



# Motion Workshop

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**SIEMENS**  
**FESTO SICK**

## 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





## 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.

## 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.





## Examples of Industrial Motion Control

### **CNC machining:**

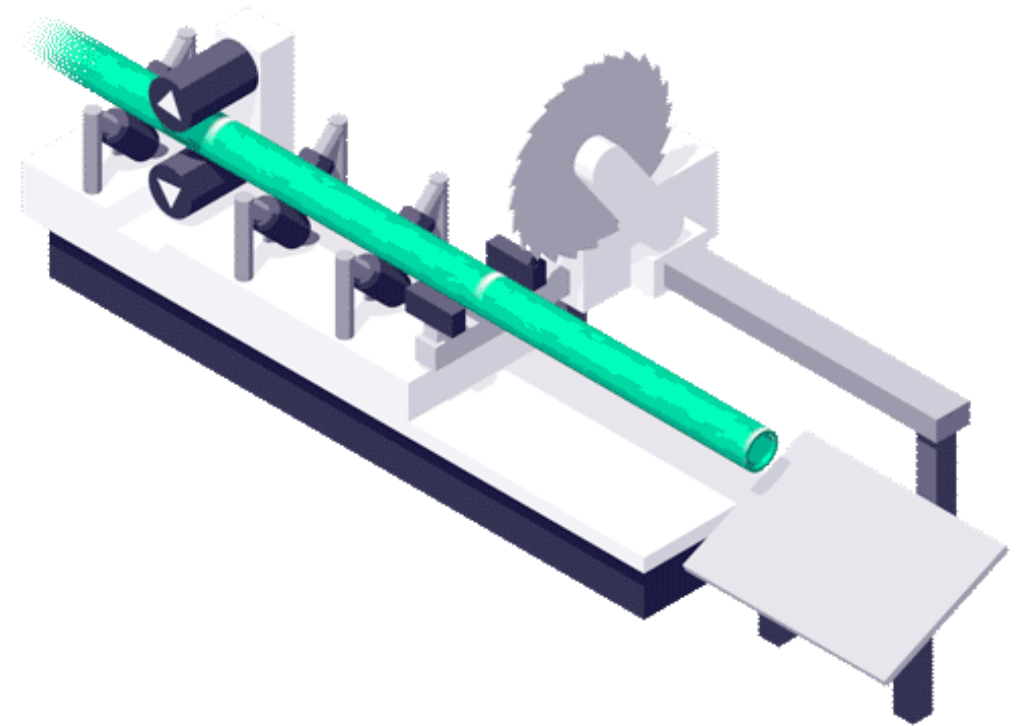
Provides precise control over cutting, drilling, and other fabrication processes to produce intricate and exact parts.



## 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.

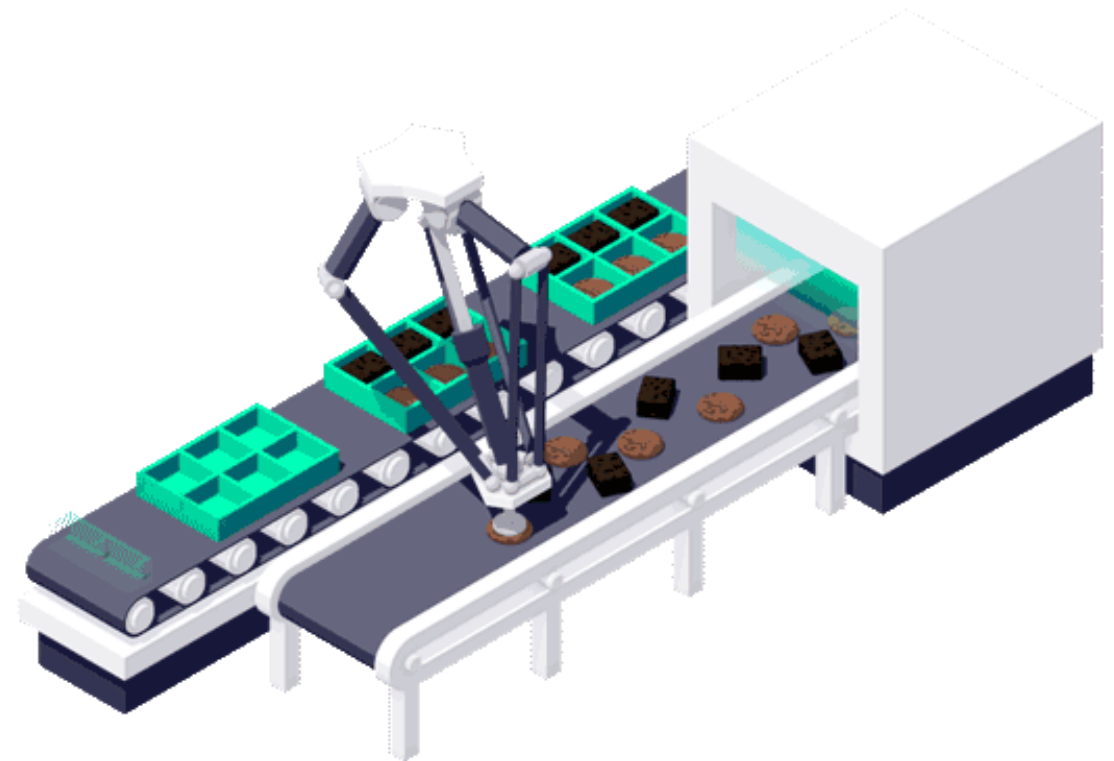




## Examples of Industrial Motion Control

### **Pick-and-Place:**

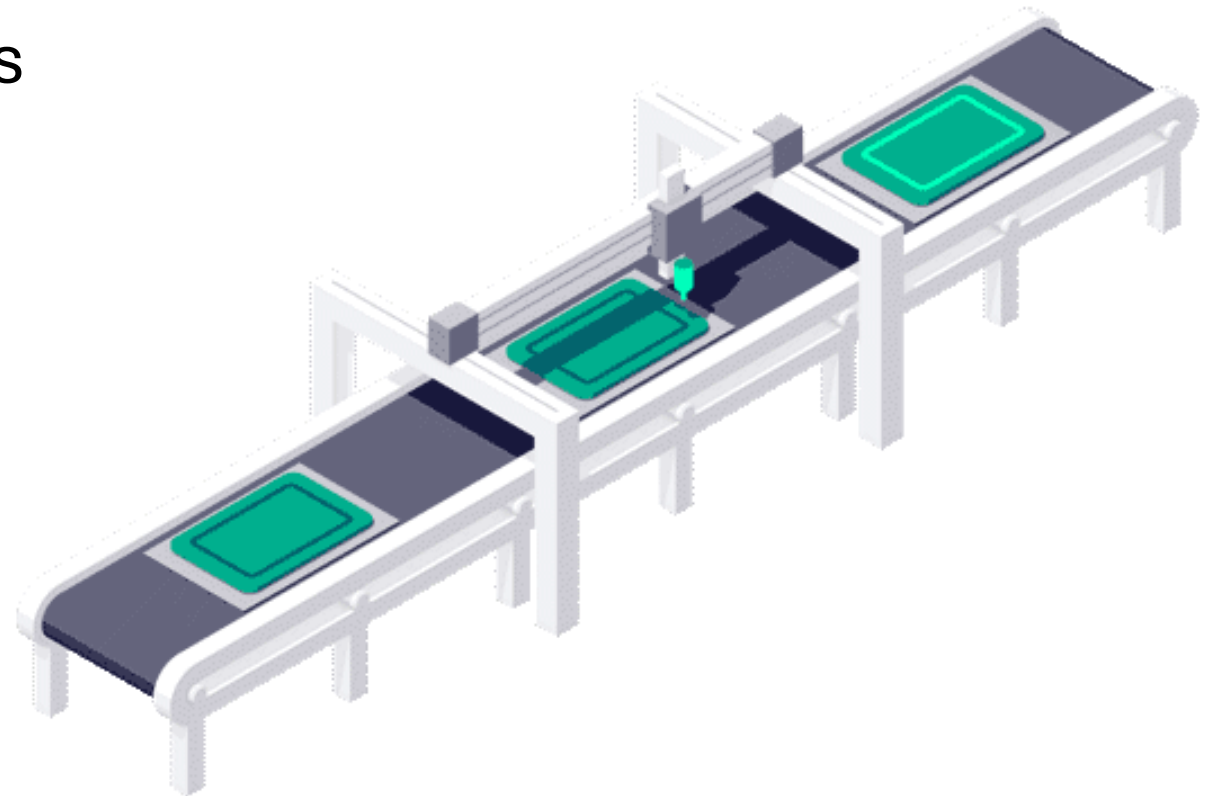
Automated systems, usually robotic arms, that automatically pick up items from one location and precisely place them onto another. In logistics and packaging, pick-and-place robots pick items from shelves or conveyors to place them into boxes, containers, or other downstream processes.



## 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.

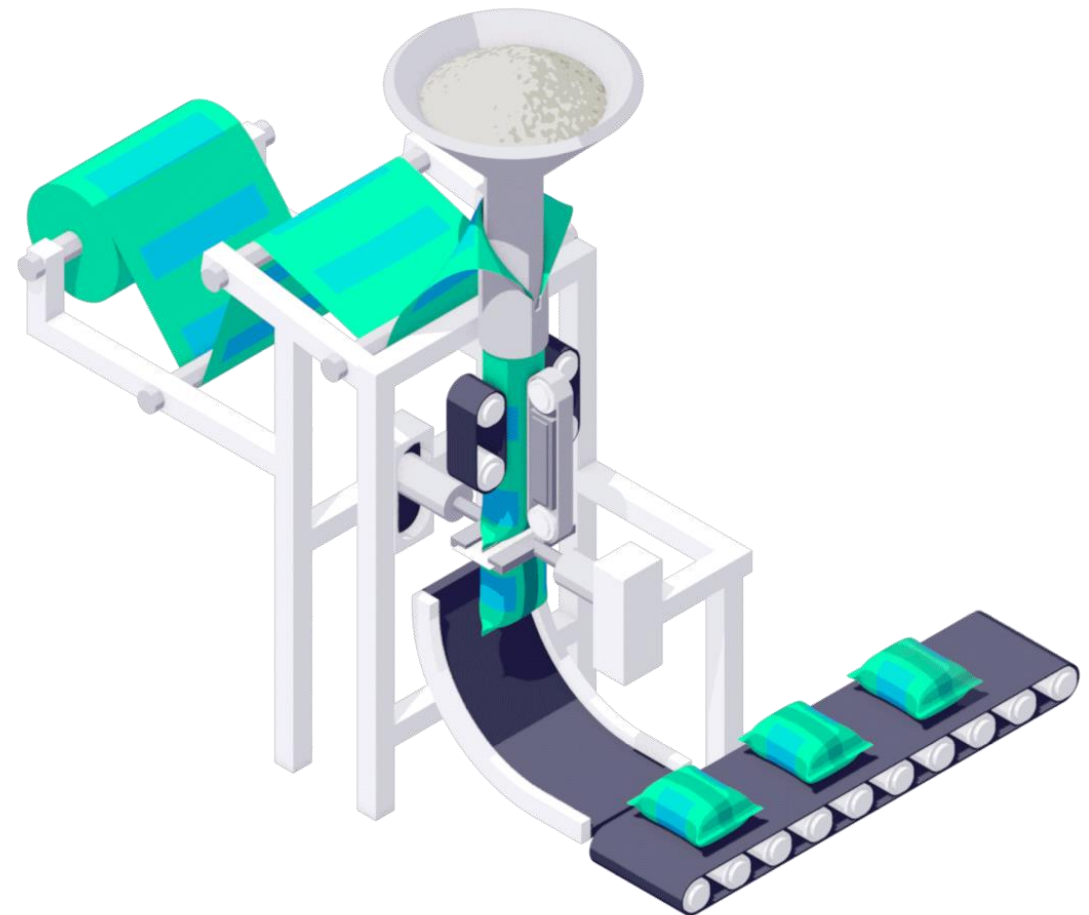




## Examples of Industrial Motion Control

### Packaging Machines:

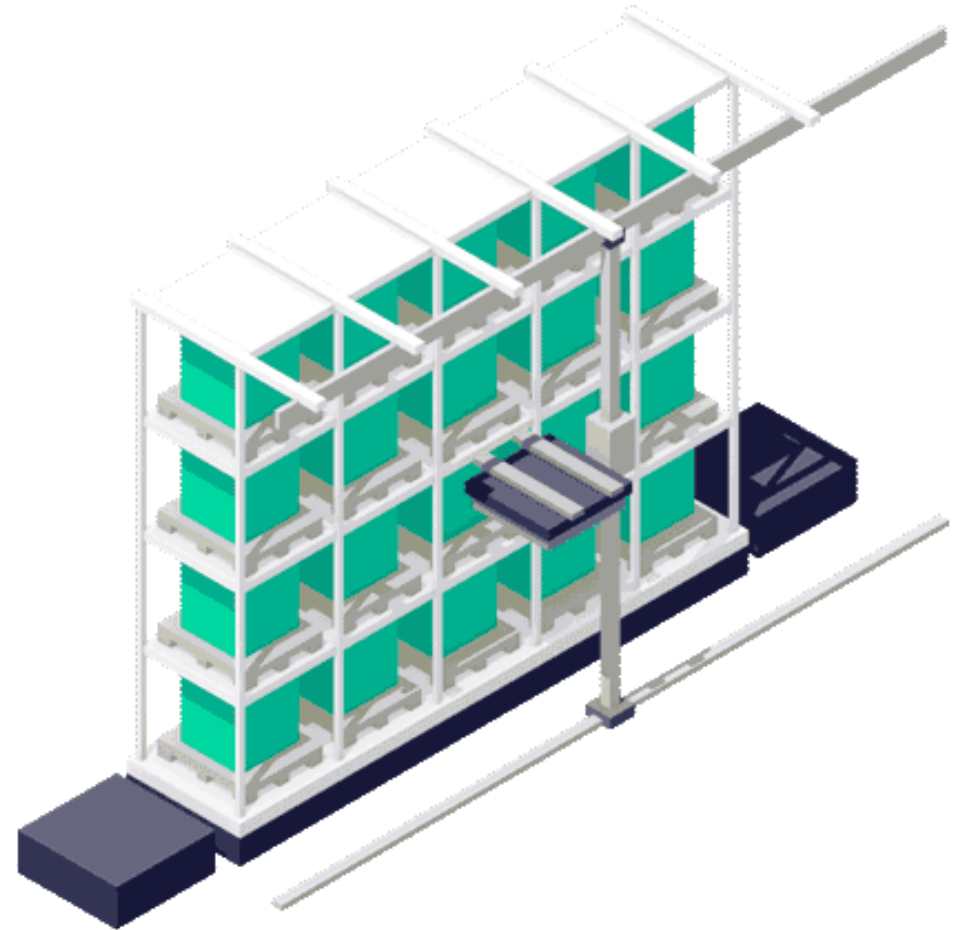
Precise movements are critical for dosing, filling, sealing, and labeling products, ensuring efficiency and minimizing waste.



## 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.

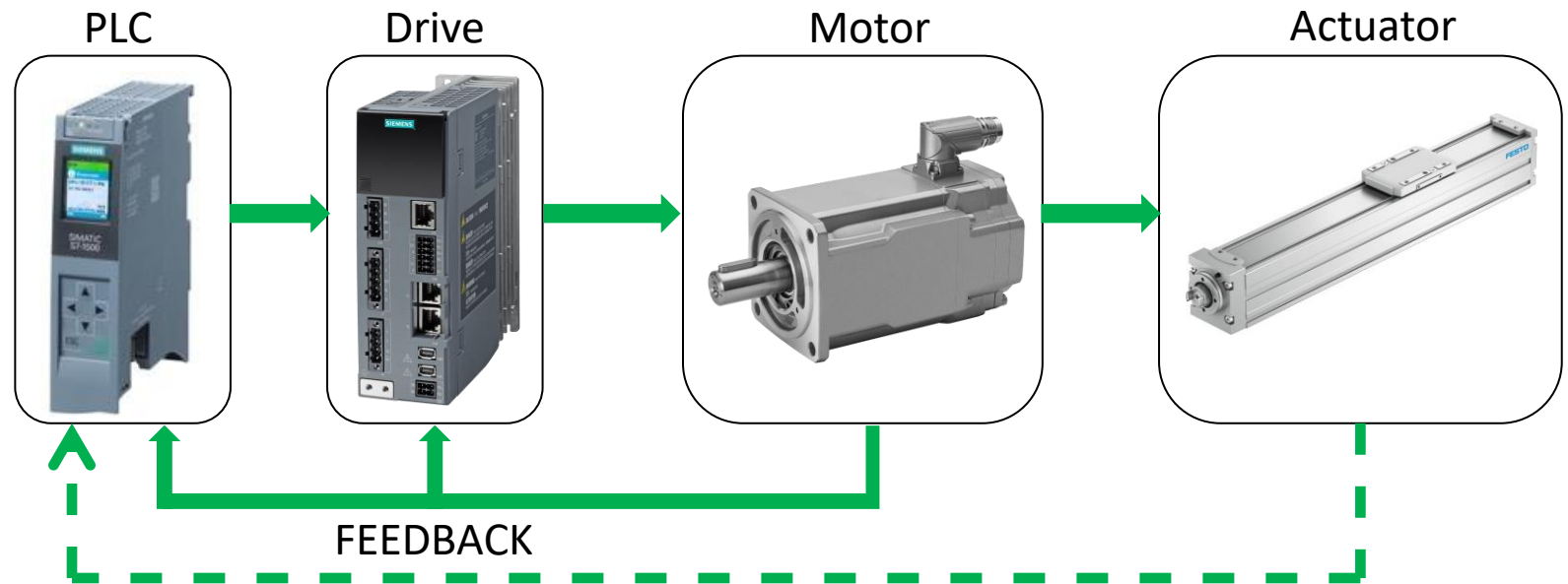




# How Does Motion Control Work?

The four essential components of a motion control system are:

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



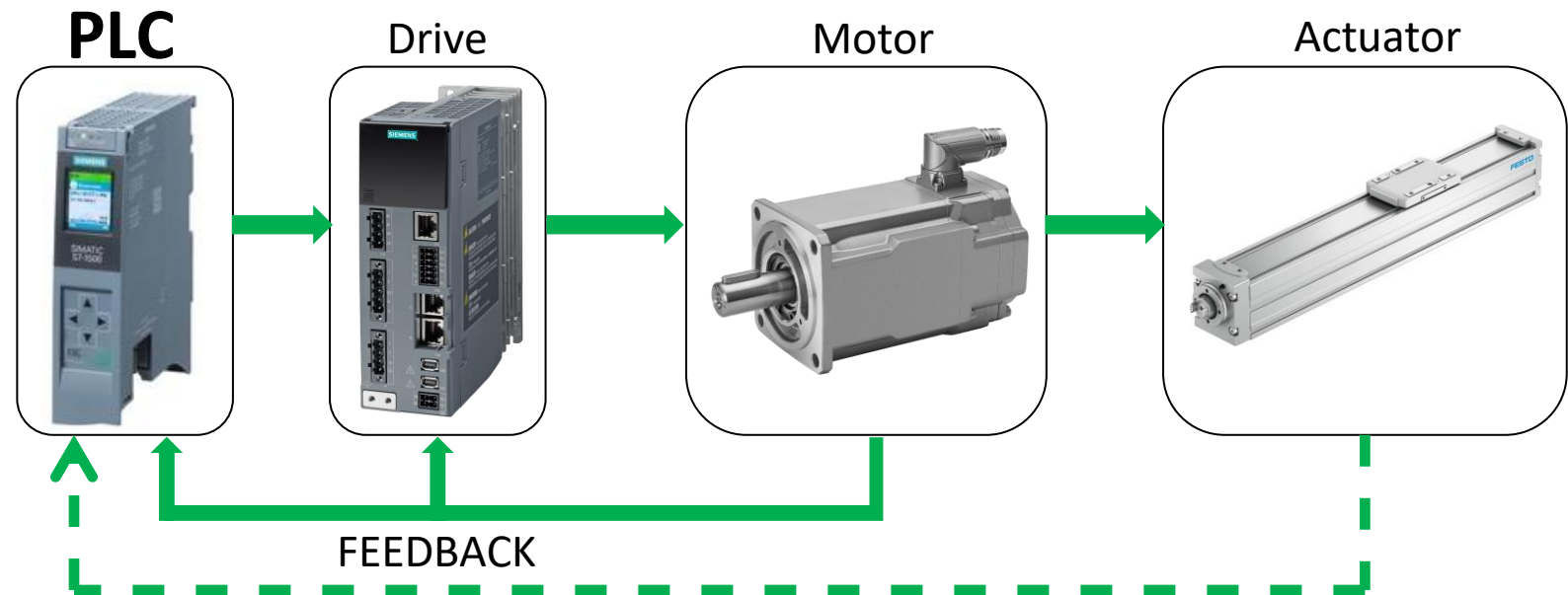
The **controller** is the "brains" of a servo system. It is responsible for generating the motion paths and for reacting to changes in the outside environment. Controllers can be something as simple as an ON/OFF switch, or a dial controlled by an operator.

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.

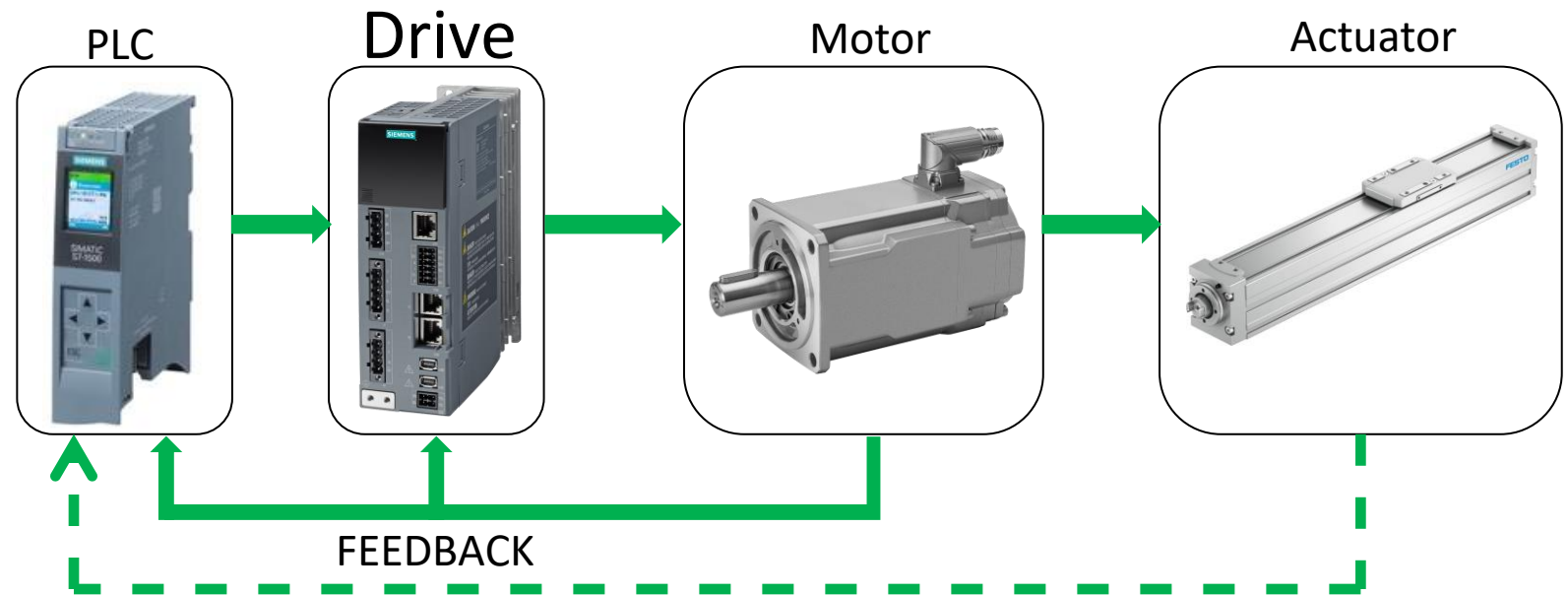
However, many amplifiers will close the velocity and/or position loops reducing computational demands from the controller.

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.



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.



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.

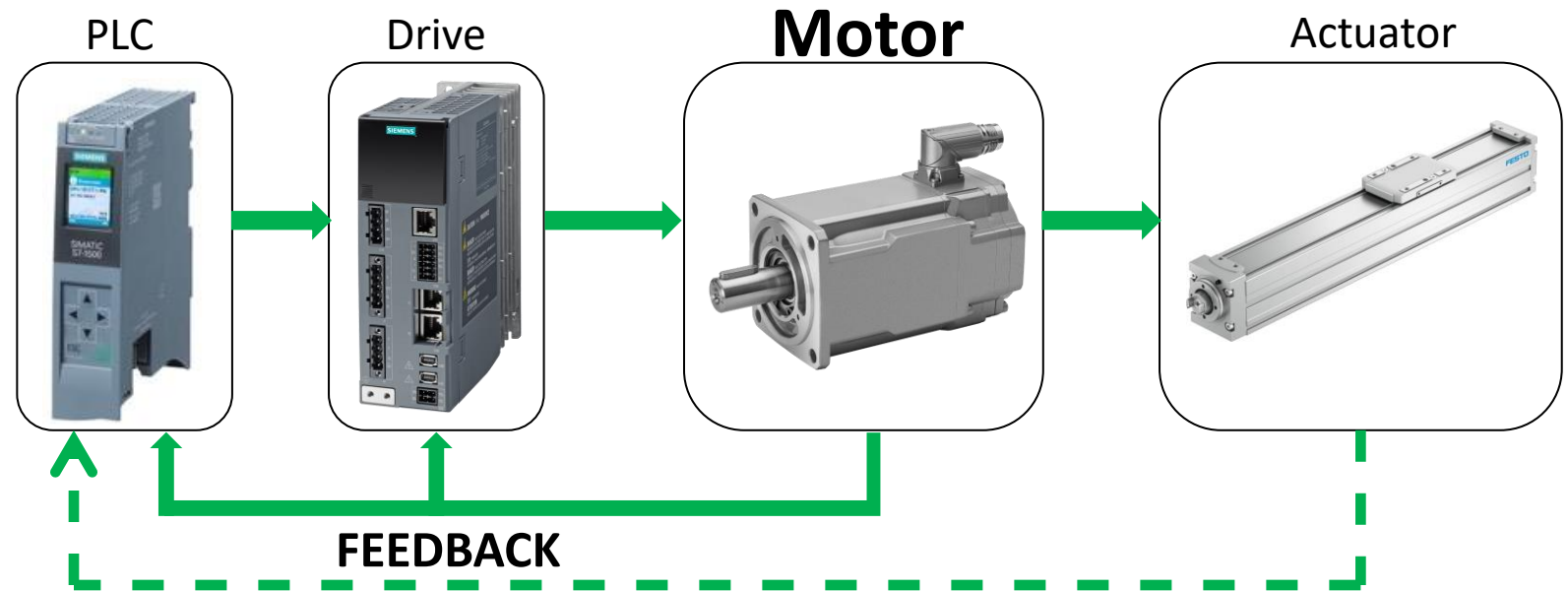
In modern control systems, **feedback** devices are used to ensure that the motor or load reaches the commanded position or velocity. Servo amplifiers and controllers use this feedback to determine how much current to deliver to the motor at any time, based on its present position and velocity versus 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.

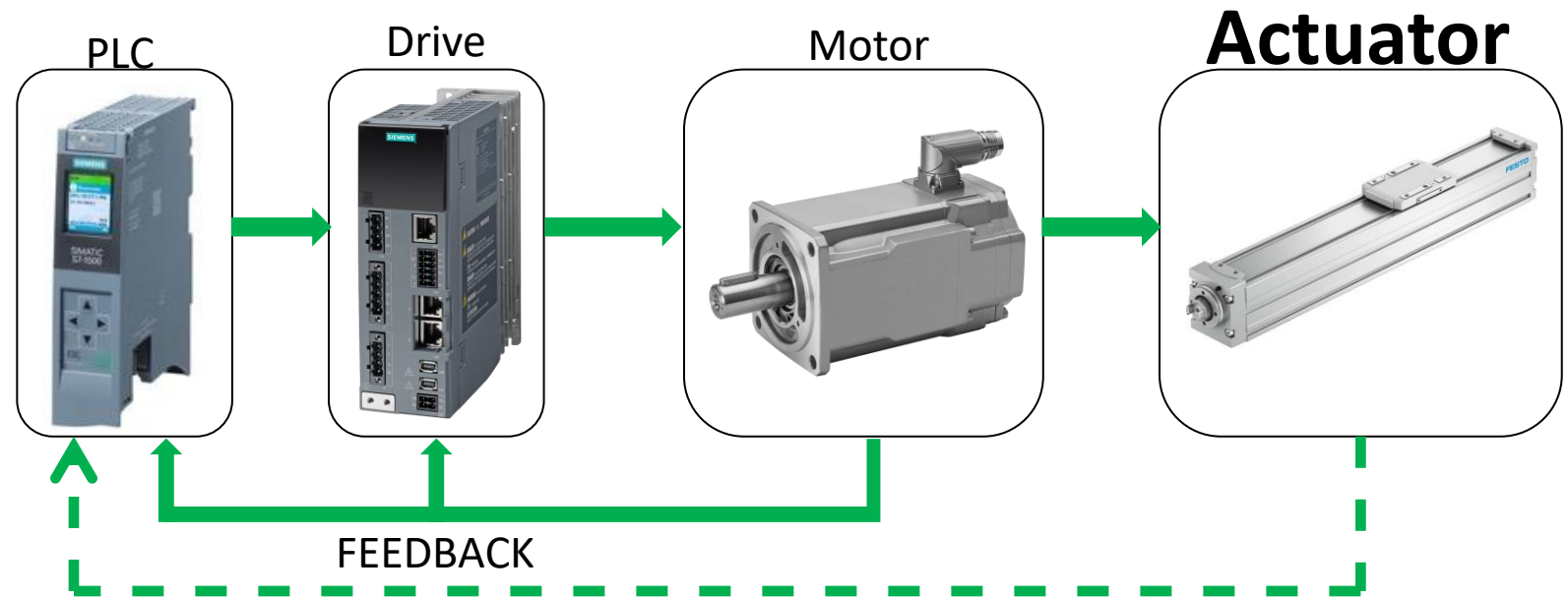




An **actuator** is a device in an automated system that makes something move or operate, such as linear or rotary movement. It serves as the "mover" of the system, physically executing commands to produce the desired force, torque, or displacement by receiving energy from electrical, hydraulic, or pneumatic 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.

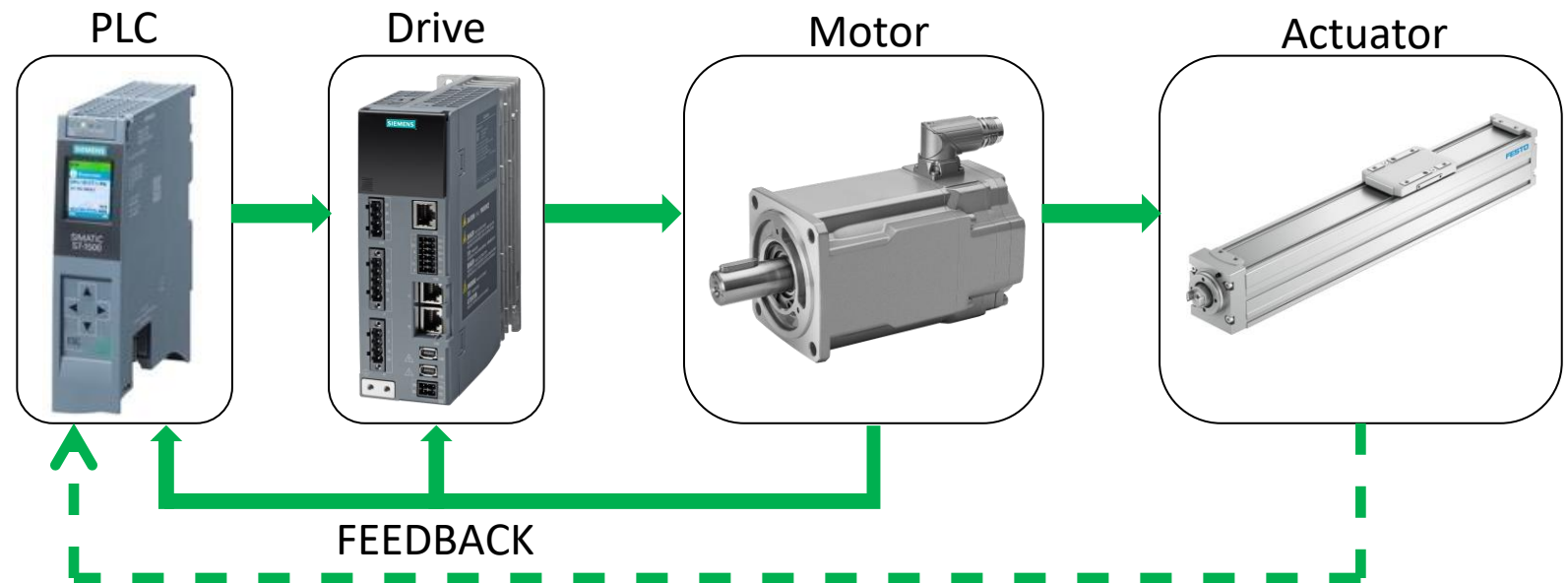


When we put it all together, it forms the Control Loop. The feedback from the motor encoder and sensors informs the controller of the actuator position. The controller compares the actual position with the desired target position.

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!**



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

SIEMENS

# Advanced Controller – SIMATIC S7-1500 T-CPU

Extended Motion Control functions with TIA Portal V18 and firmware V3.0 <sup>1)</sup>

## 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**
- 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**
- SIMATIC Safe Kinematics V2.0
  - Optional fee-based system library for safe motion monitoring in the cartesian space

New

New

## 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**
  - **CPU 1515T, CPU 1515TF**
  - CPU 1516T, CPU 1516TF
  - CPU 1517T, CPU 1517TF
  - CPU 1518T, CPU 1518TF
  - **CPU 1514SP T, CPU 1514SP TF**
  - CPU 1515SP PC2 T/TF
  - CPU 1504D TF, CPU 1507D TF
- Standard-, Safety-plc and Motion Control on one controller

Upd

New

## Programming



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

## Web server

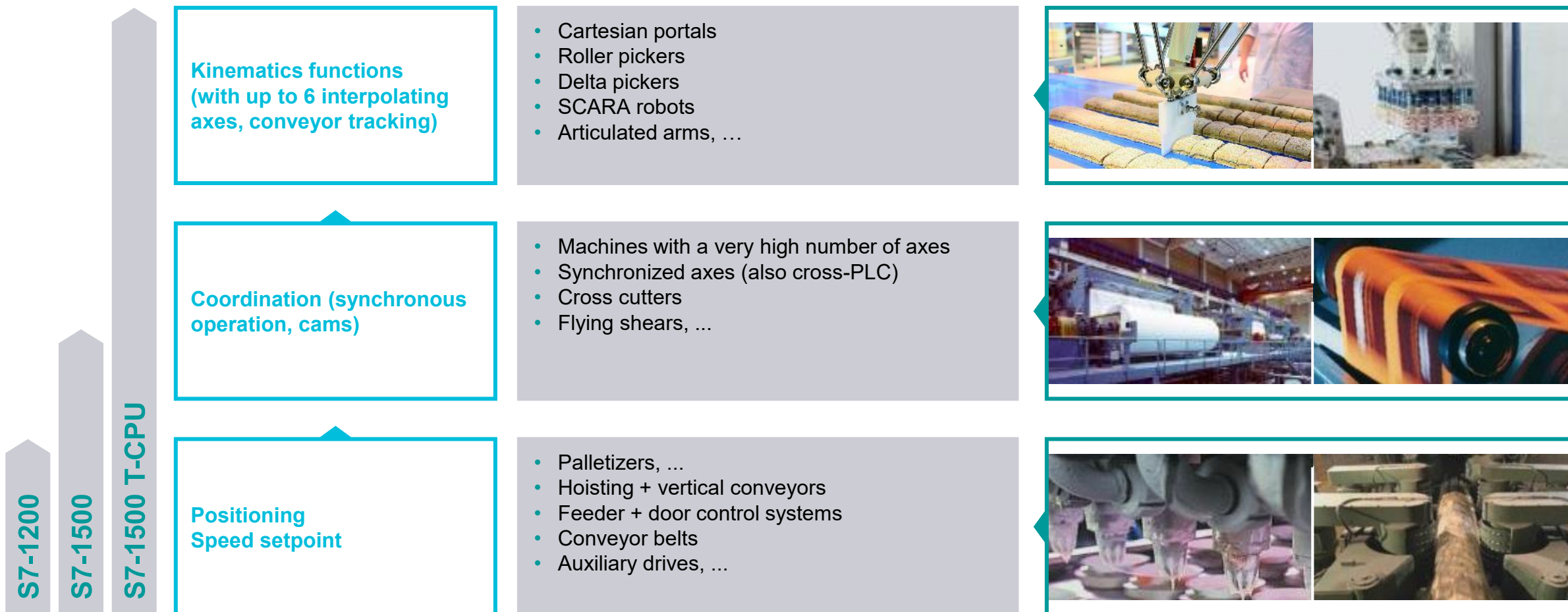


Diagnostic pages for Motion Control

<sup>1)</sup> Compared to the standard CPU

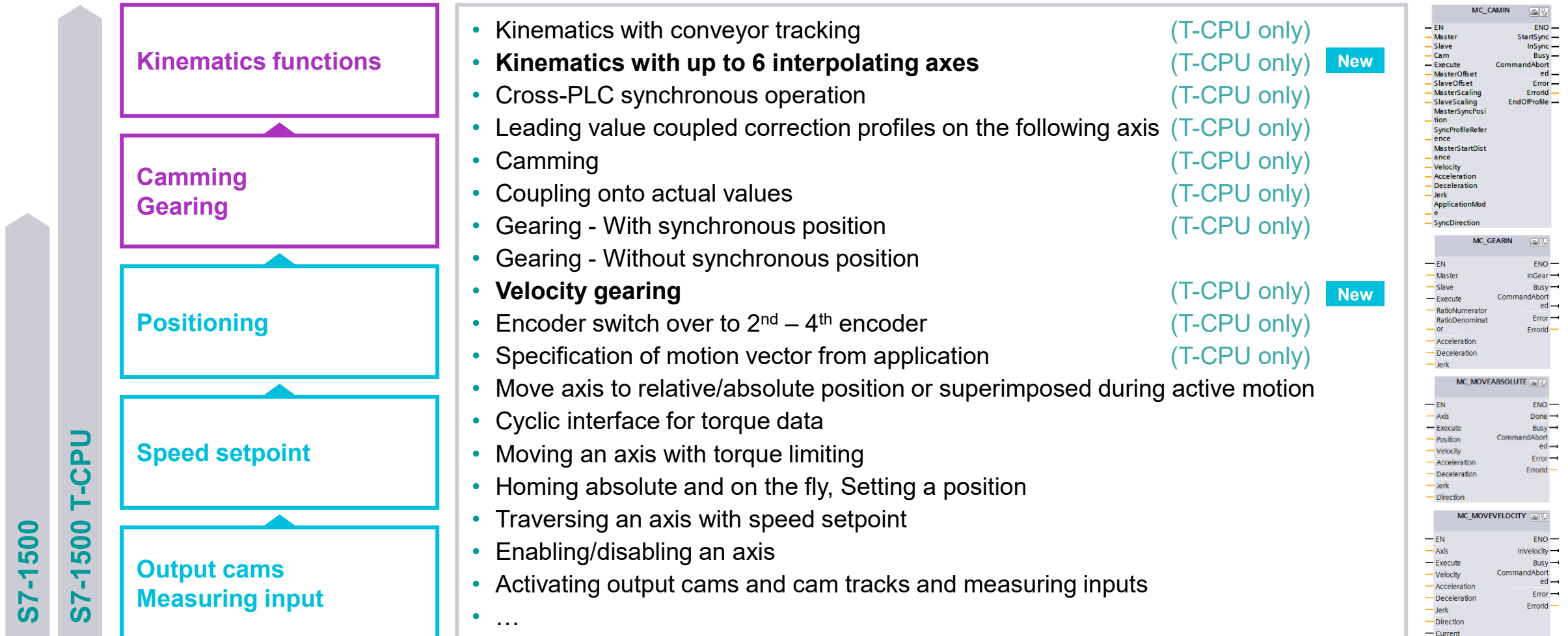
# Overview

## Motion Control functions and typical applications



# Advanced Controller – SIMATIC S7-1500










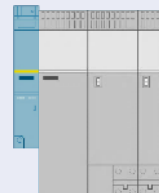









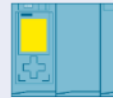
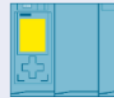





## Overview Motion Control functionalities (extract)





# 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 <sup>3)</sup>	11		11		55	70	140	11	30	12	55
	Maximum <sup>4)</sup>	14		30		80	128	192	30	30	40	160
Motion Control functionality	 Cross-PLC synchronous operation											
	 Kinematics functions											
	 Camming											
	 Gearing <sup>1</sup> (with synchronous position)											
	 Gearing <sup>2</sup> (without synchronous position)											
	 Output cam / Measuring input											
	 Positioning											
	 Open-loop speed control											

<sup>1)</sup> Synchronization with specification of the synchronous position, Velocity gearing

<sup>2)</sup> Synchronization without specification of the synchronous position

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

<sup>4)</sup> No further TO's applicable

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

# Advanced Controller – SIMATIC S7-1500

## Expansion of the CPU portfolio with Technology CPUs

	Upd.	Upd.	Upd. <sup>6</sup>			New	Upd. <sup>6</sup>	Upd. <sup>6</sup>	Upd. <sup>6</sup>
	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	450 kB	1,5 MB	3 MB	3 MB	9 MB	900 kB	3 MB	4 MB	15 MB
Data memory	1,5 MB	4,5 MB	7,5 MB	8 MB	60 MB	3,5 MB	7,5 MB	6 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)		<ul style="list-style-type: none"> <li>SINAMICS S120 Integrated (incl. 12 DI, 8 DI/DQ)</li> <li>PLC technology I/Os (8 DI/DQ)</li> </ul>	
Positioning axes									
▪ Typical <sup>1</sup>	11	11	55	70	140	11	30	12	55
▪ Maximum <sup>2</sup>	14	30	80	128	192	30	30	40	160
Motion Control Resources <sup>3</sup>	1.120	2.400	6.400	10.240	15.360	2.400	2.400	3.200	12.800
Extended Motion Control Resources <sup>4, 5</sup>	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.

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

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

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

# Advanced Controller – SIMATIC S7-1500 Technology-CPU

## Scalable Motion Control in the advanced controller portfolio

### SIMATIC S7-1500 T-CPU



#### Feature / Function

##### Extended Motion Control functions:

- Speed-, positioning axis
- Gearing
- Camming
- Kinematics with up to 6 interpolating axis

##### Kinematics configurator and trace

- Path recording
- Kinematics control panel

##### Cam editor integrated in the TIA Portal

- Simple definition of non-linear dependencies between leading and following axes

##### Consistent functionality and programming of S7-1500 throughout to S7-1500 T-CPU

##### Failsafe PLC

- With extended Motion Control functions

#### Benefits

##### 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

##### Simple 3D visualization and diagnosis of movements as well as **commissioning** of the kinematics

##### High engineering efficiency through

- Graphic-based and tabular configuration
- Optimization of cams

##### Seamless extension of the Motion Control functionality of a standard CPU in TIA Portal

##### Standard automation, Motion Control and safety functions **inside one CPU**



# SINAMICS S210 SIMOTICS S-1FK2

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





# SINAMICS S210 servo drive

## Top-10 specs



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		<ul style="list-style-type: none"><li>• Auto-configuration</li><li>• One-button tuning</li><li>• One cable connection with SPEED-CONNECT quick-lock fastener and compact, rotatable plug</li><li>• Allowed cable length: up to 165 ft. (50 m)</li><li>• Internal braking resistor</li></ul>		
Motor compatibility		Synchronous – SIMOTICS S-1FK2		
Degree of Protection		IP20		
Commissioning / Configuration Tools		Web server, Startdrive		
Safety Technology		<ul style="list-style-type: none"><li>• Safe Torque Off</li></ul>	<ul style="list-style-type: none"><li>• Safe Stop 1</li></ul>	Safe Brake Control
Standards Compliance		CE, UL		

# SIMOTICS S-1FK2 synchronous servo motor

## Highlights



<b>Format</b>		Synchronous servo motor	
<b>Supply voltages / power range</b>		<b>Power</b>	<b>Torque</b>
	1AC 200 – 240V	0.13 – 1 Hp (100 – 750 W)	0.16 Nm - 2.4 Nm
<b>Configuration</b>	<ul style="list-style-type: none"> <li>• Low rotor inertia (High dynamic) in shaft height 20 to 40 mm</li> <li>• Medium rotor inertia (compact) in shaft height 30 mm</li> </ul>		
<b>Cabling</b>	<ul style="list-style-type: none"> <li>• One cable connection with SPEED-CONNECT quick-lock fastener and compact, rotatable plug</li> <li>• Allowed cable length: up to 165 ft. (50 m)</li> </ul>		
<b>Encoder</b>	<ul style="list-style-type: none"> <li>• 20 Bit Abs. single or multiturn</li> </ul>		
<b>Options</b>	<ul style="list-style-type: none"> <li>• High Dynamic (HD) or Compact (CT)</li> <li>• Plain or feather key shaft</li> <li>• With or without holding brake</li> <li>• Plain or feather key shaft, rotary shaft seal</li> </ul>		
<b>Degree of Protection</b>	IP64; IP65 option		
<b>Standards Compliance</b>	cURus		

# SINAMICS S210 servo drive system

## Overview



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

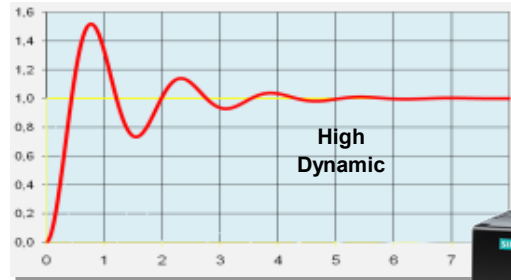


# SINAMICS S210 servo drive system

## Features

### Compact design / high performance

- 1AC 230V
- 0.05 - 0.75kW



### Simple installation with one-cable motor connection

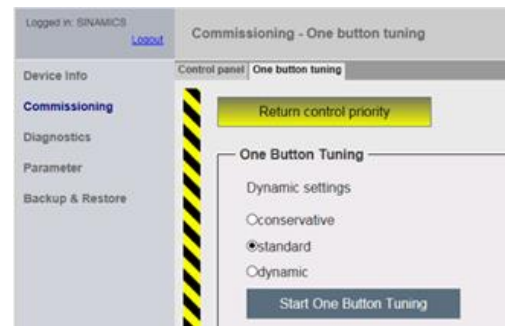


FSA

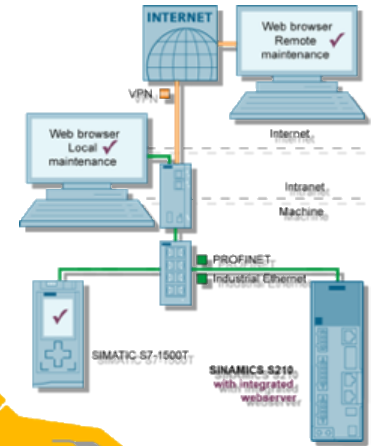
FSB

FSC

### Easy commissioning with integrated webserver and one-button tuning



### Optimal integration with SIMATIC controller



### Integrated safety functionality



### Ready for worldwide markets



# SINAMICS S210 servo drive system

## One-cable connection



Individual cable lengths up to 50m (165 ft.) may be ordered

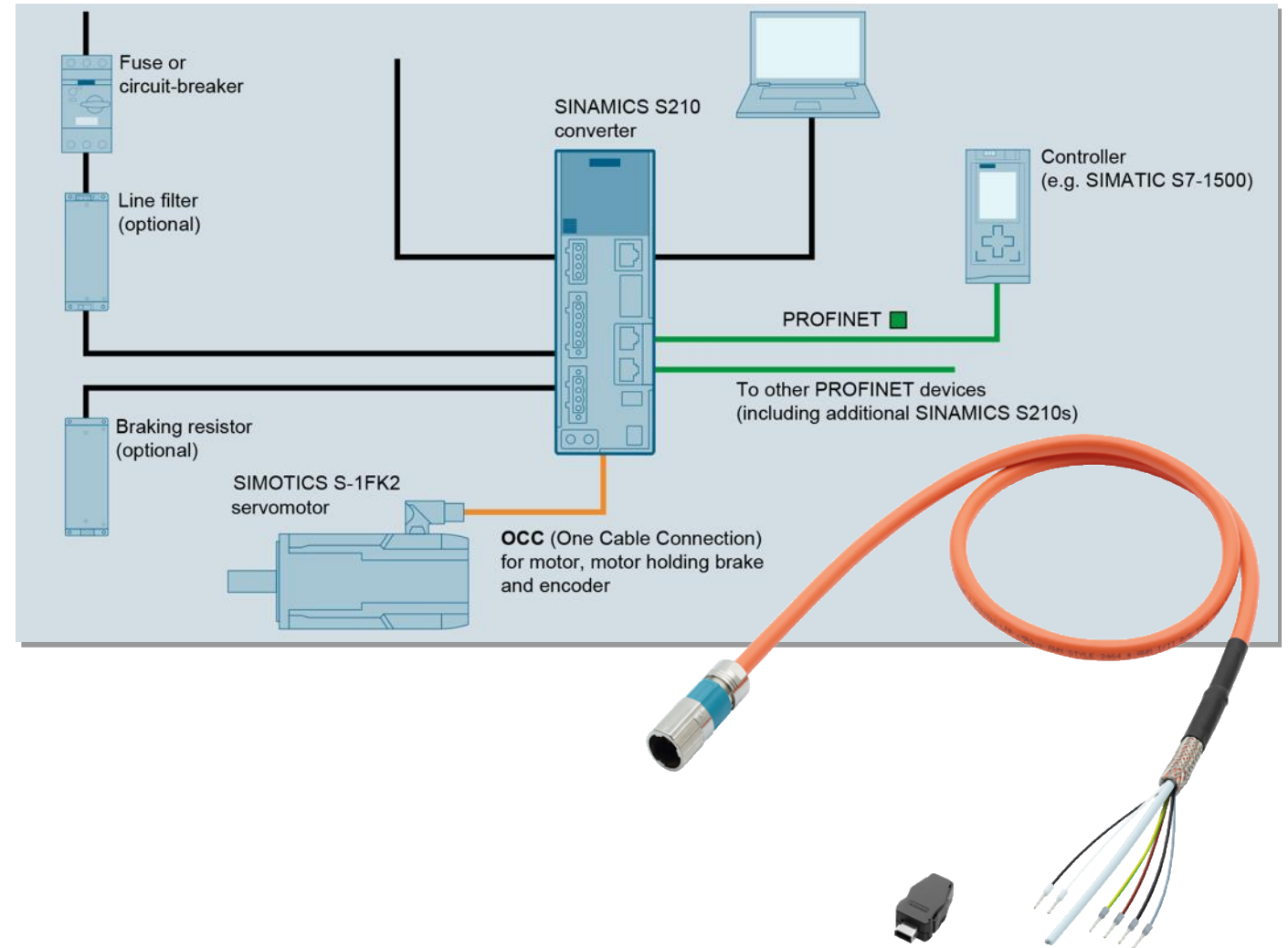
SPEED- CONNECT fast connection system with rotatable motor connector

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

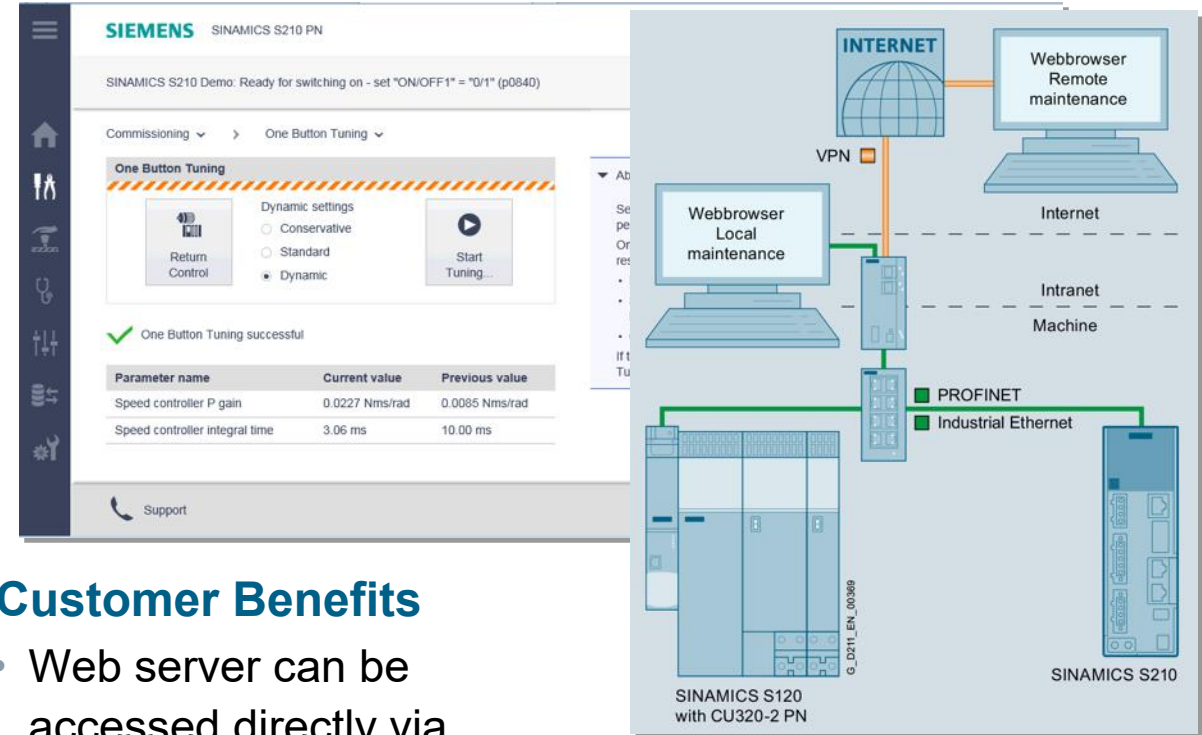
- Parameter assignment
- Commissioning purely oriented to the functionality of the drive
- Bringing drive into operation with a few clicks

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

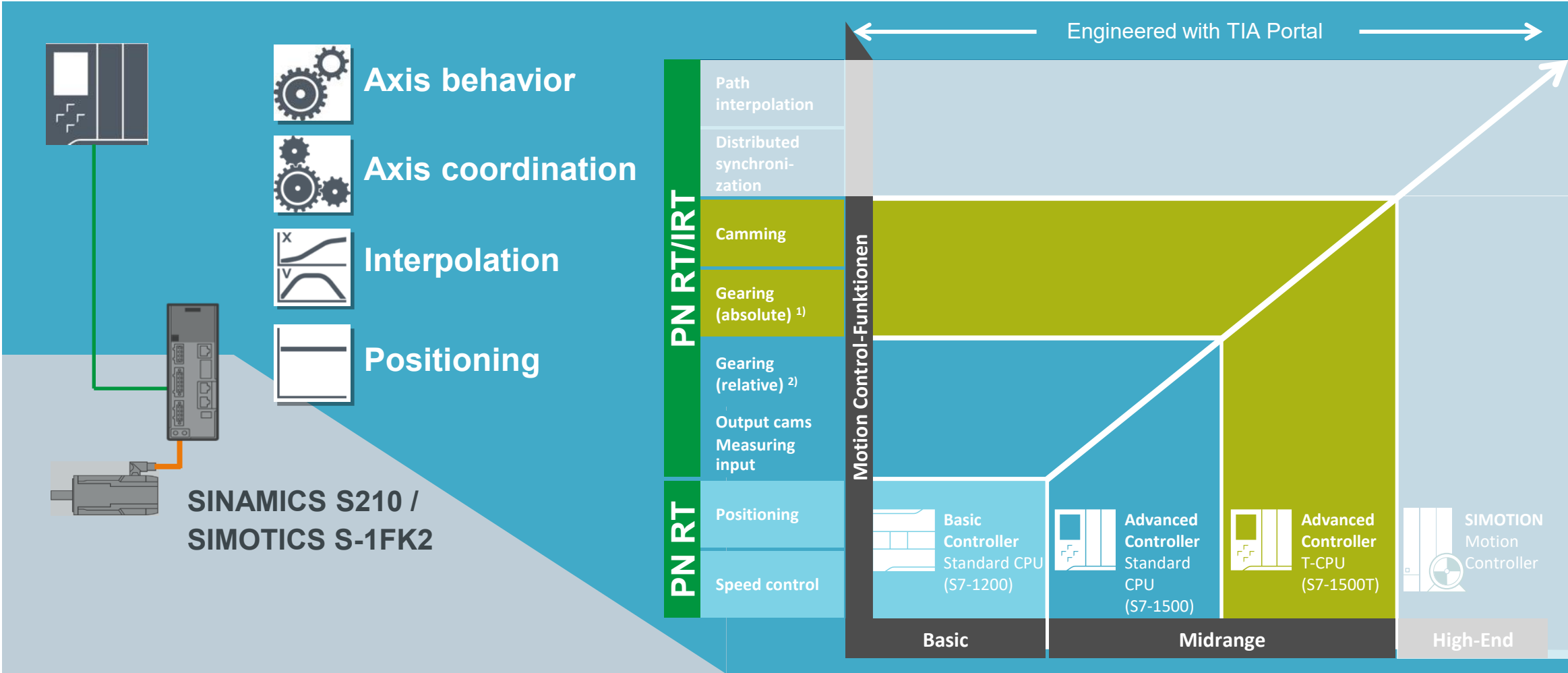


## Customer Benefits

- 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



1) Synchronization with specification of the synchronous position    2) Synchronization without specification of the synchronous position

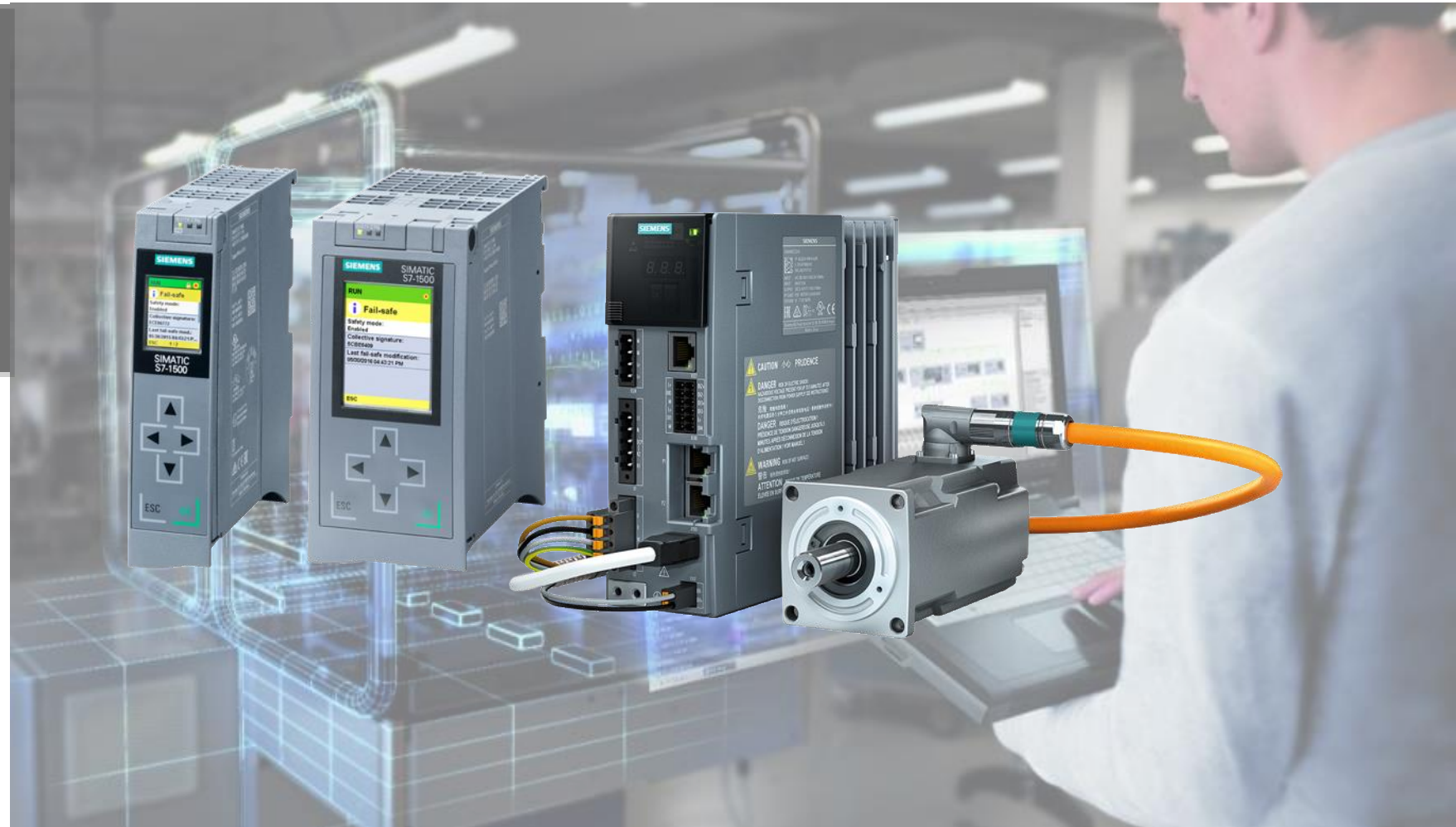
# SINAMICS S210 servo drive system

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



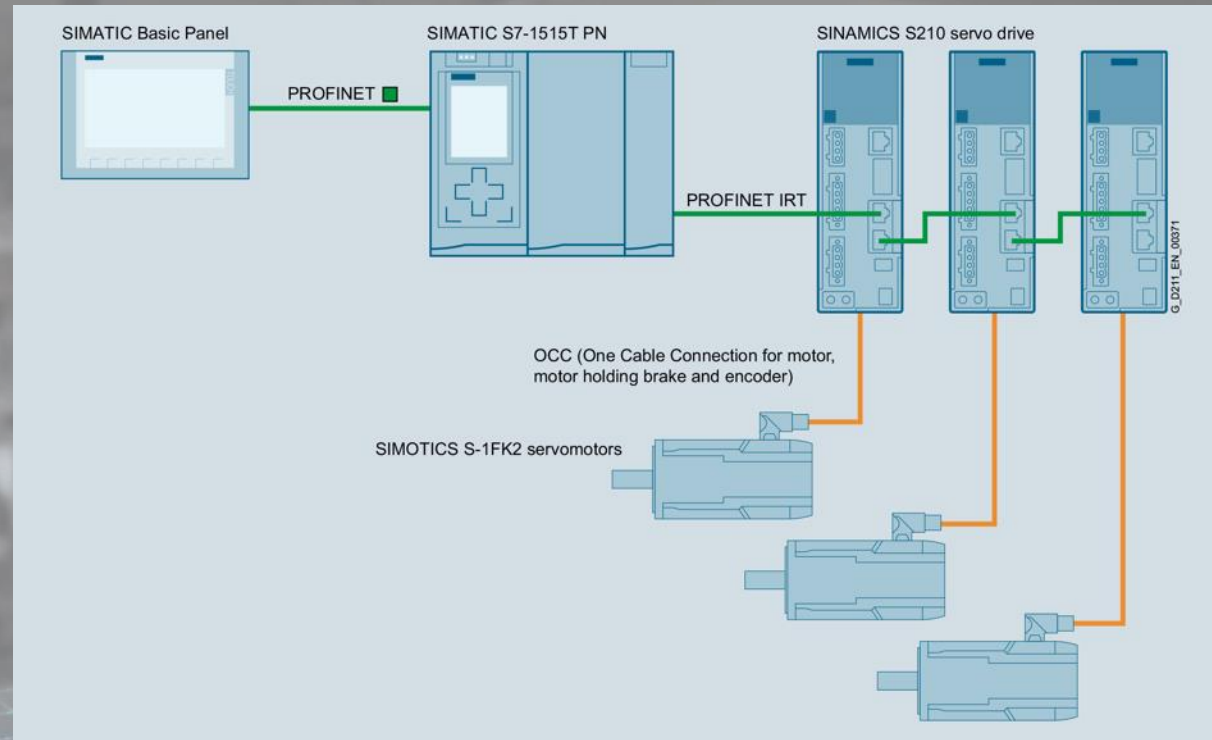
# SINAMICS S210 servo drive system

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



### 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









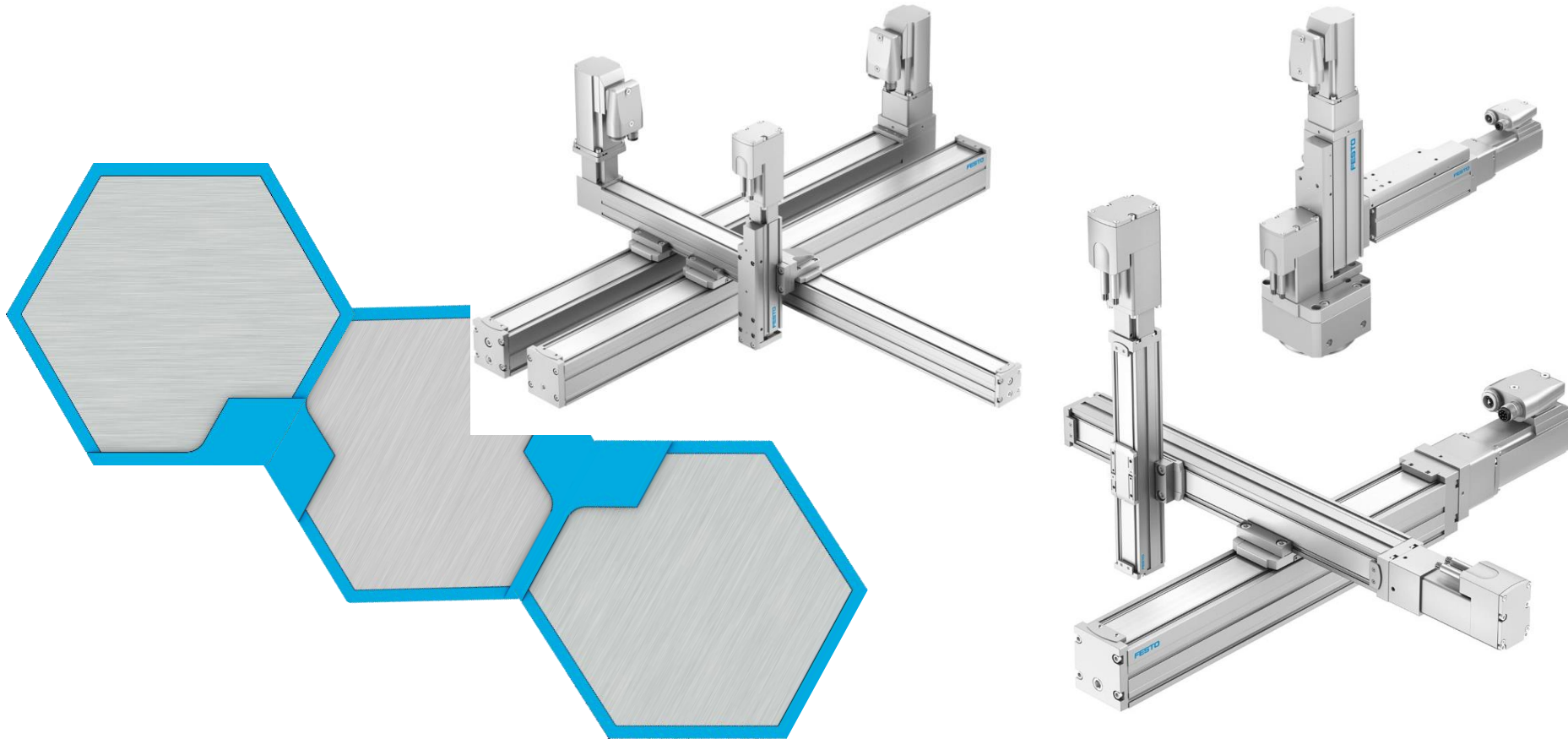
# SINAMICS S210 / SIMOTICS S-1FK2

## Midrange high-dynamic servo drive system



Performance		Continuous Motion			Discontinuous Motion		
Purpose		Basic	Medium	High	Basic	Medium	High
Pumping Ventilating Compressing		<ul style="list-style-type: none"> <li>Centrifugal pumps</li> <li>Radial/axial fans</li> <li>Compressors</li> </ul>		<ul style="list-style-type: none"> <li>Eccentric worm pumps</li> </ul>	<ul style="list-style-type: none"> <li>Hydraulic pumps</li> <li>Dosing pumps</li> </ul>		<ul style="list-style-type: none"> <li>Descaling pumps</li> <li>Hydraulic pumps</li> </ul>
Moving		<ul style="list-style-type: none"> <li>Belt conveyors</li> <li>Roller conveyors</li> <li>Chain conveyors</li> </ul>	<ul style="list-style-type: none"> <li>Belt conveyors</li> <li>Roller conveyors</li> <li>Chain conveyors</li> <li>Vert./horiz. handling</li> <li>Elevators</li> <li>Escalators</li> <li>Gantry cranes</li> <li>Ship drives</li> <li>Cable railways</li> </ul>	<ul style="list-style-type: none"> <li>Elevators</li> <li>Container cranes</li> <li>Mine hoists</li> <li>Open cast mine excavators</li> <li>Test stands</li> </ul>	<ul style="list-style-type: none"> <li>Accelerating conveyors</li> <li>Rack feeders</li> </ul>	<ul style="list-style-type: none"> <li>Accelerating conveyors</li> <li>Rack feeders</li> <li>Crosscutters</li> <li>Roll changers</li> </ul>	<ul style="list-style-type: none"> <li>Rack feeders</li> <li>Robotics</li> <li>Pick &amp; place</li> <li>Indexing tables</li> <li>Crosscutters</li> <li>Roller feeds</li> <li>Engaging / disengaging</li> </ul>
Processing		<ul style="list-style-type: none"> <li>Mills</li> <li>Mixers</li> <li>Kneaders</li> <li>Crushers</li> <li>Agitators</li> <li>Centrifuges</li> </ul>	<ul style="list-style-type: none"> <li>Mills</li> <li>Mixers</li> <li>Kneaders</li> <li>Crushers</li> <li>Agitators</li> <li>Centrifuges</li> <li>Extruders</li> <li>Rotary furnaces</li> </ul>	<ul style="list-style-type: none"> <li>Extruders</li> <li>Winders / unwinders</li> <li>Leading / Following drives</li> <li>Calenders</li> <li>Mechanical presses</li> <li>Printing machines</li> </ul>	<ul style="list-style-type: none"> <li>Tubular bagging machines</li> <li>Single-axis motion control – positioning, path profiles</li> </ul>		<ul style="list-style-type: none"> <li>Servo presses</li> <li>Rolling mills</li> <li>Multi-axis motion control – multi-axis positioning, cam discs, interpolation</li> </ul>
Machining		Main drives for <ul style="list-style-type: none"> <li>Turning</li> <li>Milling</li> <li>Drilling</li> </ul>	Main drives for <ul style="list-style-type: none"> <li>Drilling</li> <li>Sawing</li> </ul>	Main drives for <ul style="list-style-type: none"> <li>Turning</li> <li>Milling</li> <li>Drilling</li> <li>Gear cutting</li> <li>Grinding</li> </ul>	Axis drives for <ul style="list-style-type: none"> <li>Turning</li> <li>Milling</li> <li>Drilling</li> </ul>	Axis drives for <ul style="list-style-type: none"> <li>Drilling</li> <li>Sawing</li> </ul>	Axis drives for <ul style="list-style-type: none"> <li>Turning</li> <li>Milling</li> <li>Drilling</li> <li>Laser machining</li> <li>Gear cutting</li> <li>Grinding</li> <li>Nibbling / punching</li> </ul>

## ELGC/EGSC – Drives for compact handling solutions

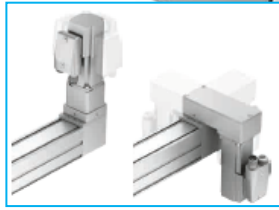
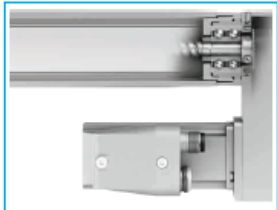


# Spindle axis and toothed belt axis ELGC

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

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

High-performance, double ball bearing integrated in the axis

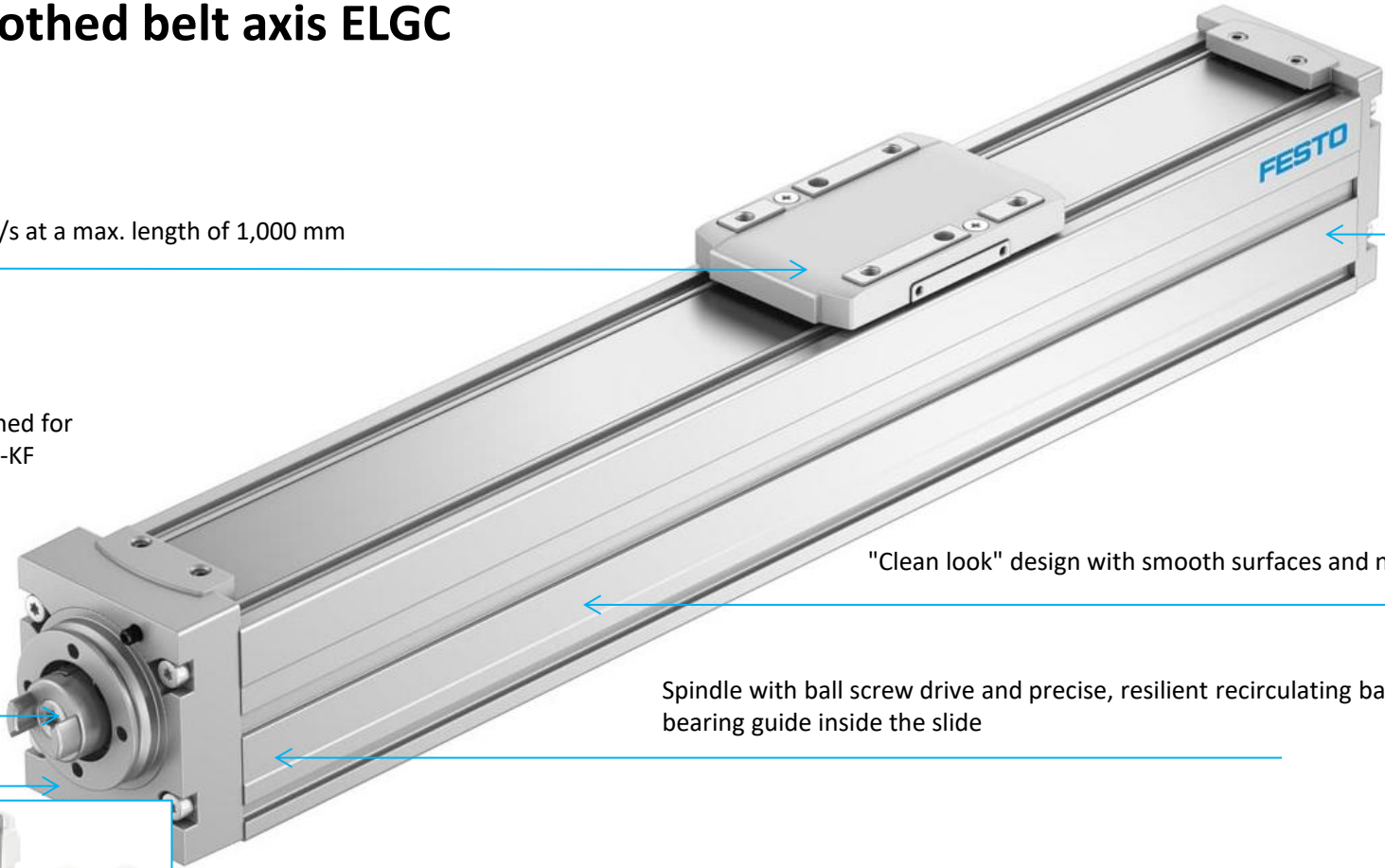


Flexible motor mounting

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

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

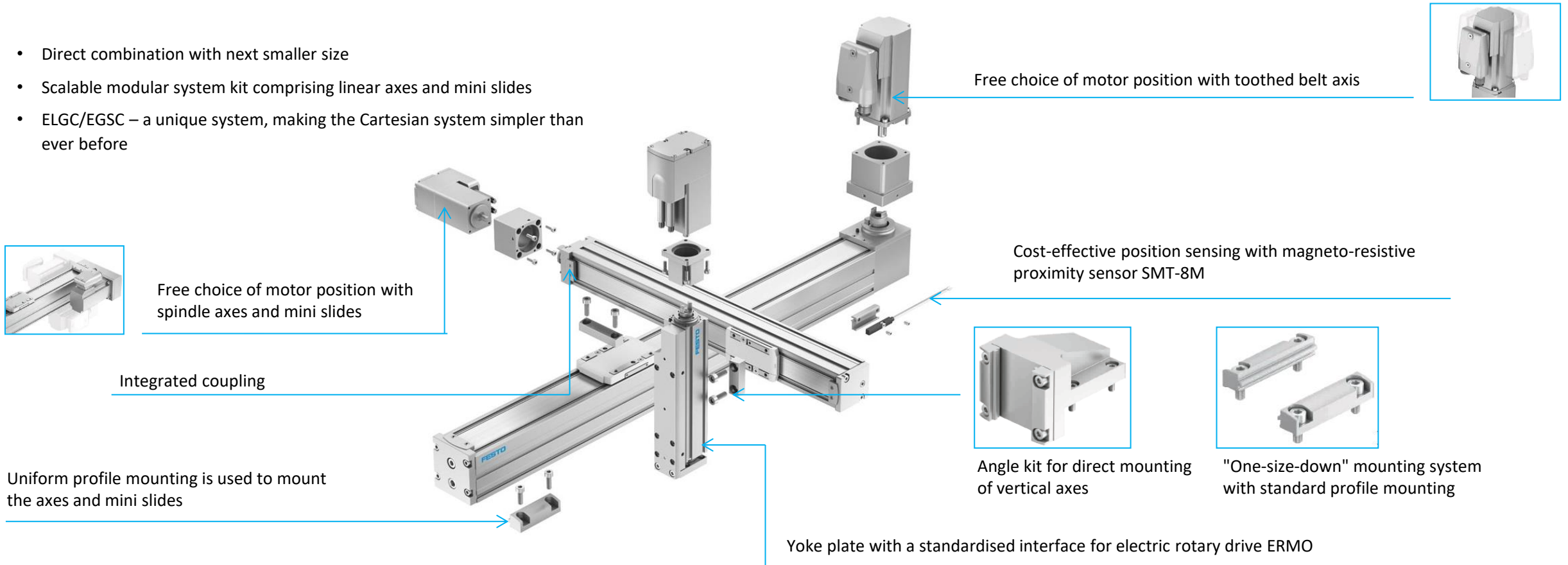
Vacuum connection; increased protection of the system due to reduced particle emissions



## 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



## From individual axes to a complete handling system



### Single-axis system

Precisely positioning and aligning workpieces also at high loads:

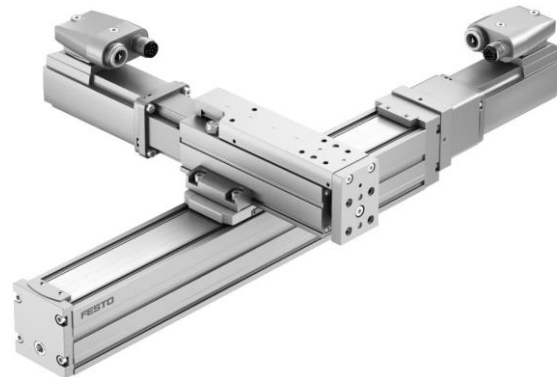
- Adapterless direct mounting of mini slides and rotary drives
- Also available as linear-rotary Z-axis in 2D and 3D systems



### Pick & place solution

Compact response to simple requirements:

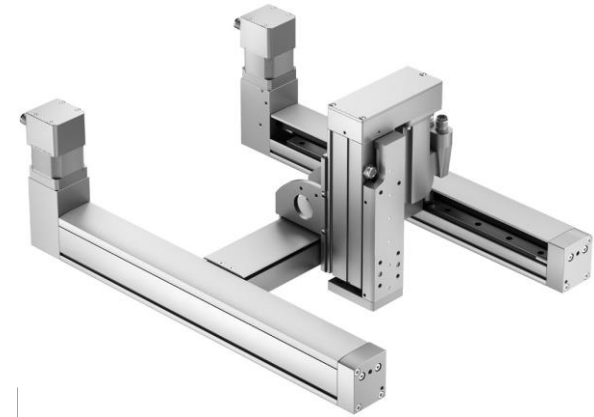
- Adapterless, cost effective direct mounting of mini slides and rotary drives
- Mechanically rigid and sturdy design with precision positioning



### 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

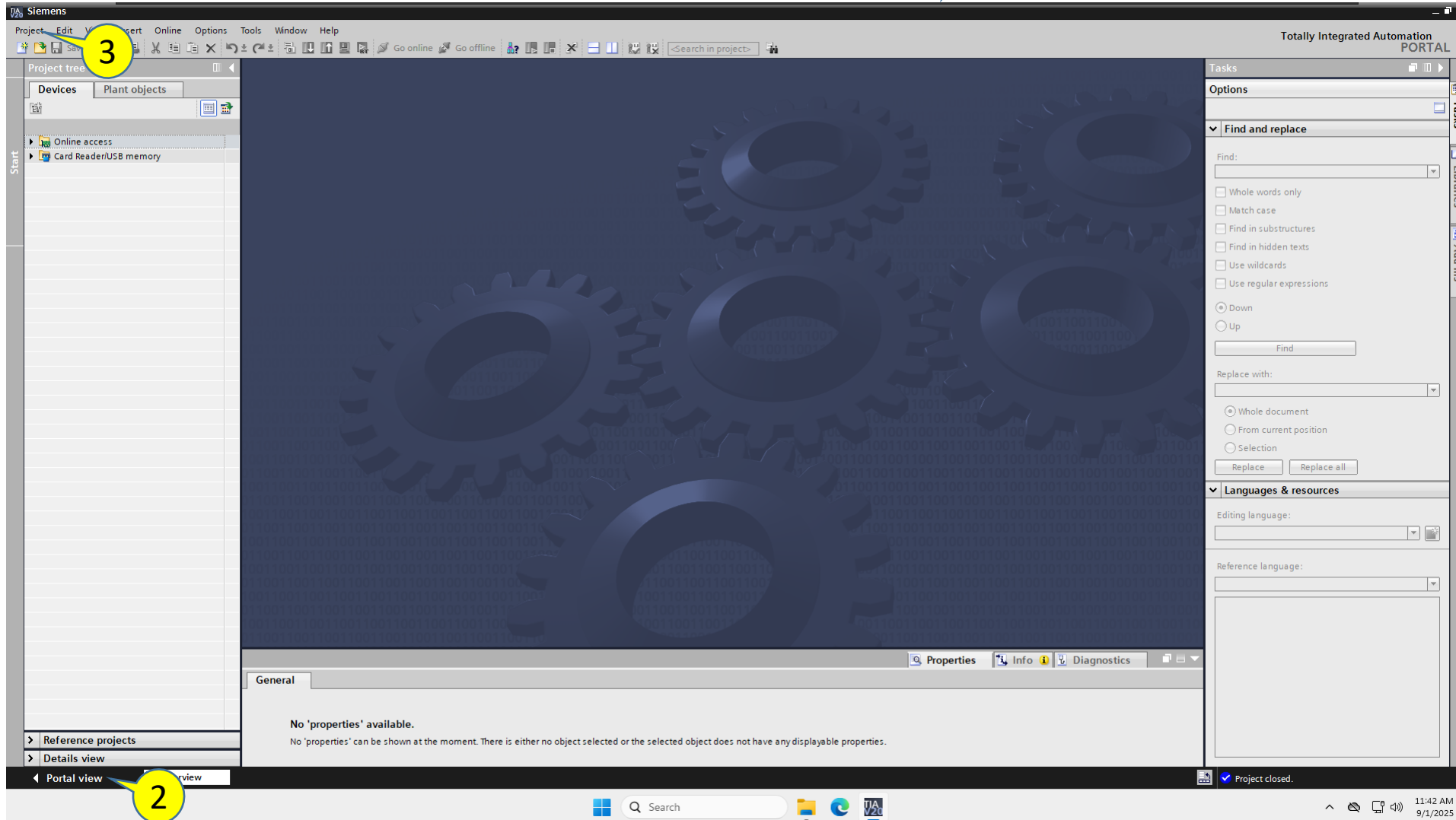
- Maximum workspace coverage by combining the small-scale gantry EXCM and mini-slide for the Z-axis
- Configurable length and width and with different Z strokes



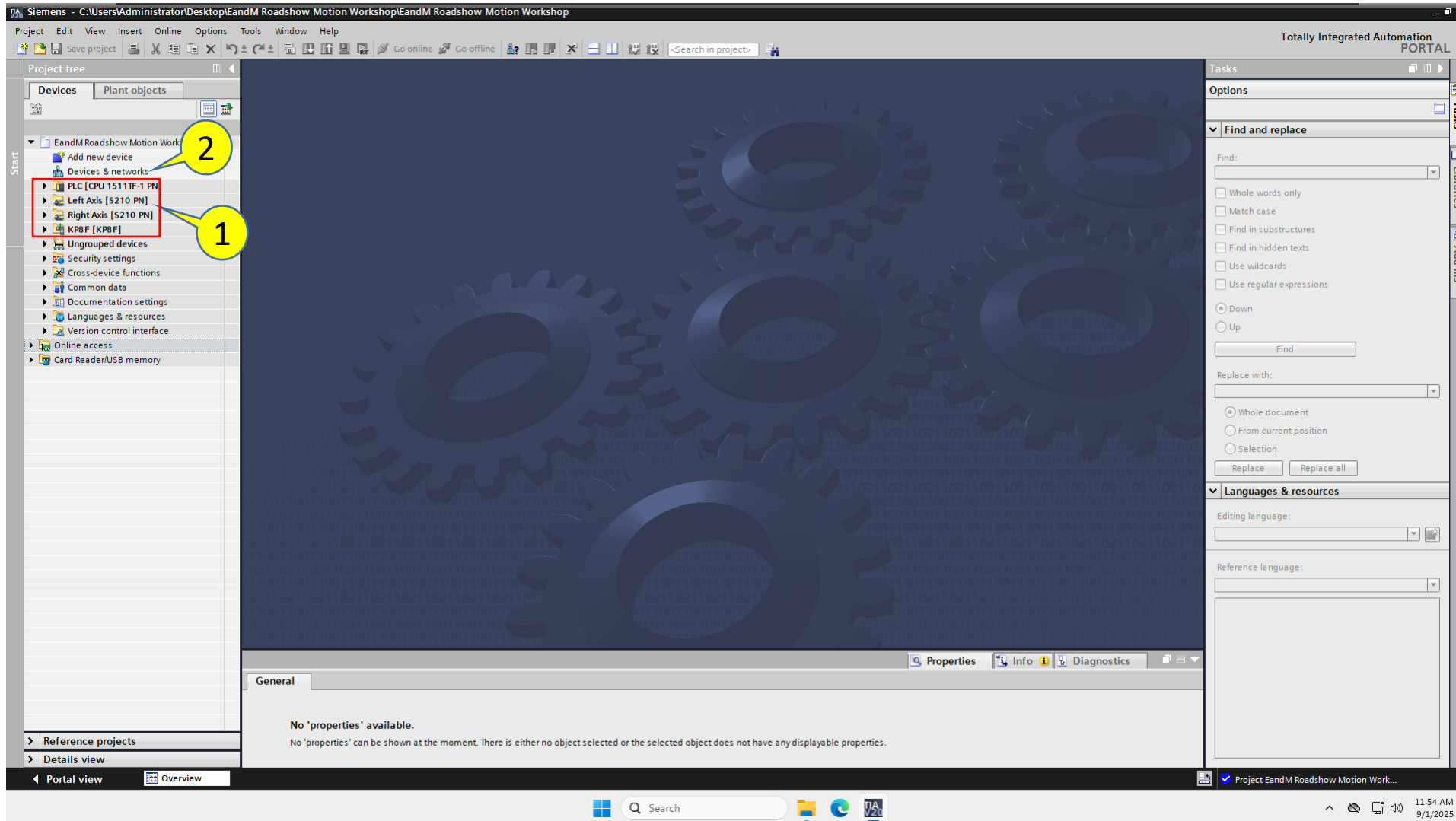


# Motion LAB

1



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



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



Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Go online Go offline <Search in project>

Project tree EandM Roadshow Motion Workshop > Devices & networks

Devices Plant objects

Network Connections HMI connection

PLC CPU 1511TF-1 PN Left Axis S210 PN Right Axis S210 PN KP8F KP8F

PN/E\_1

Network overview

Device	Type	Ad...
57-1500/ET200MP station_1	57-1500/ET200MP stati...	
PLC	CPU 1511TF-1 PN	
SINAMICS S_1	SINAMICS S	
Left Axis	SINAMICS S210 PN	
SINAMICS S_2	SINAMICS S	
Right Axis	SINAMICS S210 PN	
KP8_1	KPB	
KP8F	KP8F	

Hardware catalog

Options

Catalog

Filter Profile: <All>

- Controllers
- HMI
- PC systems
- Drives & starters
- Network components
- Detecting & Monitoring
- Distributed I/O
- Power supply and distribution
- Field devices
- Other field devices

Information

Device:

Article no.:

Version:

Description:

General

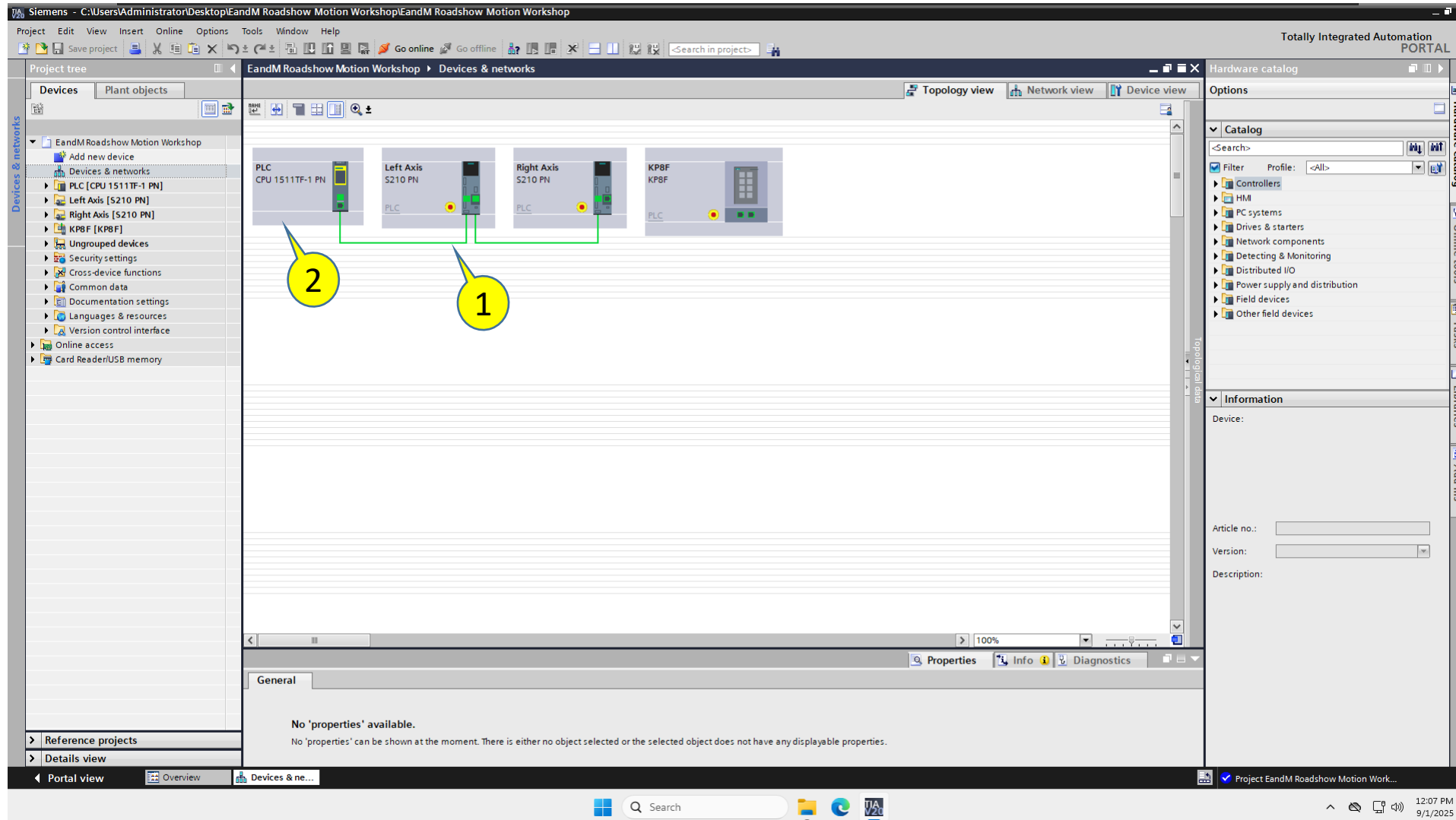
No 'properties' available.  
No 'properties' can be shown at the moment. There is either no object selected or the selected object does not have any displayable properties.

Portal view Overview Devices & ne...

Search

12:03 PM 9/1/2025

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



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



The screenshot shows the Siemens TIA Portal software interface for configuring a PLC. The main workspace displays a rack diagram with a PLC module in slot 1, highlighted by a yellow circle with the number 1. The Device overview table shows the PLC module in slot 1 and its PROFINET interface. The Properties window at the bottom shows the configuration for the PLC, with the 'Real time settings' tab selected. The 'Synchronization' section shows the 'Sync domain' set to 'Sync-Domain\_1' and the 'Synchronization role' set to 'Sync master'. The 'Bandwidth' section shows the 'Calculated bandwidth for cyclic IO data' as 0.029 ms, 0.720 %, and (max. 0.500 ms). A yellow circle with the number 2 highlights the 'Synchronization' section, and a yellow circle with the number 3 highlights the 'Real time settings' tab in the Properties window.

Module	Rack	Slot
PLC	0	1
PROFINET interface_1	0	1
	0	2
	0	3
	0	4
	0	5
	0	6
	0	7
	0	8
	0	9
	0	10
	0	11
	0	12
	0	13
	0	14

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

The screenshot shows the Siemens TIA Portal software interface. The Project tree on the left is expanded to show the 'Left Axis [S210 PN]' device. The main workspace displays a 3D model of the drive. The Properties window on the right is open, showing the 'Isochronous mode' configuration. The 'Isochronous mode for local modules' section is expanded, and the 'Isochronous mode' checkbox is checked. The 'Detail overview' table shows the configuration for the drive control modules.

Name	Slot/s...	Isochr...
Drive control/Drive...	1/3	<input checked="" type="checkbox"/>
Drive control/Drive...	1/4	<input type="checkbox"/>
Drive control/Drive...	1/5	<input type="checkbox"/>

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.

The screenshot shows the Siemens TIA Portal software interface. The project tree on the left lists various components, including the 'Left Axis [S210 PN]' drive. The main workspace displays the drive configuration, and the properties window at the bottom shows the 'Drive control-Telegram' settings. A yellow circle with the number '1' highlights the 'Send (Actual value)' option in the 'Drive control-Telegram' list. Another yellow circle with the number '2' highlights the 'MC\_Servo' and 'PIP OB Servo' options in the 'Advanced options' section.

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



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				



## 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_LIMIT_POS	Positive torque limit	---	Not assigned
PZDn+3	M_LIMIT_NEG	Negative torque limit	---	

## 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

Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Go online Go offline <Search in project>

Project tree EandM Roadshow Motion Workshop Left Axis [S210 PN]

Devices Plant objects

Left Axis [S210 PN]

MC\_Servo [OB91]

MC\_Servo [OB91] Properties

General Information Time stamps Compilation Protection Attributes Cycle time

Cycle time

☐ cyclic

☒ Synchronous to the bus

Cycle time (ms)

Source of the send clock: PROFINET IO-System (100)

Send clock (ms): 4.0

Factor: 1

Cycle time (ms): 4.0

OK Cancel

Slot: 3

Start address: PZD 1

Length: 10 words

Extension: --

Organization block: MC\_Servo

Process image: PIP OB Servo

Hardware identifier: 275

Hardware catalog

Options

Catalog

Filter Profile: <All>

SINAMICS S210

Motors

Measuring systems

Information

Device:

Article no.:

Version:

Description: SINAMICS S210

Portal view Overview Left Axis MC\_Servo (O...

Search

1:12 PM 9/1/2025

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

Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Go online Go offline Search in project

Project tree

Devices Plant objects

EandM Roadshow Motion Workshop

PLC [CPU 1511TF-1 PN]

Left Axis [S210 PN]

Device configuration

Online & diagnostics

Guided quick startup

Parameterization

Rotate & optimize

Acceptance test

User-defined lists

Traces

Right Axis [S210 PN]

KP8F [KP8F]

Ungrouped devices

Security settings

Cross-device functions

Common data

Documentation settings

Languages & resources

Version control interface

Online access

Card Reader/USB memory

Reference projects

Details view

Portal view Overview Left Axis (S2...

EandM Roadshow Motion Workshop Left Axis [S210 PN] Drive control [S210 PN] Guided quick startup

Start editing Finish editing Back Forward

Connection to PLC

Application Limits Application settings I/O configuration Telegrams Rotate & optimize Summary

Define the connection to the PLC

Do you want to use cyclic communication via telegrams?

no yes

Assign motion control

Where is the motion control executed?

Ramp-function generator or position control are in the drive

Drive PLC

Ramp-function generator or position control are in the PLC or the SIMATIC technology object (TO) is used

Defining use of Safety Integrated Functions via PROFIsafe

Preset depending on your choice

Some presettings were overwritten by user changes. The current settings can be viewed on the "Telegrams" page.

Telegram: [105] SIEMENS telegram 105

PROFIsafe: [30] PROFIsafe telegram 30

Next >>

Tasks

Options

Find and replace

Find:

Whole words only

Match case

Find in substructures

Find in hidden texts

Use wildcards

Use regular expressions

Down

Up

Find

Replace with:

Whole document

From current position

Selection

Replace

Replace all

Languages & resources

Editing language:

English (United States)

Reference language:

English (United States)

Properties Info Diagnostics

Project EandM Roadshow Motion Work...

2:17 PM 9/1/2025

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

Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline Search in project

Project tree EandM Roadshow Motion Workshop Left Axis [S210 PN] Drive control [S210 PN] Guided quick startup

Devices Plant objects

EandM Roadshow Motion Workshop

- Add new device
- Devices & networks
- PLC [CPU 1511TF-1 PN]
- Left Axis [S210 PN]
  - Device configuration
  - Online & diagnostics
  - Guided quick startup
  - Parameterization
  - Rotate & optimize
  - Acceptance test
  - User-defined lists
  - Traces
- Right Axis [S210 PN]
- KP8F [KP8F]
- Ungrouped devices
- Security settings
- Cross-device functions
- Common data
- Documentation settings
- Languages & resources
- Version control interface
- Online access
- Card Reader/USB memory

Guided quick startup

Start editing Finish editing Back Forward

Connection to PLC Application Limits Application settings I/O configuration Telegrams Rotate & optimize Summary

Limits

Define the limits for your application

Show motor data

Limitations

Positive speed limit 3000.000 rpm

Negative speed limit -3000.000 rpm

Torque limit upper 0.56 Nm

Torque limit lower -0.56 Nm

OFF1 ramp-down time 1.000 s

Quick stop (OFF3 ramp-down time) 0.000 s

Editing language: English (United States)

Reference language: English (United States)

Portal view Overview Left Axis (S2...

Properties Info Diagnostics

Project EandM Roadshow Motion Work...

2:23 PM 9/1/2025

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



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

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

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

The screenshot shows the Siemens EandM Roadshow Motion Workshop software interface. The main window displays the 'Guided quick startup' wizard, with the 'Telegrams' step highlighted by a yellow circle with the number '1'. The 'Telegrams' step is part of a sequence of steps: Connection to PLC, Application, Limits, Application settings, I/O configuration, Telegrams, Rotate & optimize, and Summary. The 'Telegrams' step is currently active, showing a 'Check the preset telegrams' dialog. This dialog includes a 'Telegram' dropdown set to '[105] SIEMENS telegram 105', a 'PROFIsafe telegram' dropdown set to '[30] PROFIsafe telegram 30, PZD-1/1', and a 'Reference speed' field set to '3000.00 rpm'. There are buttons for 'Send direction' and 'Receive direction'. A yellow circle with the number '2' points to the 'Next >>' button at the bottom of the dialog. The left sidebar shows the project tree with 'Left Axis [S210 PN]' selected. The right sidebar shows the 'Tasks' panel with 'Find and replace' and 'Languages & resources' sections. The bottom status bar shows the project name 'Project EandM Roadshow Motion Work...' and the time '2:35 PM 9/1/2025'.

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

Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline Search in project

Project tree: EandM Roadshow Motion Workshop > Left Axis [S210 PN] > Drive control [S210 PN] > Guided quick startup

Configuration summary

Commissioning summary

You have successfully completed the commissioning workflow.

Perform a download

Number	Parameter text	Value	Unit	Further settings
<b>Connection to PLC</b>				
	Cyclic communication via telegrams		yes	
	Position of the ramp-function generator		PLC	
	Safety integrated Functions via PROFIsafe		yes	<a href="#">Safety integrated commissioning</a>
<b>Application</b>				
	Application		Speed control	
<b>Limits</b>				
p210	Supply voltage		220 V	
p613[0]	Motor ambient temperature		40 °C	
p1821[0]	Direction of rotation		[0] Clockwise	
p1083[0]	Positive speed limit		3000.000 rpm	
p1086[0]	Negative speed limit		-3000.000 rpm	
p1135[0]	Quick stop (OFF3 ramp-down time)		0.000 s	
p1520[0]	Torque limit upper		0.56 Nm	
p1521[0]	Torque limit lower		-0.56 Nm	
<b>I/O configuration</b>				
	DI0		No probe	
	DI1		No probe	
p490.0	Invert measuring probe, DI 0 (X130 / 1.2)		[0] Not inverted	
p490.1	Invert measuring probe, DI 1 (X130 / 1.5)		[0] Not inverted	
	DI4		No function	
<b>Telegrams</b>				

Find and replace

Find:

Whole words only  
Match case  
Find in substructures  
Find in hidden texts  
Use wildcards  
Use regular expressions

Down  
Up

Find

Replace with:

Whole document  
From current position  
Selection

Replace Replace all

Languages & resources

Editing language:  
English (United States)

Reference language:  
English (United States)

2:38 PM 9/1/2025

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



## **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.

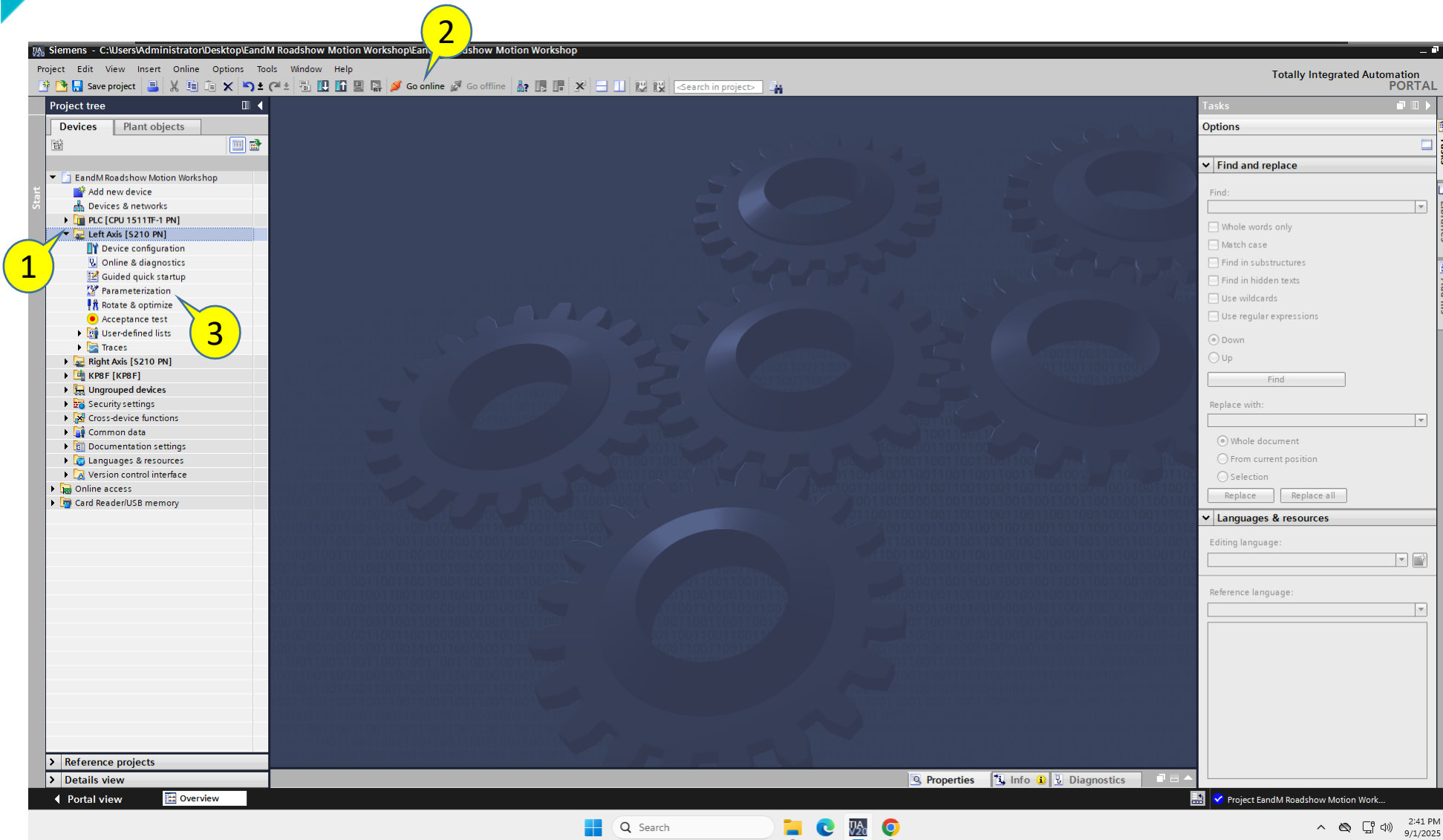




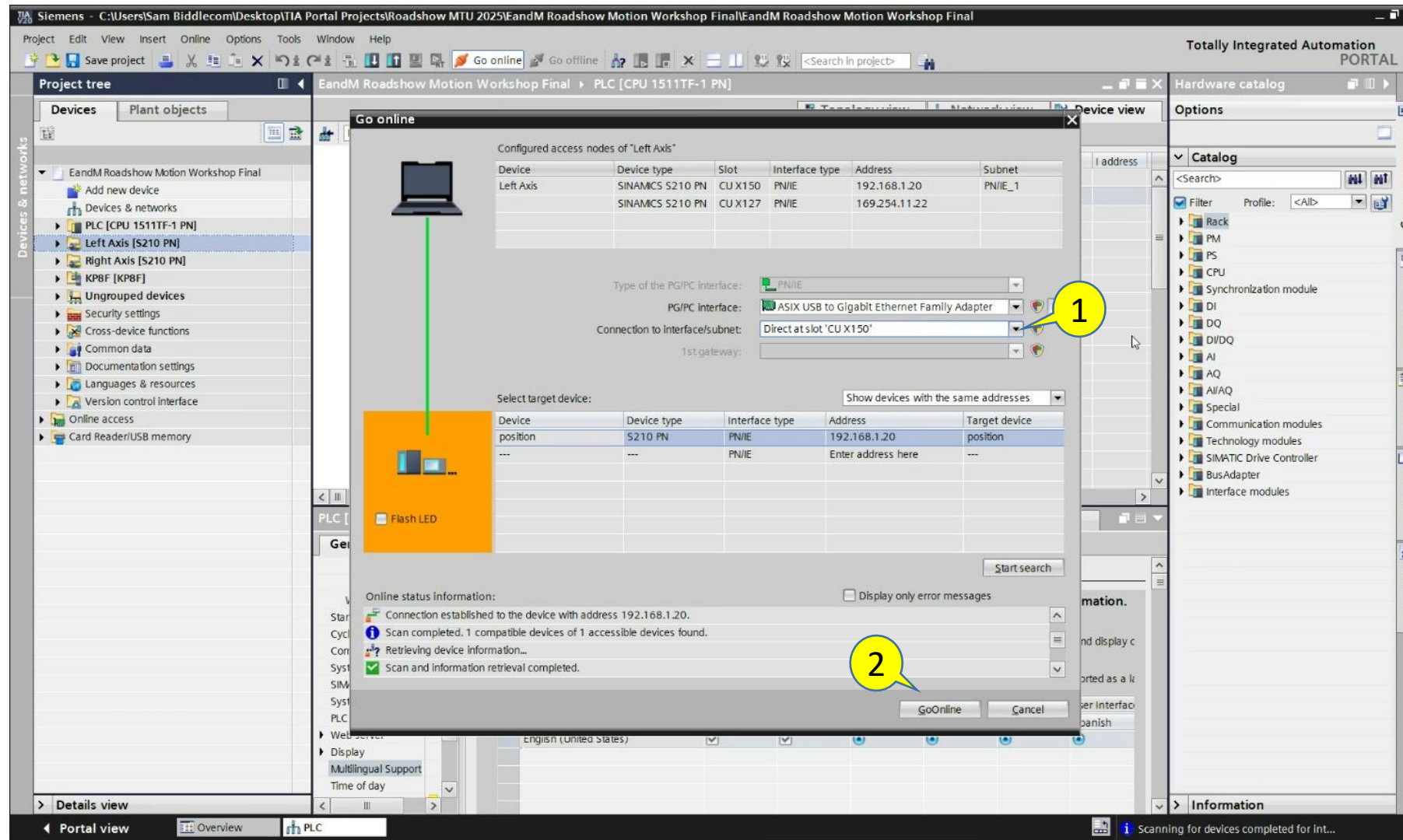
## **Siemens One-Button Tuning (OBT) Explained**



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.



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



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

The screenshot shows the Siemens TIA Portal interface. The Project tree on the left lists the project structure, with 'Left Axis [S210 PN]' selected. The breadcrumb navigation bar at the top indicates the path: 'EandM Roadshow Motion Workshop Final > Left Axis [S210 PN] > Drive control [S210 PN] > Rotate & optimize'. The main workspace displays the 'One Button Tuning' configuration window. This window includes a 'Master control' section with 'Activate' and 'Deactivate' buttons, a 'Distance limiting' section with a '720°' value, and an 'Optimization' section with 'Start' and 'Stop' buttons. A warning message states: 'Within path limits, the drive must be able to freely traverse without endangering persons and mechanics. The motor is moved within specified path limits in both directions of rotation to max. speed and to 80% of static motor torque.' The 'Configuration' section shows 'Dynamic response settings' set to 'Standard'. The 'Status' section indicates 'One button tuning performed successfully.' The 'Optimization result' table shows the following data:

Number	Parameter text	Previous value	Current value	Unit
p1460[0]	P gain	0.0088	0.00923	Nms/rad
p1462[0]	Integral time	4.07	3.45	ms
p1498[0]	Load moment of inertia	0.000006	5.32305E-06	kgm²
r5276[0]	Kv factor estimated	26.38	13.91	1000 rpm
r5277[0]	Precontrol symmetrizing time estimated	0.36	0.24	ms

Numbered callouts (1-6) indicate the sequence of steps for the tuning procedure: 1. Click on Rotate & optimize; 2. Click on One Button Tuning; 3. Activate Master control; 4. Start the tuning procedure; 5. Click on the memory card icon; 6. Repeat the procedure for the Right Axis.

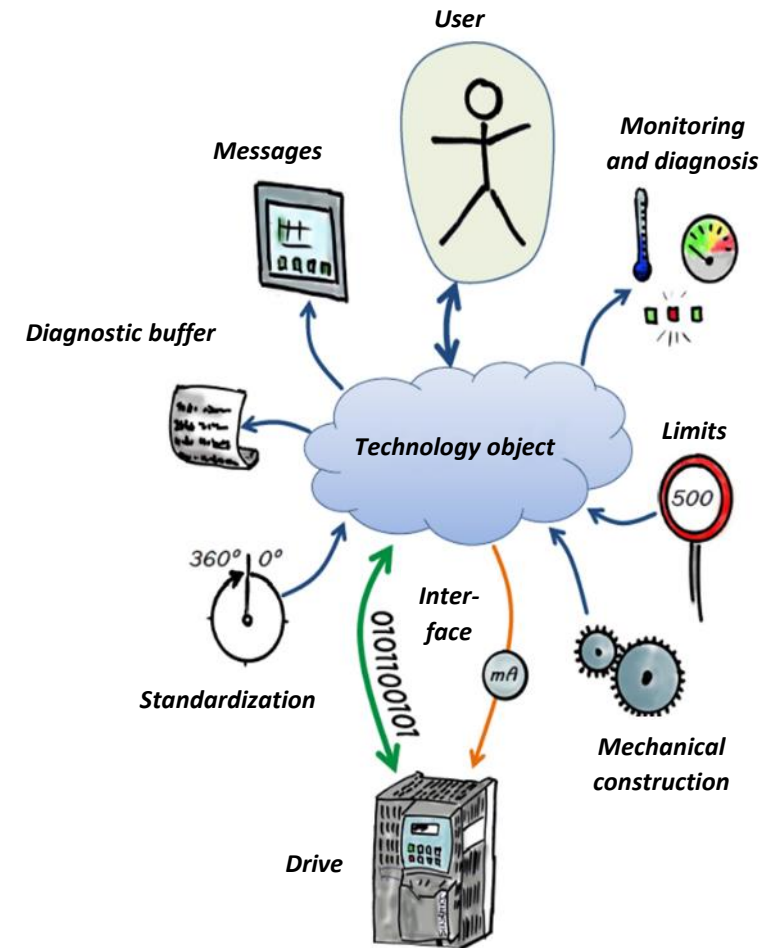
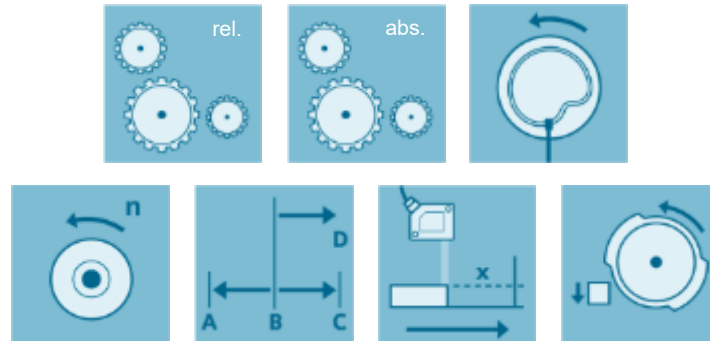
1. Click on Rotate & optimize under Left Axis
2. Click on One Button Tuning
3. Activate Master control by clicking on the Activate button (you will see a pop-up window for Master Control. Click OK)
4. Start the tuning procedure by clicking on the Start button
5. Once the tuning has completed, click on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



## What is a Technology Object?



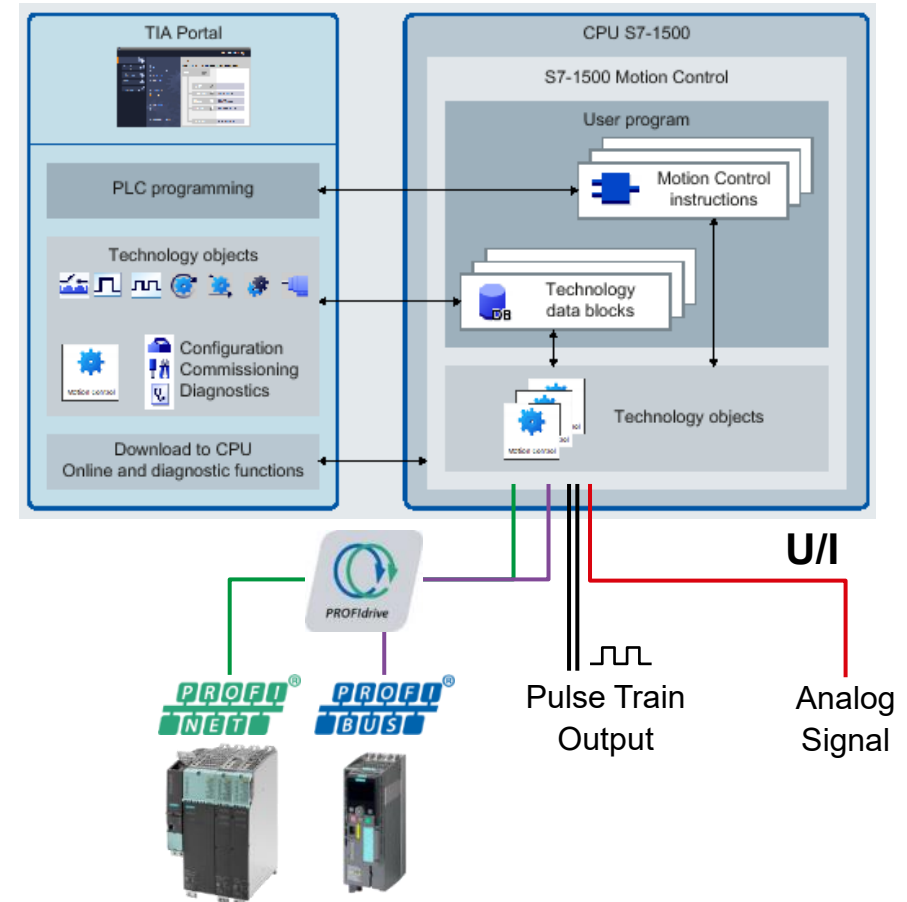
Siemens Technology Objects (TOs) are predefined software modules within the Siemens's TIA Portal programming environment that simplify the control and configuration of hardware, especially in motion control, counting, measuring, and PID regulation applications. They act as an interface between the hardware 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.





## 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

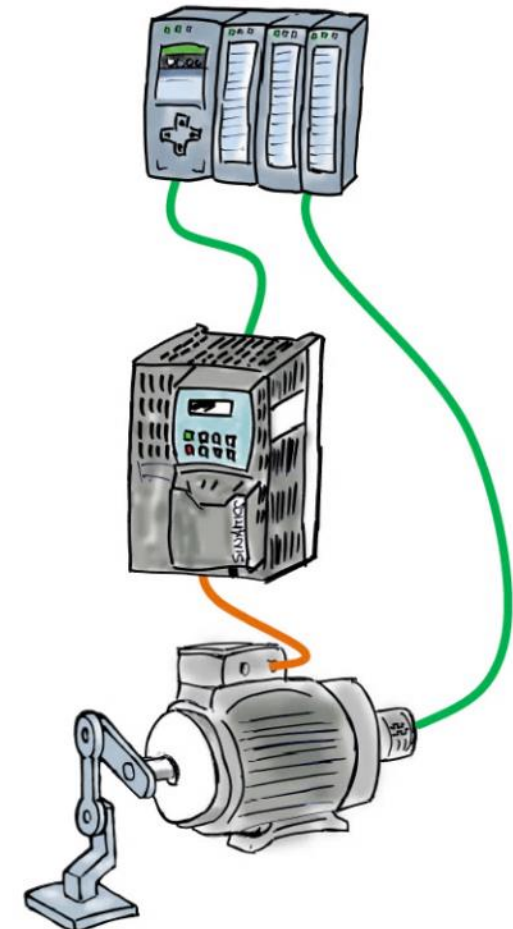
User program

- 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



Siemens - C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Project tree: EandM Roadshow Motion Workshop > PLC [CPU 1511TF-1 PN] > Technology objects > PositioningAxis\_1 [DB2]

Function view Parameter view

Basic parameters

Name: PositioningAxis\_1

PLC: User program -> Technology object Positioning axis -> Drive -> Motor

Axis type

☐ Virtual axis

☒ Linear

☐ Rotary

☒ Standard motor

☐ Linear motor

Units of measure

☐ Use position values with higher resolution

Position: mm

Velocity: mm/s

Torque: Nm

Force: N

Mass: kg

Module

Properties Info Diagnostics

Portal view Overview Left Axis (S210 PN) PositioningAxis\_1 SynchronousAxis\_1 PositioningAxis\_1

7:11 PM 9/1/2025

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

The screenshot shows the Siemens TIA Portal interface. The left-hand navigation tree is expanded to 'SynchronousAxis\_1 [DB3]'. A yellow circle with the number 1 highlights the 'Leading value interconnections' parameter. The main window displays the 'Leading value interconnections' table, which is currently empty. The right-hand pane shows the 'Options' and 'Find and replace' sections.

Possible leading values	Leading value source	Type of connection
*PositioningAxis_1*	~	Setpoint
		Setpoint

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.

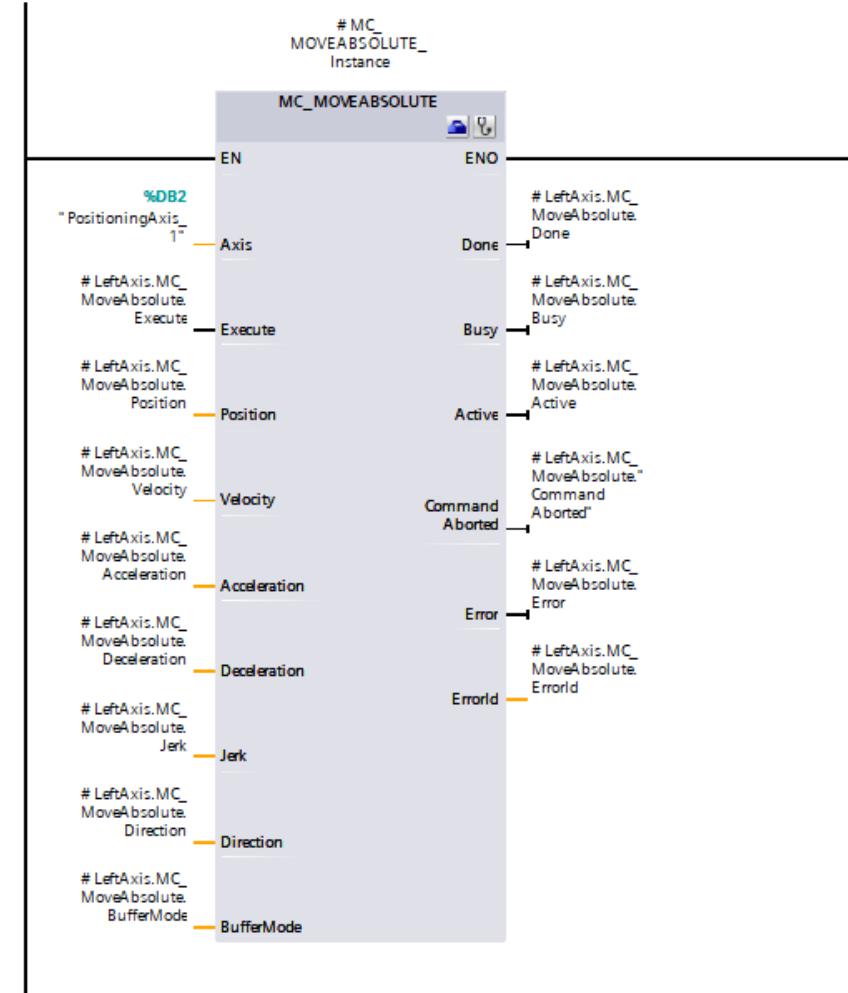


## What are Motion Control Blocks?



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.





The screenshot shows the Siemens TIA Portal software interface. The Project tree on the left lists the project structure, including 'Left Axis [FB2]'. The main workspace displays a Function Block Diagram (FBD) for 'Network 3: Call MC\_MoveJog'. The diagram shows the 'MC\_MOVEJOG' block with its inputs and outputs, including 'EN', 'ENO', 'InVelocity', 'Busy', 'Command', 'Error', and 'ErrorId'. The Properties/Instructions panel on the right shows the 'Technology' section, which lists various motion control blocks and their versions, such as 'MC\_MoveAbsolute', 'MC\_MoveRelative', 'MC\_MoveVelocity', and 'MC\_MoveSuperimposed'.

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

The screenshot displays the Siemens TIA Portal software interface for configuring a motion control system. The left sidebar shows the project tree, with the 'Right Axis [FB4]' block selected under the 'Motion Control' folder. A yellow circle labeled '1' highlights this selection. The main workspace shows a ladder logic network with a 'MC\_GearIn' block. A yellow circle labeled '2' highlights this block. The right sidebar shows the 'Instructions' panel, which includes a table of technology-specific instructions:

Name	Version
Counting, measurement...	V5.0
PID Control	
Motion Control	V9.0
SINAMICS Motion Control	V3.2
Time-based IO	V4.0

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.

The screenshot shows the Siemens TIA Portal software interface. The title bar indicates the path: C:\Users\Administrator\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop. The menu bar includes Project, Edit, View, Insert, Online, Options, Tools, Window, and Help. The toolbar contains various icons for file operations, project management, and online/offline status. The Project tree on the left shows the hierarchy of the project, including devices and networks. The main workspace displays a ladder logic program with three networks. The right-hand pane shows the 'Instructions' and 'Options' sections, with a list of basic instructions and their versions.

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.

Siemens - C:\Users\Joe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Totally Integrated Automation PORTAL

Project tree EandM Roadshow Motion Workshop Final ▶ Devices & networks

Devices Plant objects

Devices & networks

- ▼ EandM Roadshow Motion Workshop Final
  - Add new device
  - Devices & networks
  - PLC [CPU 1511TF-1 PN]
  - Left Axis [S210 PN]
  - Right Axis [S210 PN]
  - KP8F [KP8F]
  - Ungrouped devices
  - Security settings
  - Cross-device functions
  - Common data
  - Documentation settings
  - Languages & resources
  - Version control interface
  - Online access
    - Display/hide interfaces
    - COM [RS232C/PPI multi-master cable]
    - Intel(R) Ethernet Connection (4) I219...
    - VMware Virtual Ethernet Adapter for ...
    - VMware Virtual Ethernet Adapter for ...
    - Siemens PLCSIM Virtual Ethernet Ada...
    - Intel(R) Dual Band Wireless-AC 8265
    - PC internal [Local]
    - PLCSIM [PN/IE]
    - USB [S7USB]
    - ASIX USB to Gigabit Ethernet Famil...
  - Card Reader/USB memory

Details view

Module

Name

Device configuration

Online & diagnostics

Network view

Topology view Network view Device view

Network overview

Device

- ▼ S7-1500/ET200...
- PLC
- ▼ SINAMICS S\_1
- Left Axis
- ▼ SINAMICS S\_2
- Right Axis
- ▼ KP8\_1
- KP8F

Hardware catalog

Online tools

Tasks

Libraries

Add-ins

Extended download to device

Configured access nodes of "PLC"

Device	Device type	Slot	Interface type	Address	Subnet
PLC	CPU 1511TF-1 PN	1 X1	PN/IE	192.168.1.11	PN/IE_1

Type of the PG/PC interface: PN/IE

PG/PC interface: ASIX USB to Gigabit Ethernet Family Adapter

Connection to interface/subnet: PN/IE\_1

1st gateway:

Select target device: Show devices with the same addresses

Device	Device type	Interface type	Address	Target device
PLC	CPU 1511TF-1 PN	PN/IE	192.168.1.11	PLC
---	---	PN/IE	Enter address here	---

Flash LED

Start search

Online status information:

Scan completed. 1 compatible devices of 1 accessible devices found.

Retrieving device information...

Scan and information retrieval completed.

Display only error messages

Load Cancel

100%

Properties Info Diagnostics

Connection to PLC terminated.

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.

Siemens - C:\Users\Joe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Project tree EandM Roadshow Motion Workshop Final ▶ Devices & networks

Devices Plant objects

Extended download to device

Configured access nodes of "PLC"

Device	Device type	Slot	Interface type	Address	Subnet
PLC	CPU 1511TF-1 PN	1 X1	PN/IE	192.168.1.11	PN/IE_1

Establish connection to device

⚠ "PLC" might not be a trustworthy device.

The following errors were found when verifying the certificate:

- The IP address of the device does not match the addresses of the associated certificate.
- The device certificate cannot be verified as trustworthy because the chain of trust is incomplete.

If this is the device you want, it is trustworthy. If it is not the one you want, close the connection.

Display certificates Connect Abort connection

Online status information:

- Scan completed. 1 compatible devices of 1 accessible devices found.
- Retrieving device information...
- Scan and information retrieval completed.

Load Cancel

1

Hardware catalog

Options

Catalog

Filter Profile: <All>

- Controllers
- HMI
- PC systems
- Drives & starters
- Network components
- Detecting & Monitoring
- Distributed I/O
- Power supply and distribution
- Field devices
- Other field devices

Hardware catalog Online tools Tasks Libraries Add-Ins

Details view

Module

Name

Device configuration

Online & diagnostics

Portal view Overview Devices & ne...

Message

- Connection to R...
- Connection to P...
- Start downloading to device. 9/2/2025 2:16:51 PM
- Action canceled before download. 9/2/2025 2:20:08 PM
- Scanning for devices on interface ASIX USB to Gigabit Ethernet Family Adapter was started. 9/2/2025 2:20:17 PM
- Scanning for devices completed for interface ASIX USB to Gigabit Ethernet Family Adapter.... 9/2/2025 2:20:23 PM
- The device was reset. 9/2/2025 2:20:45 PM

The device was reset.

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



Siemens - C:\Users\Joe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Project tree: EandM Roadshow Motion Workshop Final > Devices & networks

Load preview

Check before loading

Status	I	Target	Message	Action
Ready for loading.		PLC		Load "PLC"
Protection from unauthorized access		Protection	Devices connected to an enterprise network or directly to the Internet must be appropriately protected against unauthorized access, e.g. by use of firewalls and network segmentation. For more information about industrial security, please visit <a href="http://www.siemens.com/industrialsecurity">http://www.siemens.com/industrialsecurity</a>	
Download software to device	✓	Software		Consistent download
Load safety program to device	✓	Safety program		Consistent download
Difference between the configured serial numbers in the Safety...	✓	Safety Identificati...		F-CPU identified (Accept online serial number)
Online	✓	Online	S C-S5A0RFLP2024	
Offline	✓	Offline	S C-S7A0KQKK2024	
User management data and access control configuration are no...	✓	User management		Download all user m...
The OPC UA server will be restarted due to data changes.		OPC UA server		Restart the OPC UA server
Download all alarm texts and text list texts to device	✓	Text libraries		Consistent download

Do not show dialog again

Refresh

Finish Load Cancel

Details view

Module

Name

Device configuration

Online & diagnostics

Portal view Overview Devices & ne...

The device was reset.

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

Siemens - C:\Users\Joe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Project tree EandM Roadshow Motion Workshop Final ▶ Devices & networks

Devices Plant objects

Network Connections HMI connection Topology view Network view Device view

PLC CPU 1511TF-1 PN Left Axis S210 PN Right Axis S210 PN KP8F KP8F

Load results

ⓘ Status and actions after downloading to device

Status	Target	Message	Action
✓	PLC	Downloading to device completed without error.	Load 'PLC'
✓	Start modules	Start modules after downloading to device.	Start module
✓	CRC comparison	Result of CRC comparison	

☐ Do not show dialog again

Finish Load Cancel

General Cross-references Compile

Show all messages

Message	Go to	?	Date	Time
'Default tag table' was loaded successfully.			9/2/2025	2:24:56 PM
'Failsafe' was loaded successfully.			9/2/2025	2:24:56 PM
'KP8F' was loaded successfully.			9/2/2025	2:24:56 PM
'S210 Left Axis' was loaded successfully.			9/2/2025	2:24:56 PM
'S210 Right Axis' was loaded successfully.			9/2/2025	2:24:56 PM
'System Byte' was loaded successfully.			9/2/2025	2:24:57 PM
Online and offline collective F-signatures match.			9/2/2025	2:24:59 PM

Portal view Overview Devices & ne...

The device was reset.

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

Siemens - C:\Users\Joe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Project tree EandM Roadshow Motion Workshop Final Devices & networks

Devices Plant objects

EandM Roadshow Motion Workshop Final

Add new device

Devices & networks

PLC [CPU 1511TF-1 PN]

Left Axis [S210 PN]

Right Axis [S210 PN]

KP8F [KP8F]

Ungrouped devices

Security settings

Cross-device functions

Common data

Documentation settings

Languages & resources

Version control interface

Online access

Display/hide interfaces

COM [RS232C/PPi multi-master cable]

Intel(R) Ethernet Connection (4) I219...

VMware Virtual Ethernet Adapter for ...

VMware Virtual Ethernet Adapter for ...

Siemens PLCSIM Virtual Ethernet Ada...

Intel(R) Dual Band Wireless-AC 8265

PC internal [Local]

PLCSIM [PN/IE]

USB [S7USB]

ASIX USB to Gigabit Ethernet Famil...

Update accessible devices

Display more information

Card Reader/USB memory

Details view

Module

Name

Device configuration

Online & diagnostics

Portal view Overview Devices & ne...

Download to device

Topology view Network view Device view

Configured access nodes of "Left Axis"

Device	Device type	Slot	Interface type	Address	Subnet
Left Axis	SINAMICS S210 PN	CU X150	PN/IE	192.168.1.20	PN/IE_1
	SINAMICS S210 PN	CU X127	PN/IE	169.254.11.22	

Type of the PG/PC interface: PN/IE

PG/PC interface: ASIX USB to Gigabit Ethernet Family Adapter

Connection to interface/subnet: PN/IE\_1

1st gateway:

Select target device: Show devices with the same addresses

Device	Device type	Interface type	Address	Target device
position	S210 PN	PN/IE	192.168.1.20	position
---	---	PN/IE	Enter address here	---

Flash LED

Start search

Online status information:

Scan completed. 1 compatible devices of 1 accessible devices found.

Retrieving device information...

Scan and information retrieval completed.

Load Cancel

Message

'Failsafe' was loaded successfully. 9/2/2025 2:24:56 PM

'KP8F' was loaded successfully. 9/2/2025 2:24:56 PM

'S210 Left Axis' was loaded successfully. 9/2/2025 2:24:56 PM

'S210 Right Axis' was loaded successfully. 9/2/2025 2:24:57 PM

'System Byte' was loaded successfully. 9/2/2025 2:24:57 PM

Online and offline collective F-signatures match. 9/2/2025 2:24:59 PM

Loading completed (errors: 0; warnings: 1). 9/2/2025 2:27:30 PM

Hardware catalog

Options

Filter Profile: <All>

Catalog

Controllers

HMI

PC systems

Drives & starters

Network components

Detecting & Monitoring

Distributed I/O

Power supply and distribution

Field devices

Other field devices

Hardware catalog

Online tools

Tasks

Libraries

Add-Ins

Diagnostics

Information

Loading completed (errors: 0; warning: 1)

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

The screenshot shows the Siemens TIA Portal software interface. The Project tree on the left lists various objects, with 'PositioningAxis\_1 [DB2]' selected under 'Technology objects'. The main area displays the 'Axis control panel' for 'PositioningAxis\_1 [DB2]'. The panel includes sections for 'Master control' (with 'Activate' and 'Deactivate' buttons), 'Control' (with position, velocity, acceleration, deceleration, and jerk settings), 'Status' (with 'Ready', 'Error', 'Enabled', and 'Homed' checkboxes), and 'Current values' (with position, velocity, and acceleration readouts). The right-hand sidebar contains 'Options', 'Find and replace', and 'Languages & resources' sections. Numbered callouts indicate the following steps:

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

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

The screenshot displays the Siemens TIA Portal interface for configuring a motion axis. The main window shows the 'Axis control panel' for 'PositioningAxis\_1 [DB2]'. The 'Operating mode' is set to 'Jog' (callout 1). The 'Velocity' is set to 30.0 mm/s (callout 2). The 'Move' slider is positioned to the right, indicating positive direction movement (callout 3). The 'Status' section shows the axis is 'Ready' and 'Enabled'. The 'Current values' section shows the 'Position setpoint' and 'Actual position' at 38.685 mm.

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



Siemens - C:\Users\Administrat\Desktop\EandM Roadshow Motion Workshop\EandM Roadshow Motion Workshop

Project Edit View Insert Online Options Tools Window Help

Go online Go offline <Search in projects>

Project tree EandM Roadshow Motion Workshop

Devices Plant objects

EandM Roadshow Motion Workshop

Add new device

Devices & networks

PLC [CPU 1511TF-1 PN]

Device configuration

Online & diagnostics

Safety Administration

Software units

Program blocks

Technology objects

Add new object

PositioningAxis\_1 [DB2]

Configuration

Commissioning

Diagnostics

Output cam

Measuring input

SynchronousAxis\_1 [DB3]

External source files

PLC tags

PLC data types

Watch and force tables

Online backups

Traces

OPC UA communication

Web applications

Device proxy data

Program info

PLC supervisions & alarms

PLC alarm text lists

Local modules

Distributed I/O

Left Axis [S210 PN]

Right Axis [S210 PN]

KP8F [KP8F]

Ungrouped devices

Security settings

Cross-device functions

Common data

Documentation settings

Languages & resources

Reference projects

Details view

Portal view Overview Main (OB1) PositioningA...

Axis control panel Tuning

Master control:

Activate Deactivate

Axis:

Enable Disable

Operating mode:

Positioning absolute

Control

Position: Acceleration: Move:

Velocity: Deceleration:

Adjust velocity: 1.0 %

JerK:

Status

Ready Enabled

Error Homed More

Active errors:

Confirm

Alarm display

Current values

Position setpoint:

Actual position:

Velocity setpoint:

Actual velocity:

Find and replace

Find:

Whole words only

Match case

Find in substructures

Find in hidden texts

Use wildcards

Use regular expressions

Down

Up

Find

Replace with:

Whole document

From current position

Selection

Replace Replace all

Languages & resources

Editing language:

English (United States)

Reference language:

English (United States)

Properties Info Diagnostics

Action canceled before download.

8:13 PM 9/1/2025

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

The screenshot shows the Siemens TIA Portal software interface. The Project tree on the left lists various objects, with 'SynchronousAxis\_1 [DB3]' selected under 'Technology objects'. The central workspace displays the 'Axis control panel' for this axis. The panel includes sections for 'Master control', 'Control', 'Status', and 'Current values'. Four yellow callouts with numbers 1, 2, 3, and 4 highlight specific steps in the configuration process:

- 1: Points to the 'Commissioning' button in the Project tree.
- 2: Points to the 'Activate' button in the Master control section.
- 3: Points to the 'Enable' checkbox in the Axis section.
- 4: Points to the 'Jog' dropdown menu in the Operating mode section.

The 'Control' section shows parameters for Velocity (30.0 mm/s), Acceleration (30000.0 mm/s²), Deceleration (300000.0 mm/s²), and Jerk (6000000.0 mm/s³). The 'Status' section shows 'Ready' and 'Enabled' status indicators. The 'Current values' section shows 'Position setpoint' (24.001 mm), 'Actual position' (24.001 mm), 'Velocity setpoint' (0.0 mm/s), and 'Actual velocity' (0.0 mm/s).

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

Siemens - C:\Users\Uoe Schlitzer\Desktop\EandM Motion Training\EandM Roadshow Motion Workshop Final\EandM Roadshow Motion Workshop Final

Project Edit View Insert Online Options Tools Window Help

Save project Go online Go offline <Search in project>

Project tree: EandM Roadshow Motion Workshop Final > PLC [CPU 1511TF-1 PN] > Technology objects > SynchronousAxis\_1 [DB3]

Axis control panel

Master control: **2** Activate Deactivate

Axis: Enable **1** Disable

Operating mode: Jog

Control

Velocity: 30.0 mm/s Acceleration: 30000.0 mm/s² Move: [Slider]

Adjust velocity: 100.0 % Deceleration: 300000.0 mm/s² Jerk: 6000000.0 mm/s³

Status

Ready Enabled Error Homed More

Active errors: [Box] Confirm

Alarm display [Icon]

Current values

Position setpoint: 137.546 mm Actual position: 137.546 mm

Velocity setpoint: 0.0 mm/s Actual velocity: 0.0 mm/s

Tasks

Options

Find and replace

Find: [Text box]

Whole words only Match case Find in substructures Find in hidden texts Use wildcards Use regular expressions

Down Up

Find

Replace with: [Text box]

Whole document From current position Selection

Replace Replace all

Properties Info Diagnostics Languages & resources

Portal view Overview Devices & ne... PositioningA... Synchronous...

The F-CPU "PLC" was successfully regist...

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

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

## KP8F Touch Buttons

Enable the Axis  
Solid Green = Enabled

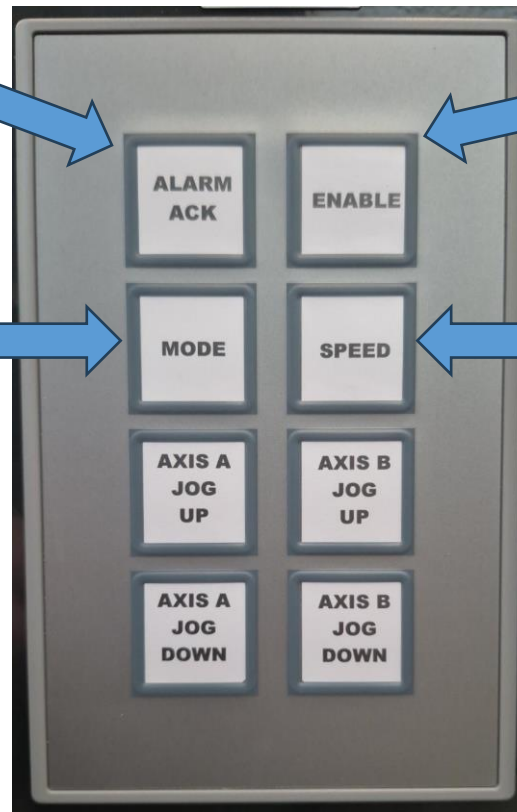
Switch between Auto and Manual  
mode.

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?