



**EFFICIENT MOTION CONTROL**

# Five Steps to **Efficient Motion Control**

The performance, reliability, and efficiency of a motion control system – comprising of controller, drive and motor – is largely defined during engineering. However, the inherent complexity of state-of-the-art motion control systems can easily lead to sub-par solutions. Engineering teams should therefore utilize smart solutions for system engineering and an aligned motion control portfolio to ensure that their motion control design delivers optimum performance and return on investment over the entire machine lifecycle from system configuration and engineering to validation and optimization.

**SIEMENS**

**MARKET TRENDS AND REQUIREMENTS**

# Efficient Motion Control

Faster time-to-market, increasing functionality and complexity, and demands for safety and sustainability are major challenges for machine builders. Efficient motion control solutions enable creating innovative machines faster and without costly prototyping. This helps machine builders (OEMs) meet customer requirements.

**Ensuring success in a challenging market**

The market for production machines is extremely competitive. Machines are sourced and sold globally, technologies are evolving rapidly, and the level of automation is on the rise no matter the application. This is why OEMs are faced with numerous challenges during machine and especially, motion control engineering. OEMs need to:

- deliver a broad spectrum of technologies and machine capabilities
- achieve a short time-to-market
- enable high production flexibility with a minimum of manual operations
- ensure machine safety
- meet ever tighter time and budget requirements

Until recently, machine builders have addressed the challenge by “doing more of the same”—that is, expanding business strategies that have been successful in the past – but these strategies often are not sufficient to help companies make optimum use of their resources.

**Increasing efficiency along the entire value chain**

This is why they need to take a new perspective on motion control engineering throughout the entire machine development process. Using the right set of integrated, digital solutions, OEMs and machine operators alike can:

- simplify complex procedures and automate repetitive and/or tedious tasks to reduce the workload for staff;
- increase flexibility through modular, standardized, and user-friendly engineering and operation;
- reduce time to market through parallelization and virtualization of work routines; and
- ensure maximum machine and operator safety while maintaining productivity and flexibility.

Moreover, by selecting motion control solutions that support efficiency for engineering, operation, and service, OEMs can ensure that the systems provide maximum value over time over the entire lifecycle.

**The five steps to efficient motion control**

Designing motion control systems is a journey on which every step counts. This guide presents the key challenges and criteria for selecting and engineering efficient motion control solutions that deliver the best return on investment from the electrical and mechanical design, automation engineering, functional testing and validation through to installation and commissioning in five steps.

## MOTION CONTROL SYSTEM CONFIGURATION

# Step 1: Dimensioning and selecting the optimum product combination

Machine mechanics, travel profiles, ambient conditions: Configuring a motion control system is complex. Intelligent tools and selection wizards support you in selecting the right components and combinations.

## Challenge

The rising level of automation in industrial manufacturing and the growing complexity of production operations results in higher demands on motion control for machines. But in order to implement an ideal motion control solution for the machine, the components of the motion control system – controller, drive, and motor – have to be optimally designed and aligned. It can be quite difficult to select the best motion control system and configuration for the requirements of the application (e.g., torque, acceleration, motion profiles) from the many components available on the market.

## Solution

To facilitate this crucial first step users shall choose a flexible and future viable motion control system, with simple engineering and smart selection wizards. Users are guided through the selection process step by step to find a suitable configuration based on the project requirements. This makes sure that all relevant details on the mechanical system and the required performance are entered into the selection tool. Through integration with an ordering system, users can:

- create the required engineering data (e.g., characteristic curves, calculated expected physical values)
- select the optimal motion control system components and export their order numbers
- export the documentation for the selected components and the related technical data
- order the selected components.

All without the need for in-depth knowledge of the vendor's portfolio.

## Benefit

Using such smart tools helps users select and order the required hardware combinations quickly and easily and get immediate access to all information required for documentation. This also facilitates adapting requirements and configurations to future projects.

### TIA Selection Tool

TIA Selection Tool guides users through the device and component selection process optimized towards the specific application requirements for error-free motion control system configuration based on Siemens products. The selected products can be ordered directly from the Siemens Industry Mall.

[siemens.com/tia-selection-tool](https://www.siemens.com/tia-selection-tool)



## MOTION CONTROL ENGINEERING

# Step 2: Perfect control for axes and systems

Engineering a holistic and seamless Motion Control solution for specific requirements typically involves implementing and coordinating continuous and cyclic axes movements as well as transport systems. State-of-the-art engineering tools simplify this task.

**Challenge**

To meet the needs of today's manufacturing operations, OEMs have to constantly improve machines and machine performance, flexibility, efficiency, and safety. Moreover, faced with fierce competition, they have to offer a solution with optimum return on investment. All these requirements ask for increased efficiency during motion control engineering.

**Solution**

Using integrated engineering tools for controller, drives, and HMI helps users engineer and optimize their motion control solutions while minimizing training expenses. They also help to reduce the number of interfaces during engineering, eliminating manual routines for data transfer, and also include solutions for efficient safety engineering. State-of-the-art engineering frameworks can cover a broad range of use cases and applications:

- engineering and integration of controller, drives, motors, and HMI
- motion control engineering from single-axes to coordinated-axes control
- engineering and integration of flexible conveyance solutions

**Benefit**

Using one tool for automation, drives and motion control engineering reduces project complexity. Ready-to-use application examples and available technology objects for certain typical motion tasks like positioning, gearing, camming etc. of drives and motors, and also templates with pre-tested building blocks reduce both the time and effort needed for motion control engineering. Projects become more standardized and can be more easily adapted to new requirements. Paired with a matching hardware portfolio, this also helps make optimum use of hardware resources to deliver a very cost-efficient solution.

**TIA Portal**

TIA Portal enables intuitive and efficient engineering of simple to complex motion control tasks. Technology objects support users with motion control functions for SIMATIC controllers and SINAMICS servo drive systems. Predefined standard application examples significantly reduce your development time.

[siemens.com/tia-portal](https://www.siemens.com/tia-portal)



## ROBOTICS ENGINEERING

# Step 3: Easy integration and optimization of robotics

An increasing number of machines and applications use robots to increase the level of automation or support operators during handling and assembly. To enable optimum return on investment, OEMs need efficient solutions to integrate robotics into their automation and motion control projects.

## Challenge

Integrating robots into automation projects not only involves the technological aspects of motion control. Machines and manufacturing lines are typically equipped with application specific kinematics including variable frequency drives and/or complete robots system solutions from different vendors, each having its own controller, programming language and HMI. Moreover, simulating kinematics and robot behavior and its interaction with the production systems (e.g., for safety validation) will also involve different tools and solutions.

## Solution

Comprehensive robot control systems eliminate the need for additional external systems, allowing the commissioning engineer to program automation, safety, and the robot within their familiar environment. The SIMATIC S7-1500T offers a comprehensive robot control system with its Kinematics technology object. A user-friendly interface enables engineers to create motion programs including robots using a sequential programming language without requiring prior knowledge. For integrating other robot systems, the SIMATIC Robot library provides a standardized programming interface with pre-tested blocks.

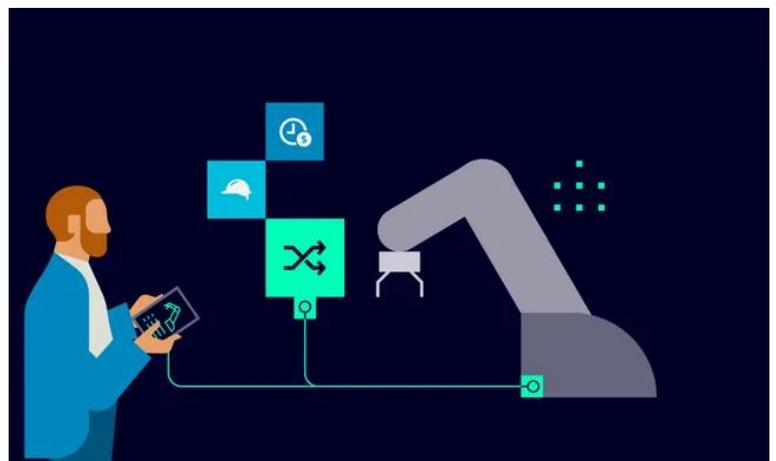
## Benefit

Engineers no longer need robot-specific engineering expertise but can work in their familiar engineering environment when designing and programming their robot application. Integrated safety features streamline the safety engineering for both motion control and robotics.

### Solutions for the integration of industrial robots

Driven by innovative technologies and applications, the use of robots in industry continues to grow and will change dramatically in the coming years. To help users take advantage of these new opportunities, Siemens has developed a full set of solutions for integrating industrial robots.

[siemens.com/robotics](https://www.siemens.com/robotics)



## PROGRAM AND MECHATRONIC VALIDATION

# Step 4: Simulation and testing

Errors and flaws in the mechanical design or machine program can lead to project delays and additional costs. To meet the demand for shorter project lead times and to save valuable resources, OEMs and machine operators need to find new ways to verify their mechanical design and motion control program early on.

**Challenge**

Systems tests and validation are a vital project step, yet it can be very time-consuming. When tests are performed on physical systems, this can also lead to delays in the machine project, as the solution performance can be verified only after the machine or system has been built. When errors are detected late in the project, this will also incur added engineering and design costs. To bring new machines to the market faster, OEMs need to establish efficient processes that help them validate and optimize motion control applications without prototypes and hardware.

**Solution**

State-of-the-art engineering frameworks offer integrated simulation software and test capabilities to validate and simulate motion control applications. In addition to simulating the automation model, users can utilize electrical and behavior models of the drive system to optimize drive parameters and even commission the drive system in a virtual environment before it is built. The interaction of mechanical system and kinematics can be tested through mechanical and kinematic modelling including robotics applications and 3D visualization for visual inspection.

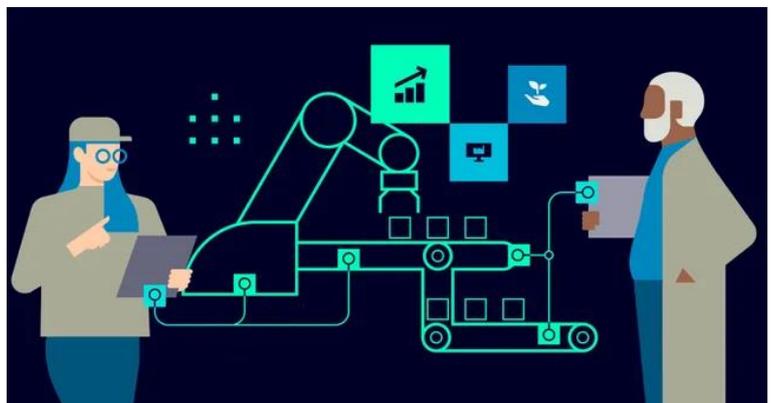
**Benefit**

By using tools for simulation and model-based testing of motion control, users can identify and rectify errors at an early stage of the development process which helps save project time and cost. Simulation also helps improve interdisciplinary collaboration and parallelize workflows. And finally, the ability to test and validate applications in a virtual environment eliminates the need for hardware and resource-intensive physical prototyping.

**Simulation for Motion Control**

Siemens offers a scalable set of integrated tools and solutions for the simulation of PLCs (PLCSimAdvanced), drives (SIMIT), HMIs, Kinematics movements and 3D visualization of the entire machine (NX MCD) and therefore solutions for comprehensive virtual commissioning.

[siemens.com/simulation](https://www.siemens.com/simulation)



## MOTION CONTROL OPTIMIZATION

# Step 5: Optimizing system performance

Integrated solutions for motion control tuning, diagnostics and analysis help optimize axis performance in combination with the actual mechanical and load characteristics of the machine. This enables users to reach the full dynamic potential for the motion control system.

**Challenge**

Optimizing motion control system performance is as complex as engineering: During start-up or operation, it takes time to identify and analyze the right motion control and drive signals which cause sporadic, suboptimal machine behavior. Identifying the optimum setting of the drive parameters can require a substantial amount of technical expertise.

**Solution**

Integrated system features and tools significantly reduce the complexity of motion control optimization. They are able to identify the ideal drive settings based on the required response from the mechanical system and automatically optimize closed-loop control parameters. Tracing tools can record drive signals as well as triggered and cyclically synchronous PLC signals over longer periods of time and help users analyze sporadic errors and their root cause.

**Benefit**

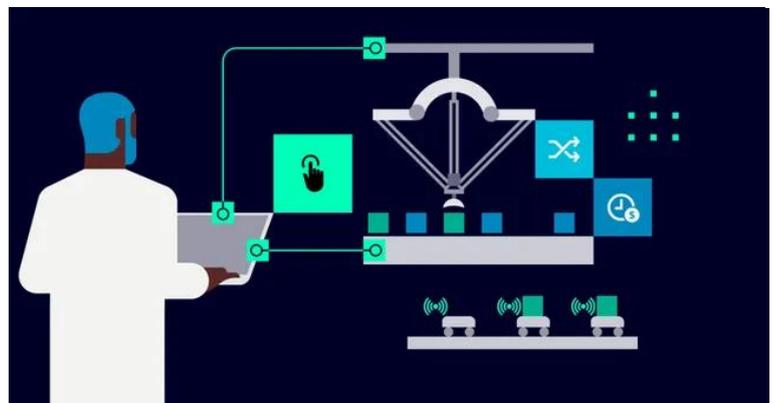
Using self-tuning features and tuning wizards for the drive systems, staff will be able to optimize drive systems fast and with no in-depth technical drive expertise, which helps reduce the time and effort required to optimize the required axes performance. Long-term signal diagnostics and analysis significantly facilitate troubleshooting, especially for sporadically occurring machine faults. As a result, the machine can be commissioned faster and operate with optimum settings immediately after start-up.

**Motion Control Optimization**

"One-Button-Tuning" in SINAMICS servo drive systems helps optimize the dynamic performance of machine axes. The "LongTermTrace" function of TIA Portal records drive and PLC signals for convenient analysis.

[siemens.com/tia-portal](https://www.siemens.com/tia-portal)

[siemens.com/servodrives](https://www.siemens.com/servodrives)



# Training for motion control

SITRAIN Digital Industry Academy offers a dedicated learning path for Efficient Motion Control: Master complexity with ease and build your expertise and efficiency.

[Efficient Motion Control \(Curriculum\)](#)

## More information

**„Efficient Motion Control“ online:**

[siemens.com/efficient-motion-control](https://www.siemens.com/efficient-motion-control)

**„Efficient Motion Control“ SiePortal:**

<https://support.industry.siemens.com/cs/ww/en/view/109955074>

**„SIMATIC Motion Control“ SiePortal:**

<https://support.industry.siemens.com/cs/ww/en/view/109751049>

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