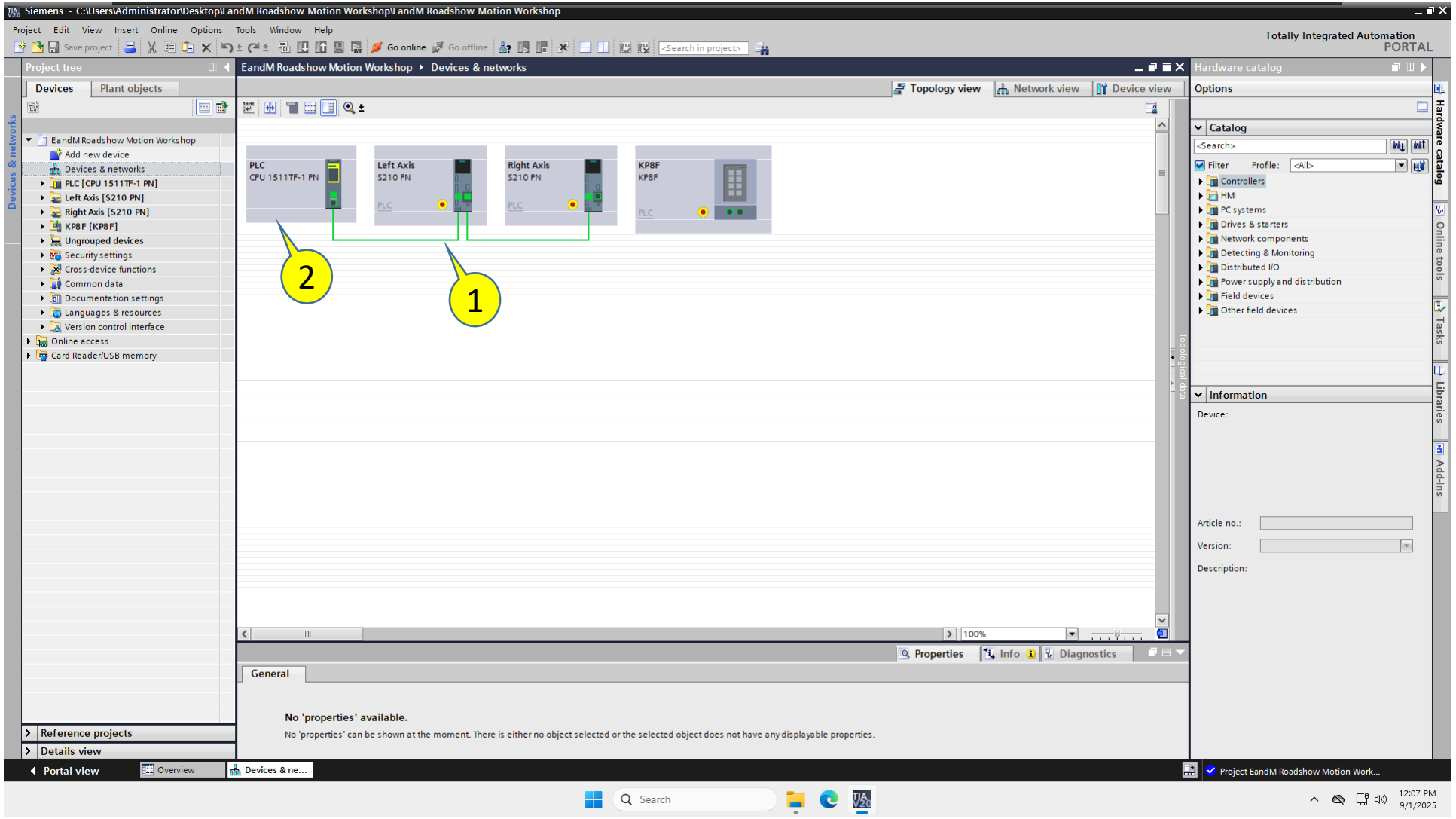
1. When the project is open, you will now have the following devices in the project tree
   - PLC
   - Left Axis
   - Right Axis
   - KP8F
2. Double click on Devices & networks

Motion Lab



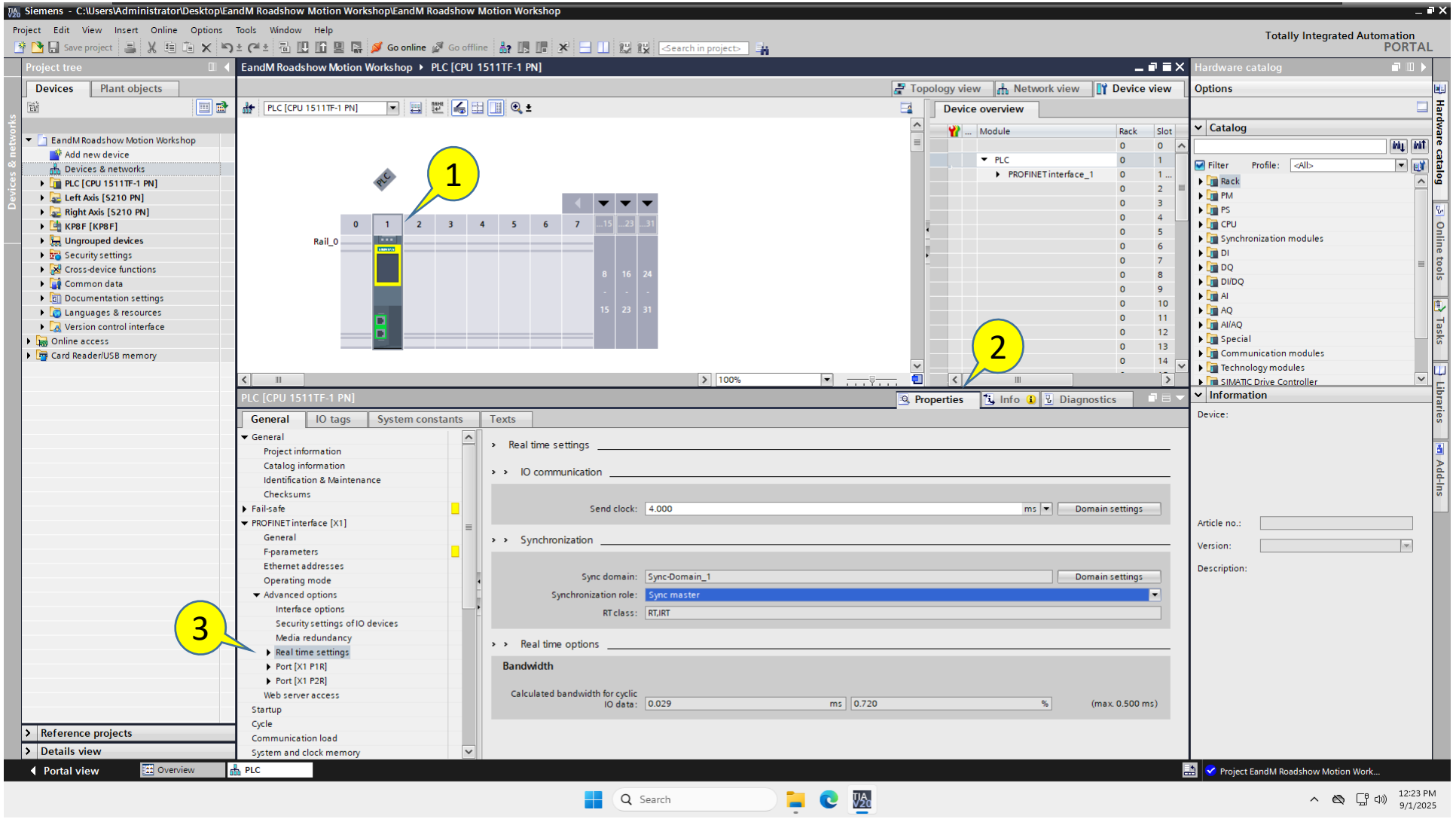
1. The Network view shows which devices are apart of the Profinet network.
2. Click on the Topology view tab

Motion Lab



1. In order to establish an isochronous connection between the CPU and the drives, you need to configure the topology of the stations.
2. Double click on the PLC device to open the PLC in the device view

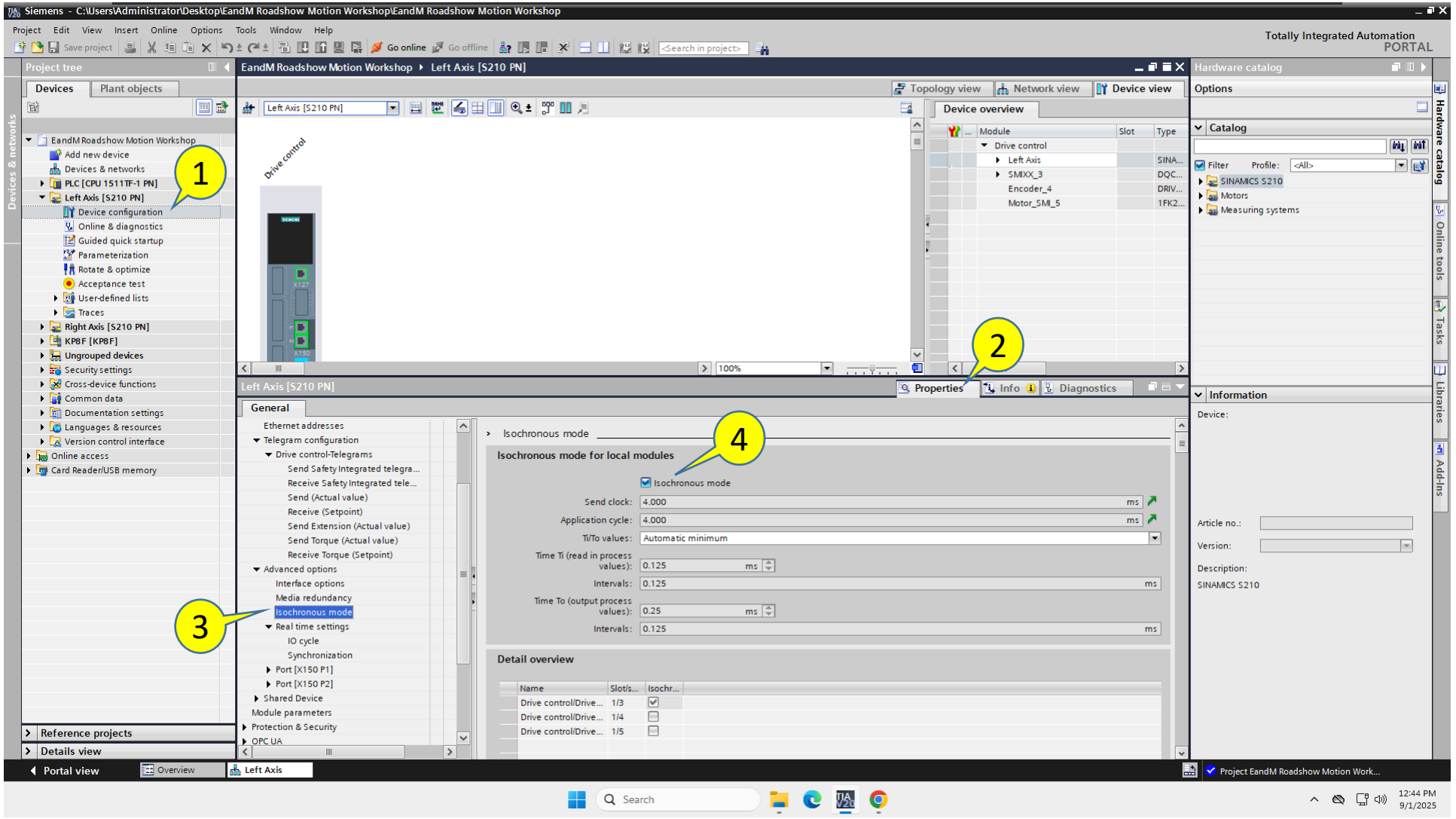
Motion Lab



1. In the Device view, select the PLC in slot 1
2. Click on the Properties tab
3. Expand open PROFINET interface [X1] ⍰ Advanced options and click on Real time settings

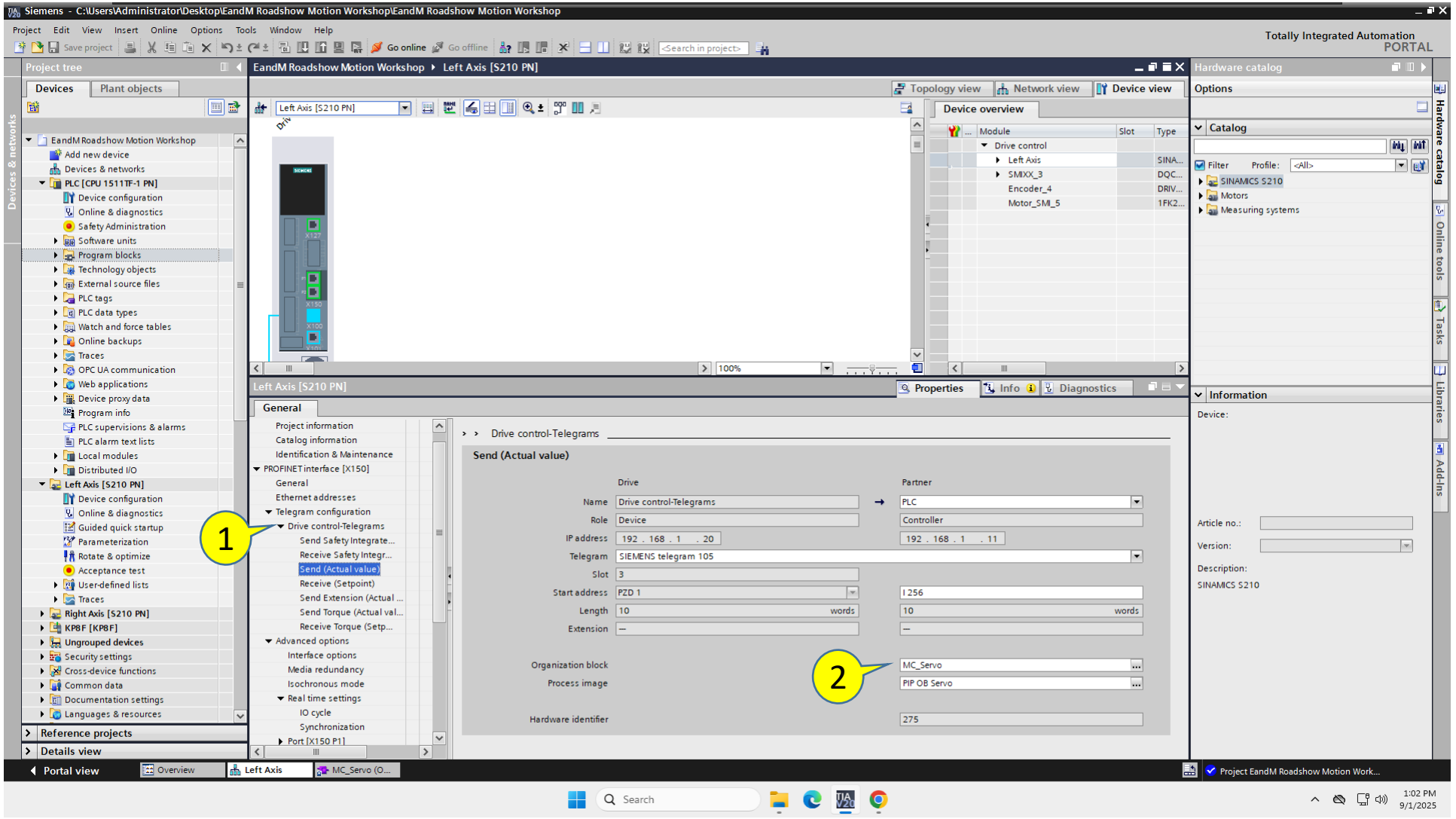
To ensure seamless operation of the drives, they must be run off the SIMATIC S7-1500 in isochronous mode. The PLC is configured as the Sync master

Motion Lab



1. Expand open Left Axis in the Project tree and double click Device Configuration
2. Click on the Properties tab
3. Expand open PROFINET interface [X150] ⍰ Advanced options and click on Isochronous mode
4. Isochronous mode is enabled in the drives. They are configured as Sync slaves.

Motion Lab



1. In the Left Axis properties under PROFINET interface [X150] ⍰ Telegram configuration ⍰ Drive control-Telegrams, you will find the configure telegrams for data exchange between the drive and PLC.
2. The non safety telegrams are linked to the MC_Servo OB to ensure they are exchanged in sync with the isochronous PROFINET IO system

Motion Lab

What is a PROFINET telegram?

A PROFINET telegram is a structured block of data exchanged cyclically between a PROFINET controller and an IO device (like a PLC and a drive) to transfer real-time process data, forming a fundamental part of the communication for industrial automation. Each telegram contains input and/or output data, with specific telegram types (e.g., Telegram 105) defining the structure and amount of data for different applications like motion control. These telegrams are transmitted over an Industrial Ethernet network and are essential for the real-time, deterministic exchange of signals necessary for controlling automated systems.

Siemens Telegram 105

Telegram 105 is suitable for the closed-loop speed control with Dynamic Servo Control (DSC) and closed-loop position control of a drive and to control 1 position encoder.

Requirement:

Isochronous mode with PROFINET IRT (isochronous real-time)

Process data	Telegram 105			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	MOMRED	Torque reduction	MELDW	Message word
PZD06	G1_STW	Control word for encoder 1	G1_ZSW	Status word for encoder 1
PZD07	XERR	Position controller deviation	G1_XIST1	Position actual value 1 from encoder 1
PZD08				
PZD09	KPC	Gain factor for the position controller	G1_XIST2	Position actual value 2 from encoder 1
PZD10				

Motion Lab

Siemens Telegram 750

Supplementary telegram 750 is suitable for controlling the drive torque, e.g. for the electronic counterweight of a vertical axis.

Process data	Telegram 750			
	Control system → Converter		Converter → Control system	
	Signal	Explanation	Signal	Explanation
PZDn+1	M_ADD1	Acceleration compensation	M_ACT	Actual torque
PZDn+2	M_LIM-IT_POS	Positive torque limit	---	Not assigned
PZDn+3	M_LIM-IT_NEG	Negative torque limit	---	

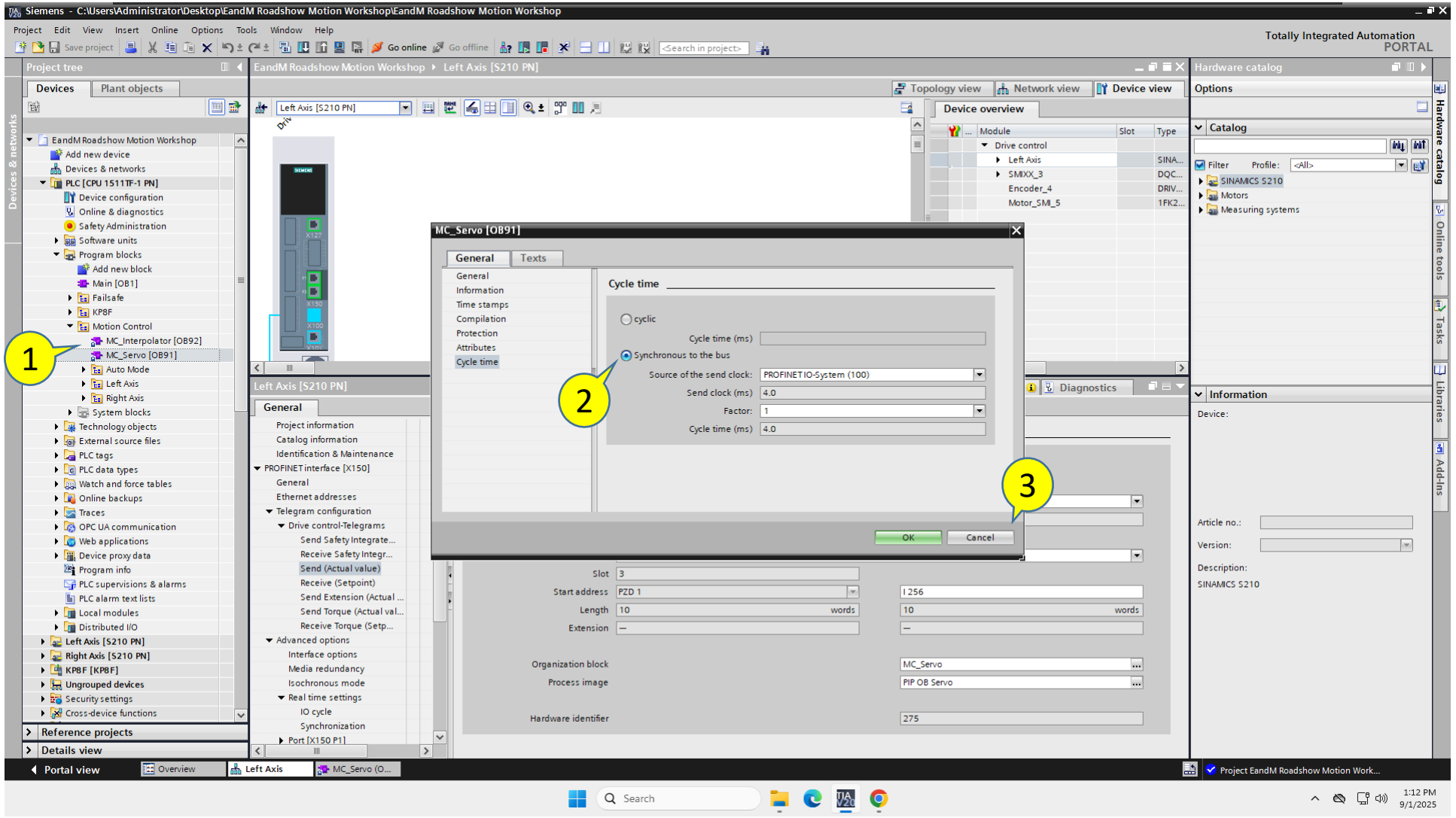
Motion Lab

PROFIsafe Telegram 30

Via a PROFIsafe telegram, the higher-level failsafe control activates the Safety Integrated Functions of the converter and receives feedback on the status of the Safety Integrated Functions.

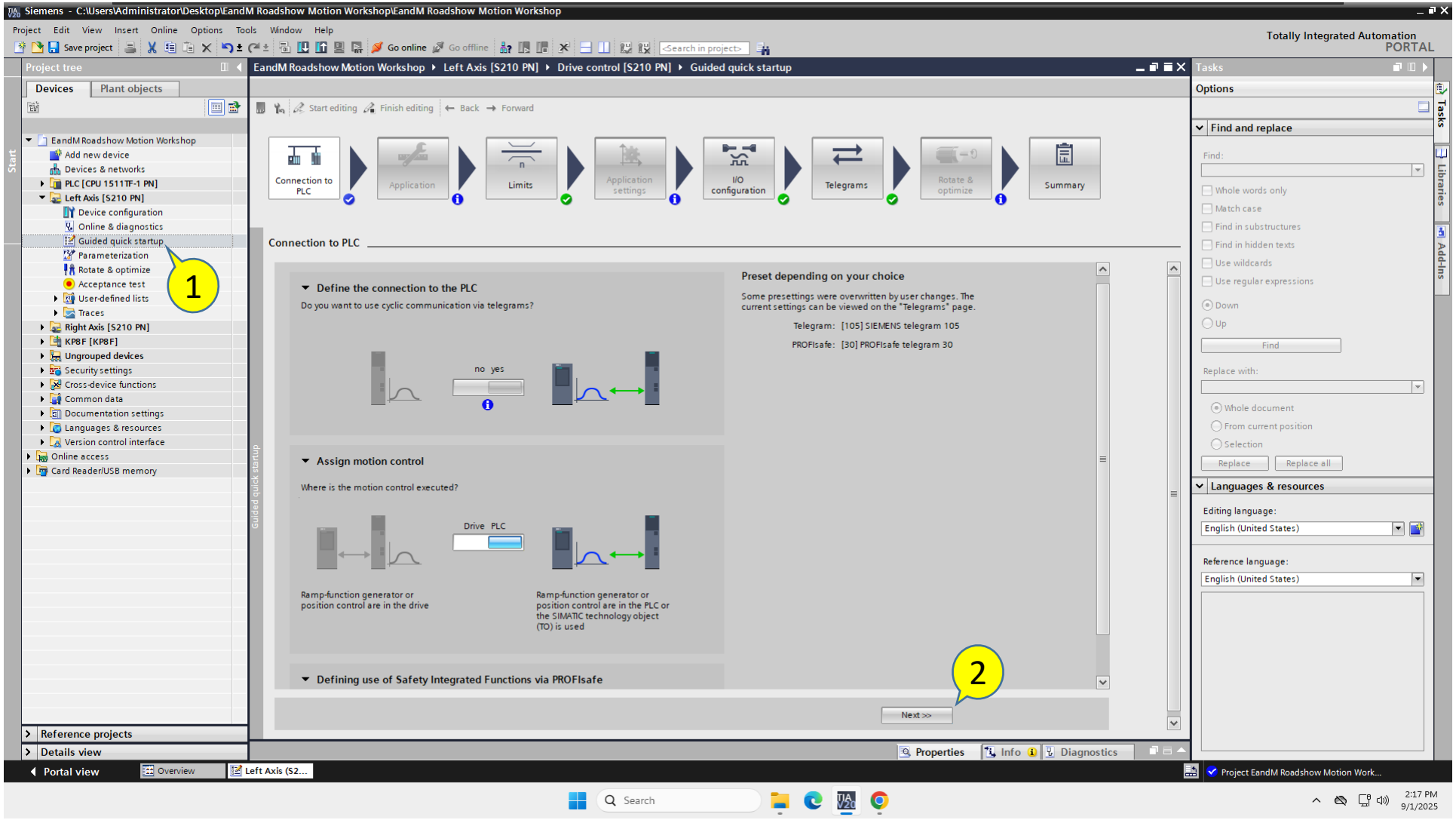
Process data	Telegram 30			
	Failsafe control → Converter		Converter → Failsafe control	
	Signal	Explanation	Signal	Explanation
PZD01	S_STW1	Safety control word 1	S_ZSW1	Safety status word 1

Motion Lab



1. Open the properties of MC_Servo [OB91]. The block is located in PLC ▯ Program blocks ▯ Motion Control
2. The cycle time of MC_Servo is set to be synchronous to the bus. This means it runs in sync with the isochronous PROFINET IO system
3. Click on the Cancel button to close the properties window

Motion Lab



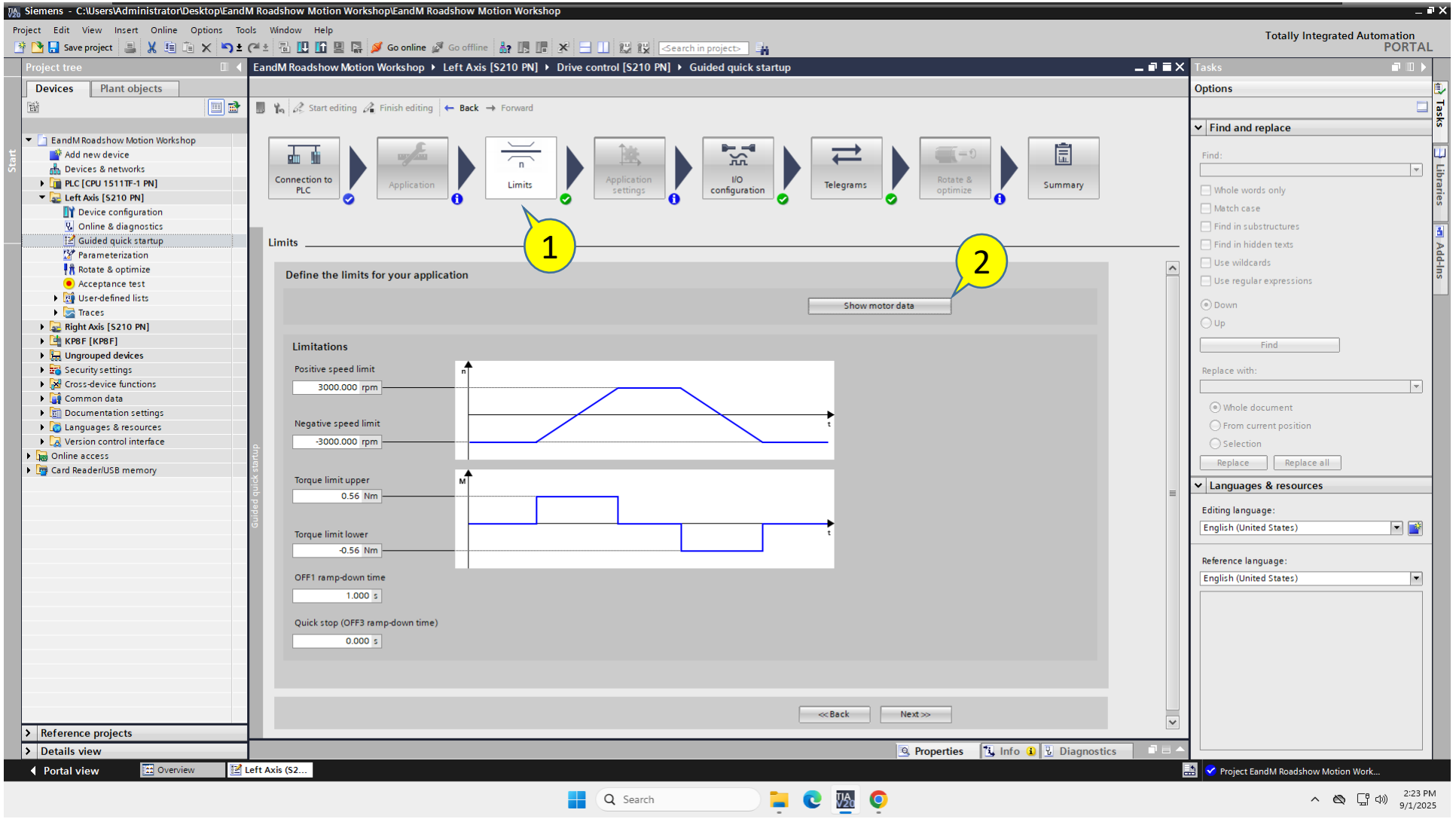
1. Open the Left Axis Guided quick startup

This wizard walks through the configuration steps of the drive.

These are the PLC connection settings

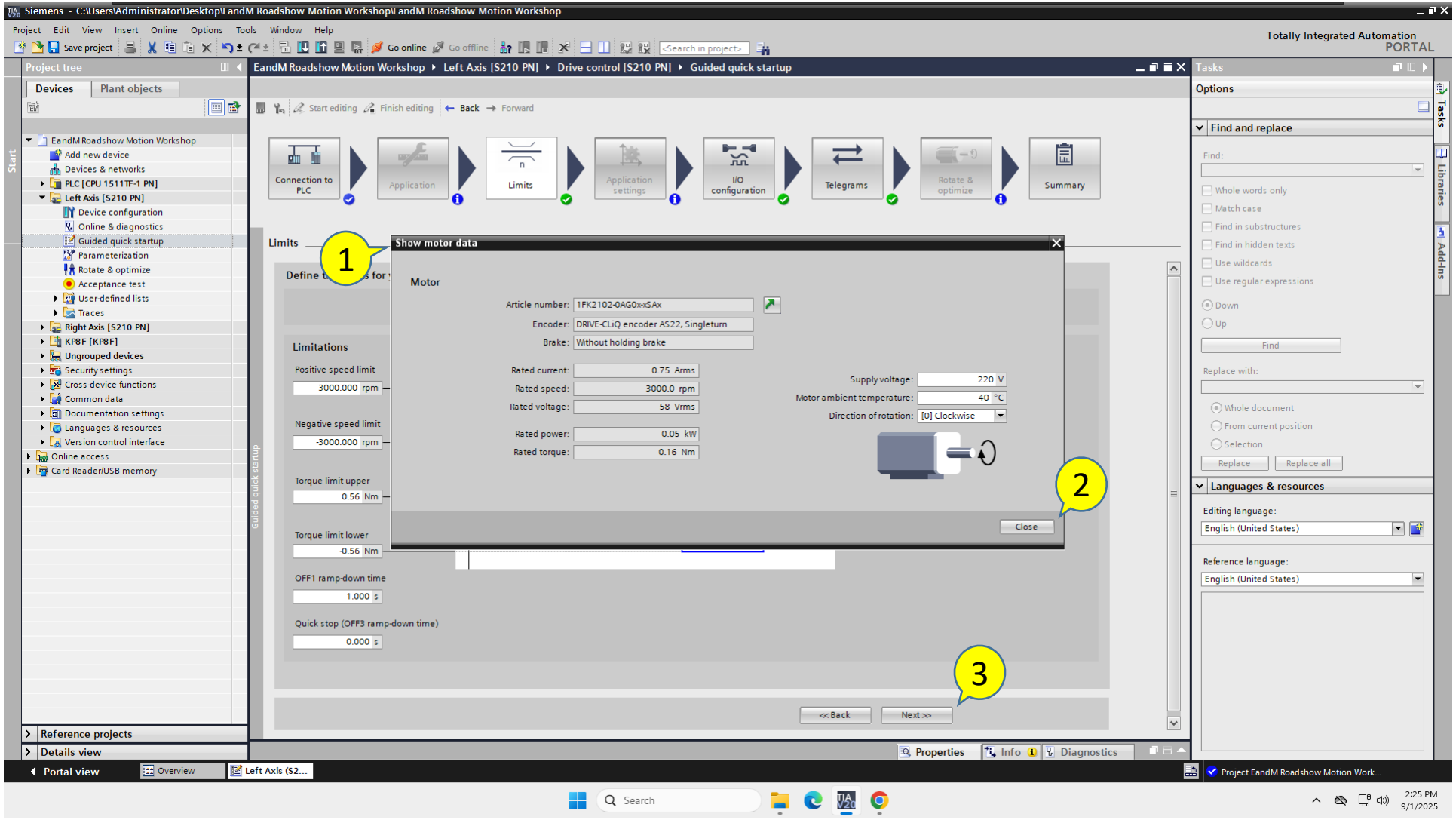
2. Click Next

Motion Lab



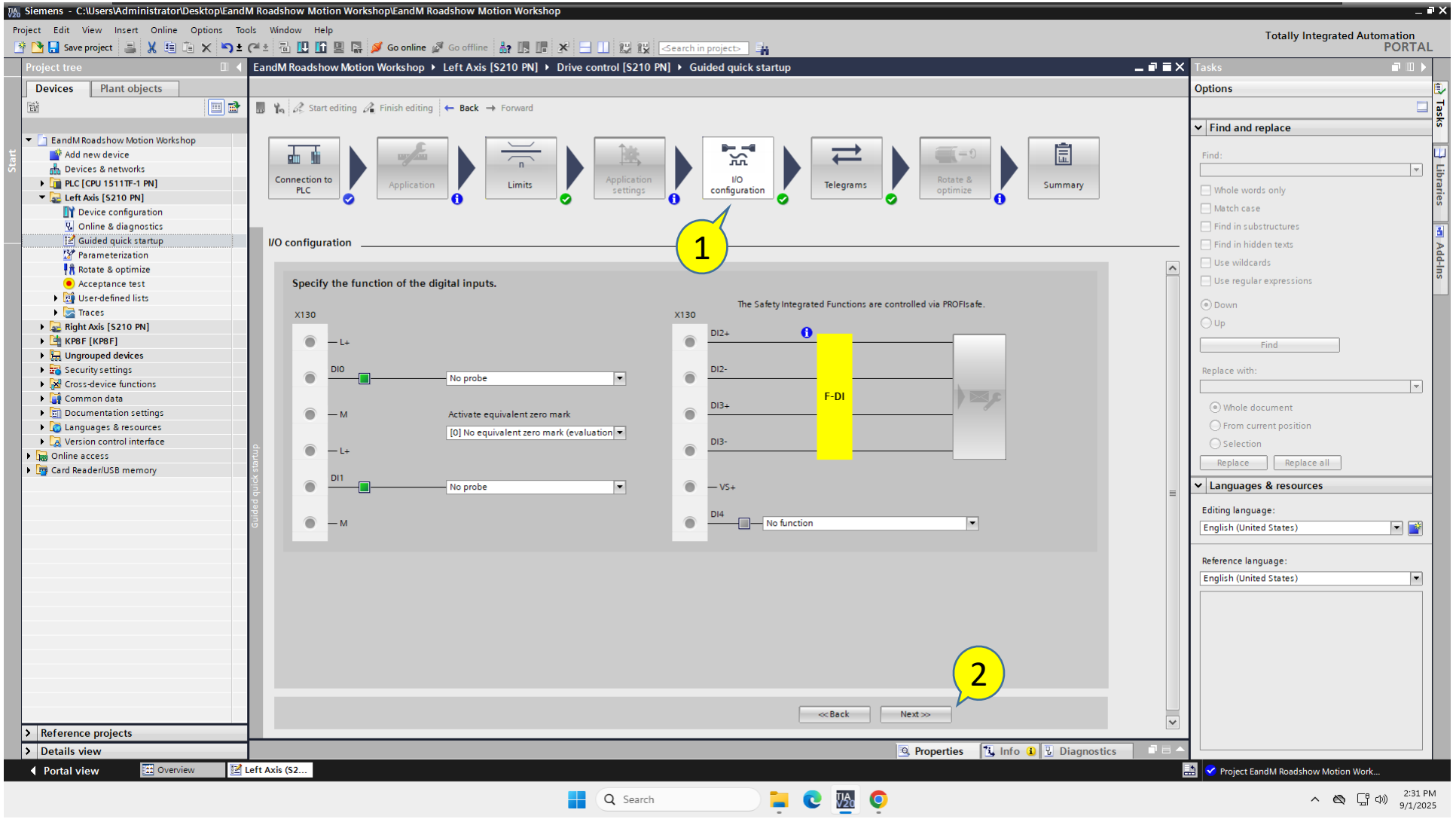
1. These are the limit settings for speed, torque and ramp times
2. Click on the Show motor data button

Motion Lab



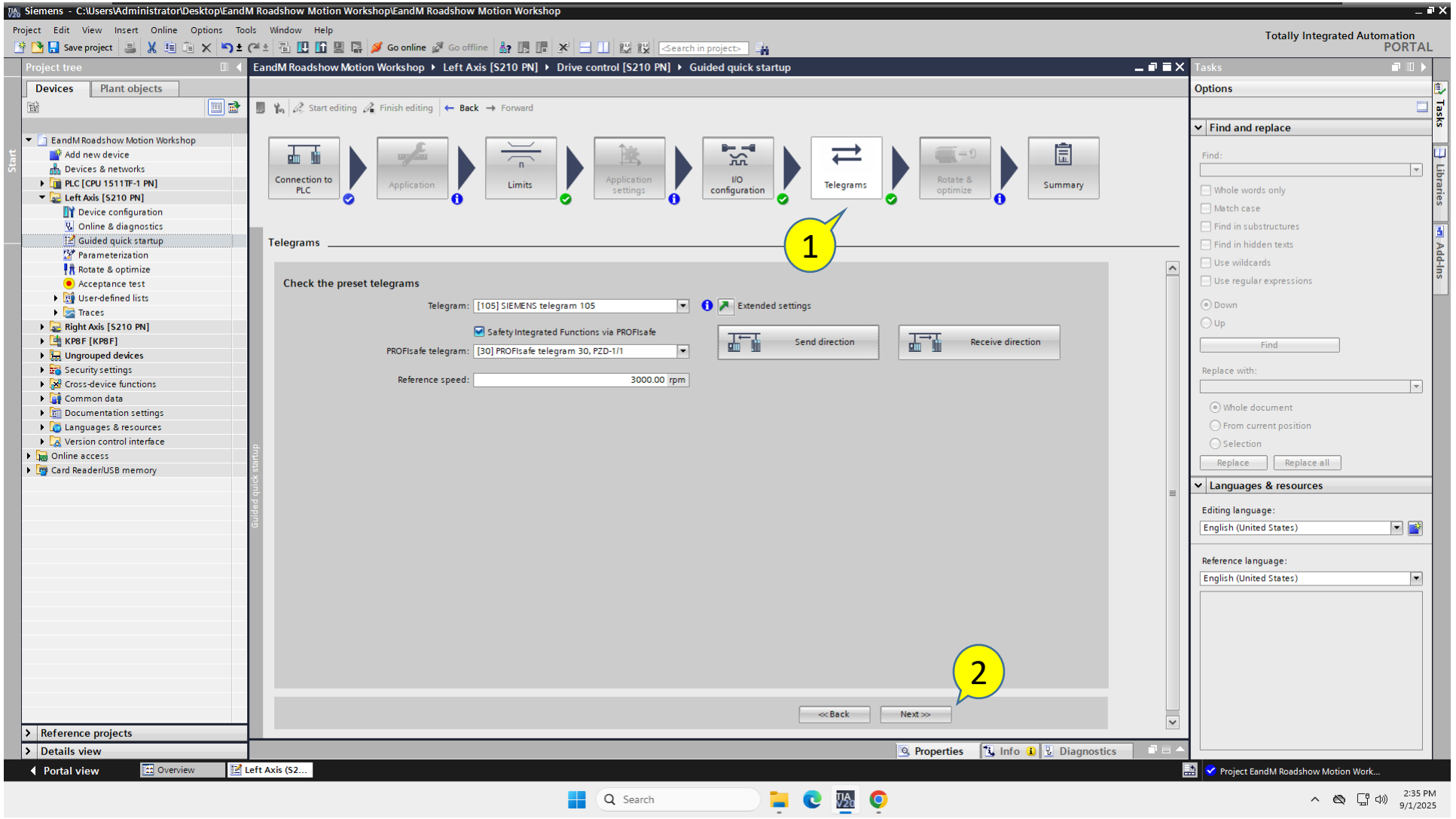
1. When the drive powers up, it automatically reads motor and encoder information. No need to manually enter in this information.
2. Click on the Close button
3. Click on the Next button

Motion Lab



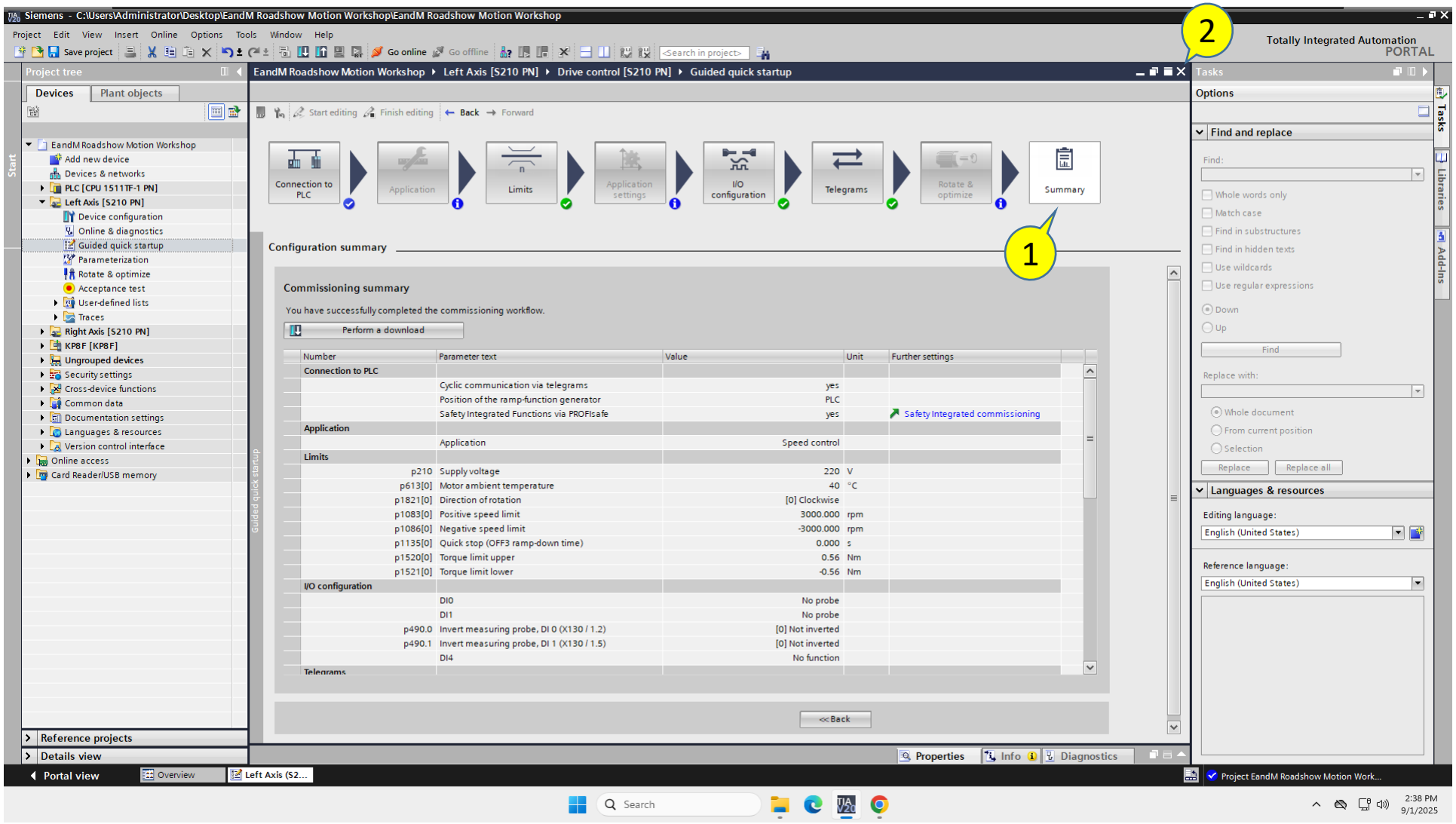
1. These are the onboard I/O settings
2. Click on the Next button

Motion Lab



1. These are the Telegram settings
2. Click on the Next button

Motion Lab



1. These are the Telegram settings
2. Click on the Close button

Motion Lab

Why do you need to tune a servo drive?

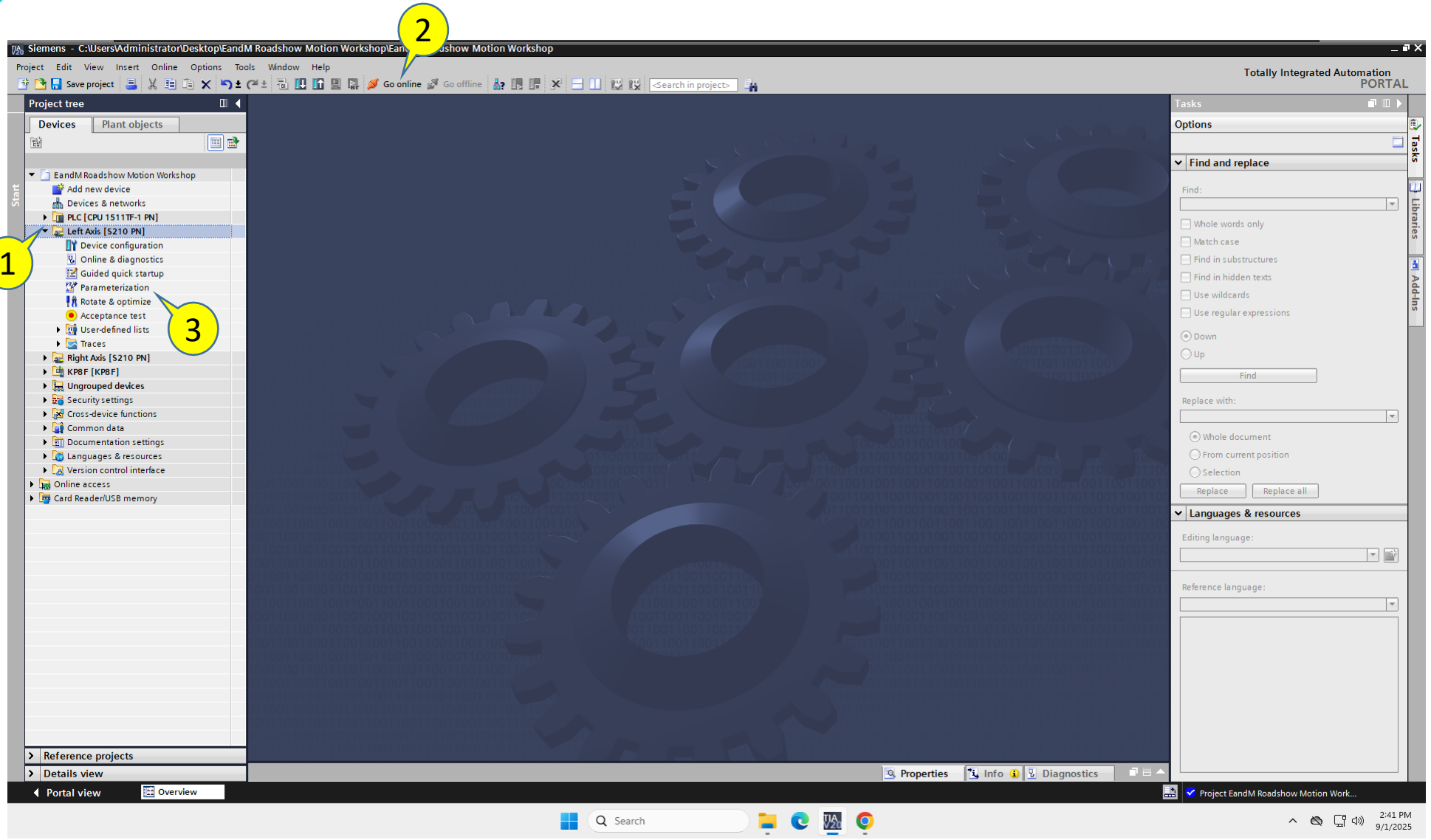
You need to tune a servo drive to ensure the servo motor operates smoothly, accurately, and stably by adjusting controller gains and other parameters to optimize the feedback loop's response to the machine's unique mechanical and electrical characteristics. Tuning eliminates unwanted behaviors like oscillation and resonance, reduces settling time, improves overall system efficiency, and ensures the system accurately follows command profiles, even when faced with variations in load or mechanical components.

Motion Lab

Siemens
One-Button Tuning (OBT)
Explained

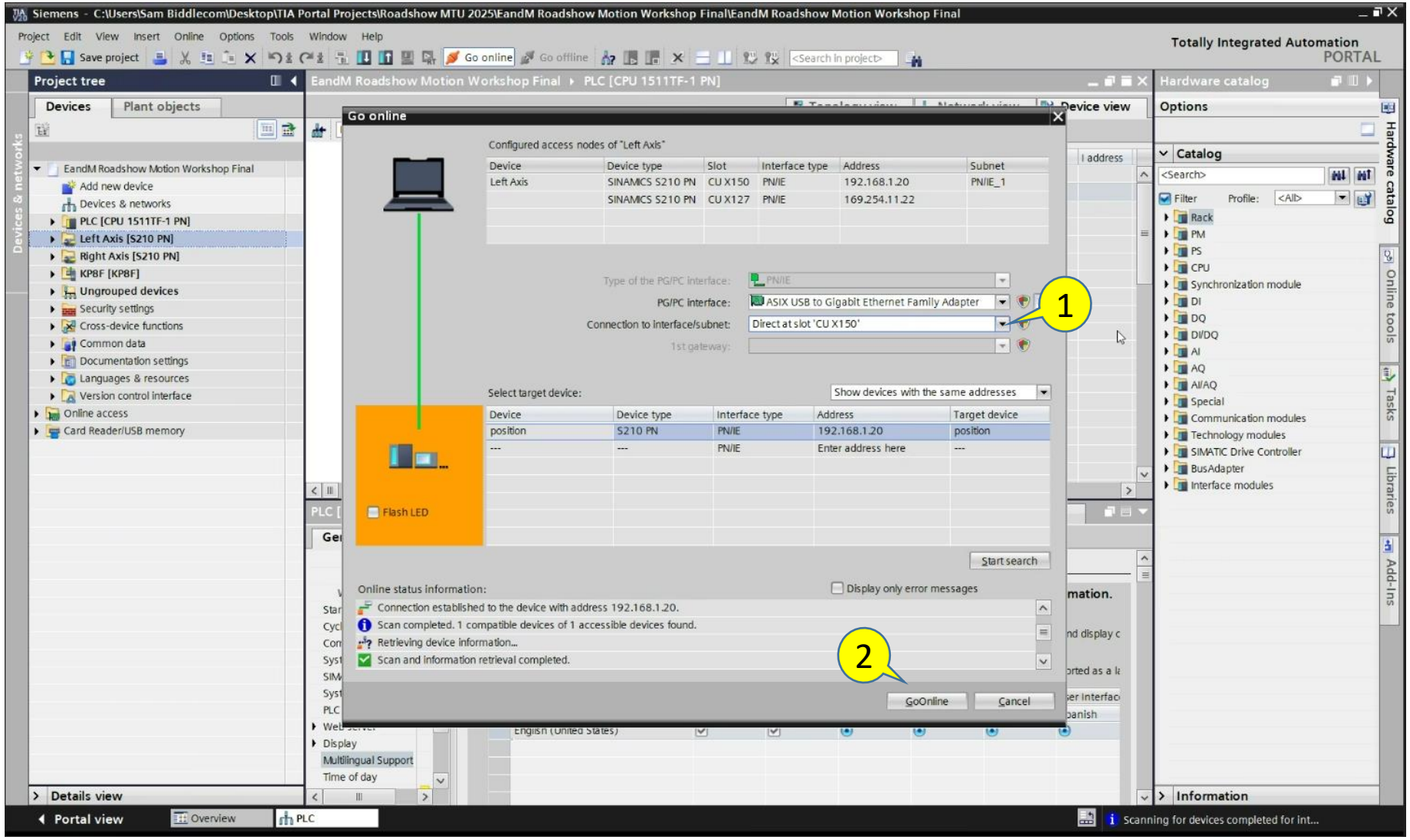
One-Button Tuning (OBT) on the Siemens S210 servo drive automatically optimizes the drive's speed and position controller parameters by measuring the load inertia and then performing an automated test movement to find the best settings. Users select a dynamic level (conservative, standard, or dynamic), and the drive adjusts settings like the P gain and integral time to achieve sharp, responsive, and accurate motor movements with the connected load. This simplifies the commissioning process, allowing for quick and effective setup of the drive system.

Motion Lab



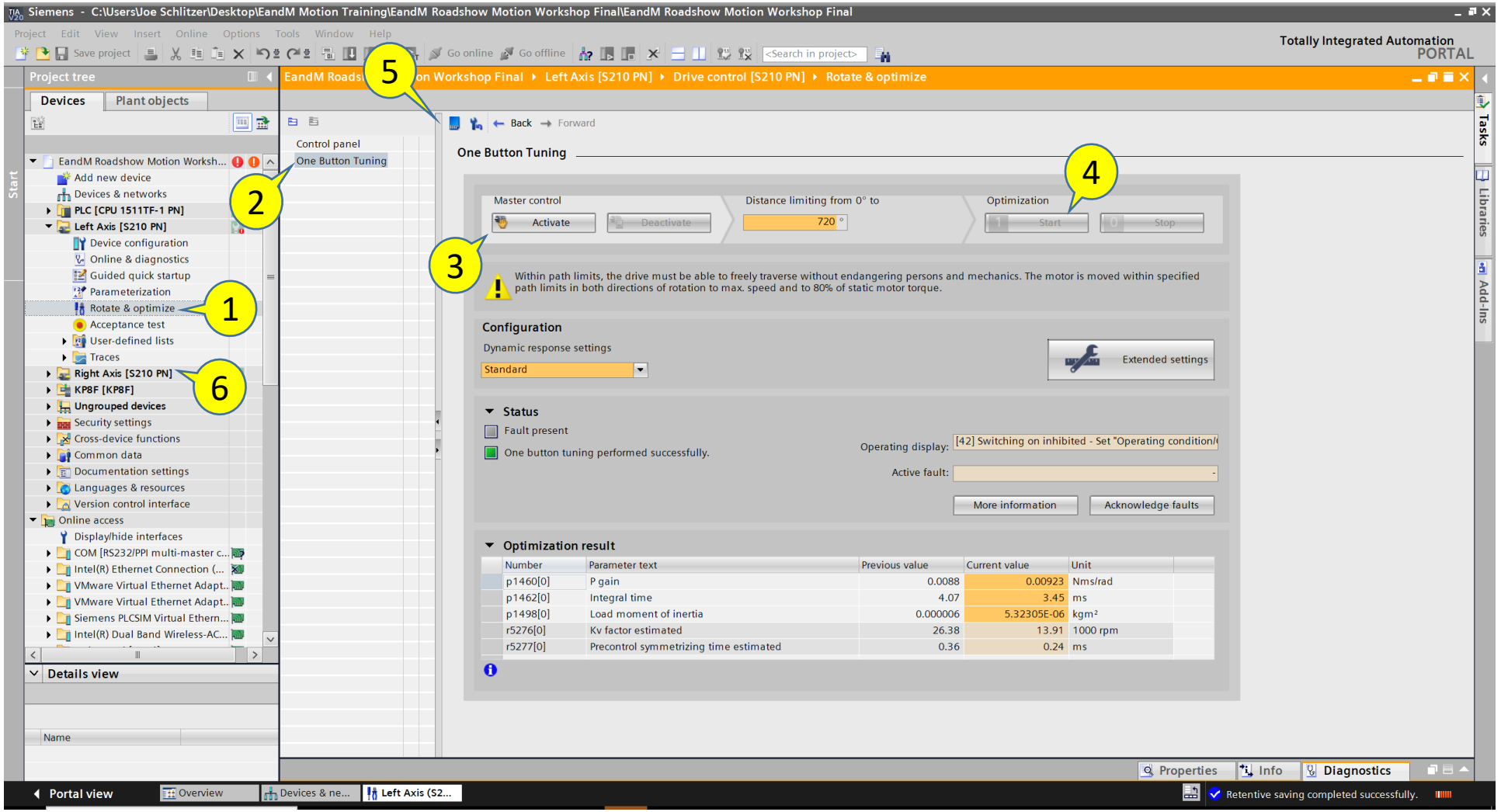
1. Click on Left Axis in the Project tree so that it's selected
2. Click on the Go online button in the toolbar
3. Double click on Rotate & optimize

Motion Lab



1. In the Go online window, there is a drop down menu for “Connection to interfaces/subnet”. Select “Direct at slot ‘CU X150’”.
2. Click on the Go online button

Motion Lab

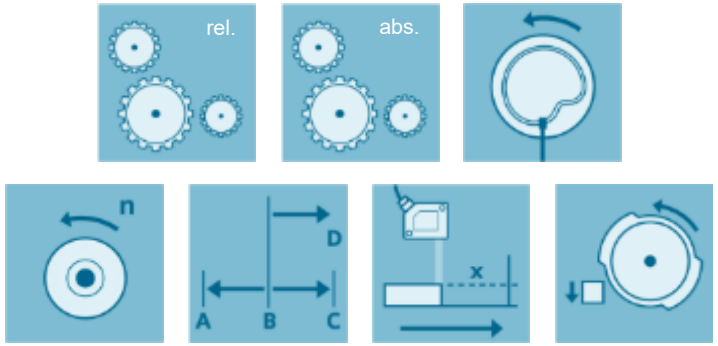


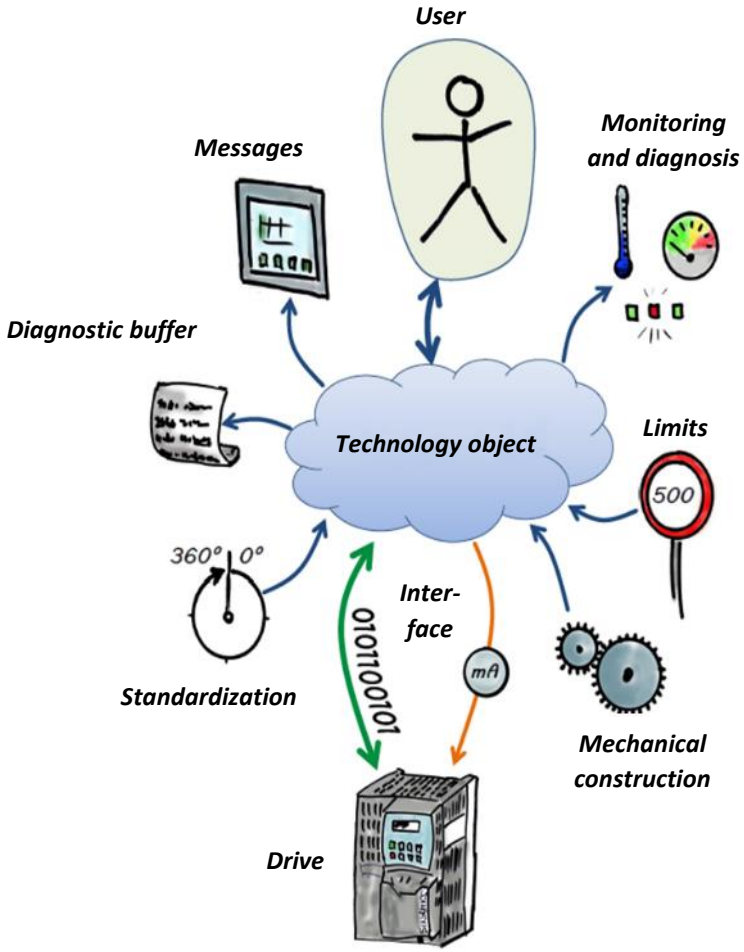
1. Click on Rotate & optimize under Left Axis
2. Click on One Button Tuning
3. Activate Master control by clicking on the Activate button (you will see a pop-up window for Master Control. Click OK)
4. Start the tuning procedure by clicking on the Start button
5. Once the tuning has completed, click on the memory card icon in the toolbar to retentively save the tuning parameters
6. Repeat this same procedure for the Right Axis

Motion Lab

What is a Technology Object?

Siemens Technology Objects (TOs) are predefined software modules within the Siemens's TIA Portal programming environment that simplify the control and configuration of hardware, especially in motion control, counting, measuring, and PID regulation applications. They act as an interface between the hardware and the user's program, encapsulating complex functions for easy access and use. For example, a motion control technology object can handle the control of physical axes, while a PID control TO manages temperature regulation.

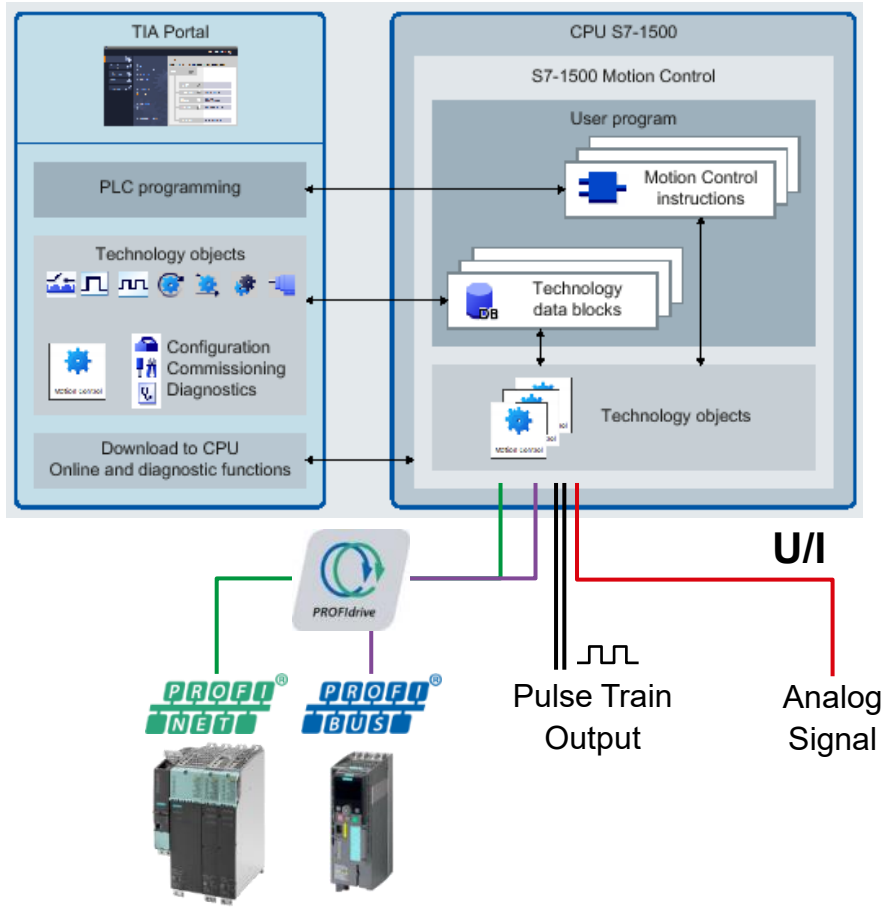




Motion Lab

Technology objects for Motion Control

- TOs for speed, positioning and synchronous axes, cams, output cams, Kinematics measuring inputs and external encoders/sensors
- A TO data block contains all of the configuration data, setpoint/actual values and status information of the TO
- TOs communicate with the drive and I/O
  Drive data are automatically adapted
- TOs control (open-loop and closed-loop)
  a drive or drive group
- TOs are programmed via the user program
  using PLCopen function blocks
- Position values with higher resolution (6 decimal places)
  Highest accuracy for calculations in the application



TO Axis Types

Synchronized axis

Positioning axis

Speed-controlled axis

Moving with open-loop speed control

User program

- Velocity setpoint

TO generates the acceleration and braking ramps

The drive controls the speed
⍰ Position encoder is not required

Positioning

User program

- Position setpoint
- Homing
- Superimposed motion

TO generates the acceleration and braking ramps

TO controls the position

The drive controls the speed
⍰ Position encoder is required

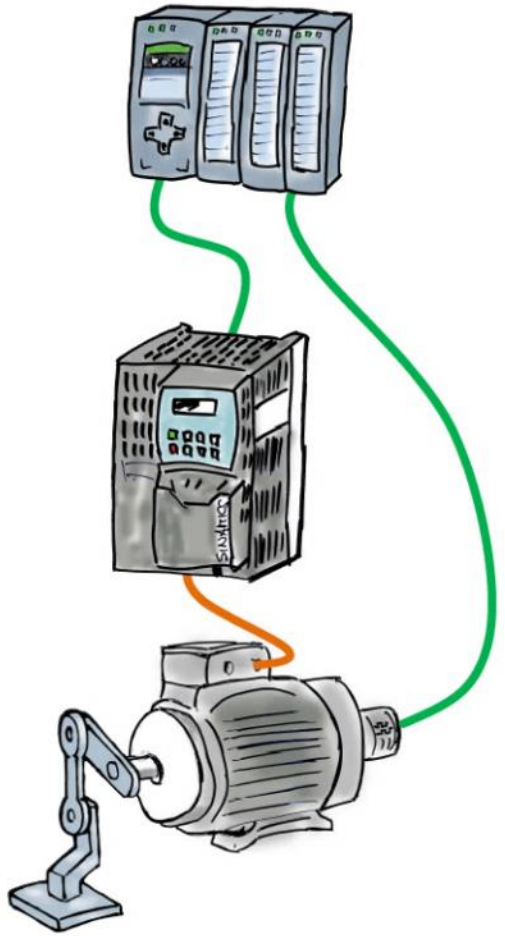
Gearing and camming

User program

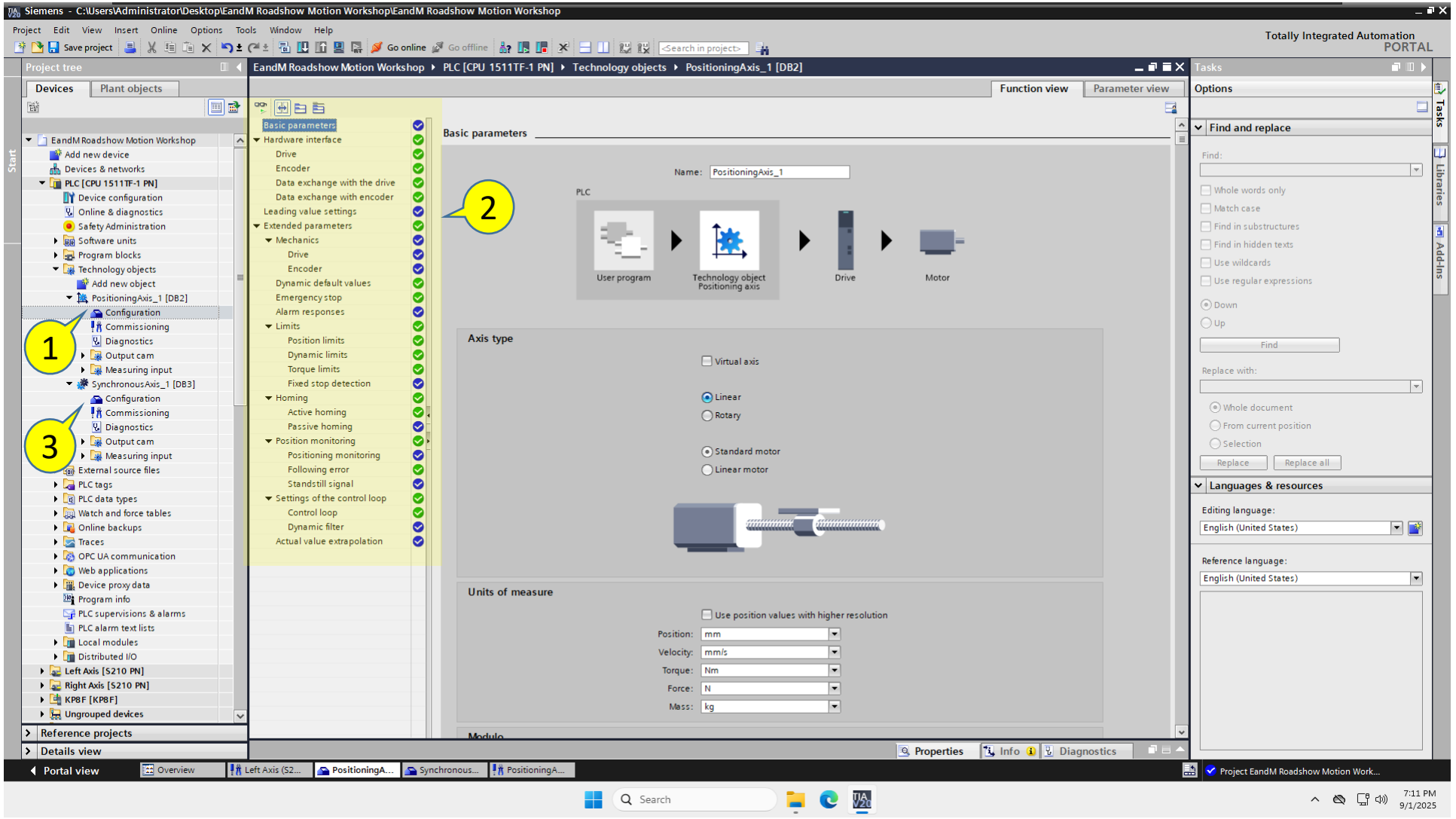
- Synchronization
  - Leading value
  - Gear ratio
  - Cam

TO calculates and controls the position for the synchronized axis depending on a leading value

The drive controls the speed
⍰ Position encoder is required

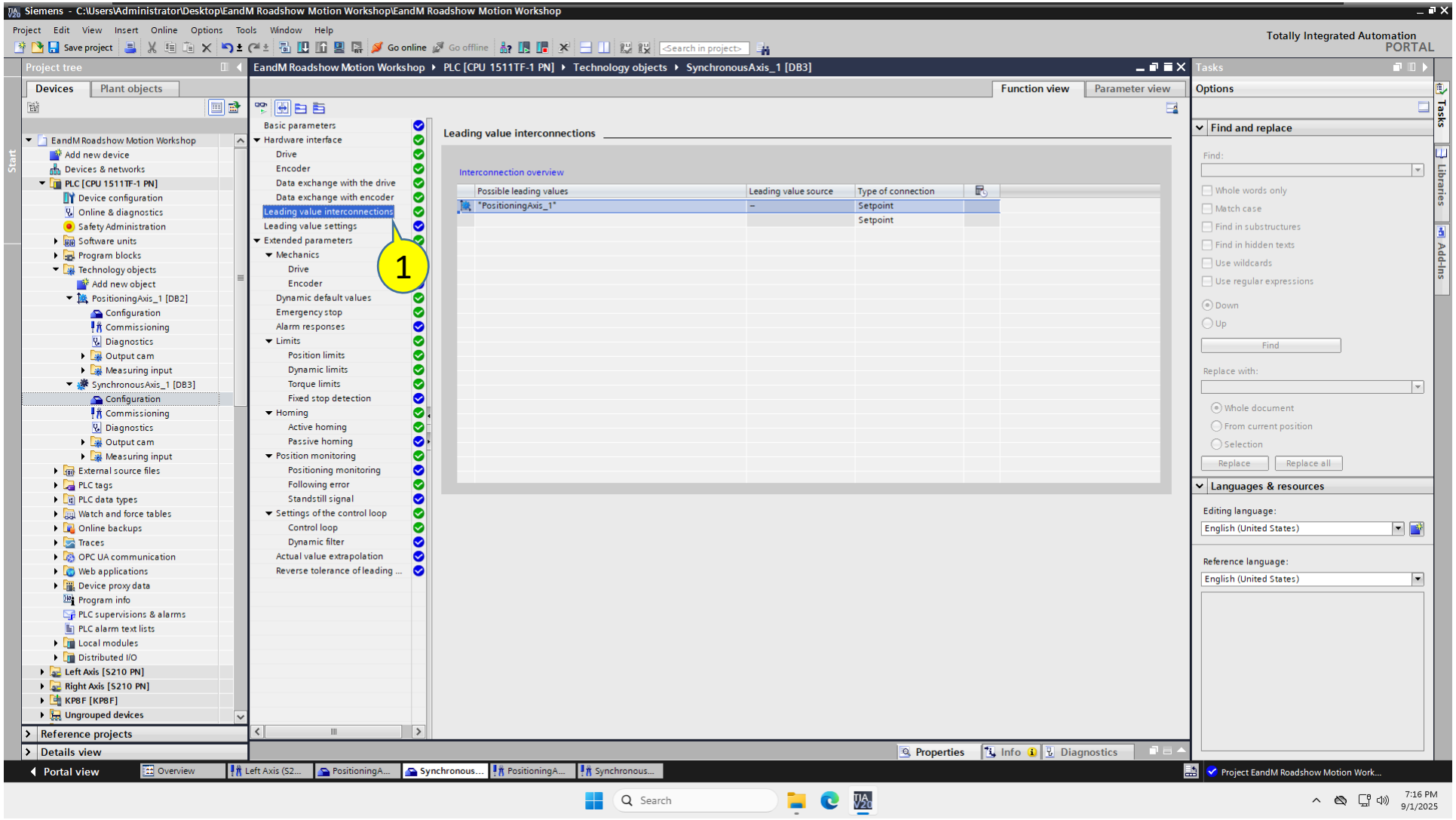


Motion Lab



1. Open the Positioning Axis TO under PLC Technology objects
2. Examine the different properties of the TO configuration
3. Examine the Synchronous Axis TO configuration

Motion Lab



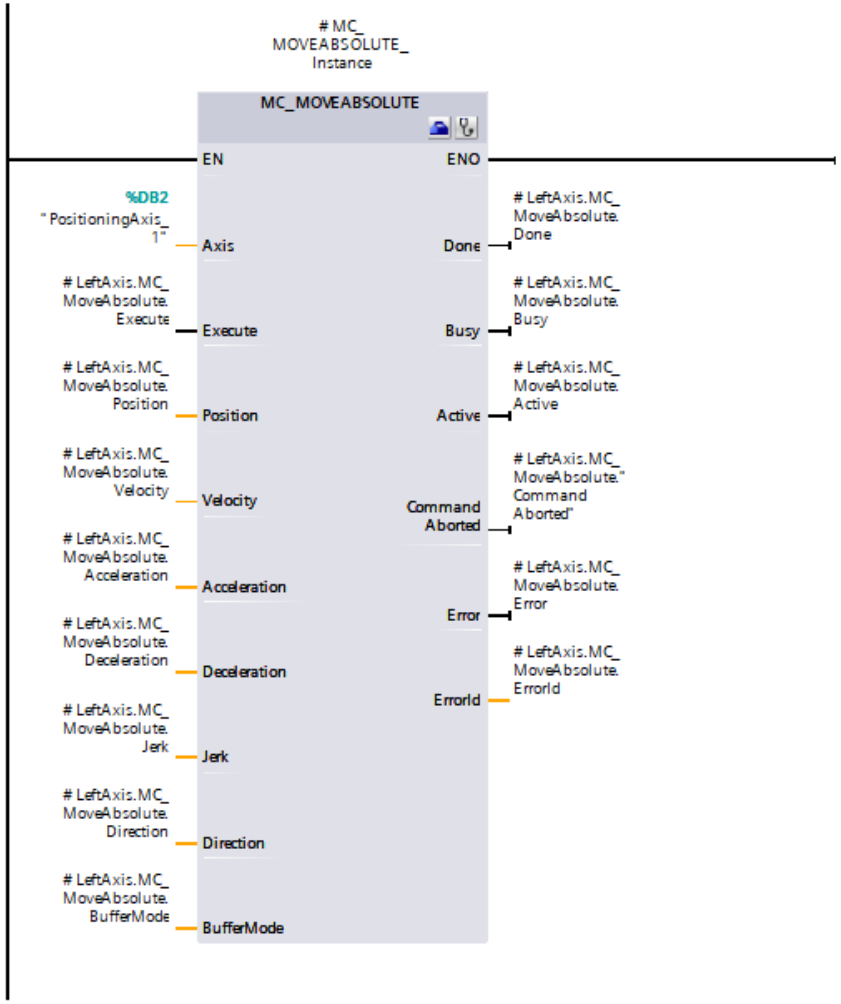
1. The Synchronous Axis TO configuration parameters are nearly identical to the Positioning Axis. The Leading value interconnections parameter is where you assign its leading value, which in this case is the Positioning Axis.

Motion Lab

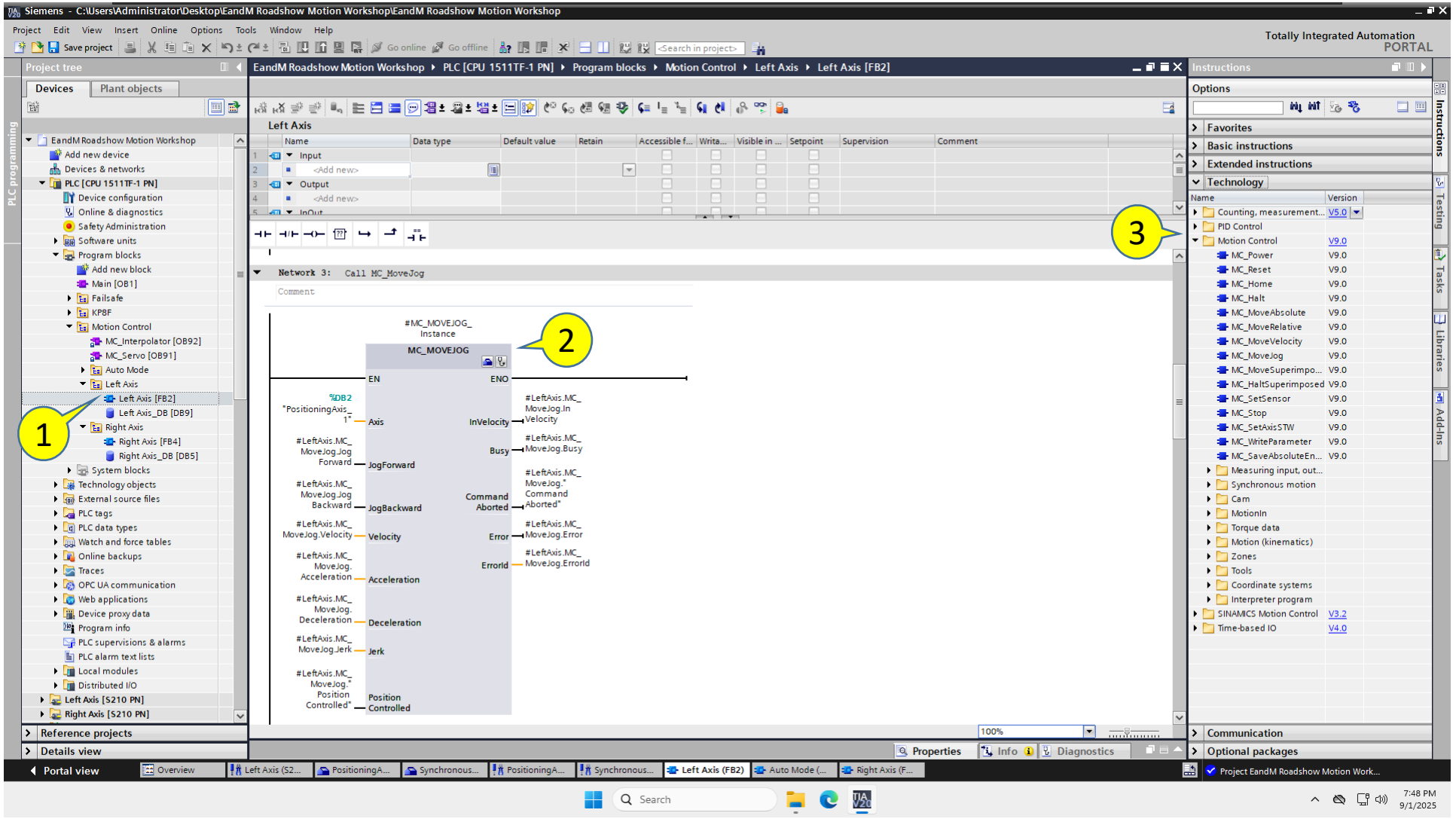
What are Motion Control Blocks?

Siemens motion control blocks, also known as Motion Control (MC) instructions or function blocks, are pre-built programming components within Siemens' TIA Portal software used in industrial automation to control the movement of machinery. These blocks interface with technology objects (TOs) representing physical axes and drives, allowing users to program complex motion tasks like "Move Absolute," "Move Relative," "Move Velocity," "Home," and "Halt" through a standardized, user-friendly interface.

Siemens uses PLCopen standards for its motion control function blocks in TIA Portal, providing a standardized interface (e.g., MC_Power, MC_MoveAbsolute, MC_MoveVelocity) for axis control. These blocks offer basic motion functions such as enabling axes, homing, positioning, and jogging, simplifying programming, commissioning, and testing by using a common, vendor-independent set of commands.

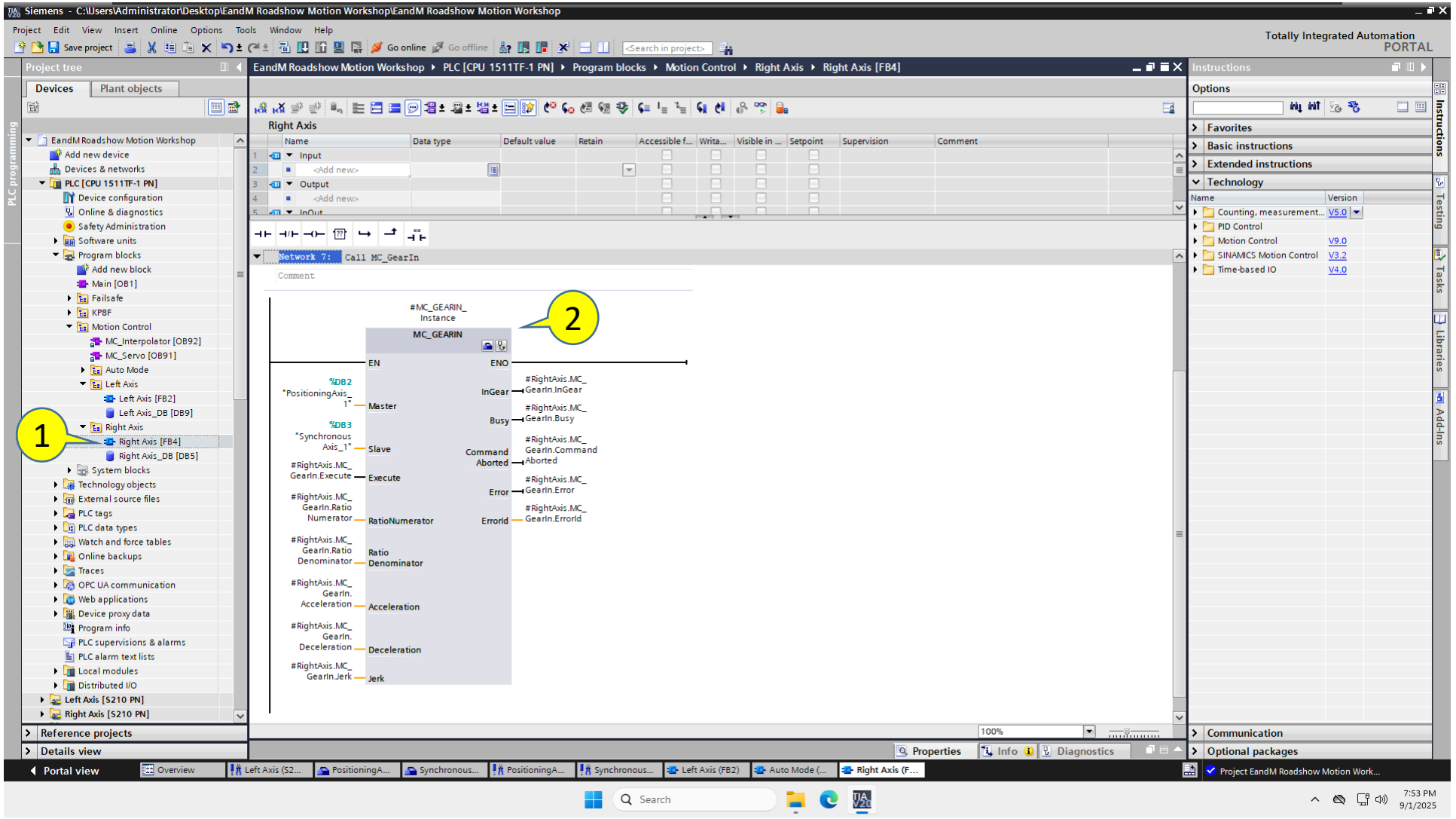


Motion Lab



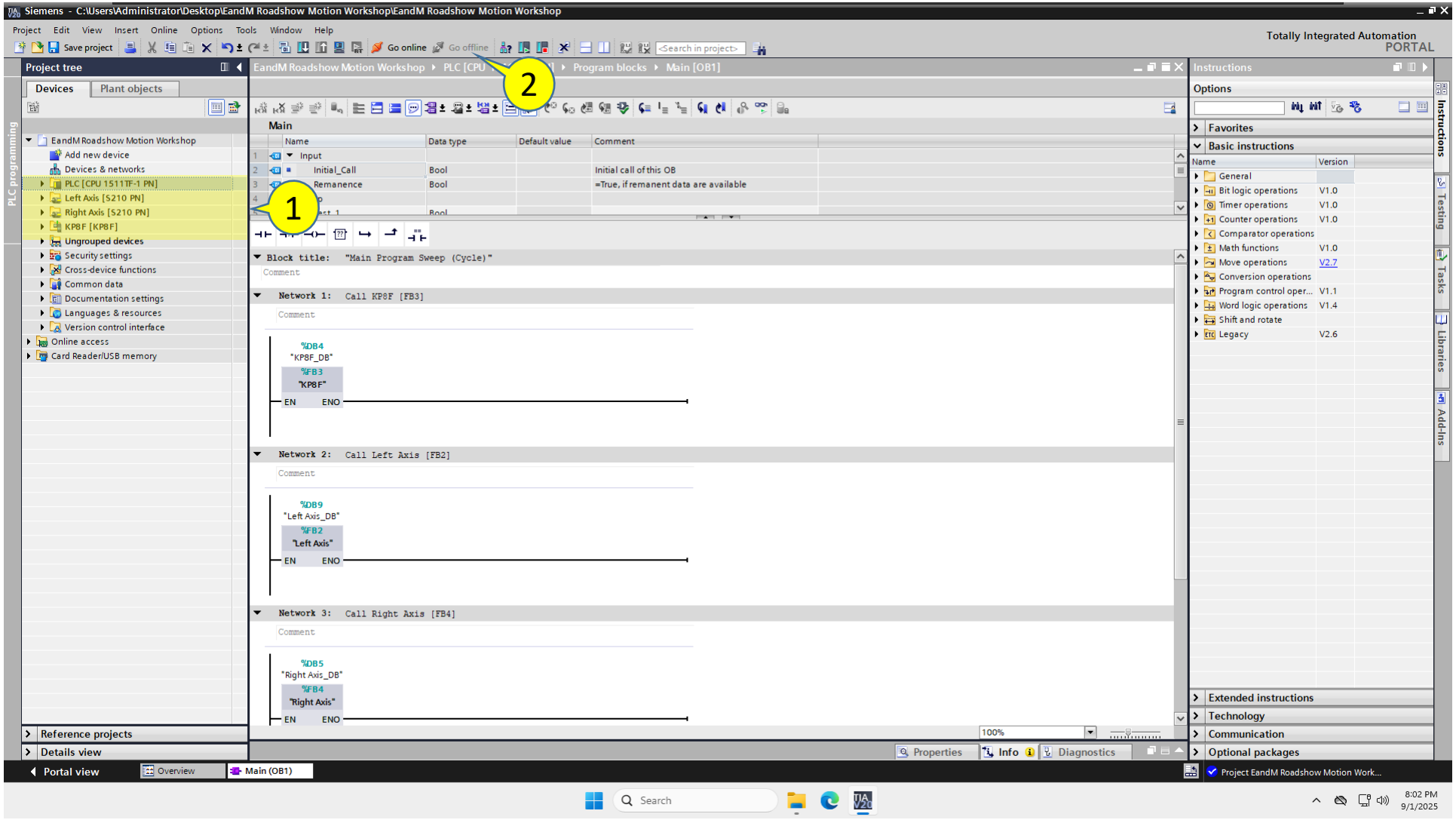
1. Open Left Axis [FB2]. It can be found under PLC ▯ Program blocks ▯ Motion Control ▯ Left Axis.
2. Scroll through FB2 to examine the different Motion Control blocks being called in this function
3. You can find the extensive list of Motion Control blocks in the instruction under Technology ▯ Motion Control

Motion Lab



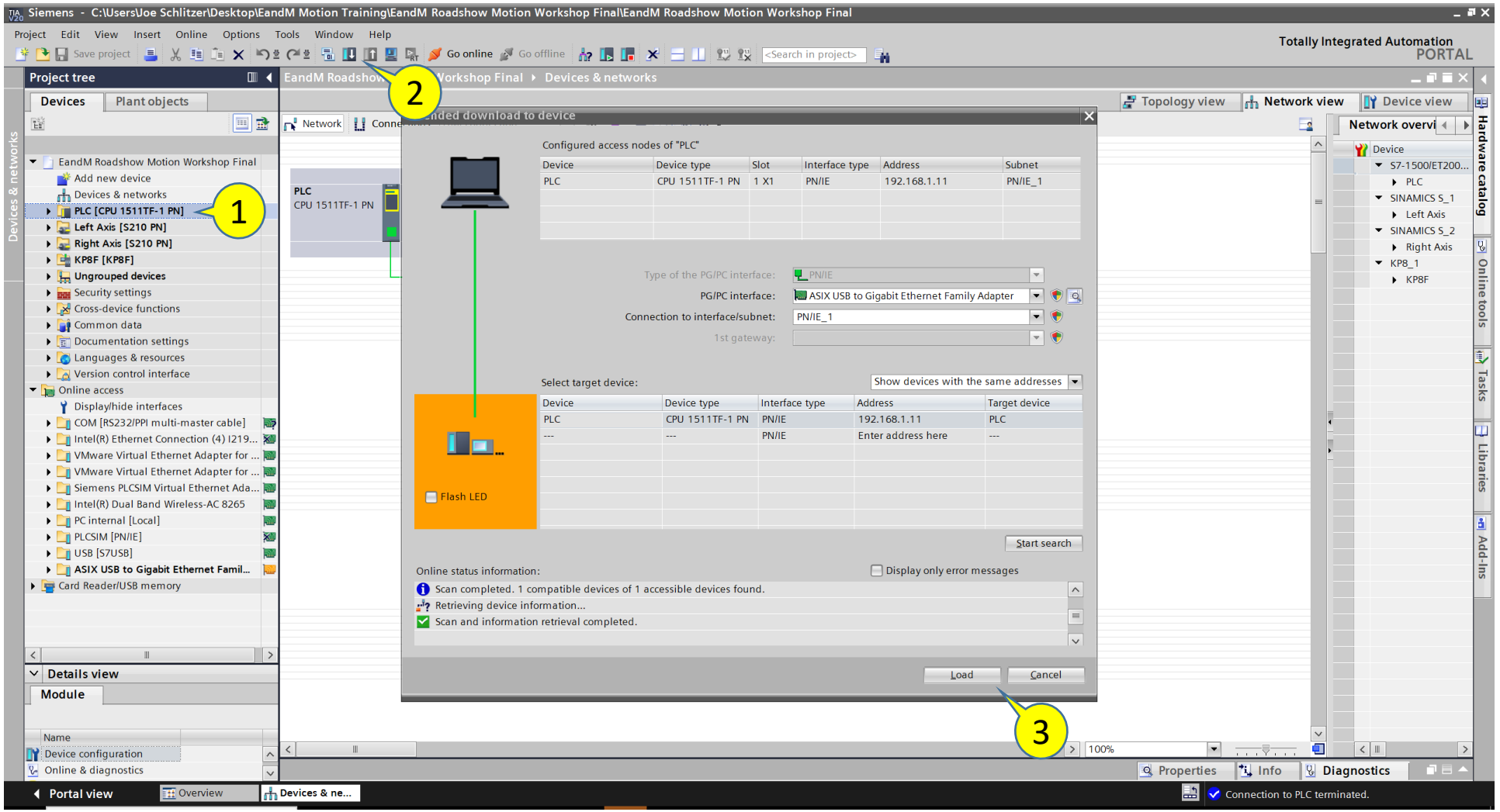
1. Open Right Axis [FB4]. It can be found under PLC ▸ Program blocks ▸ Motion Control ▸ Right Axis.
2. Scroll through FB2 to examine the different Motion Control blocks being called in this function. This axis has an additional block – MC_GEARIN. This is used synchronous it's motion with the Left Axis.

Motion Lab



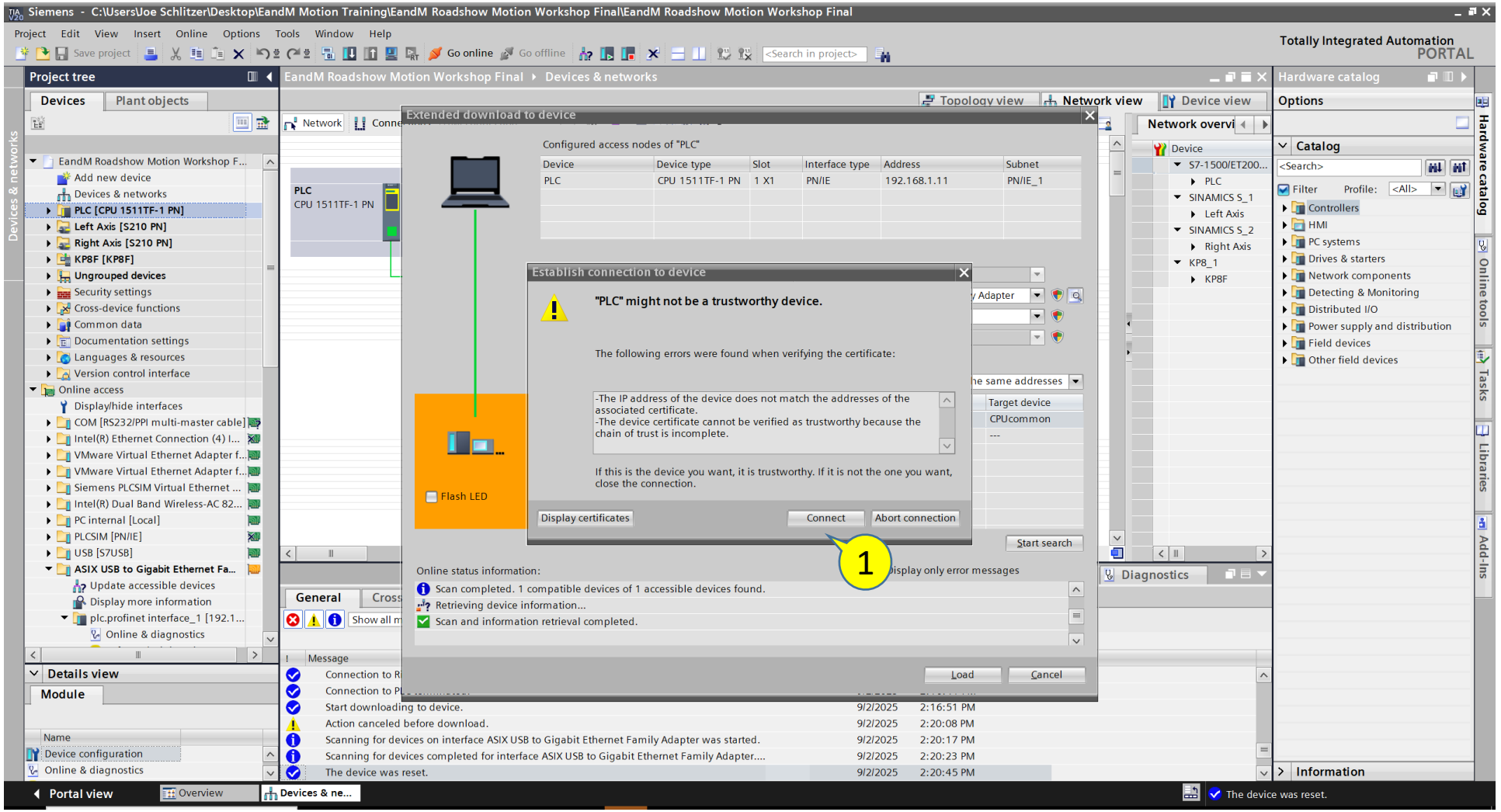
1. Make sure you're offline from all Devices. There should not be any online indicators next to the names of the devices in the Project Tree
2. Also, the Go offline button in the toolbar should be greyed out.

Motion Lab



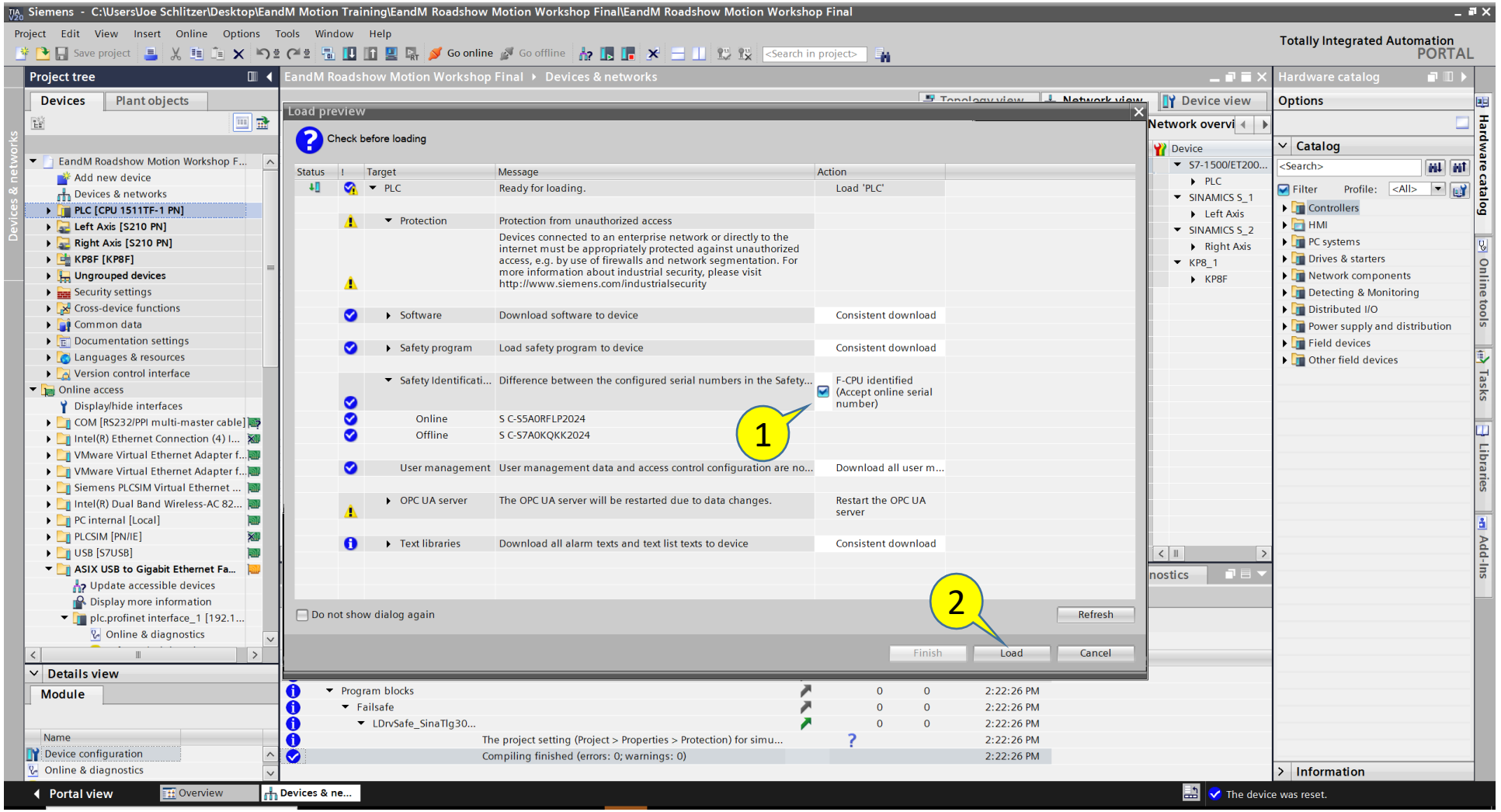
1. Select the PLC in the Project Tree
2. Click the download to device button in the toolbar.
3. In the Extended download to device window, click on the Load button.

Motion Lab



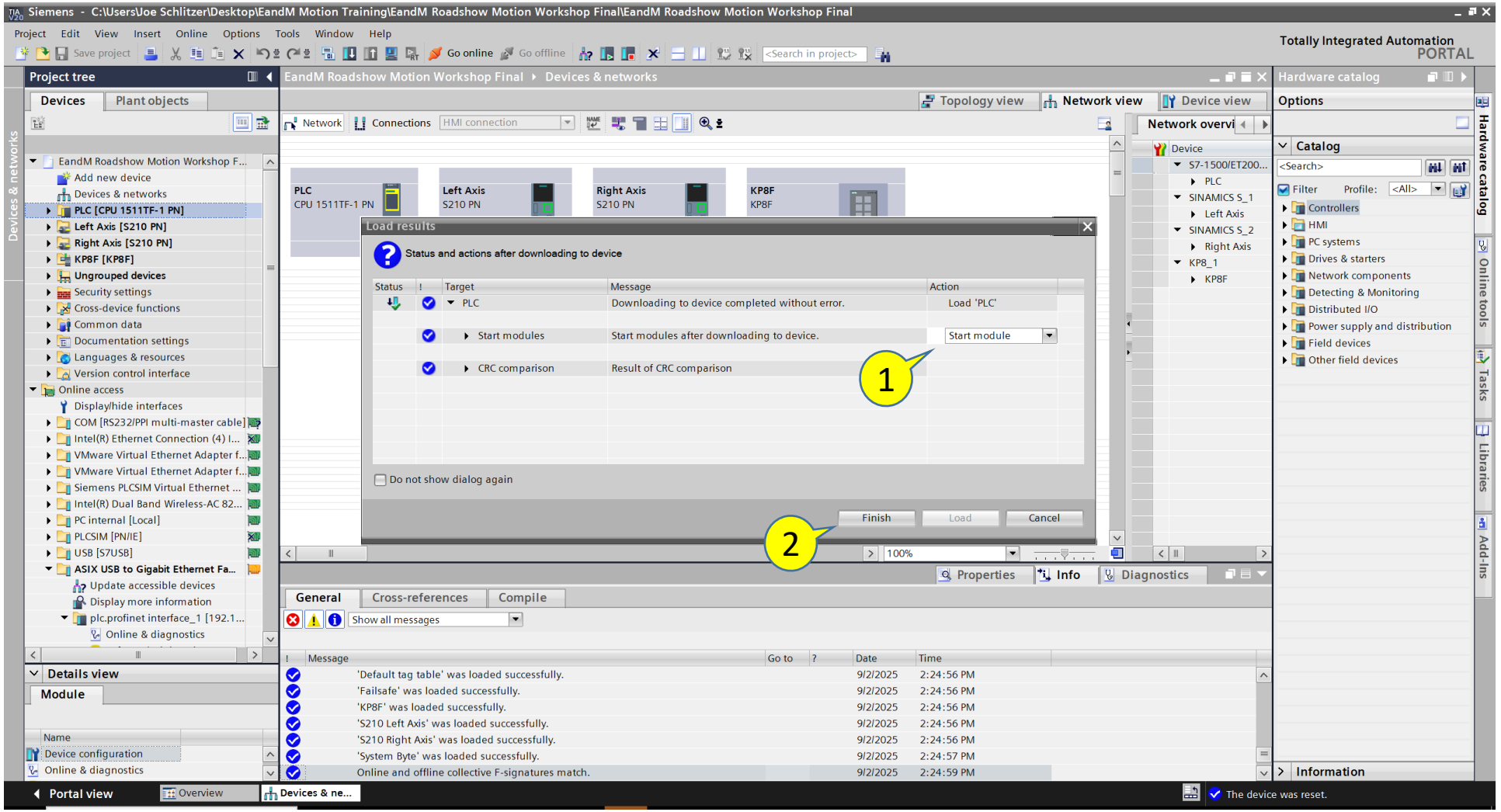
1. In the Establish connection to device window, clic on the Connect button

Motion Lab



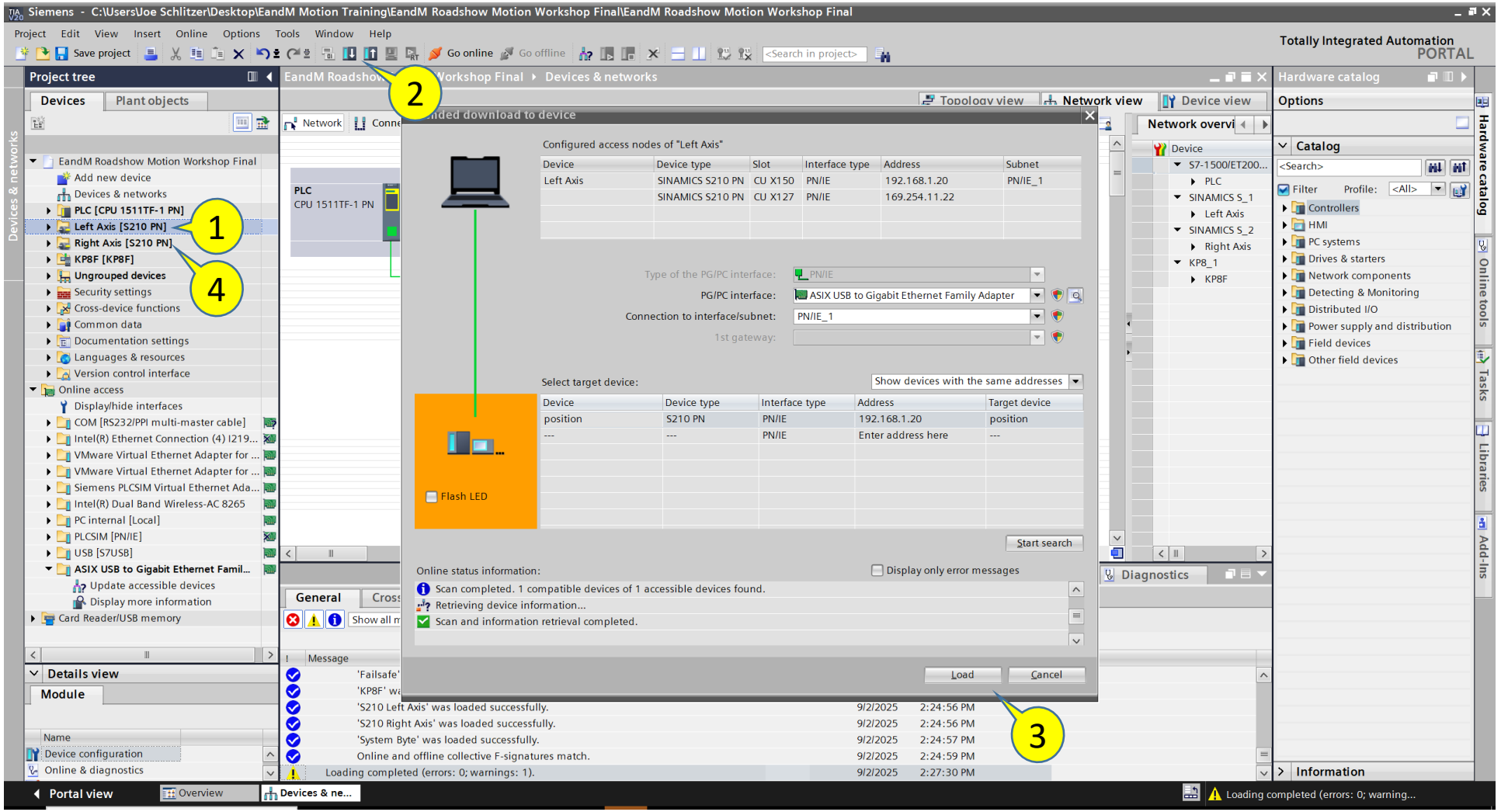
1. Check the box for F-CPU identified
2. Click on the Load button

Motion Lab



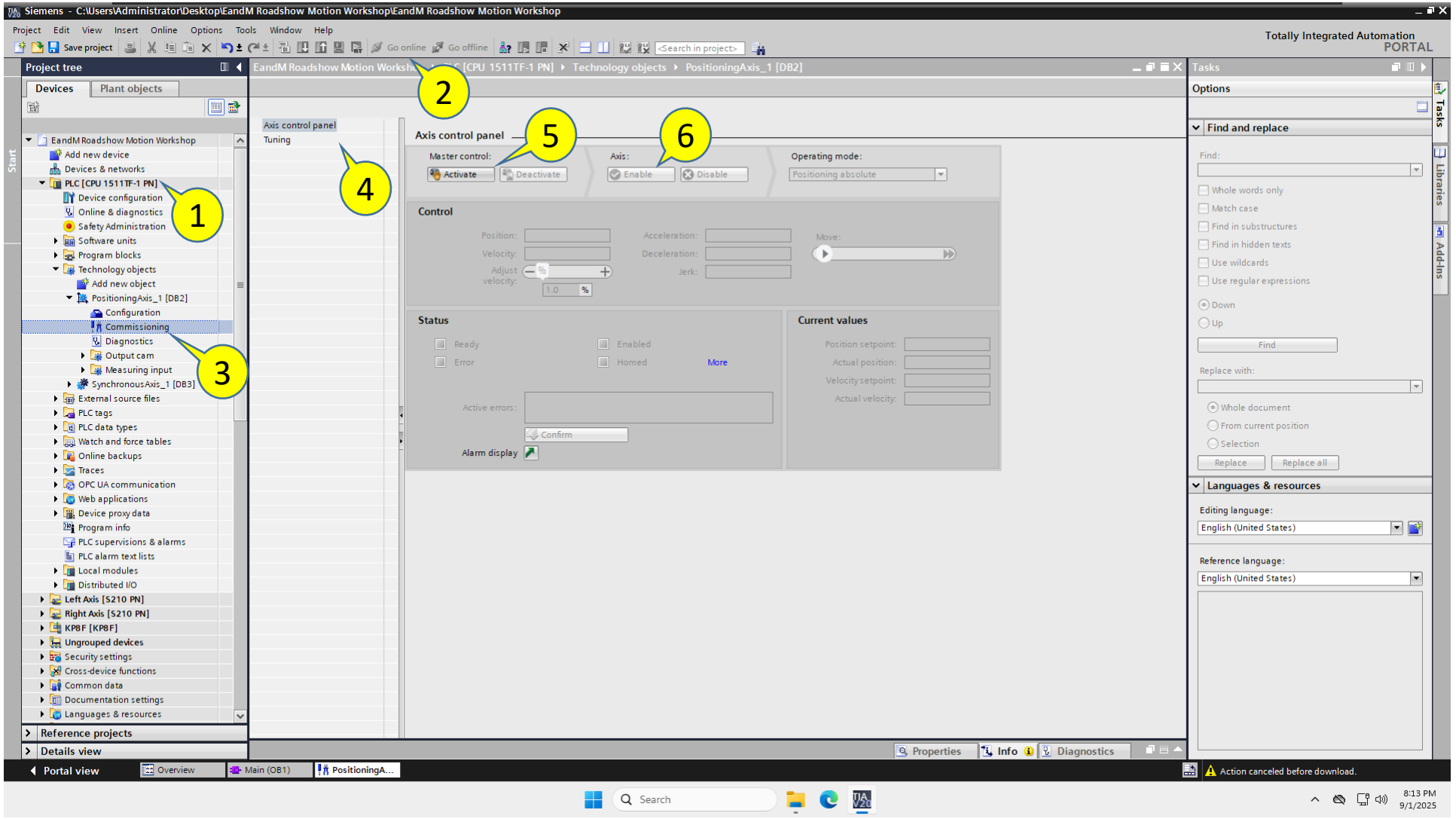
1. In the pull down menu, select “Start module”
2. Click on the Finish button

Motion Lab



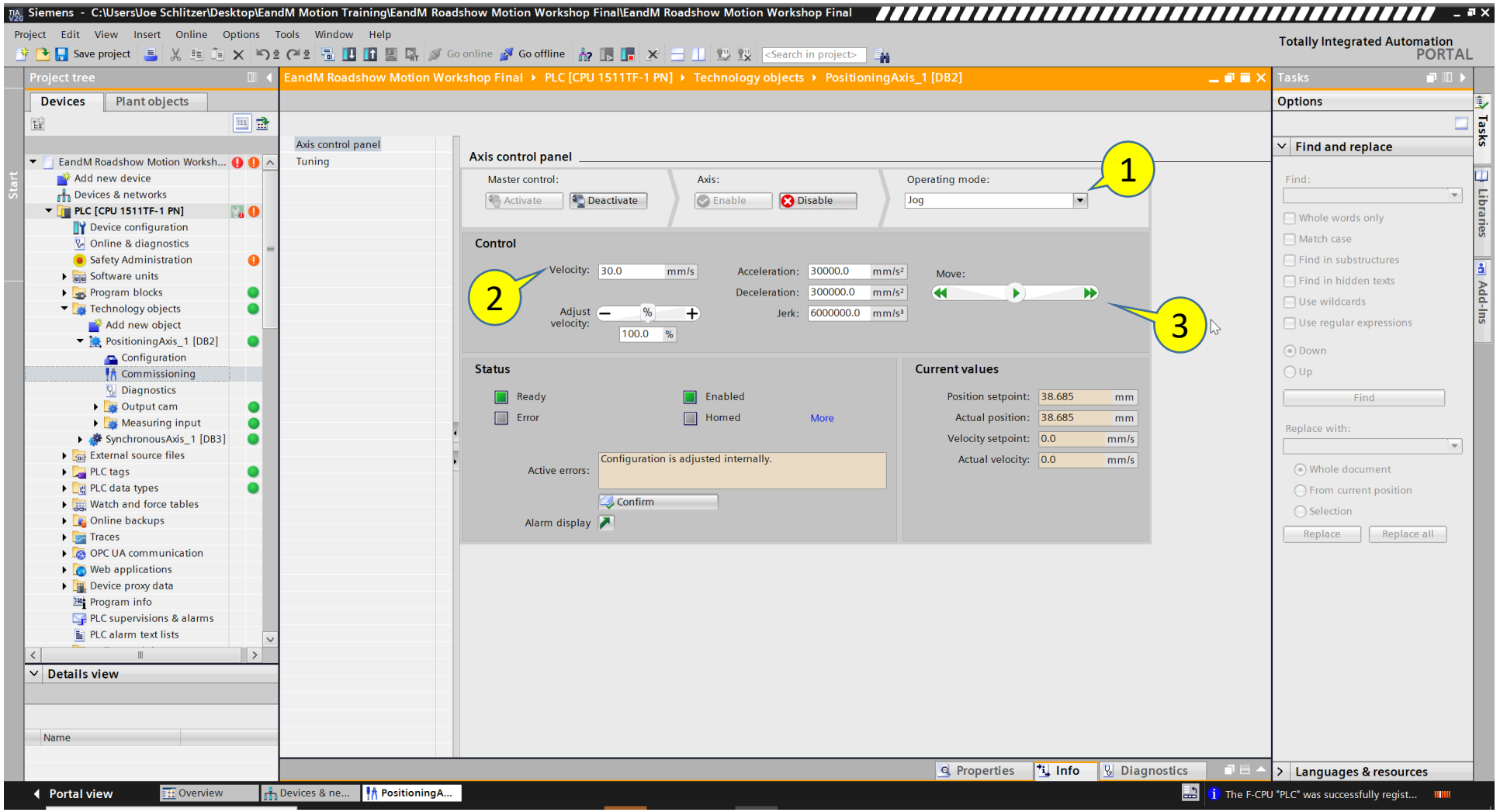
1. Select the Left in the Project Tree
2. Click the download to device button in the toolbar.
3. In the Extended download to device window, click on the Load button.
4. Do the same thing for the Right Axis

Motion Lab



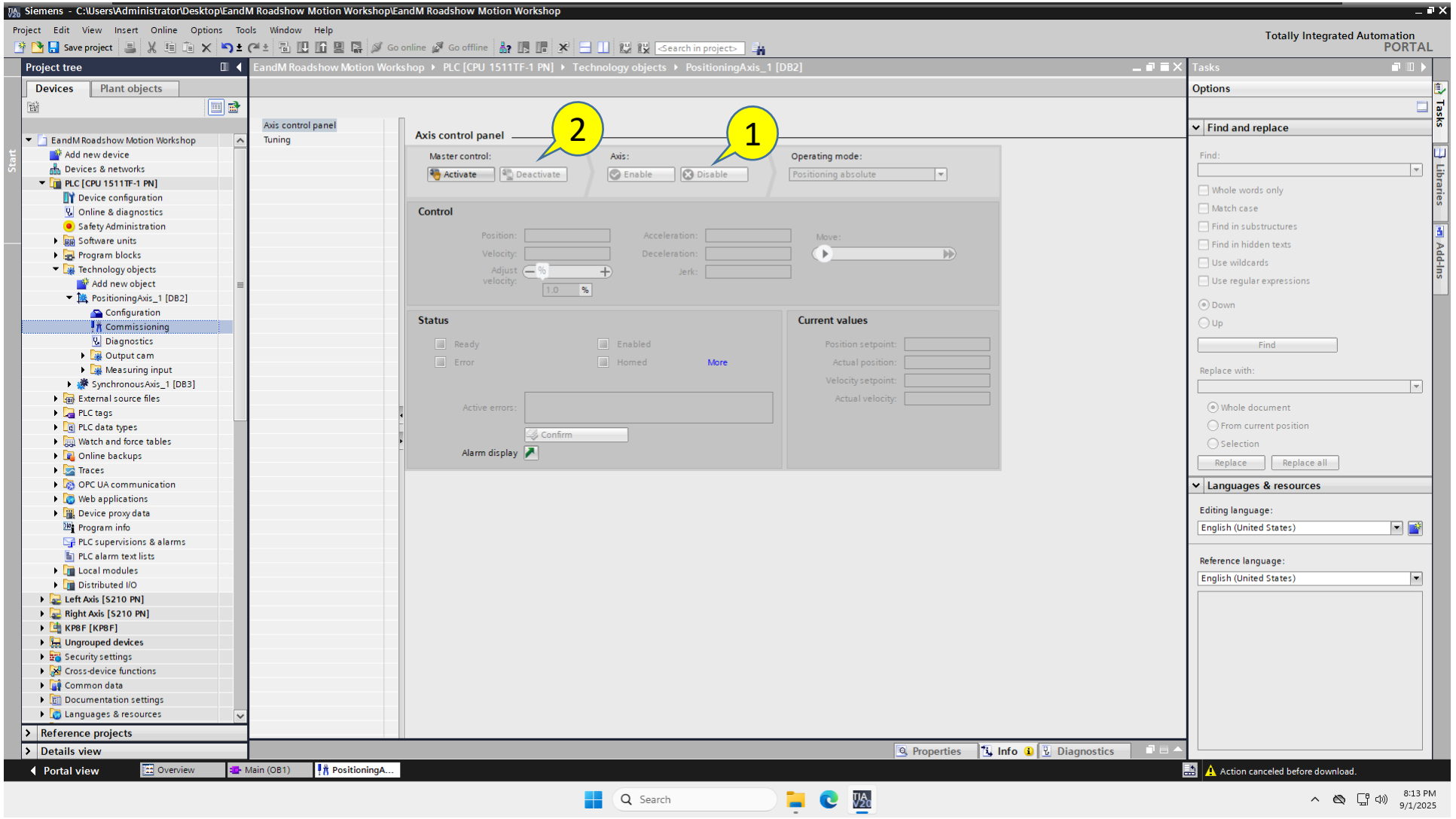
1. Select the PLC in the Project Tree
2. Click the Go online button in the toolbar
3. Double click on Commissioning under the Positioning Axis TO
4. Click on Axis control panel
5. Activate master control
6. Enable the Axis

Motion Lab



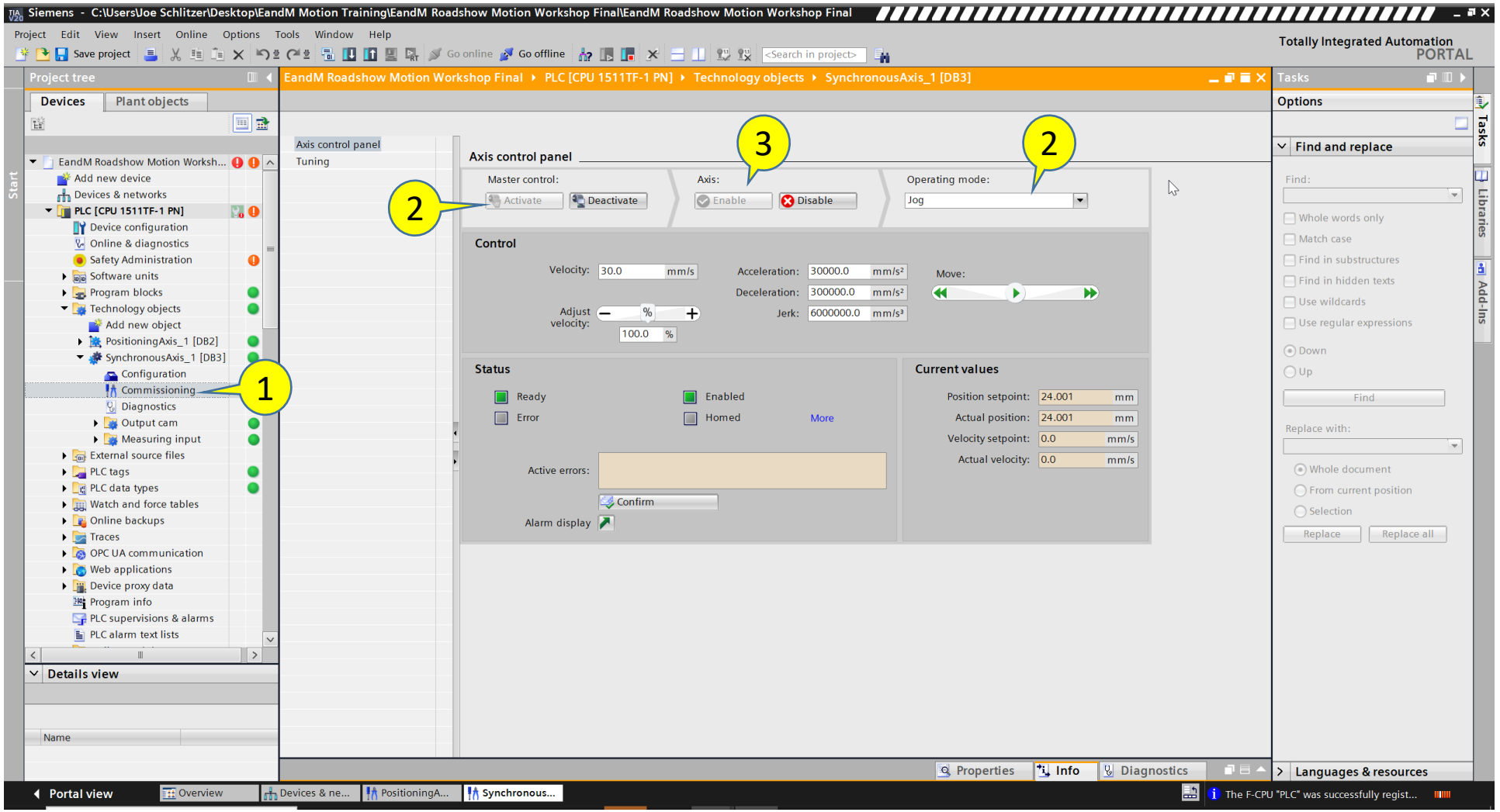
1. Under "Operating mode", select "Jog" from the drop-down list
2. Specify the dynamic parameters for the traversing motion as shown in the screen shot. 30.0mm/s is a nice slow jogging speed
3. To move the axis in the positive direction, click on the arrow symbol slider and drag the slider to the right. To move the axis in the negative direction, click on the arrow symbol slider and drag the slider to the left. To stop the traversing motion, release the pressed mouse button

Motion Lab



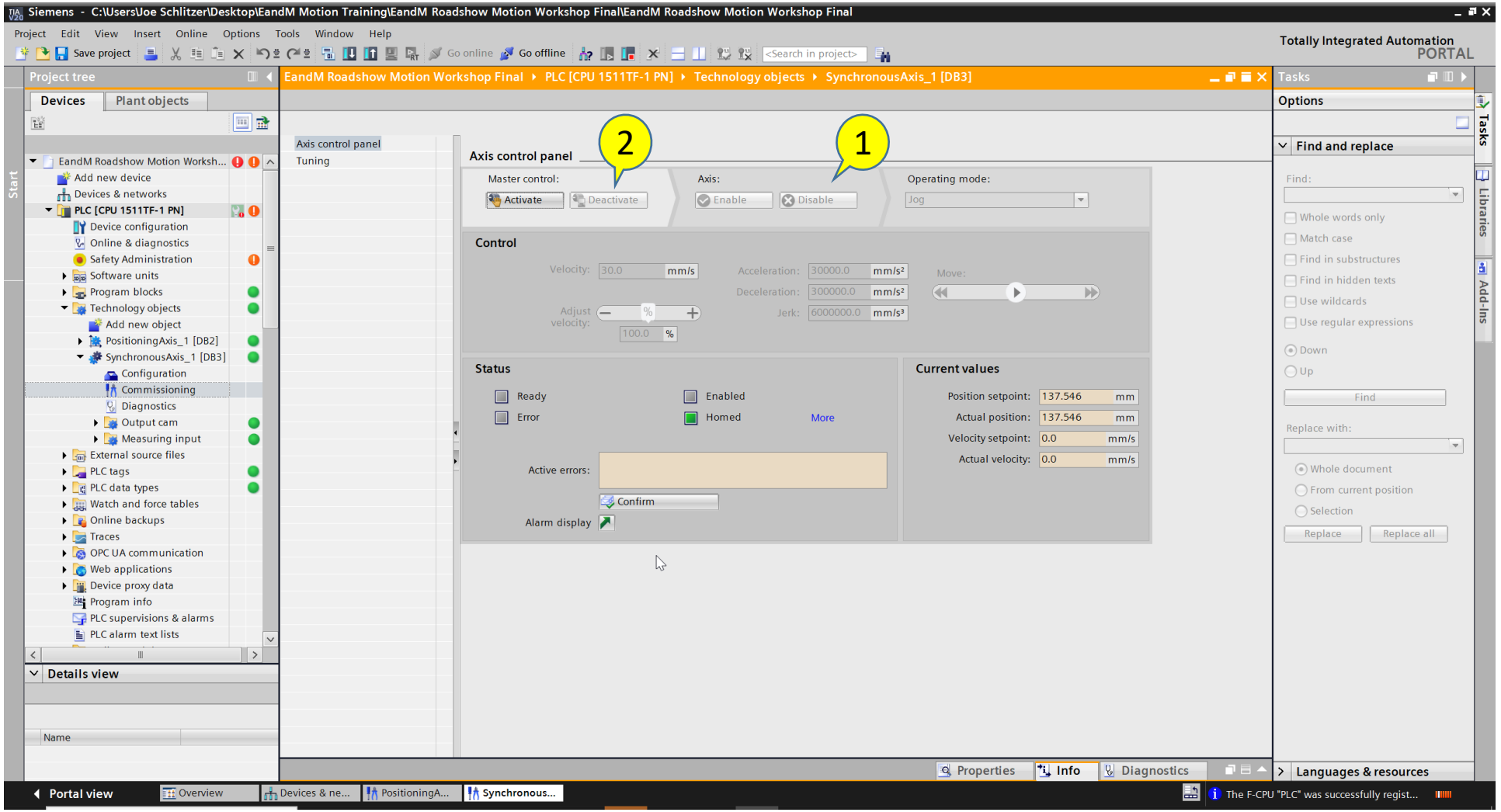
1. Disable the Axis
2. Deactivate master control from the Axis.

Motion Lab



1. Go into Commissioning for the Synchronous Axis
2. Take Master Control of the Axis
3. Enable the Axis
4. Jog the axis using 30.0 mm/s as the velocity

Motion Lab



1. Disable the Axis
2. Deactive Master Control of the Axis

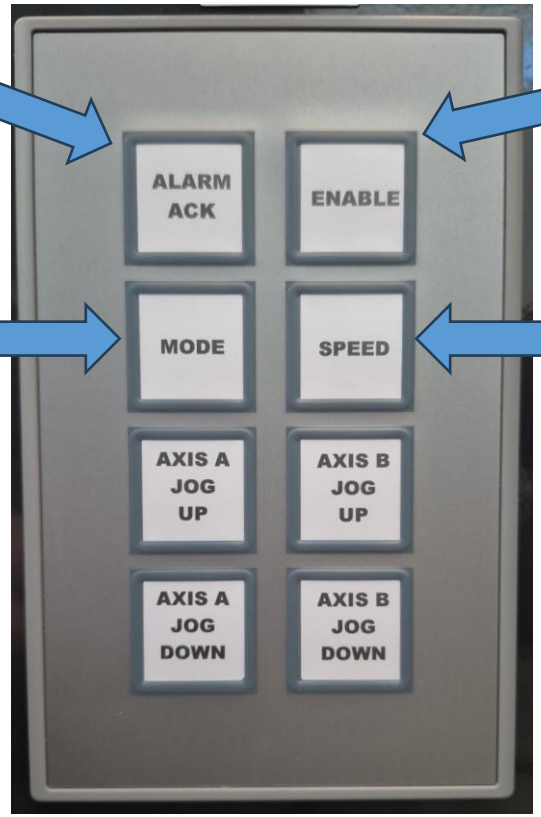
Motion Lab

Flashes RED when there is an alarm.
Press to ACK alarms

KP8F Touch Buttons

Enable the Axis
Solid Green = Enabled

Switch between Auto and Manual mode.
Flashing Yellow = Manual Mode
Solid Blue = Demo Mode
Flashing Blue = Synchronous Mode



Auto Mode Speeds
Slow, Medium and Fast

Jog buttons are self explanatory. Only work in Jog mode

THANK YOU

Questions?