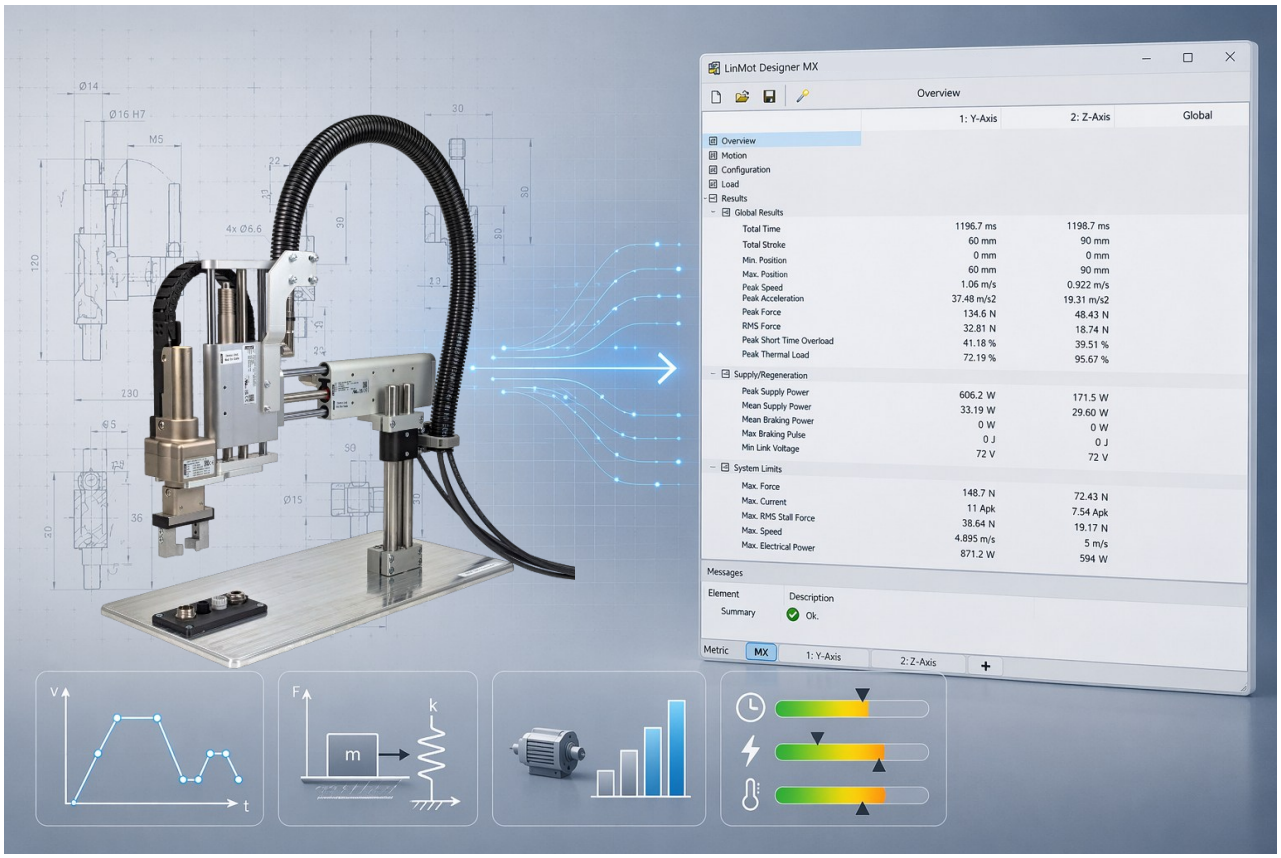
LinMot®

ENG

# Tutorial: LinMot® Designer 2.0.0
## Single Axis Mode (SX)
## Multi Axes Mode (MX)



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# 1 Introduction

## 1.1 About This Tutorial

This tutorial guides you through the LinMot Designer, a sizing and selection tool for LinMot linear and linear-rotary motor systems. It is written for project planners, automation engineers, machine designers, and anyone who needs to select, verify, or optimize a LinMot drive configuration.

By the end of this tutorial you will be able to:

- Define your application requirements (moved mass, load forces, motion profile).
- Let the LinMot Designer filter thousands of motor/drive/module combinations to find those that fit.
- Evaluate whether your chosen configuration meets force, speed, and thermal limits.
- Optimize motion sequences — for example, to reduce cycle time or energy consumption.
- Select a matching power supply and export your project data.




## 1.2 Why Use a Design Tool?

Although linear motion follows the basic relation F = m × a, accurate drive sizing must account for effects that are difficult to evaluate by hand:

- **Speed-dependent force limits.** Like rotary servomotors, linear motors produce less force at higher speeds due to counter-EMF. The available force depends on the motor, the servo amplifier, and the power supply.
- **Stroke-dependent constraints.** Short strokes may limit the achievable peak speed because there is insufficient distance to accelerate and decelerate. With longer strokes, the motor can reach higher speeds, making the maximum-speed limit more relevant.
- **Thermal behaviour over the full cycle.** The motor must not overheat during continuous operation, so the cumulative power dissipation across all motion segments must be checked.
- **Iterative motor selection.** The motor's own moving mass contributes to the total moved mass. Changing the motor therefore changes the total load and requirements, potentially requiring another motor selection.

The LinMot Designer handles all of these calculations automatically, letting you focus on your mechanical design.

## 1.3 Tutorial Structure

This LinMot-Tutorial contains the following subjects:

Chapter 1: **Introduction**

Chapter 2: **SX Mode** and with examples “**Horizontal Pusher**”, “**Vertical Pressing (MagSpring)**” and “**Linear Rotary Motor**”

Chapter 3: **MX Mode** and examples “**Pick and Place**” and “**Full Gantry**”

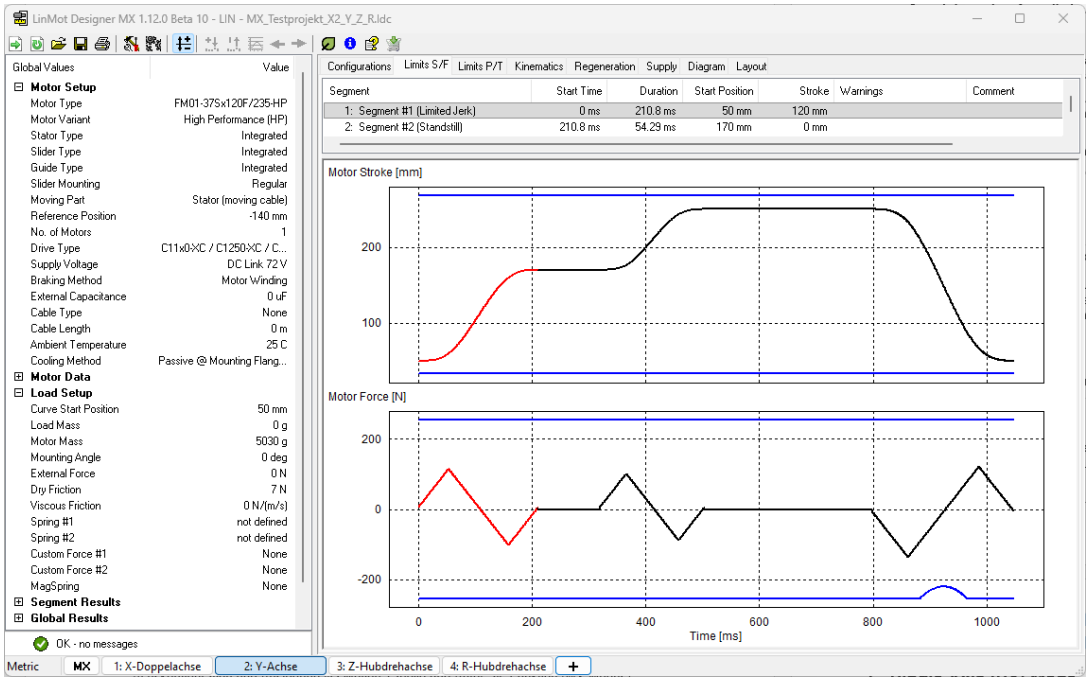
Chapter 4: Additional **Features & Information**

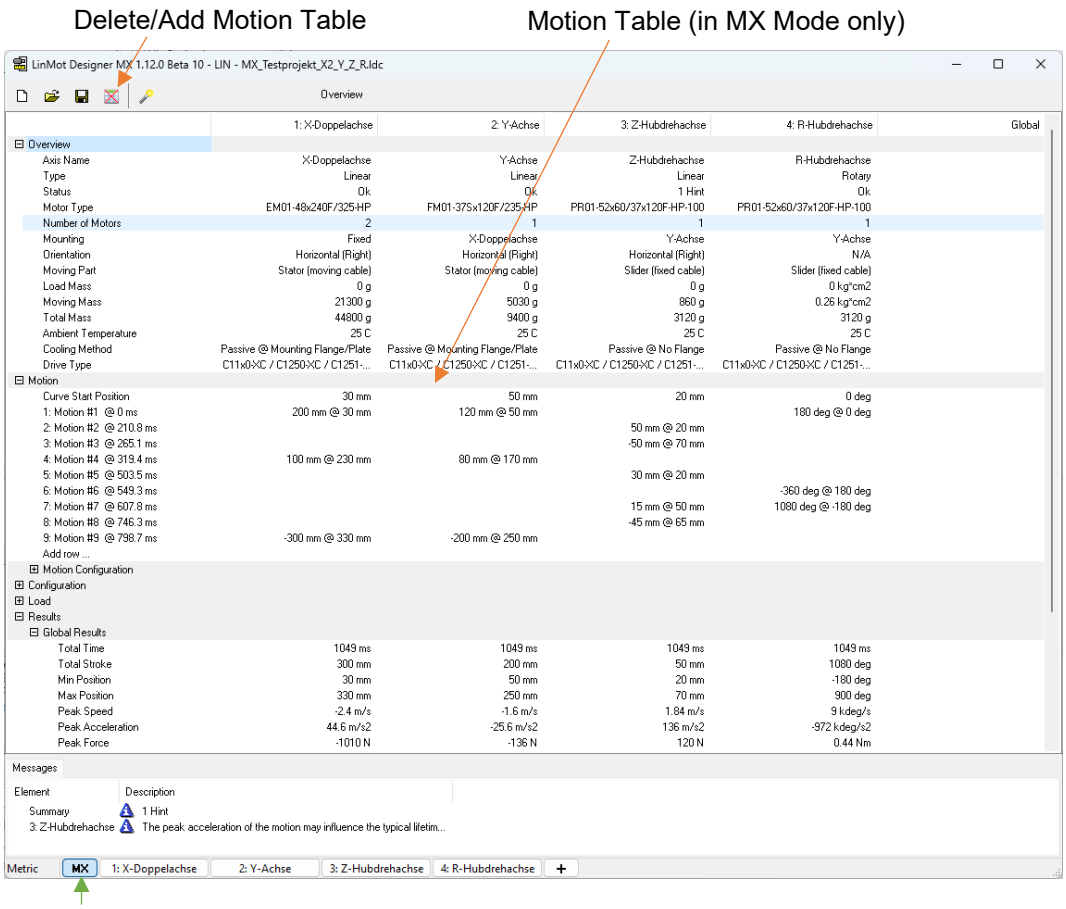
## 1.4 What's New

Until LinMot Designer V1.11.1, only a single drive axis could be configured and sized. The current version supports **multiple axes within a single project**. A dedicated program tab is available for each axis. As before, every axis can be individually defined, sized, and evaluated (**SX Mode**). In addition, a new data table can be used to configure the axes, review simulation results, and easily compare axis data. By adding a **motion table (MX Mode)**, you can also define, plan, and optimize the movements of all axes over time. For motion optimization, an **AutoCalc** function is available that automatically optimizes the motion parameters based on the characteristics of the respective axis.

The new LinMot-Designer introduces the following major enhancements, in addition to supporting many new components:

- Support for **multiple axes** within a single project
- Selection of the active axis for configuration via the **axis tabs**
- Adding, duplicating, moving, and deleting individual axes
- **Table** of configuration values and results for all axes (one column per axis)
- **Editing** of axis **parameters** directly within the **configuration table**
- Option in table view to **select** another axis as the **mounting base**. The mass of the current axis is automatically taken into account as load mass on the selected axis.
- Saving and loading projects with multiple axes in a single **configuration file (*.ldc)**
- Support for the traditional sizing approach in **SX Mode** (each axis independent, except mounting base/mass)
- Simplified motion planning using a **Motion Table** (**MX Mode**)
- Automatic optimization of motion timing in MX Mode using the **AutoCalc** function






In **MX Mode**, where the motion of all axes is controlled through the **Motion Table**, there are some **limitations**:

- All motions are of the **Limited Jerk** (VAJ) type.
- The **VAJ parameters** apply to all motions of an axis.
- **Segment Mode** is disabled in the single-axis view.
- **No segment-specific loads** can be defined.

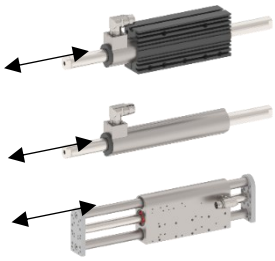
In return, the VAIJ motion parameters for all axes can be automatically determined using the AutoCalc function to achieve the shortest possible motion times.

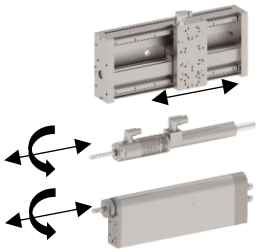
The MX Mode is typically used for Pick and Place or Gantry Systems, where the moving mass is more or less constant. A change from MX Mode to SX Mode is possible without data loss, so individual modifications can be done afterwards.

# 2 Single Axis (SX) Mode

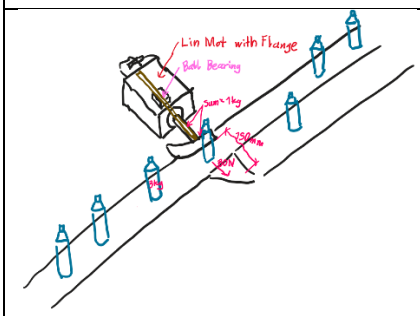
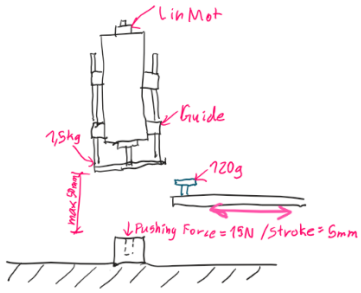
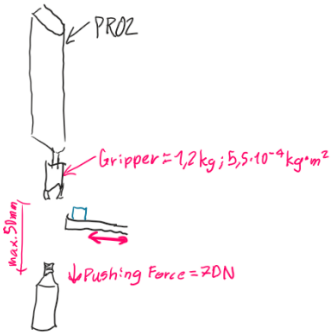
## 2.1 Introduction

In SX Mode, each axis is configured independently: you define its load, motion profile, and motor/drive separately, and the LinMot Designer evaluates force, speed, and thermal behavior for that axis alone. A single project file can contain multiple independent axes.

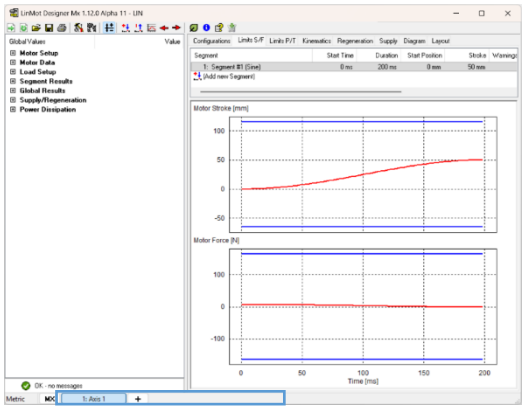




This chapter walks through three complete examples of increasing complexity:

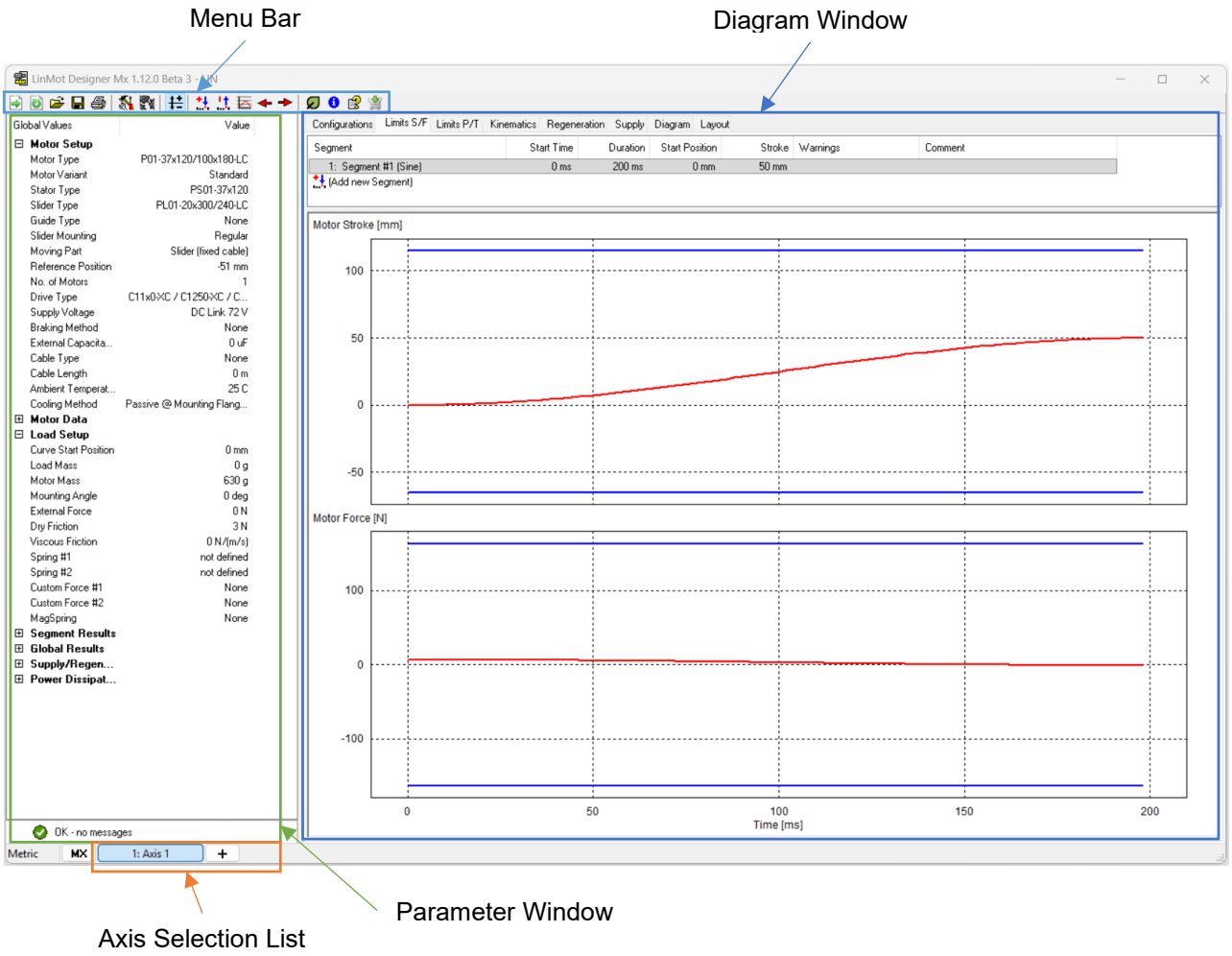
| **Application Example 1: Horizontal** Pusher | **Application Example 2: Vertical Pressing (**MagSpring) | **Application Example 3: Linear Rotary** Motor |
|---|---|---|
|  |  |  |
| A horizontal pushing motion with changing moving mass and friction during the cycle.<br>Focus areas:<br>• Limited Jerk for soft product handling<br>• Dynamic return stroke sizing<br>• Force and thermal constraint optimization<br>• Corrective actions (curve adjustment & motor selection) | A vertical axis for pushing applications supported by a MagSpring for continuous and dynamic motions.<br>Focus areas:<br>• Gravity compensation setup<br>• MagSpring behavior and selection<br>• Multi-step pressing process<br>• Oversizing identification and motor downsizing | A combined pick-and-tighten screwing process with coordinated linear and rotary axes.<br>Focus areas:<br>• Coordinated segment timing between two axes<br>• Custom Torque curves for screwing<br>• Thermal coupling between PR02 motors<br>• Multi-axis power-supply sizing |

Before starting the examples, Section 2.2 explains the main window layout and its four areas (Menu Bar, Parameter Window, Diagram Window, Axis Selection List). Refer back to it whenever you need to locate a control.



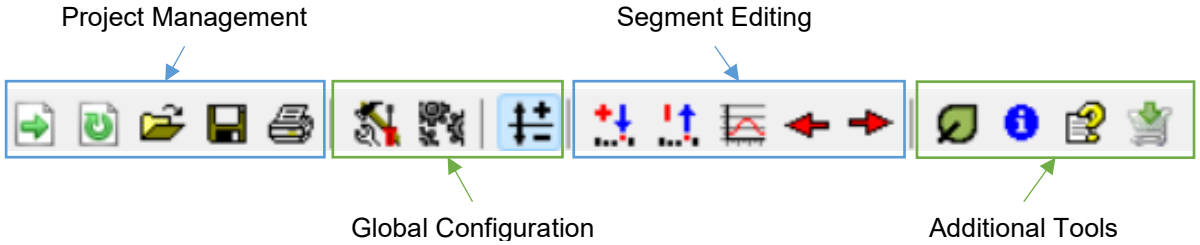
## 2.2 Main Window Overview for SX Mode

The main window in SX Mode is divided into four primary areas, which are described in more detail in this section.



### 2.2.1 Menu Bar

The menu bar provides all global project commands and essential SX-Mode functions. Settings apply only to the selected axis in the *Axis Selection List*.




#### 2.2.1.1 Project Management



**New Linear / Rotary Project**

These two buttons allow users to create either a *Linear or Rotatary Project*. The chosen option will apply exclusively to the selected axis from the *Axis Selection List*.
If modifications have already been made to this axis, altering the selection will result in the removal of the existing configuration; a notification window will appear in advance.

**Open / Save Project**

Open a previously created project or save (Section 4.6.1) the current project progress.

**Print Project**

Clicking this button generates a printable document for the selected axis, containing details about its configuration and results. See Section 4.6.1 for more information.

#### 2.2.1.2 Global Configuration

With these buttons generally valid selections can be made for this project.



**Global Settings**

The global configuration settings for the project encompass various elements, including motor selection and load definition. Additional details can be found in Section 4.1.

**Measurement Settings**

Allow switching between metric and English units and set the number of significant digits shown. Key energy-efficiency parameters can be adjusted as needed (Section 4.5.1).

**Auto Centering Mode**

This button enables or disables the auto-centering mode. By default, auto-centering is enabled.



**Info**
If auto-centering is **turned off**, please manually set the Start position under Global Settings → Motor → Reference Position.

The *Auto-Centering Mode* automatically positions the motor's reference point so that the available motor stroke is centered around the defined motion curve. This ensures that the motor stroke limits and the position curve align optimally, providing the best performance and efficient use of the motor's available stroke.

#### 2.2.1.3 Motion Segment Editing

These buttons allow users to modify the segments within the *Diagram Window*, which are essential for defining the curve. More information about the *Motion Segments* can be found in Section 4.2.



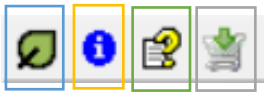
**Add Segment** 
Insert a new segment before (above / to the left of) the selected one.

**Delete selected Segment** 
Delete the currently selected segment.

**Edit selected Segment** 
The segment editor window opens for the chosen segment, allowing you to define each segment individually.

**Move selected Segment** 
Move the selected segment to the “left / up” or “right / down”.

#### 2.2.1.4 Additional Tools



**Show / Hide Efficiency-Tab** 
This button adds an *Efficiency* tab to the *Diagram Window*. See Section 4.5 for more information about this Window.

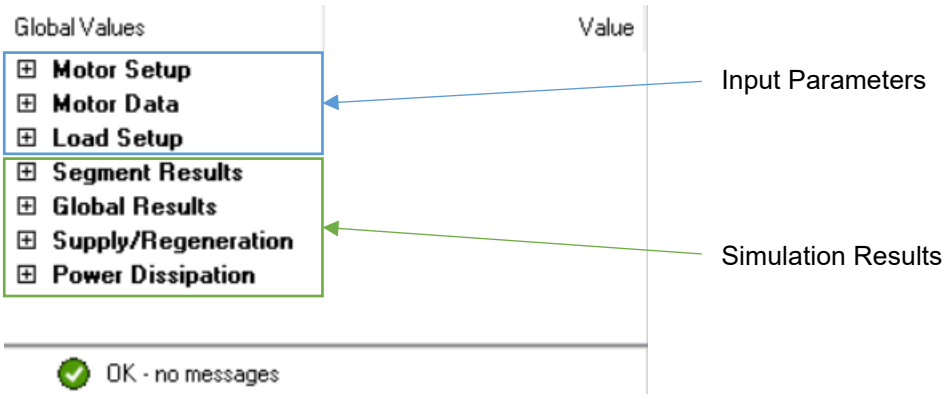
**Show Program Info** 
This button opens the About window of the LinMot Designer software. This includes general Information about this software, License and Release Information. It also has a link to the LinMot Website and a Check for Updates button.

**Display Tutorial** 
This button will open this documentation.

**Show BOM** 
With this button the Bill of Material (BOM) will be created and opened. See Section 4.6.3 for more information.

### 2.2.2 Parameter Window

This window contains all input parameters and numerical simulation results. The data is displayed in a parameter tree view with the following main sections:




#### 2.2.2.1 Input Parameters

All input parameter can be edited the *Global Settings* (Section 4.1).

**Hint:**
A double-click on any parameter opens its corresponding settings window.

| | |
|---|---|
| **Motor Setup**<br>Motor Type: P01-37x120/100x180-LC<br>Motor Variant: Standard<br>Stator Type: PS01-37x120<br>Slider Type: PL01-20x300/240-LC<br>Guide Type: None<br>Slider Mounting: Regular<br>Moving Part: Slider (fixed cable)<br>Reference Position: -51 mm<br>No. of Motors: 1<br>Drive Type: C11x0-XC / C1250-XC / C12...<br>Supply Voltage: DC Link 72 V<br>Braking Method: None<br>External Capacitance: 0 uF<br>Cable Type: None<br>Cable Length: 0 m<br>Ambient Temperature: 25 C<br>Cooling Method: Passive @ Mounting Flange... | The **Motor Setup** section defines the primary configuration of the selected LinMot motor or module. Adjusting these settings influences performance limits, thermal behavior, and system compatibility. |
| **Motor Data**<br>Max Force: 163 N<br>Max Current: 8 Apk<br>Standard Stroke SS: 100 mm<br>Extended Stroke ES: 180 mm<br>Max Speed: N/A<br>Max Acceleration: N/A<br>Slider Mass: 630 g<br>Slider Diameter: ø20 mm<br>Slider Length: 300 mm<br>Stator Mass: 740 g<br>Stator Diameter: ø37 mm<br>Max Stator Length: 216 mm | The **Motor Data** panel displays detailed motor-specific parameters used internally for the simulation. These values reflect the chosen motor configuration and help users verify if the selected motor meets application requirements. |

| | |
|---|---|
| **Load Setup**<br>Curve Start Position 0 mm<br>Load Mass 0 g<br>Motor Mass 630 g<br>Mounting Angle 0 deg<br>External Force 0 N<br>Dry Friction 3 N<br>Viscous Friction 0 N/(m/s)<br>Spring #1 not defined<br>Spring #2 not defined<br>Custom Force #1 None<br>Custom Force #2 None<br>MagSpring None | The **Load Setup** section defines the mechanical load acting on the axis. Load values can be defined globally (for the full motion) or locally (per segment). |

### 2.2.2.2 Simulation Results

| | |
|---|---|
| **Segment Results**<br>Segment Stroke 50 mm<br>Peak Speed 0.39 m/s<br>Peak Acceleration 6.17 m/s2<br>Peak Force 6.89 N<br>RMS Force 4.07 N<br>Power Dissipation 0.31 W | The **Segment Results** provide calculated results specific to the currently selected segment of the motion profile. |
| **Global Results**<br>Total Time 1700 ms<br>Min Stroke 0 mm<br>Max Stroke 50 mm<br>Total Stroke 50 mm<br>Peak Speed 0.39 m/s<br>Peak Acceleration 6.17 m/s2<br>Peak Force 6.89 N<br>RMS Force 2.16 N<br>Peak Short Time Overload 0.047 %<br>Peak Thermal Load 0.52 % | The **Global Results** section provides system-wide performance and safety metrics for the entire motion cycle. These aggregated metrics help determine whether the axis design is feasible and within allowable motor performance limits. |
| **Supply/Regeneration**<br>Peak Supply 2.22 W<br>Mean Supply 0.26 W<br>Mean Braking Power 0 W<br>Max Braking Pulse 0 J<br>Min Link Voltage 72 V | The **Supply/Regeneration** section displays calculations related to the power supply, DC-link behavior, and regeneration energy. |
| **Power Dissipation**<br>Actual 0.087 W<br>Max. Actual Cooling 16.9 W (Passive @ Mountin...<br>Max. Default Cooling 16.9 W (Passive @ Mountin...<br>Max. Optimal Cooling 56.1 W (Fan @ Mounting Fla... | The **Power Dissipation** section displays the electrical and thermal losses of the motor and drive during operation. These metrics are critical for verifying long-term thermal stability and determining whether higher cooling capacity or an alternative motor size is needed. |
| **2nd Motor Setup**<br>Max. Power Dissipation 20 W<br>Max. RMS Torque 0.447 Nm | The **2nd Motor Setup** is only visible when working with PR02 or PR04 linear-rotary motors. It displays the thermal coupling information of the second motor. |

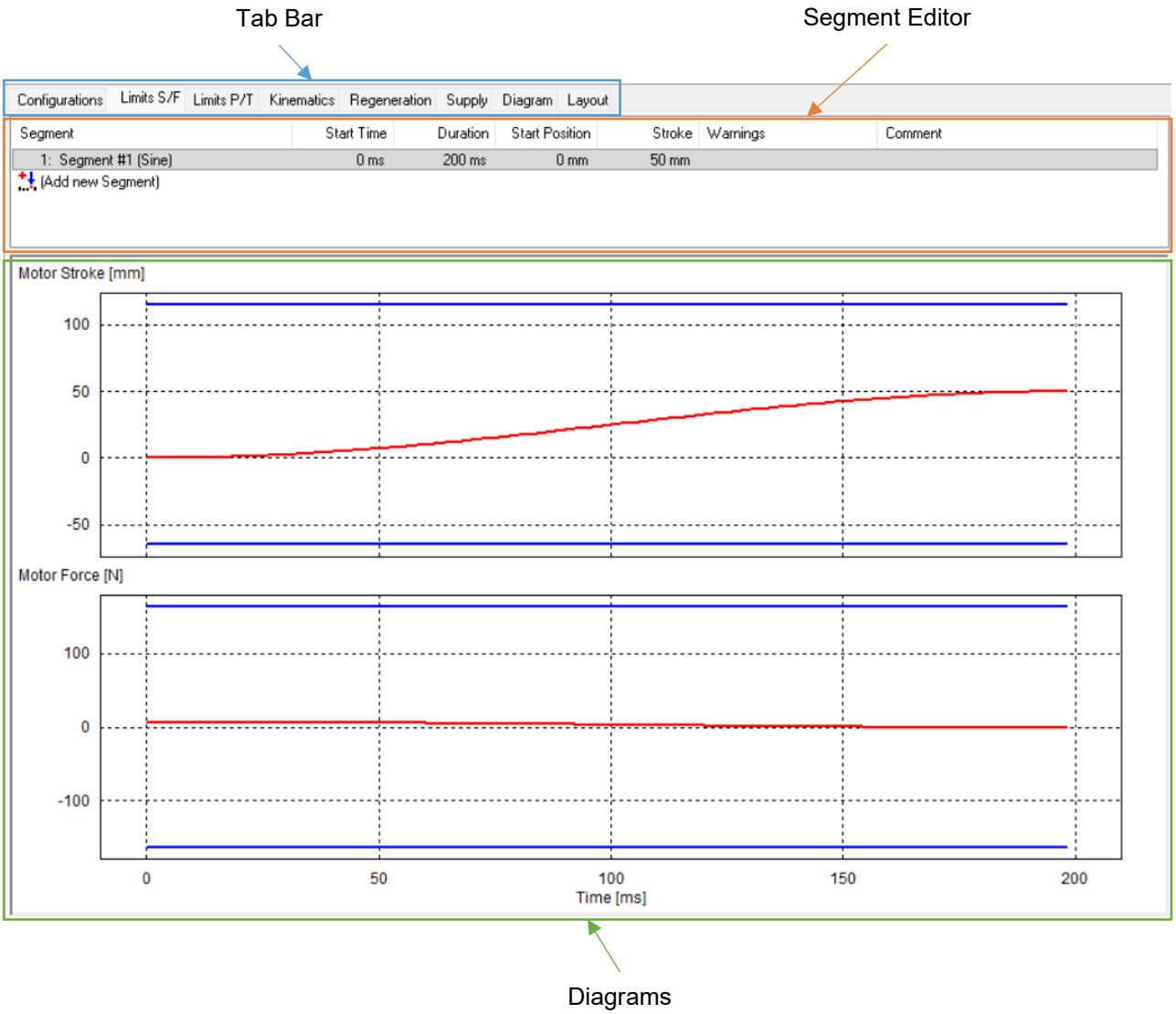
| | |
|---|---|
| | **Messages** |

| | |
|---|---|
|  | The *Messages* panel shows all system notifications. These are assigned four different types of messages:<br>• OK (green)<br>  ○ No warnings/errors; design is valid<br>• Errors (red)<br>  ○ Design cannot be simulated properly<br>• Warnings (yellow)<br>  ○ Performance limits close to being exceeded<br>• Notes (blue)<br>  ○ Recommendations and non-critical hints<br><br>These real-time checks serve to verify the configuration and display any issues. |

### 2.2.3 Diagram Windows – Graphs & Visualizations

The *Diagram Window* displays all graphical simulation results. This chapter gives a short summary of each tab in the *Tab Bar*.

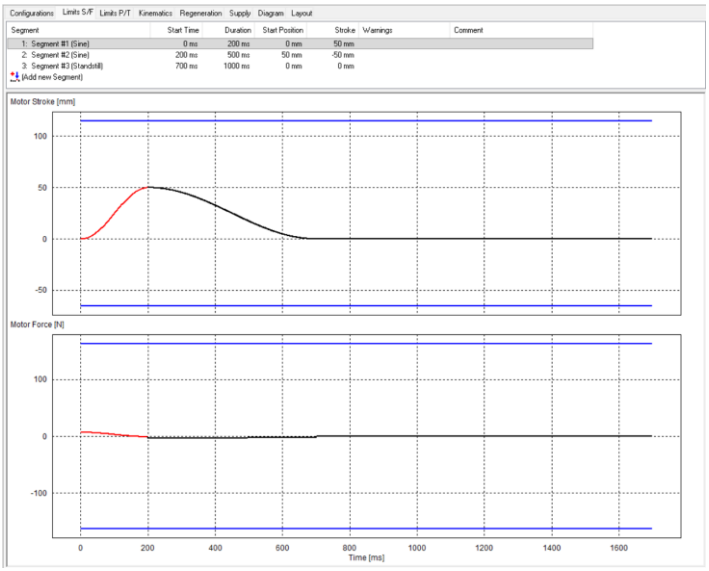
**Note**
The selected segment is highlighted in red in the graphs.




#### 2.2.3.1 Configurations Tab

The *Configurations* data tab is a motor configuration tool and is described in more detail in Section 4.4.

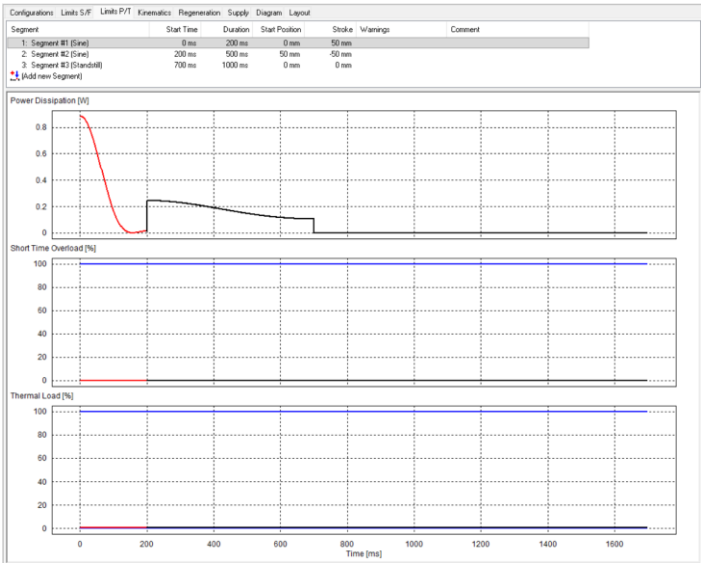
### 2.2.3.2 Limits S/F




The *Limits S/F* (Speed / Force) tab displays the time-dependent speed and force profiles of the defined motion in comparison with the motor's performance limits. Graphs include maximum allowable motor force, maximum speed, and actual simulated values. This allows engineers to verify whether the motion profile stays within the safe operational range of the chosen motor configuration.

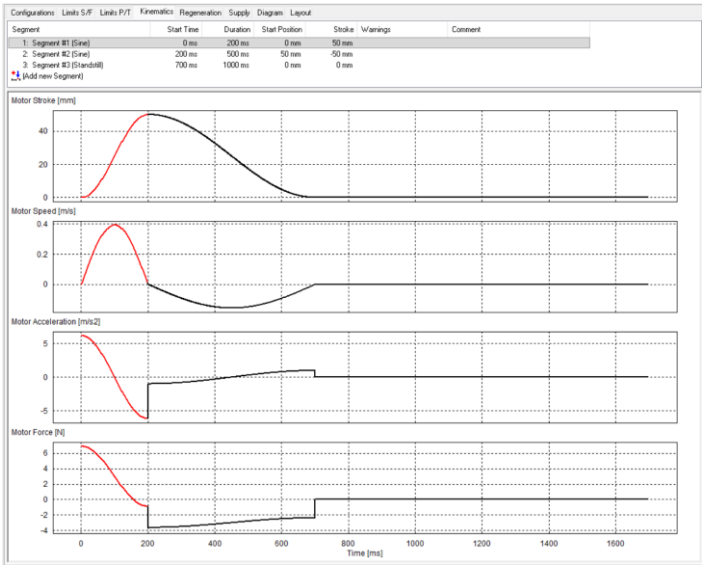
If the motion approaches or exceeds any limits, warnings or errors are triggered in the Messages panel. This view is crucial for validating performance feasibility, particularly for high dynamic moves or applications requiring high peak force or velocity.

### 2.2.3.3 Limits P/T (Power / Temperature)




The *Limits P/T* (Power / Temperature) tab shows thermal parameters like Power Dissipation, Short Time Overload Protection, and Thermal Load. It compares calculated thermal values against the motor's continuous and peak temperature limits. This helps verify whether a selected motor can operate within safe thermal boundaries during continuous or cyclic operation.

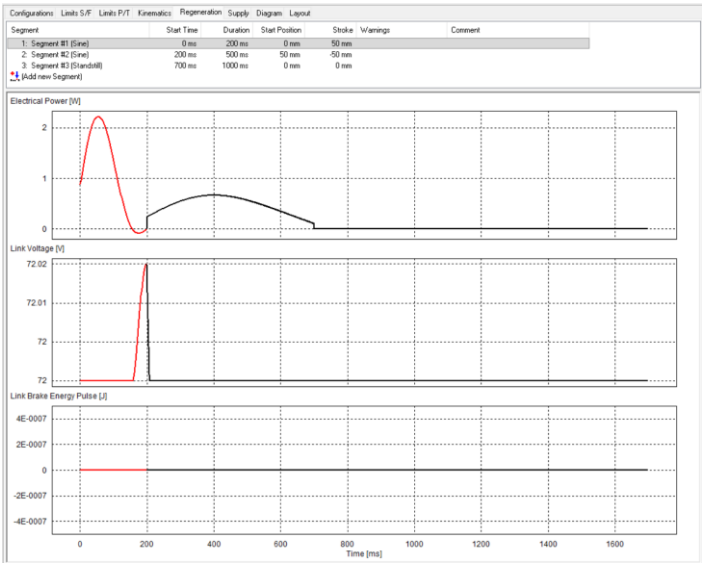
### 2.2.3.4 Kinematics




The *Kinematics* tab visualizes the fundamental motion characteristics of the axis over time. It includes detailed graphs for stroke/position, velocity, acceleration, and force, enabling full insight into how the axis behaves during each motion segment. This sectional view plays a central role in evaluating segment timing, identifying motion profile irregularities, and ensuring that the commanded curve matches real system behavior.

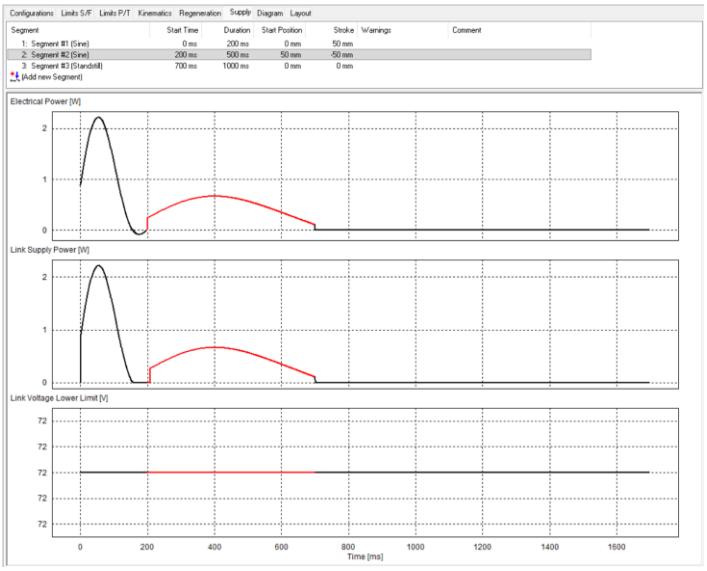
This section specifically notes the importance of accurate curve definition - especially stroke, duration, and curve type - to ensure realistic simulation results. Kinematic analysis also aids in optimizing smoothness, cycle time, and mechanical stress on the system.

### 2.2.3.5 Regeneration




The *Regeneration* tab focuses on energy that is fed back into the system during deceleration phases. In linear motor systems, regenerated energy can accumulate in the DC-link capacitors and must be safely dissipated or stored. This view shows the Electrical Power, Link Voltage, and Link Brake Energy Pulse. This section is critical for preventing over-voltage situations, sizing external brake resistors, and ensuring stable supply operation.

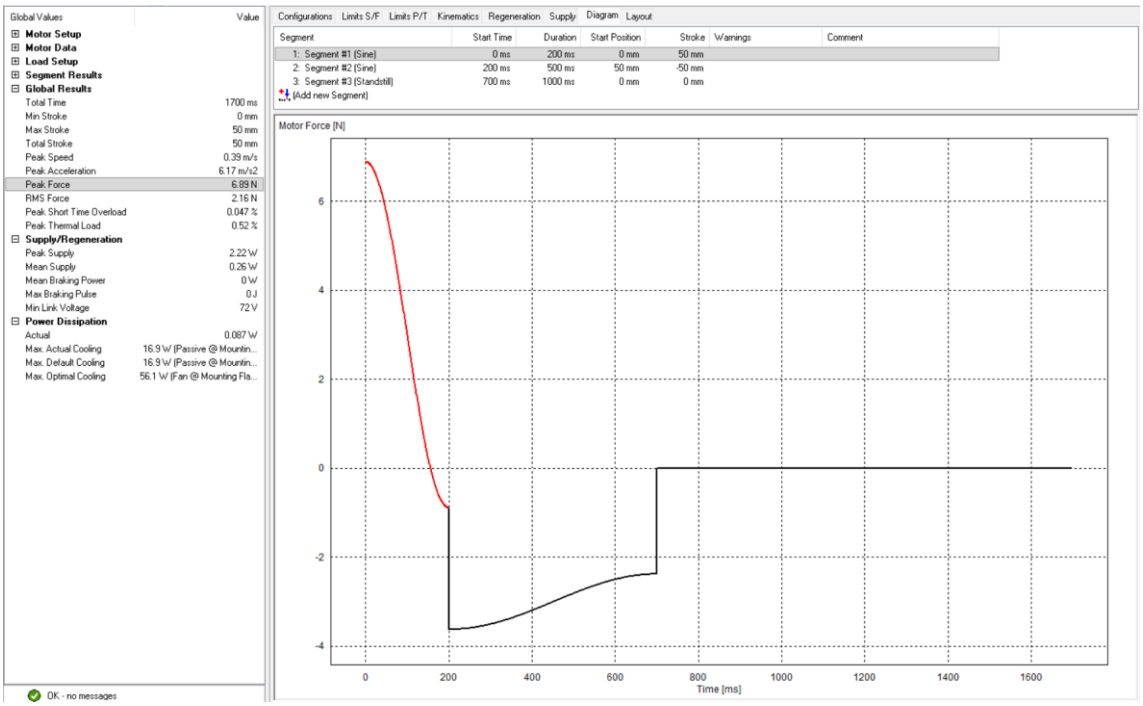
### 2.2.3.6 Supply




This tab combines supply-side and regeneration-related data, giving a comprehensive view of the DC-link voltage, supply currents, and regenerative energy interactions. It visualizes how the supply responds to motion demands, including power draw, regeneration spikes, and capacitor behavior during dynamic movement.

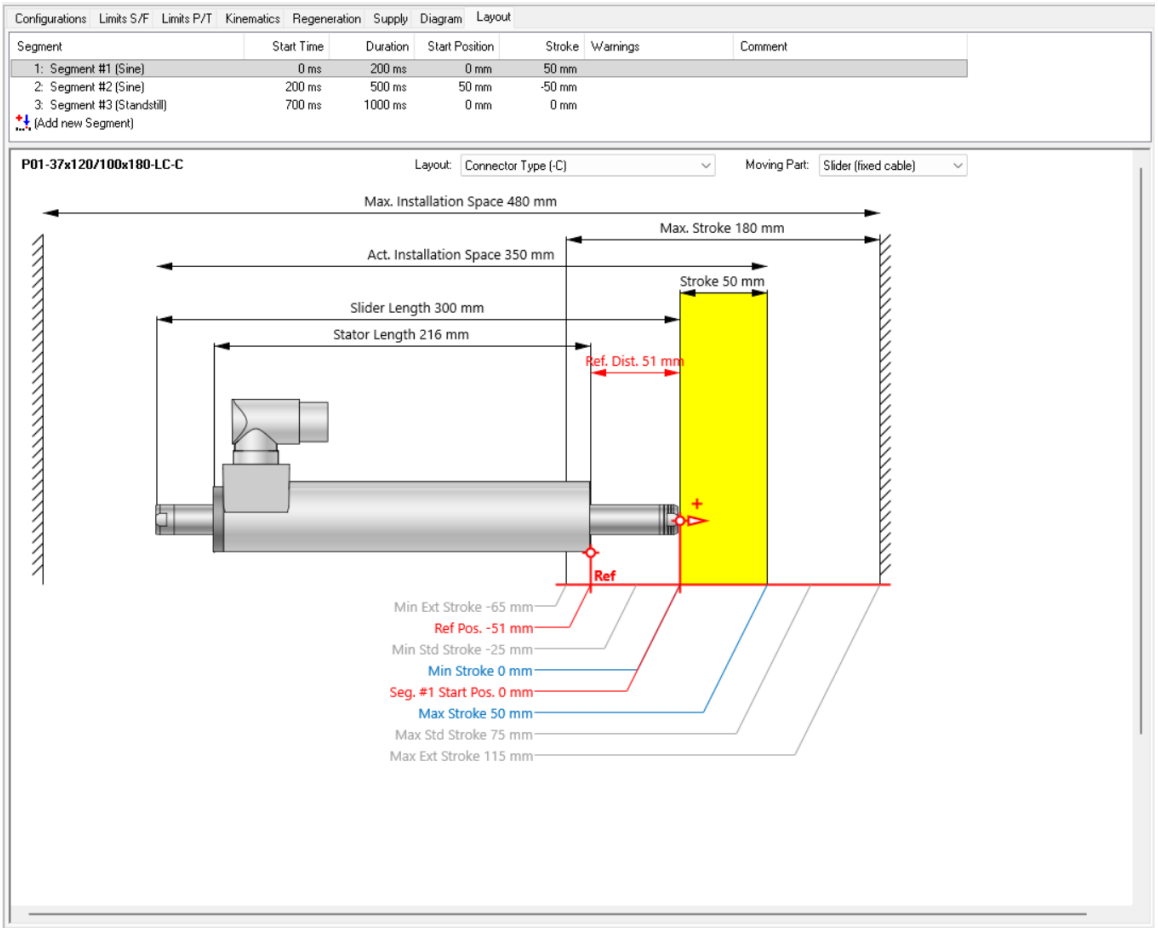
This tab explains that supply configuration (e.g. capacitance, drive type, braking method) can significantly influence these results. This view is essential when designing applications with frequent acceleration/deceleration cycles, long strokes, or high dynamic loads, as it helps ensure the supply system remains within safe electrical limits.

### 2.2.3.7 Diagram




The *Diagram* tab is a universal plotting area where any calculated parameter (in this example the peak force has been selected) can be displayed by selecting it from the Global Results, Supply Regeneration or Power Dissipitation window. This flexible visualization helps users explore specific performance metrics in detail and compare different values directly.

### 2.2.3.8 Layout



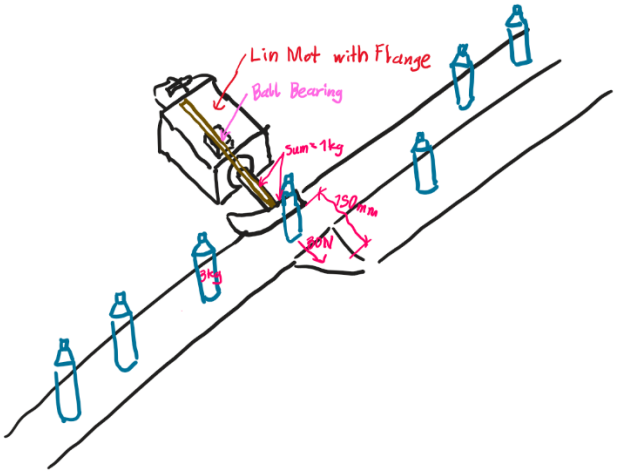

The Layout section provides a geometric visualization of the motor or module, including stator, slider, reference point, stroke limit indicators, and overall installation length. It graphically displays the physical relationship between the motor components and the defined motion profile.

It emphasizes the importance of layout visualization to confirm correct orientation, slider movement range, and mechanical integration into the machine. This section also helps detect if the configured stroke exceeds standard or extended stroke limits, or if the motor geometry mismatches the mounting constraints of the application. It is an essential tool for mechanical validation before hardware integration.

### 2.2.3.9 Efficiency

The Efficiency Tab displays the energy use and operating costs of the linear motor versus a pneumatic cylinder. More details are described in Section 4.5.

## 2.3 Application Example 1: Horizontal Pusher




### 2.3.1 Requirements

#### 2.3.1.1 Application Overview

This example describes a horizontal bottle pusher used to transfer bottles from a conveyor into a downstream process. Bottles arrive at irregular intervals (700 – 1000 ms), and each bottle must be pushed sideways by a defined stroke of 150 mm and then released before the next bottle arrives. The complete forward and backward motion must be completed within 500 ms under all operating conditions to ensure clearance before the next bottle arrives.

The main challenge of this application is combining high dynamic performance with gentle product handling, while ensuring that the complete push-and-return cycle fits into a fixed maximum time.

#### 2.3.1.2 Boundary Conditions and Assumptions

- Ambient temperature is assumed to be 40 °C, representing a worst-case industrial environment (southern Europe).
- Motor-drive cable length is 2 m.
- Guide friction of the customer-designed ball bearing is unknown and assumed to be low.
- The conveyor friction acting on the bottle during pushing is modeled as a constant external force of 30 N.

#### 2.3.1.3 Mechanical Model

The mechanical system consists of:

- A pusher mounted on the motor slider (1 kg constant mass)
- An additional 3 kg bottle mass, acting only during the forward (push) motion
- Horizontal mounting (no gravitational force component)

#### 2.3.1.4 Purpose of the Example

This example demonstrates how to configure a single-axis application in LinMot Designer using SX Mode and how to:

- Define global and local load conditions
- Build a realistic motion sequence using four segments (waiting, soft forward motion, settling pause, fast return)
- Evaluate force, thermal load, and regeneration behavior
- Perform corrective actions such as adjusting the motion parameters or selecting a larger motor
- Validate mechanical feasibility using the Layout tab
- Select an appropriate power supply based on calculated supply and regeneration values

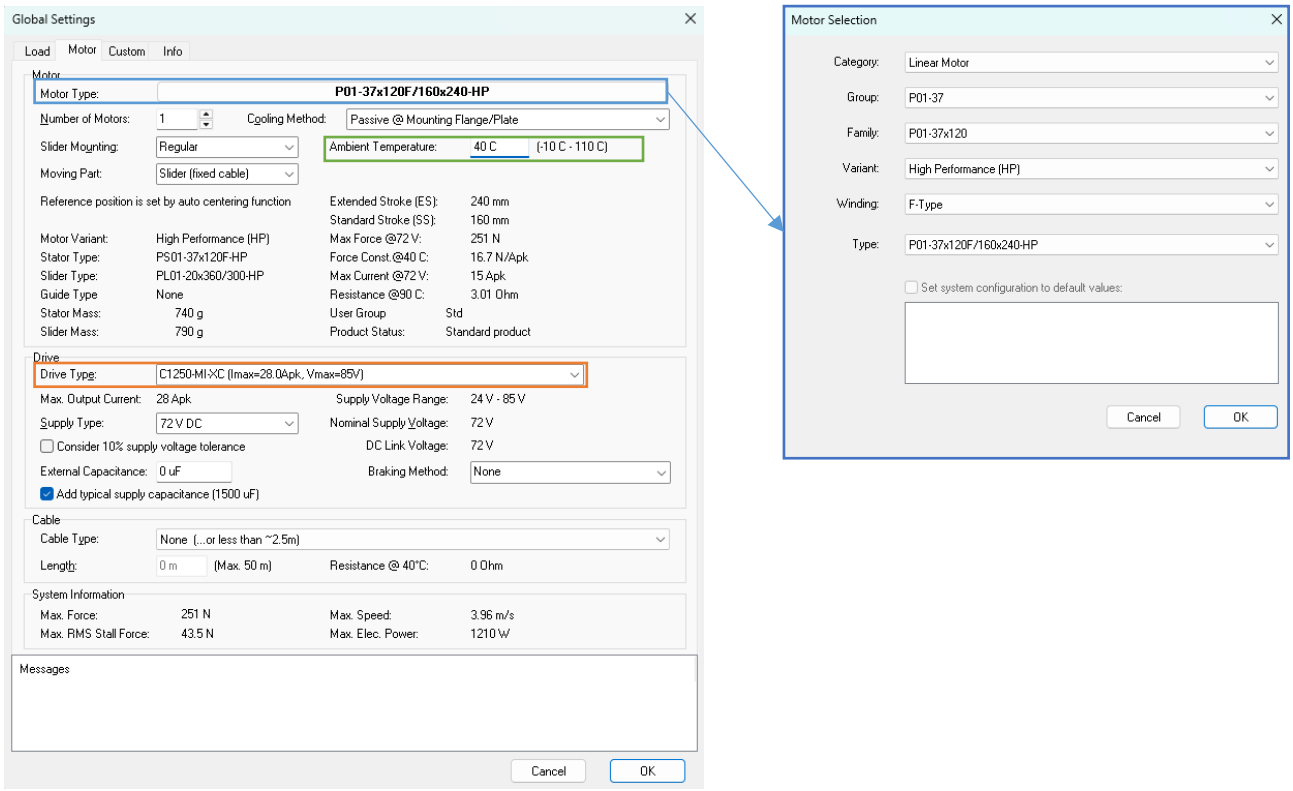
The scenario reflects a typical real-world use case where both dynamic performance and smooth product handling are essential, providing a complete step-by-step workflow for proper motor sizing in LinMot Designer.

### 2.3.2 Global Settings

The Global Settings define the key motor, load, and system parameters used throughout the project. These values form the basis for all simulations and configuration checks in LinMot Designer.
A detailed explanation of each parameter is provided in Section 4.1.

#### 2.3.2.1 Motor Selection

Navigate to Global Settings → Motor and apply the following selections:



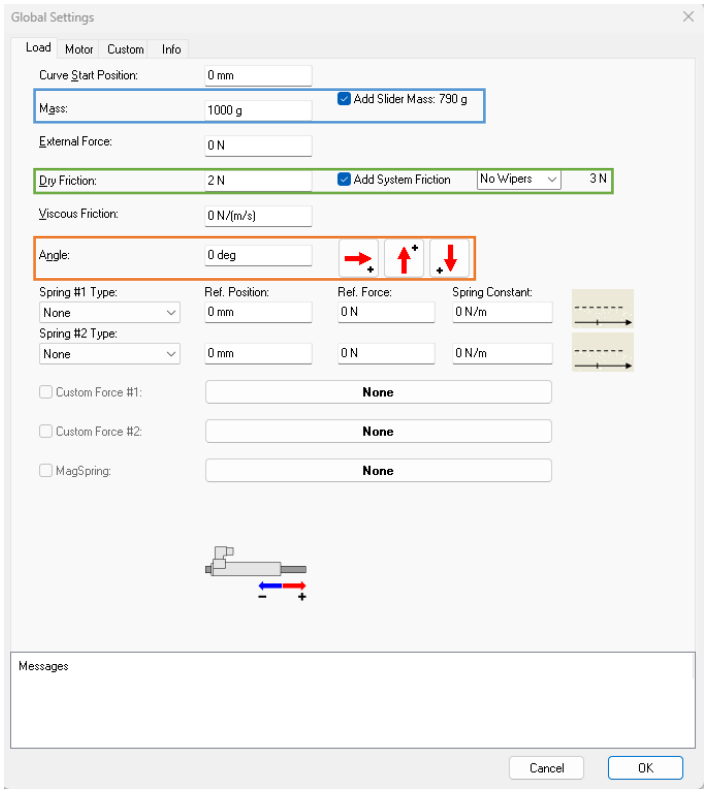

**Explanation of Choices and Considerations**

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Motor Type | P01-37x120F/160x240-HP | If you already have a rough idea of the required motor type, you may proceed with this selection. Otherwise, ensure that the selected motor provides at least 150 mm stroke for the application. It is acceptable to use a motor with slightly longer stroke to allow mechanical safety margins. The exact motor type will be verified and, if necessary, adjusted after the first simulation. |
| Category | Linear Motor | This application requires a purely linear motion system. |
| Group | P01-37 | Select a motor group that offers configurations with the required stroke and force range. The P01-37 group covers typical medium-size industrial applications. |
| Family | P01-37x120 | This family includes motors that can provide the needed stroke length and dynamic performance for the defined motion profile. |
| Variant | High Performance (HP) | Choose the HP variant when there are no specific constraints against it. HP-motors offer higher dynamics (acceleration, peak force) and additional thermal margin compared to standard variants. This is advantageous in early sizing, as it reduces the risk of hitting force or temperature limits detected by the Designer's simulations. |

| | | |
|---|---|---|
| Winding | F-Type | The F-winding is suitable for standard applications and serves as a robust default. It provides a good balance between force, speed, and thermal behavior for typical industrial use cases. |
| Type | P01-37x120F/160x240-HP | Select a motor configuration that guarantees at least 150 mm stroke, considering mechanical tolerances and end-stop safety distances. |
| Number of Motors | 1 | Only one motor is required to move the defined load in this application. Multi-axis setups are not necessary at this stage. |
| Cooling Method | Passive | The motor will be flange-mounted and is initially assumed to be passively cooled. After running the simulation, verify that no thermal limits are exceeded. |
| Slider Mounting | Regular | Use Regular mounting unless special mechanical constraints (e.g., inverted mounting, special adapters) require a different configuration. |
| Ambient Temperature | 40°C | The customer did not specify the ambient temperature. For a typical production hall in Italy, an ambient of 40 °C is a realistic design assumption. |
| Moving Part | Slider | In this application, the slider is the moving part, while the stator remains fixed. |
| Drive Type | C1250-MI-XC | At the time of writing, this is the recommended drive for this motor class. |
| Supply Type | 72 V DC | LinMot recommends using a 72 V DC LinMot power supply. This ensures that the internal Designer models for supply, regeneration, and protective functions match the actual hardware. If a third-party supply is used, the regeneration and supply-related warnings in Designer must be evaluated carefully. |
| Braking Method | None | Select this for standard applications. This may need to be changed later. |
| Cable Type / Length | None | The required motor cable is less than 2.5 m.<br>Both the cable type and the cable length determine the resulting supply resistance to the motor, which directly influences the simulation results.<br>The longer the cable and the smaller the conductor cross-section, the more relevant an explicit cable model becomes.<br>This effect is particularly significant for motors with low winding resistance, where the cable resistance represents a comparatively large portion of the total electrical resistance seen by the drive. |

### 2.3.2.2 Load Selection

Navigate to Global Settings → Load and apply the following selections:




**Explanation of Choices and Considerations**

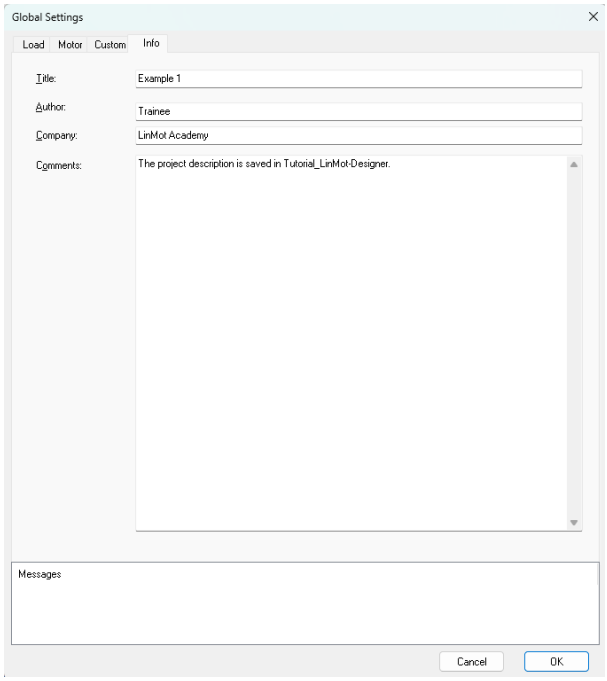
| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Curve Start Position | 0 mm | Not required for this application. |
| Mass | 1000 g | The moving mass mounted to the slider is 1 kg (pusher head & guide). Entering accurate mass values is essential because the Designer uses mass directly in force, acceleration, thermal, and power calculations. |
| Add Slider Mass | Enable | Always enable this selection unless it is a very specific use case. |
| External Force | 0 N | Not required for this application. |
| Dry Friction | 2 N | The application uses a ball bearing guide, which introduces a small dry friction force. Only guide friction is added here — friction caused by the load movement during specific process steps will be added directly in the corresponding motion segment |
| Add System Friction | Enable | Always enable this selection unless it is a very specific use case. |
| Wipers | No Wipers | Select the number of wipers used with this Motor. |
| Viscous Friction | 0 N/(m/s) | Not required for this application. |
| Angle | 0 deg | The motor is mounted horizontally. |
| Spring | None | Not required for this application. |
| Custom Force | None | Not required for this application. |
| MagSpring | None | Not required for this application. |

### 2.3.2.3 Custom Selection

No changes are required in the Custom tab because this application uses a standard LinMot drive and a standard LinMot power supply.

### 2.3.2.4 Info Tab

Entering project information in the Info tab is not required, but it may be helpful for future reference or documentation purposes.



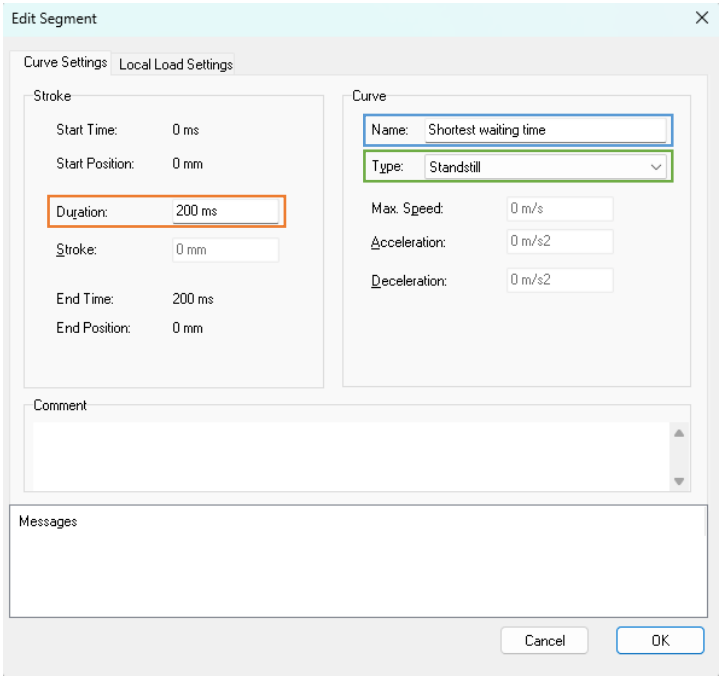
### 2.3.3 Motion Segments

*Motion Segments* define the complete movement cycle by breaking it into clear, individually configurable steps. The motion cycle defined here should represent the shortest achievable cycle time of the application - even if this is not the typical or average operating time - so that the system can be sized safely under its most demanding conditions.
A detailed explanation of each parameter can be found in Section 4.2.

#### 2.3.3.1 Segment #1

Segment 1 represents the waiting phase before the next pushing motion begins.
In LinMot Designer, it is crucial that the simulation reflects the worst-case operating scenario, which means this segment must use the shortest possible waiting time. This ensures that all calculations—including RMS force, thermal load, and overall system performance—are based on the highest expected cycle frequency.

Edit Segment 1 and apply the following selections:

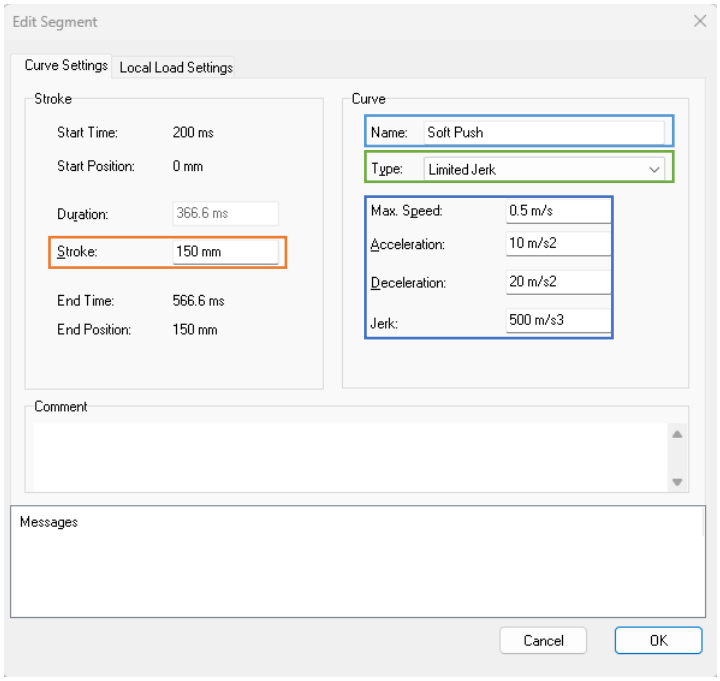



| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Name | Shortest waiting time | Enter a descriptive name. |
| Type | Standstill | Waiting time has no stroke. |
| Duration | 200 ms | Enter the shortest possible waiting time occurring in the application. |

### 2.3.3.2 Segment #2

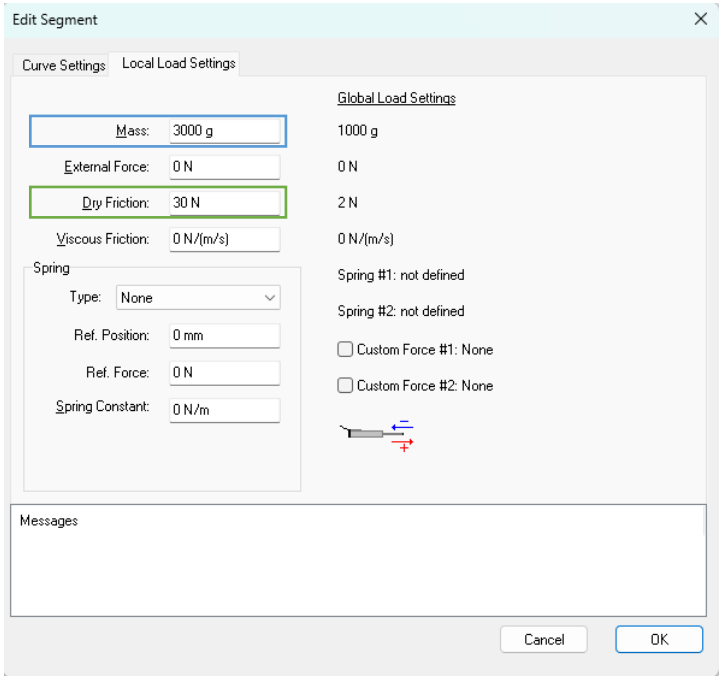
Segment 2 represents the soft pushing motion that moves the bottle forward.
Because this motion must be smooth enough to prevent the bottle from tipping, a Limited Jerk curve type is used. Limited-jerk profiles ensure continuous transitions of acceleration and speed, making them ideal for gentle handling applications. Moving the bottle puts also additional load on the motor, which needs to be added in this segment. Local load parameters are added on top of the global values.

Add Segment 2 and apply the following selections to the Curve Settings:




| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Name | Soft Push | Enter a descriptive name. |
| Type | Limited Jerk | Ensures smooth acceleration and deceleration to prevent bottle tipping. |
| Stroke | 150 mm | Defines the required forward displacement for the pushing motion. |
| Max. Speed | 0.5 m/s | Limited velocity for a slow movement. |
| Acceleration | 10 $m/s^2$ | Provides moderate acceleration to maintain smoothness. |
| Deceleration | 20 $m/s^2$ | Slightly higher deceleration to bring the axis to a stable stop. |
| Jerk | 500 $m/s^3$ | Controls the rate of change of acceleration and deceleration, ensuring smooth motion transitions. |

Change to the Local Load Settings in Segment 2 and apply the following selections:

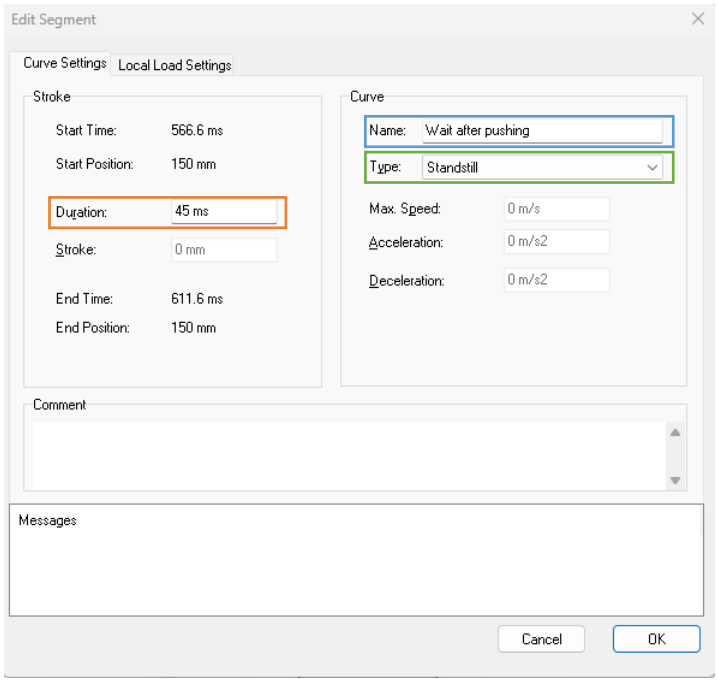



| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Mass | 3000 g | Enter the additional mass of 3 kg, which needs to be moved by the slider. |
| Dry Friction | 30 N | Moving the bottle generates an additional friction of 30 N. |

### 2.3.3.3 Segment #3

Segment 3 represents a short waiting phase at the end of the pushing motion.
As with all standstill phases, this waiting time must be explicitly included in the motion sequence, because LinMot Designer requires every standstill to be modeled to simulate the full cycle accurately.

Add Segment 3 and apply the following selections:




| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Name | Wait after pushing | Enter a descriptive name. |
| Type | Standstill | The axis does not move during this pause. |
| Duration | 45 ms | Enter the required pause time before the next motion begins. |

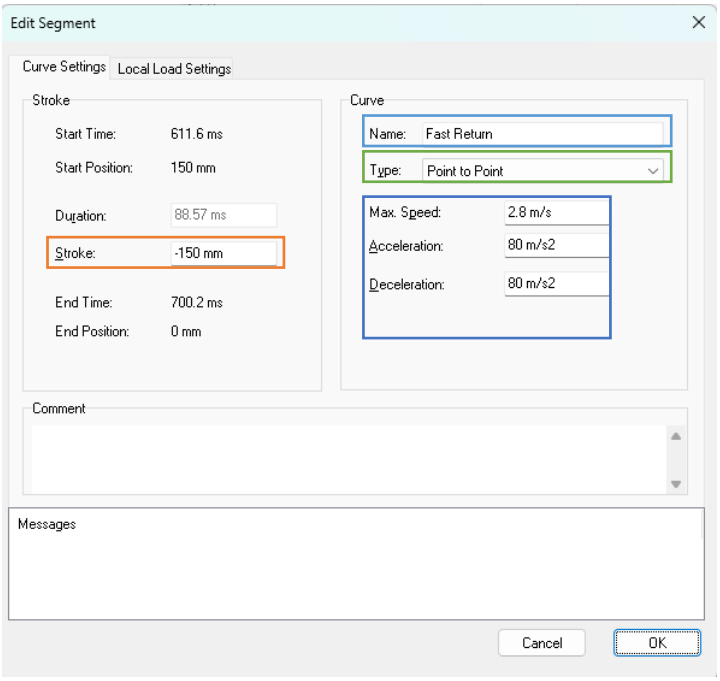
#### 2.3.3.4 Segment #4

Segment 4 represents the fast backward movement returning the axis to its initial position.
This step closes the motion loop and prepares the system for the next cycle. Because it must reflect the worst-case dynamic load, a Point-to-Point curve type is recommended - unless the customer explicitly confirms that a Sine motion profile will be used in the real application. A Sine curve can artificially smooth the motion and underestimate dynamic motor load.



**Attention:**
Do not use a Sine motion profile unless you are absolutely certain the customer can and will implement it in the final machine.

Add Segment 4 and apply the following selections to the Curve Settings:




| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Name | Fast Return | Enter a descriptive name. |
| Type | Point to Point | Standard profile; represents the worst-case load scenario. |
| Stroke | -150 mm | Defines the required backwards displacement for the return to the initial position. |
| Max. Speed | 2.8 m/s | High return velocity to reduce overall cycle time. |
| Acceleration | 80 m/s$^2$ | Provides the required dynamic performance for a fast backward motion. |
| Deceleration | 80 m/s$^2$ | Symmetric deceleration. |



**Hint:**
If you are unsure about suitable speed or acceleration values:
Create a temporary Sine curve using the required stroke and desired duration, then copy the resulting max. speed and acceleration values into the Point to Point segment.

### 2.3.4 Evaluation

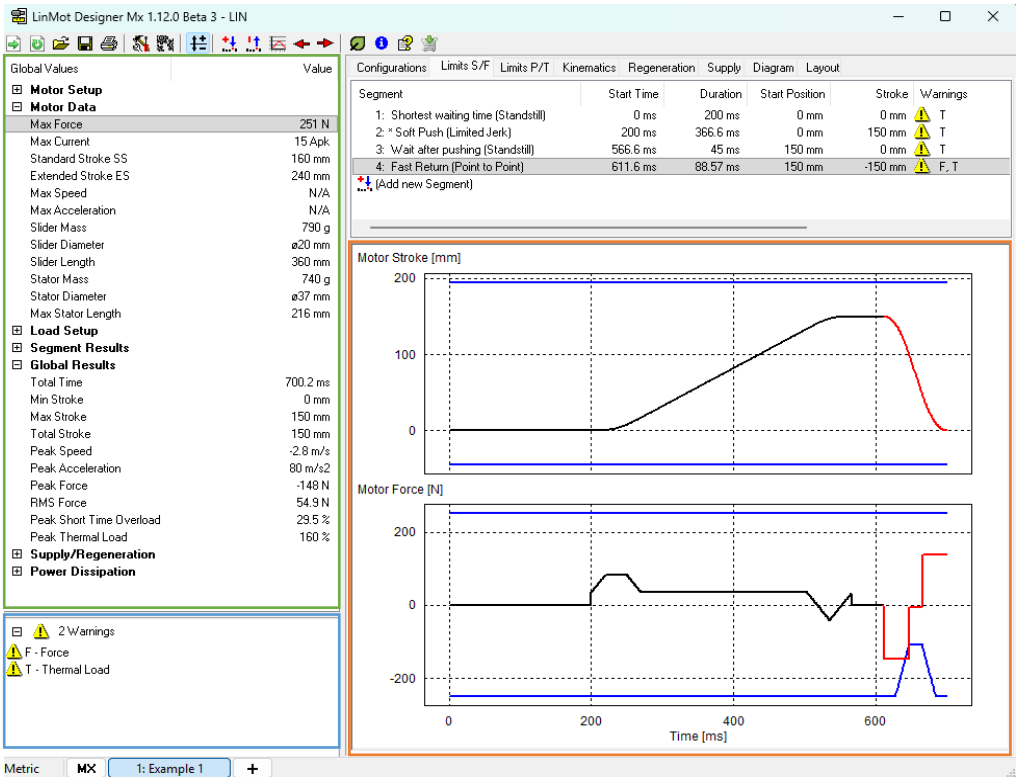
After defining the motion segments and load conditions, the next step is to evaluate the configuration. LinMot Designer automatically simulates the motion sequence and calculates all relevant physical parameters. The evaluation step verifies whether the selected motor, drive, and configuration can safely execute the defined motion, especially at the most challenging sequence (e.g. shortest cycle time).

If no errors or warnings are displayed, the current motor configuration is generally suitable for the application. However, all results must still be checked against the customer's real conditions and requirements.

A detailed explanation of evaluation logic and messages description can be found in Section 4.3.

#### 2.3.4.1 Evaluating Design

After completing the motion and load setup, LinMot Designer automatically recalculates the simulation results:




A typical evaluation sequence consists of the following steps:

**1. Check for Errors or Warnings**

Errors, warnings, and notes are displayed in the message area and must be reviewed first.

- In this design, two errors are present:
  - Force
  - Thermal Load
- In the segment warning overview, it can be seen that the Force warning occurs only in Segment 4 (Fast Return).

**2. Review the Global Values**

The Global Values window shows peak, RMS, and mean values of all relevant physical parameters.

- Here, the Peak Thermal Load is significantly above the allowed limit, reaching 160 %.

**3. Analyze Critical Parameters in the Diagram Windows**

To analyze the Force Error, the Limits S/F window is the most relevant.

- **Force Warning:**
  In the Motor Force diagram, the required force for the Fast Return segment (red curve) exceeds the maximum available motor force (blue curve). This confirms the Force Error.
- **Thermal Load Warning:**
  For fast motions, the motor temperature changes only marginally within a single cycle. Therefore, the Peak Thermal Load is the relevant criterion, while the time-dependent thermal load curve in the Limits P/T tab provides little additional information. For slower cycles, the thermal load over time becomes more meaningful.

#### 2.3.4.2 Results

The Peak **Thermal Load** of 160% means that the motor will overheat over time when running continuously with this cycle.

Even though the Max Force (from the Motor Data) is higher than the Peak Force (from Global Results), there is still a **Force** warning. This is because during Fast Return the available max motor force decreases so much that it can't provide the required force.
The blue line decreases because Back-EMF rises with speed, reducing the voltage margin available for the drive to supply current. With lower current, the motor cannot generate its nominal force anymore, causing the maximum available motor force to drop at higher velocities.

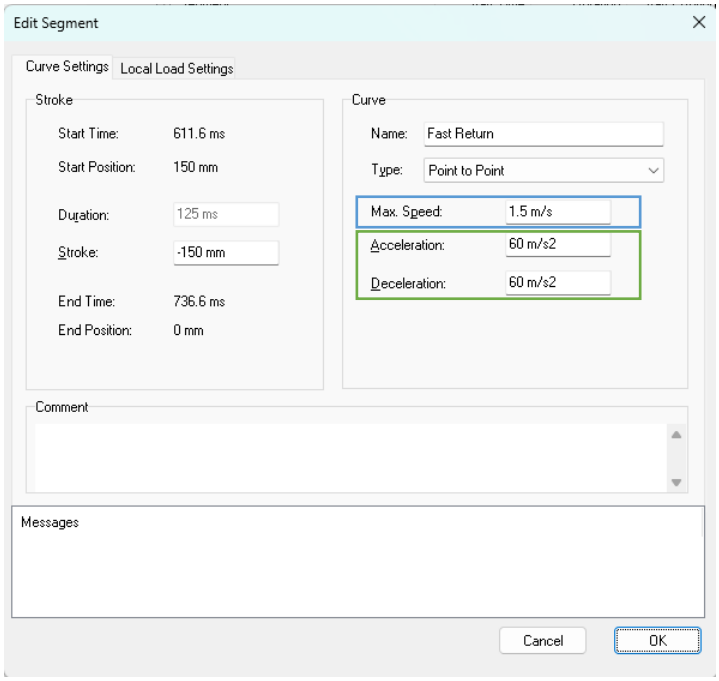
### 2.3.5 Corrective Actions

Several measures can be taken to resolve the errors and warnings identified during evaluation. The following options illustrate how changes to the motion definition or the motor configuration influence force limits, thermal behavior, and regeneration requirements.

#### 2.3.5.1 Adjust Cycle Time

One approach is to modify the motion in the segment definitions until the warnings disappear.
The magnitude of the motor force directly influences the thermal load. By reducing the required motor force to resolve the Force Warning in Segment 4 (Fast Return), the thermal load is reduced as well.

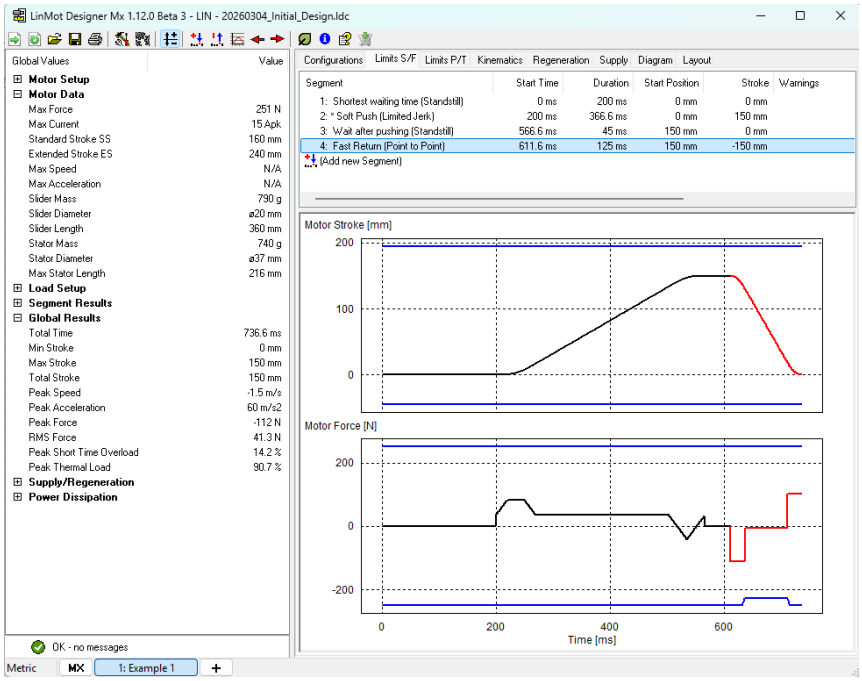
In this case, the applied measures eliminate both the force and the thermal warning.




To achieve this, the following adjustments were made:

- Reduce Max. Speed of Segment 4 from 2.8 m/s to 1.5 m/s
  This reduces Back-EMF and increases the available motor force during the backward motion.

- Reduce Acceleration and Deceleration from 80 m/s² to 60 m/s²
  Lower acceleration decreases peak force demand, reducing both Force and Thermal Load.




After applying these changes:

- The configuration shows no more Force warnings.
- The Peak Thermal Load decreases to 90.7 %, remaining below the 100 % limit.
- The total cycle time increases from 700.2 ms to 736.6 ms.

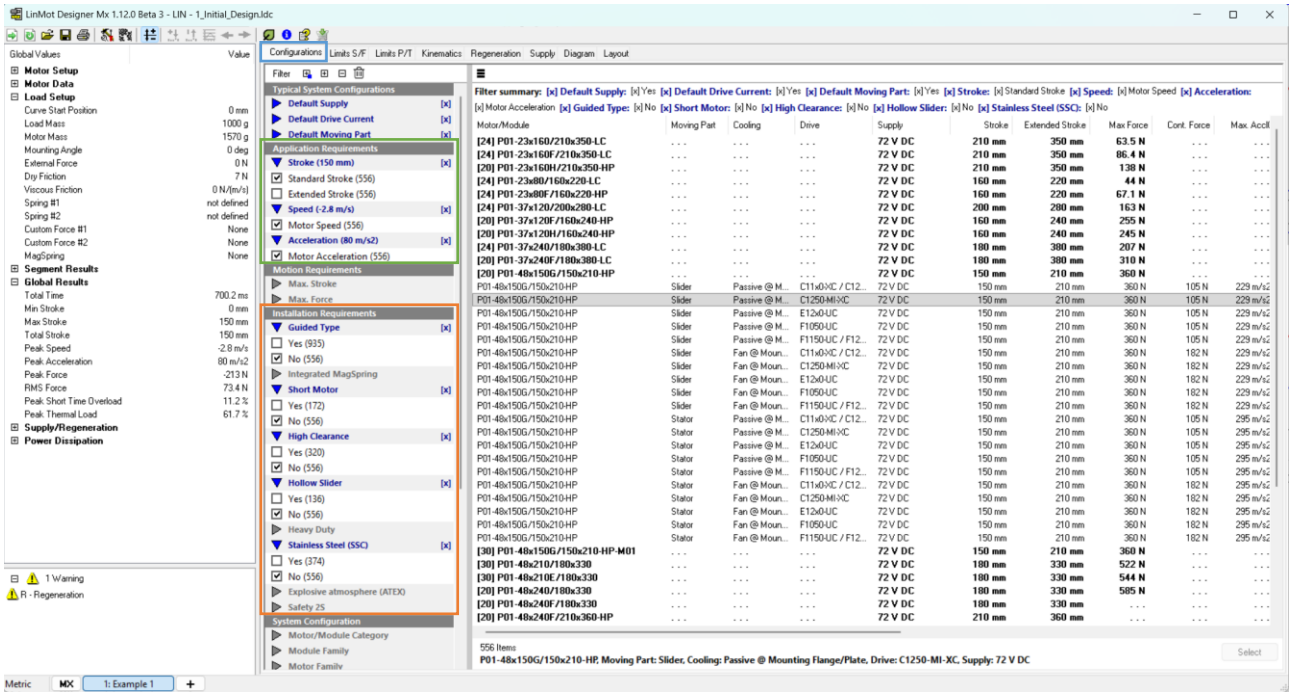
This setup is technically valid, but the longer cycle time may or may not be acceptable for the customer. The decision depends on required throughput.

### 2.3.5.2 Change Motor

Another corrective measure is to select a more powerful motor that can handle the required force and thermal load without modifying the cycle time.

To perform this:

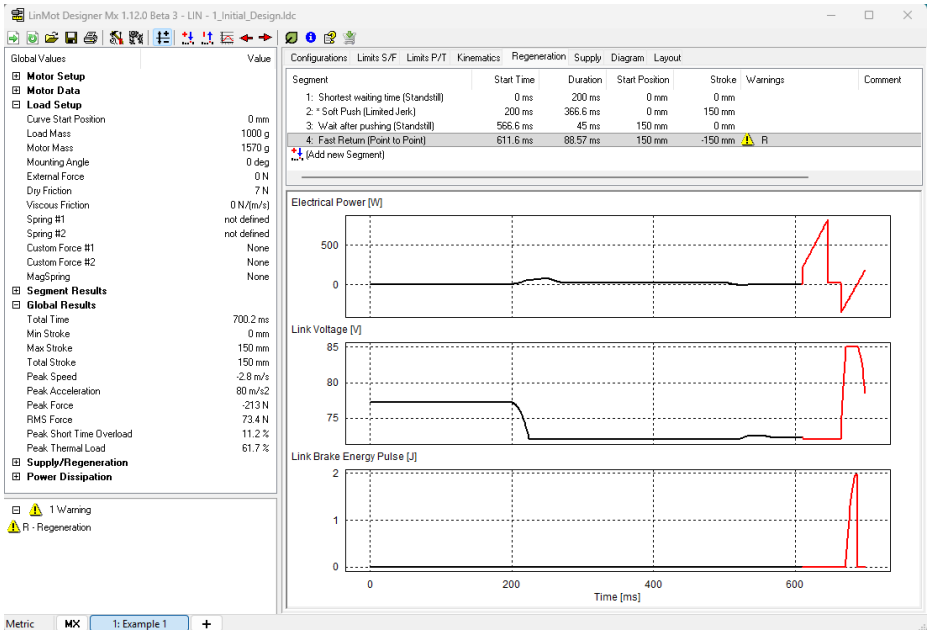
1. Open the Configurations tab.
2. Enable Application Requirements filters to ensure the list only shows motors that technically meet the motion requirements.
3. Optionally enable Installation Requirements to filter out configurations with unnecessary features.



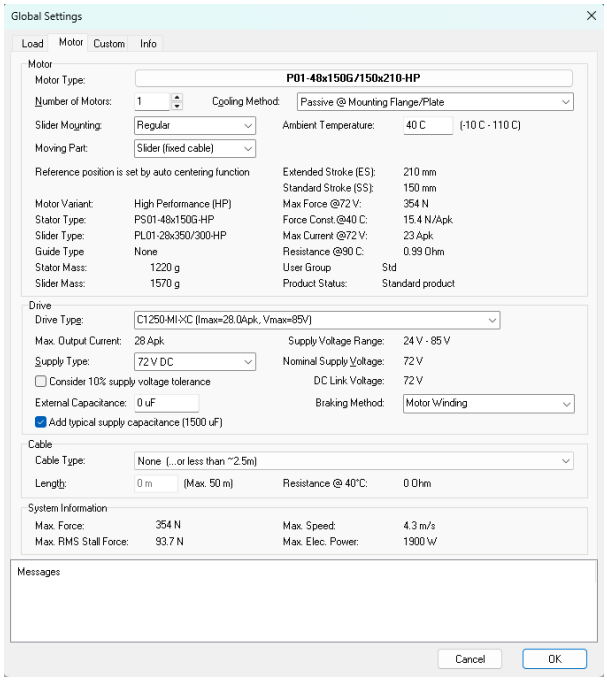
Based on these filtered results, the next larger HP motor P01-48x150G/150x210-HP was selected.

With the new motor:

- All previous Force and Thermal Load errors disappear.
- However, a Regeneration Warning appears, caused by the high deceleration forces during the Fast Return segment.

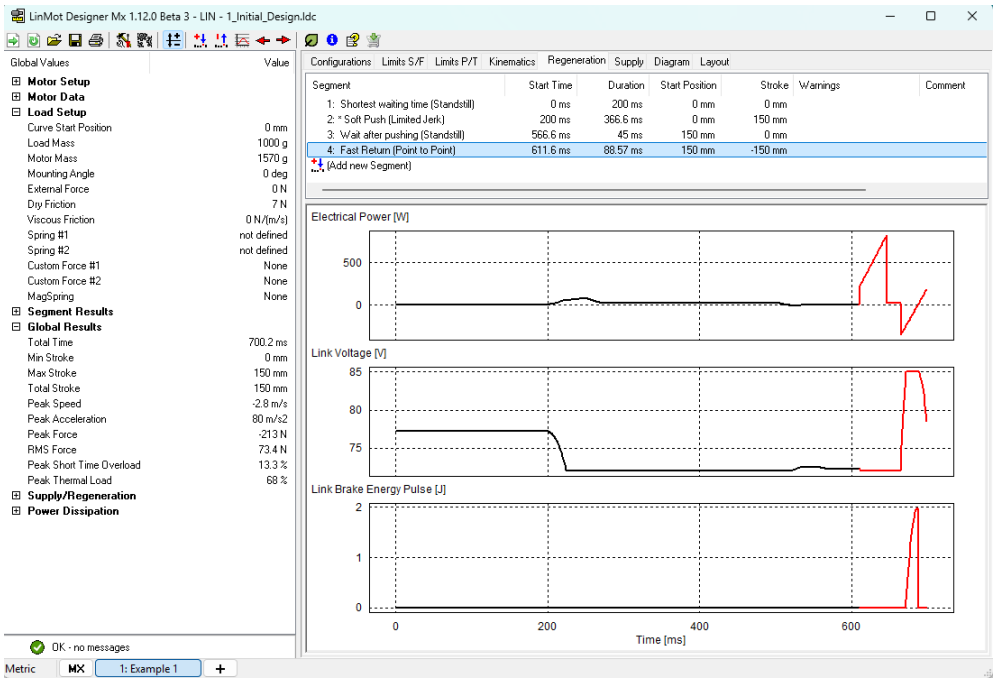


The issue can be resolved by changing the Braking Method to Motor Winding in the Global Settings. This method allows excess energy to be dissipated in the motor itself. (Another approach is to add an additional External Capacitance.)






**Attention:**
When Motor Winding is used as the braking method, this must be communicated to the customer, because the setting must also be applied on the actual drive hardware using LinMot-Talk.




With the new motor and braking method:

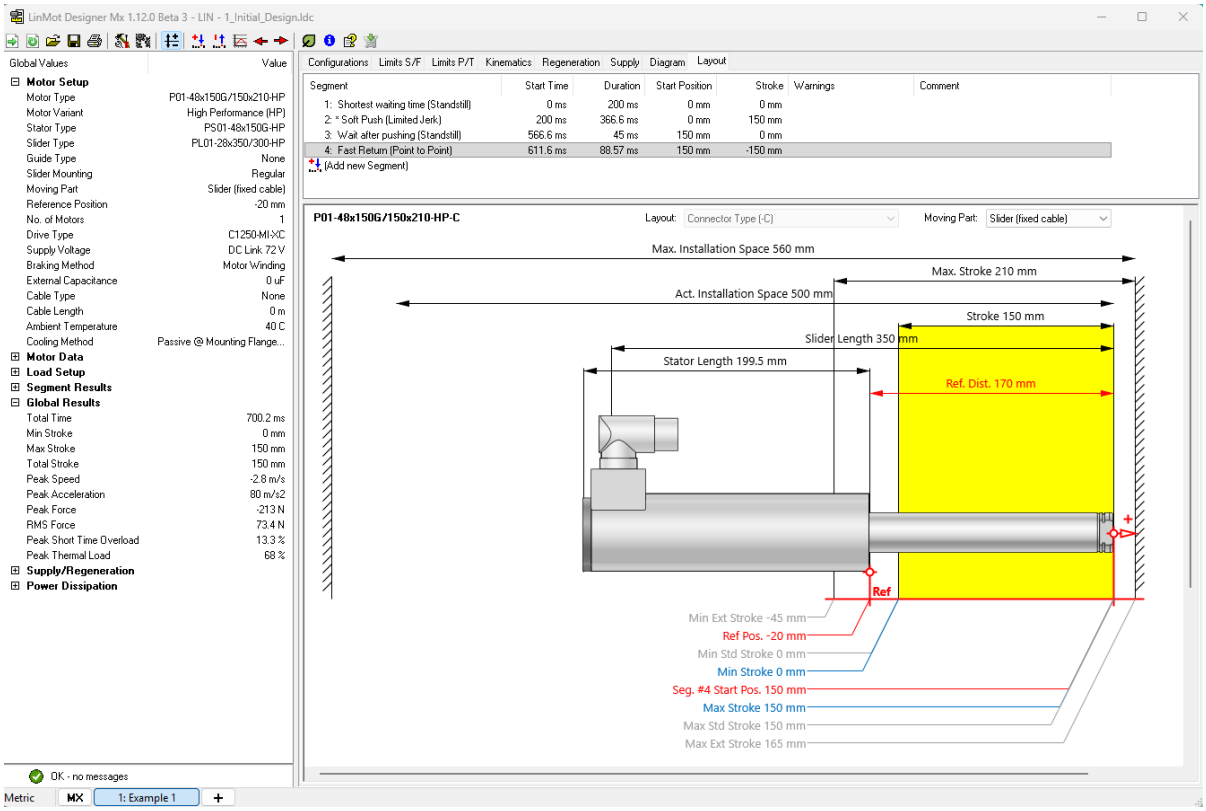
- Peak Thermal Load is reduced to 68 %
- No errors or warnings are present
- Original cycle time can be maintained

If the cycle time is critical to the customer, this configuration is likely the most appropriate solution—provided that motor winding regeneration is enabled on the drive.

### 2.3.6 Layout Check

The Layout Tab provides a visual overview of the mechanical dimensions, positions, and installation space of the selected motor. It is a key tool for verifying whether the chosen configuration fits the mechanical constraints of the application and whether the motion profile stays within the physical stroke limits of the motor.

The visualizations shown below are based on the larger motor selected in section 2.3.5.2.




This layout confirms that the entire stroke is performed outside the stator, meaning the mounting hardware used in the application can remain unchanged. The Layout Tab also displays all relevant dimensional information required to ensure proper installation, including standard and extended stroke limits, component lengths, and the total installation space.

This information is crucial for the customer's machine design, as it clearly defines the mechanical envelope that must be kept free to accommodate the motor/module within the intended stroke range.

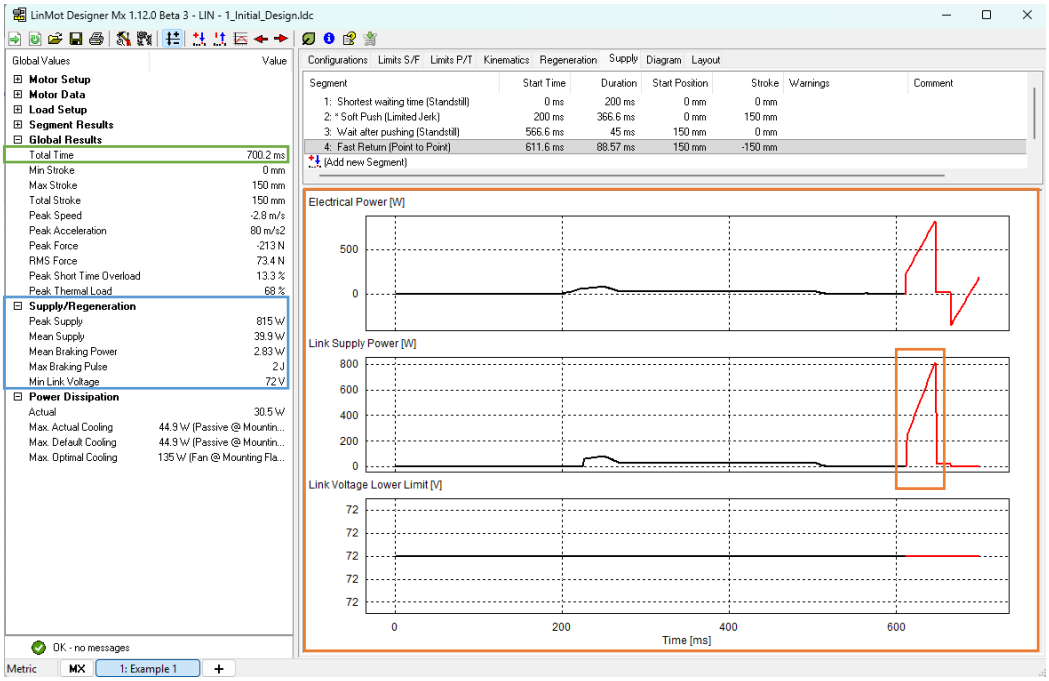
### 2.3.7 Select Power Supply

To ensure reliable operation of the axis, the power supply must be selected based on voltage level, mean power demand, and peak power / energy demand of the motion profile.

In this example, it is assumed that only this one motor (selected in section 2.3.5.2) is connected to the power supply.

The following values are relevant from the figure below:

Min Link Voltage = 72 V
Total Cycle Time = 700 ms
Mean Supply = 39.9 W
Peak Supply = 815 W for approximately 44 ms




1. **Match the DC Output Voltage**
   Select a power supply whose nominal DC output voltage matches the required DC bus voltage of the drive.
   For this application, a 72 V DC supply is required. The power supply type S02-72/600 provides a fixed output of 72 V DC ±1% at 100% load and is therefore suitable from a voltage perspective.

2. **Check Continuous (Mean) Power Requirement**
   The calculated mean power demand of the axis is:
   - Mean Supply Power: 39.9 W

   The power supply must provide at least 110% of the Mean Supply:
   - $P_{\text{required, continuous}} \approx 1.1 \times 39.9\ \text{W} \approx 43.9\ \text{W}$

   The selected power supply must provide a continuous output power greater than this value.
   - The S02-72/600 offers a continuous output power of 600 W, which is significantly higher than the required 43.9 W. This ensures ample margin for continuous operation and additional consumers on the DC bus if needed.

3. **Check Peak Power and Energy Requirement**
   The motion profile requires a peak power of:
   - Peak Supply Power: 815 W
   - Peak Duration: 44 ms
   - Total Cycle Time: 700 ms

   For peak evaluation, both peak power and boost energy must be within the capabilities of the power supply:
   - The S02-72/600 supports Powerboost up to 250% of nominal power for 2 s, i.e. up to 1500 W for 2 s (1500 Ws).
   - The energy required by the application peak is approximately:
     $$E_{\text{peak}} \approx 815\ \text{W} \times 0.044\ \text{s} \approx 36\ \text{Ws}$$
     This is far below the available 1500 Ws boost capability.

- According to the load behaviour specification, overloads up to 500 Ws within 4 s do not require a cool-down phase. The required ~36 Ws is well within this limit, so no additional cool-down is necessary within the 700 ms cycle time.

Thus, the peak power and energy demands of the axis are safely covered by the boost capability of the selected power supply.

4. **Check Installation and Environmental Conditions**
   Finally, verify that the installation and ambient conditions comply with the power supply specifications:
   - Input voltage: 1 × 95–132 V AC / 220–264 V AC, 50/60 Hz
   - Operating temperature range: 0…40 °C with integrated, temperature-controlled fan
   - Installation in a control cabinet with minimum protection class IP54
   - Altitude: < 2000 m above sea level

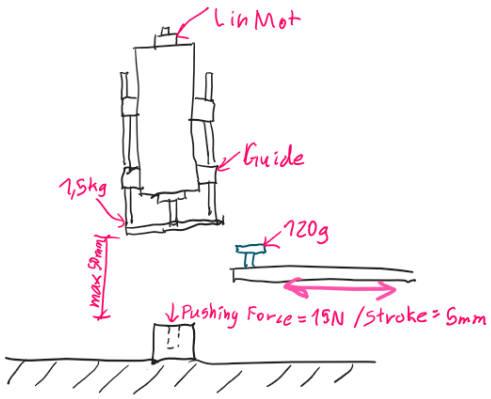
   If these conditions are met, the device can be used without additional derating.

5. **Recommendation**
   Based on the calculated mean power (39.9 W), peak power (815 W for 44 ms), and the cycle time of 700 ms, the power supply S02-72/600 (72 V / 600 W, with 250% Powerboost) fulfills all electrical and thermal requirements with a large safety margin and is therefore the recommended power supply for this application.

### 2.3.8 Export / Print Project Data

The Tutorial on how to export relevant data and what it includes can be found in Section 4.6.2.

## 2.4 Application Example 2: Vertical Pressing (MagSpring)




### 2.4.1 Requirements

#### 2.4.1.1 Application Overview

This example describes a vertical pick-and-press application in which a part is picked from a feeder, moved vertically, and pressed with a defined force. The application uses gravity compensation via a MagSpring, allowing force-controlled pressing without an external force sensor.

One complete cycle - including picking, positioning, pressing, and returning to the initial position - must be executed in under 2 s. Pressing force is generated solely by motor current control, which simplifies the mechanical setup while still meeting process requirements.

The main challenge of this application is combining precise vertical positioning, force-controlled pressing, and thermal efficiency under gravity load.

#### 2.4.1.2 Boundary Conditions and Assumptions

- Ambient temperature is assumed to be 35 °C, representing a typical industrial environment in Central Europe.
- Motor–drive cable length is 10 m
- No external force sensor is used; pressing force is generated by motor current control.
- The exact force curve during the pressing phase is unknown and is modeled as a constant pressing force.
- Friction of the customer-designed ball-bearing guides is unknown and assumed to be low; no additional guide friction is modeled in the initial sizing step.

#### 2.4.1.3 Mechanical Model

The mechanical system consists of:

- A vertically mounted motor with gripper and guides (1.5 kg constant mass)
- An additional 120 g part mass, acting only while the part is gripped
- A total vertical stroke of 50 mm
- Gravity acting continuously on all moving masses
- A maximum pressing force of 15 N, applied over a pressing stroke of 5 mm
- Gravity compensation is implemented using a MagSpring, reducing the continuous force demand on the motor during holding and slow movements.

#### 2.4.1.4 Motion Sequence and Segmentation

The application cycle is represented by a segmented motion profile:

1. Move down 10 mm to pick the part
2. Standstill (200 ms) while the gripper grips the part
3. Move up to initial position to allow the feeder to retract (≈ 500 ms)
4. Move down 45 mm to the pre-press position
5. Pressing segment: force-controlled motion with 15 N over 5 mm
6. Standstill (100 ms) while the gripper releases the part
7. Move to initial position
8. Standstill (500 ms) waiting for the feeder to present the next part

#### 2.4.1.5 Purpose of the Example

Based on the defined boundary conditions and mechanical model, this example demonstrates how to design and evaluate a vertical pressing application in LinMot Designer using MagSpring gravity compensation. It shows how to:

- Model gravity-loaded vertical axes
- Define global and local load conditions, including part-dependent mass
- Implement force-controlled motion without an external force sensor
- Segment complex pick-and-press sequences
- Evaluate force limits, thermal load, and holding behavior
- Verify the effectiveness of MagSpring compensation
- Select a suitable motor and power supply based on calculated load and energy values

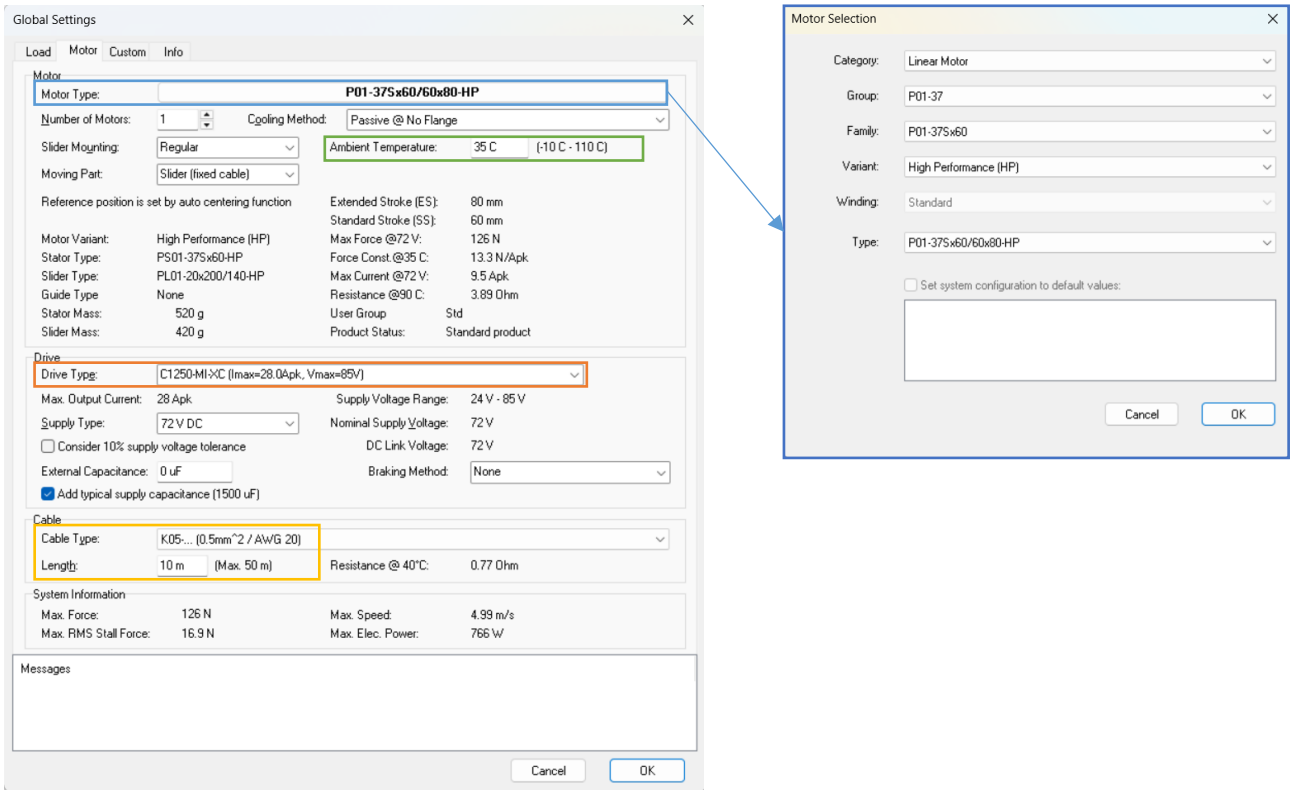
The scenario reflects a typical real-world assembly or pressing task and provides a complete, structured workflow for sizing and validating vertical applications in LinMot Designer.

### 2.4.2 Global Settings

The Global Settings define the key motor, load, and system parameters used throughout the project. These values form the basis for all simulations and configuration checks in LinMot Designer.
A detailed explanation of each parameter is provided in Section 4.1. This example describes only the parameters that are new and therefore not explained in Application Example 1: Horizontal Pusher.

#### 2.4.2.1 Motor Selection

Navigate to Global Settings → Motor and apply the following selections:

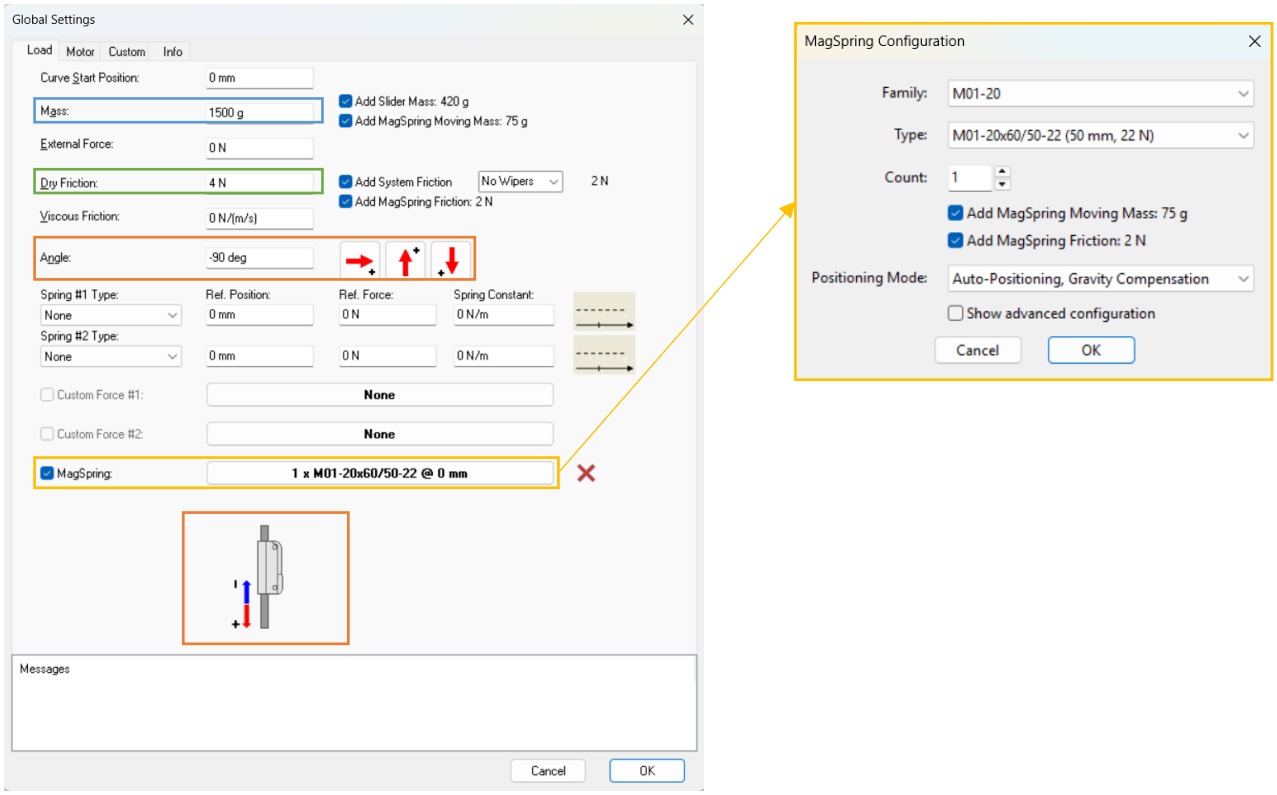



**Explanation of Choices and Considerations**

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Motor Type | P01-37Sx60/60x80-HP | If you already have a rough idea of the required motor type, you may proceed with this selection. Otherwise, ensure that the chosen motor provides at least **50 mm stroke** for the application. |
| Category | Linear Motor | |
| Group | P01-37 | |
| Family | P01-37Sx60 | |
| Variant | High Performance (HP) | |
| Winding | Standard | |
| Type | P01-37Sx60/60x80-HP | |
| Cooling Method | Passive | |
| Ambient Temperature | 35°C | The task description specifies an ambient temperature of 35 °C. |
| Moving Part | Slider | |
| Drive Type | C1250-MI-XC | |
| Supply Type | 72 V DC | |
| Braking Method | None | |
| Cable Type | K05-… (0.5mm² /AWG 20) | For this motor only K05 cables are available (see shop.linmot.com). |
| (Cable) Length | 10 m | The required cable length for this task is 10 m. |

### 2.4.2.2 Load Selection

Navigate to Global Settings → Load and apply the following selections:




**Explanation of Choices and Considerations**

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Mass | 1500 g | |
| Dry Friction | 4 N | The application uses two ball-bearing guides, which introduce a small dry friction force. |
| Angle | -90 deg | The motor is mounted vertically. The Visual Load Representation at the bottom of the window illustrates the mounting angle and indicates the positive moving direction. |
| MagSpring | 1 × M01-20x60/50-22 @ 0 mm | A MagSpring is used to compensate for the weight of the moving mass (gripper, guiding system, part and its own weight). |
| Family | M01-20 | The application requires approximately 1620 g + slider mass, of compensating force. The M01-20 family offers compensation forces up to 22 N. |
| Type | M01-20x60/50-22 (50 mm, 22 N) | The 22 N MagSpring with 50 mm stroke provides the optimal counterforce for this application *1. Below a short explanation on why this MagSpring is the best solution. |
| Count | 1 | One MagSpring is sufficient. |
| Positioning Mode | Auto-Positioning, Gravity Compensation | This mode automatically positions the MagSpring so it counterbalances the gravitational load of a vertically mounted axis. |

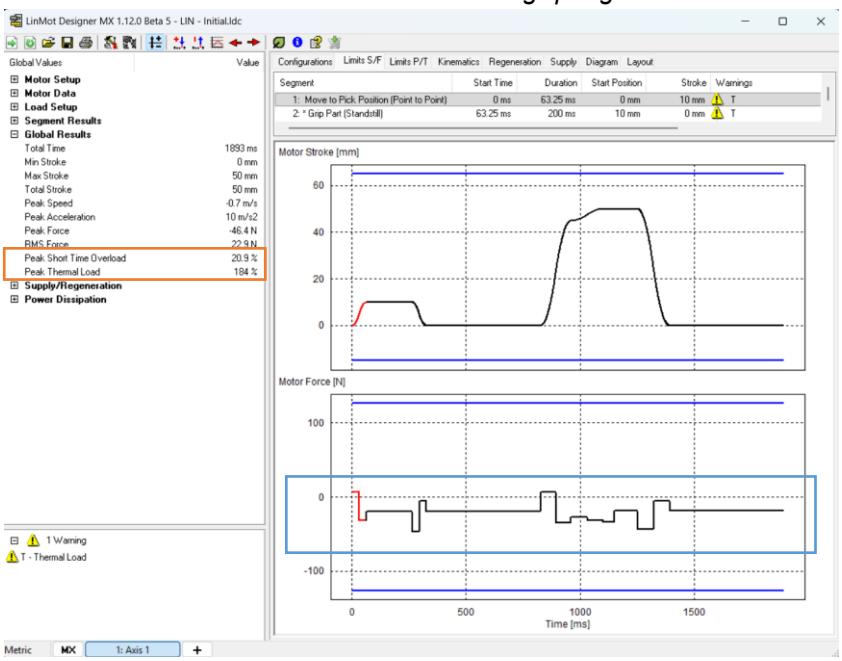


**Attention *1:**
If unsure, always select the longer MagSpring that covers the full (extended) stroke of the motor. This provides additional flexibility for possible future changes to the application.

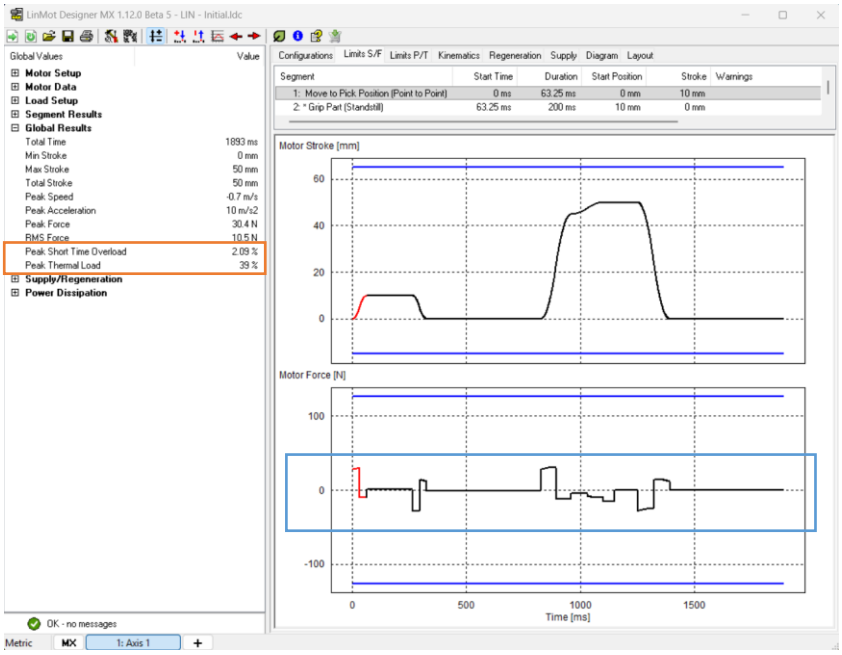
### MagSpring Selection

The following explanation assumes that all motion segments have already been defined. This allows the MagSpring effects to be evaluated directly in the dynamic force and thermal simulations.

*Motor Force and Thermal Load **Without** MagSpring*




*Motor Force and Thermal Load **With** MagSpring*




A comparison of the force graphs shows:

- **Without** a MagSpring, the motor must constantly pull up the load. This results in:
  - Higher average force
  - Increased continuous thermal load
- **With** a MagSpring, the motor requires almost no force to maintain its vertical position at standstill. This is especially beneficial because standstill periods make up a significant portion of the cycle.
- Additionally, the thermal load is significantly reduced.
  This reduction becomes even more important in applications with high dynamic requirements.

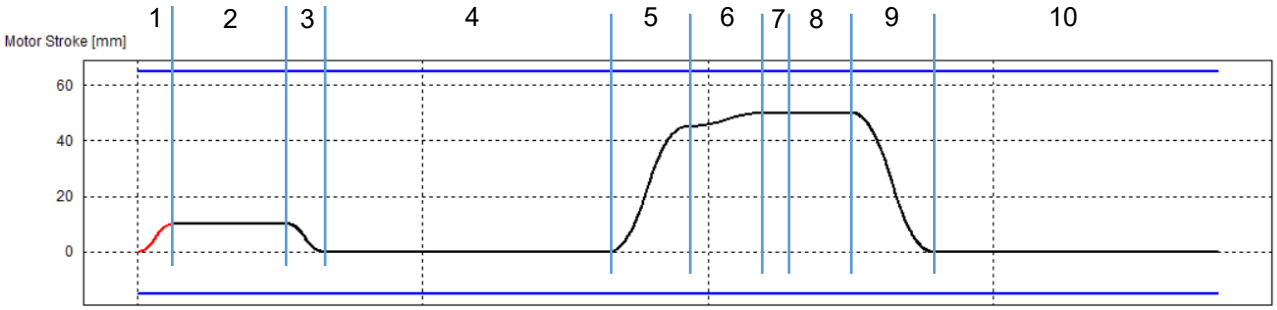
#### 2.4.2.3 Info Tab

Entering project information in the Info tab is not required, but it may be helpful for future reference or documentation purposes.

### 2.4.3 Motion Segments

Motion segments define the complete movement cycle by breaking it into clear, individually configurable steps. The motion cycle defined here should represent the shortest achievable cycle time under maximum load, even if this is not the typical operating cycle. Designing for the most demanding case ensures safe motor sizing and sufficient performance reserves.

The following graph shows the stroke of one cycle with each Motion segment marked separately.




A detailed explanation of each parameter can be found in Section 4.2.

| Seg. | Name | Type | Stroke / Duration | Dynamics | Local Mass | External Forde | Description |
|---|---|---|---|---|---|---|---|
| 1 | Move to Pick Position | Point to Point | 10 mm | vel: 1 m/s<br>acc: 10 m/s²<br>dcc: 10 m/s² | - | - | Downward movement toward the pickup position |
| 2 | Grip Part | Standstill | 200 ms | - | - | - | Waiting phase while the gripper closes around the part |
| 3 | Lift Part | Point to Point | -10 mm | vel: 1 m/s<br>acc: 10 m/s²<br>dcc: 10 m/s² | 120 g | - | Upward movement back to the initial position, creating space for the part delivery system |
| 4 | Wait for Clearance | Standstill | 500 ms | - | 120 g | - | Waiting phase while the part delivery system retracts |
| 5 | Move to Insert Position | Point to Point | 45 mm | vel: 1 m/s<br>acc: 10 m/s²<br>dcc: 10 m/s² | 120 g | - | Movement to the position right before the pressing starts |
| 6 | Insert Part | Point to Point | 5 mm | vel: 0.1 m/s<br>acc: 1 m/s²<br>dcc: 1 m/s² | 120 g | 15 N[1] | Pressing movement of the part into the support |
| 7 | Perform Press Operation | Standstill | 50 ms | - | - | 15 N | Additional pressing time to ensure the part is fully seated and does not slip |
| 8 | Open Gripper | Standstill | 100 ms | - | - | - | Short waiting phase while the gripper opens and releases the part |
| 9 | Retract to Home Position | Point to Point | -50 mm | vel: 1 m/s<br>acc: 10 m/s²<br>dcc: 10 m/s² | - | - | Fast upward motion back to the initial position |
| 10 | Wait for Next Part | Standstill | 500 ms | - | - | - | Waiting phase while the part delivery system brings the next part |

[1] The exact pressing force curve is unknown; therefore, a worst-case scenario is used.

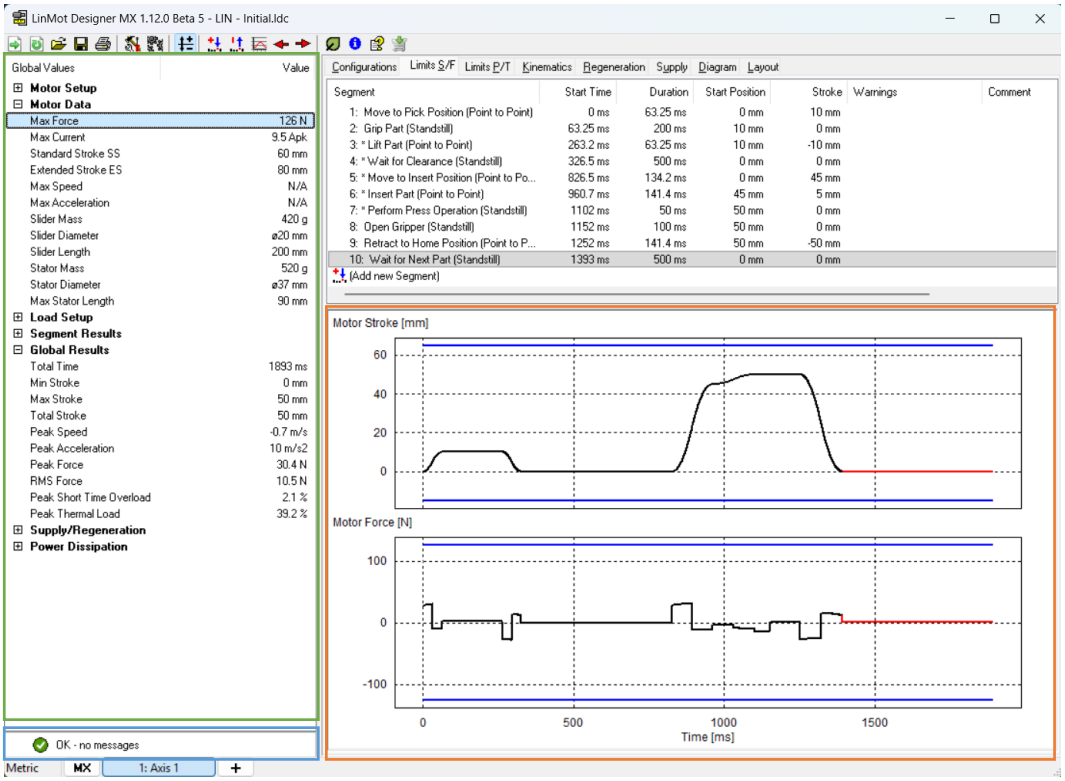
**Attention:**
Do not use a Sine motion profile unless you are absolutely certain the customer can and will implement it in the final machine.

### 2.4.4 Evaluation

A detailed explanation of evaluation logic and messages description can be found in Section 4.3.

#### 2.4.4.1 Evaluating Design

After completing the motion and load setup, LinMot Designer automatically recalculates the simulation results:




A typical evaluation sequence consists of the following steps:

**1. Check for Errors or Warnings**

Errors, warnings, and notes appear in the message area and must always be reviewed first.

- In this design, no errors are present.

**2. Review the Global Values**

The Global Values window shows peak, RMS, and mean values of all relevant physical parameters.

- In this design, all parameters are well below their maximum permissible limits.

**3. Analyze Critical Parameters in the Diagram Windows**

All diagram windows provide time-based visualizations of motion, force, speed, thermal load, and other system behaviors.

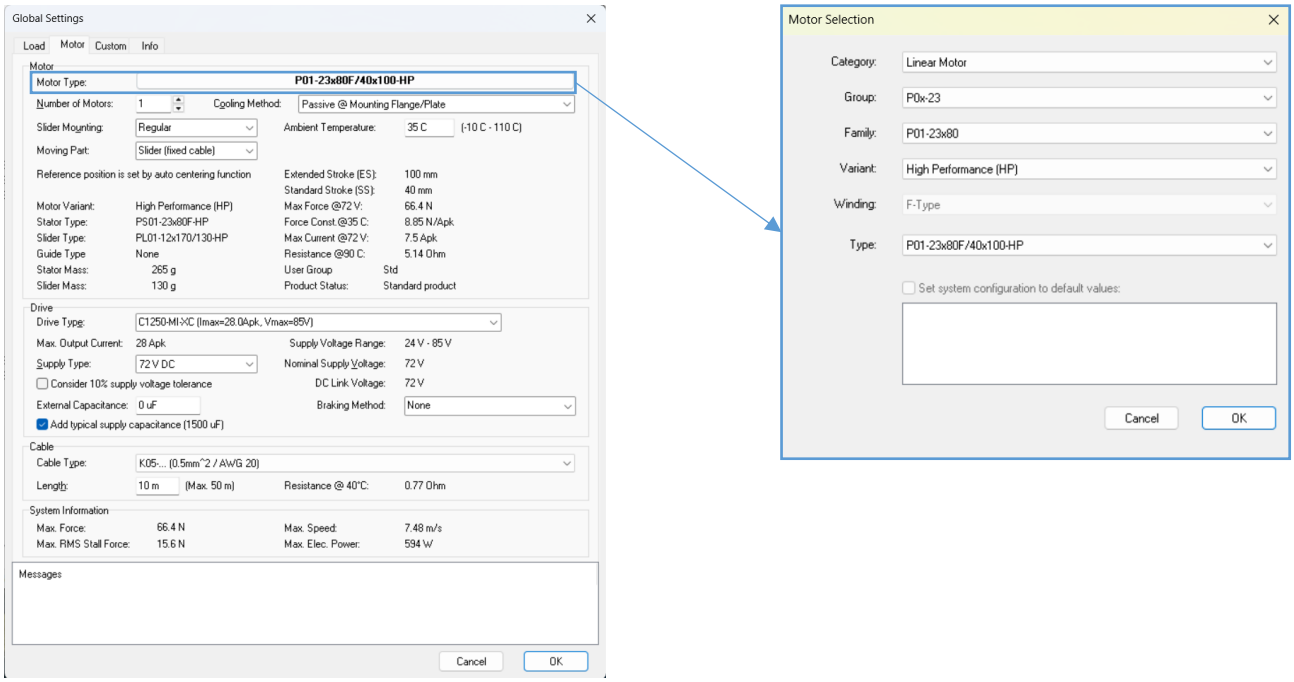
- In this design, the diagrams show clean profiles with substantial performance reserves.

#### 2.4.4.2 Results

Based on the simulation results, the selected motor is most likely oversized.
A smaller motor could be used to reduce installation space and energy consumption while still meeting all performance requirements.

### 2.4.5 Corrective Actions

A smaller motor can be used for this application. This motor can either be selected in the Configurations tab (see Chapter 4.4), or it can be chosen manually under Global Settings → Motor → Motor Type:

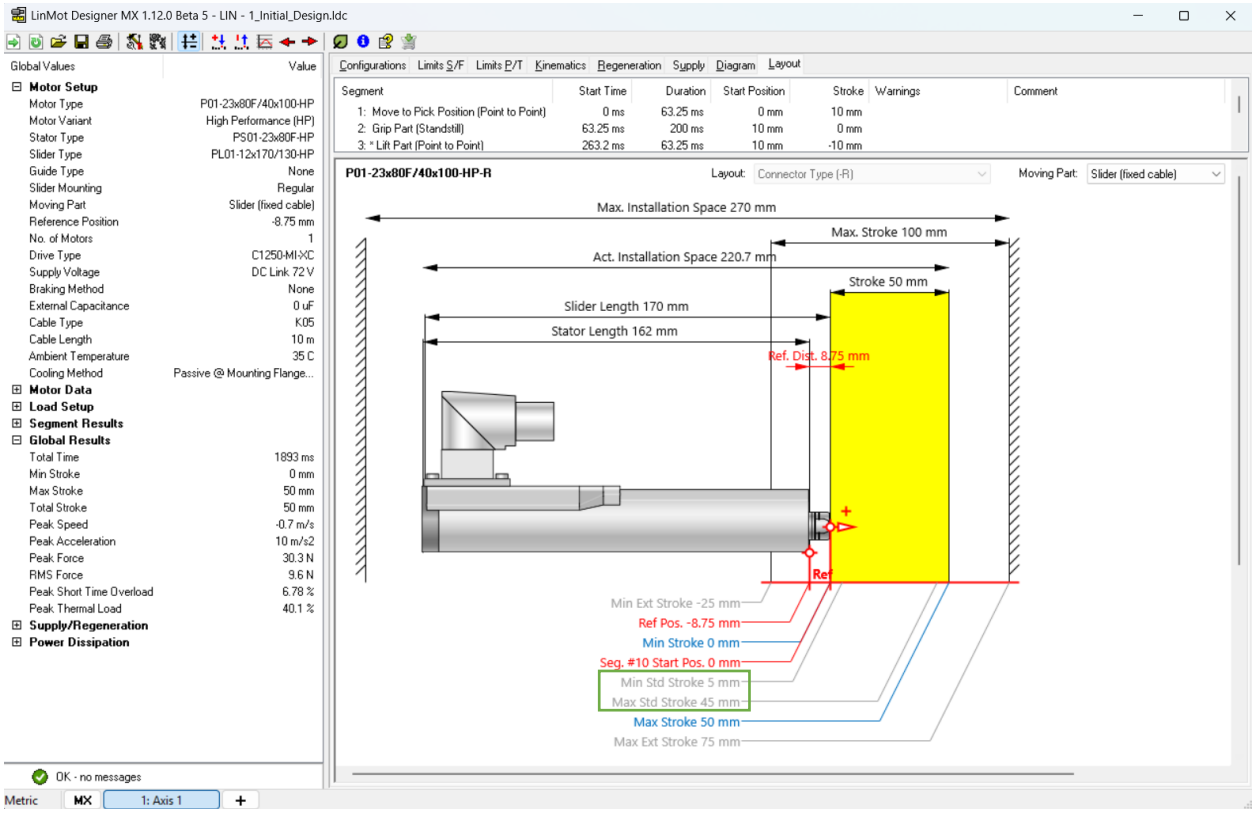



In this example, the **Motor** P01-23x80F/400x100HP motor has been selected.
The smaller motor results in a reduced slider diameter and length, decreasing the slider mass from 420 g to 130 g. This reduction has a significant positive impact on the system's performance.

It can also be re-evaluated whether the MagSpring needs to be reduced. In this case, the 17 N MagSpring results in nearly the same thermal loads as the 22 N version, because a compensation force between roughly 17 N and 22 N is required for this application. Therefore, the 22 N MagSpring is retained.

### 2.4.6 Layout Check

The Layout Tab provides a visual overview of the mechanical dimensions, positions, and installation space of the selected motor. It is a key tool for verifying whether the chosen configuration fits the mechanical constraints of the application and whether the motion profile stays within the physical stroke limits of the motor.

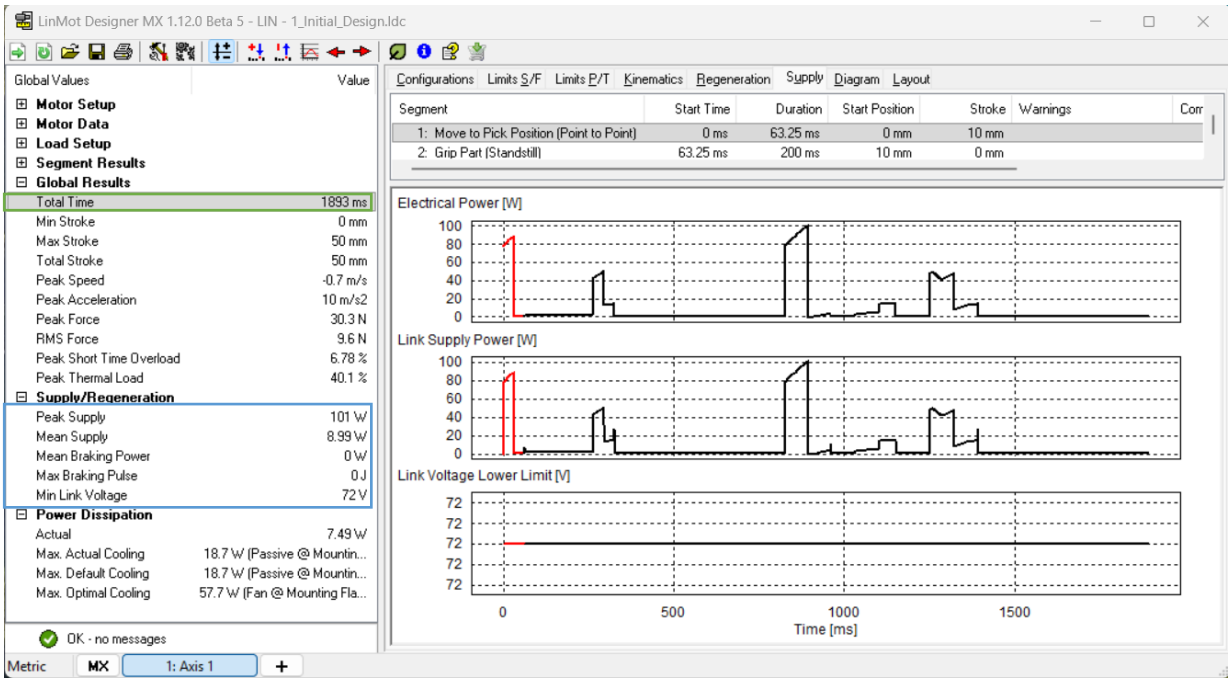



It can be seen that the 50 mm stroke lies outside the motor's Standard Stroke range. This is not an issue, as the design results confirm that the configuration remains valid.

The Layout tab provides all relevant dimensional information required to ensure proper installation, including standard and extended stroke limits, component lengths, and the total installation space. This information is essential for the customer's machine design because it clearly defines the mechanical envelope that must remain unobstructed to accommodate the motor or module throughout the intended stroke range.

### 2.4.7 Select Power Supply

To ensure reliable operation of the axis, the power supply must be selected based on voltage level, mean power demand, and peak power / energy demand of the motion profile.
In this example, it is assumed that only this one motor is connected to the power supply.




1. **Match the DC Output Voltage**
   Select a power supply whose nominal DC output voltage matches the required DC bus voltage of the drive.
   For this application, a 72 V DC supply is required. The power supply type S02-72/600 provides a fixed output of 72 V DC ±1% at 100% load and is therefore suitable from a voltage perspective.

2. **Check Continuous (Mean) Power Requirement**
   The calculated mean power demand of the axis is:
   - Mean Supply Power: 8.99 W

   The power supply must provide at least 110% of the Mean Supply:
   - $P_{required,\ continuous} \approx 1.1 \times 8.99\ W \approx 9.9\ W$

   The selected power supply must provide a continuous output power greater than this value.
   - The S02-72/600 offers a continuous output power of 600 W, which is significantly higher than the required 9.9 W.

3. **Check Peak Power and Energy Requirement**
   The motion profile requires a peak power of:
   - Peak Supply Power: 101 W

   For peak evaluation, both peak power and boost energy must be within the capabilities of the power supply:
   - The S02-72/600 offers a continuous output power of 600 W, which is significantly higher than the required 101 W.

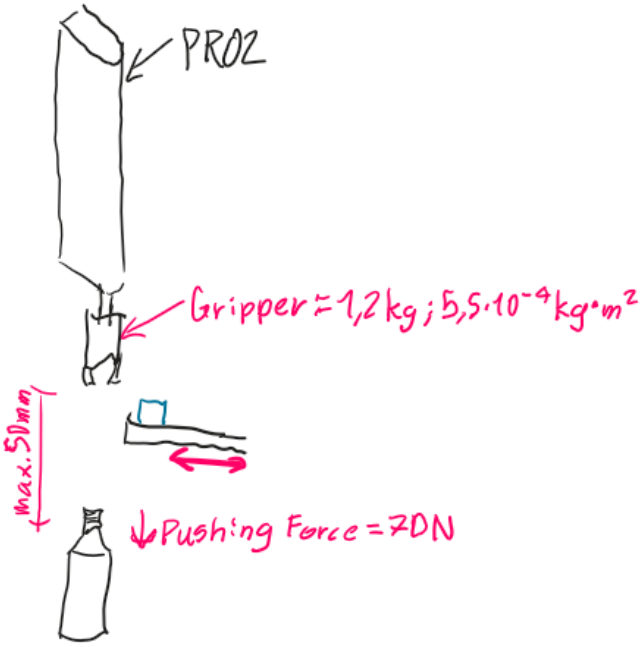
4. **Check Installation and Environmental Conditions**
   See Application Example 1: Horizontal Pusher for more details

**Recommendation**
The S02-72/600 is definitely suitable for this application.

### 2.4.8 Export / Print Project Data

See Chapter 4.6 for more information.

## 2.5 Application Example 3: Linear Rotary Motor




### 2.5.1 Requirements

Because this example requires two motor designs, they are both set up in one MX-Designer-File in SX-Mode. The advantage is that this project can be kept in one File.

#### 2.5.1.1 Application Overview

This example describes a combined linear-rotary application used for picking up and screwing a cap onto a bottle. The process requires precise vertical positioning combined with torque-controlled rotation during the tightening phase.

Both the linear axis (vertical motion) and the rotary axis (screwing motion) are implemented using a linear-rotary PR02 motor and are configured within a single MX-Designer project. This allows coordinated evaluation of motion, force, torque, thermal load, and power-supply requirements in one file.

One complete cycle - including picking, positioning, screwing, and returning to the initial position - must be completed within 1.5 s.

The main challenge of this application is synchronizing fast dynamic motion with accurate torque-controlled tightening while maintaining thermal and mechanical limits.

#### 2.5.1.2 Boundary Conditions and Assumptions

- Ambient operating temperature is assumed to be 35 °C, representing a typical industrial machine environment.
- Motor–drive cable length is 30 m.
- Torque control is used for tightening; torque is derived from motor current.
- An additional torque sensor may be used in the machine for verification, but it is not modeled in MX-Designer.
- The complete pick-and-screw cycle must be finished within 1.5 s under all operating conditions.

#### 2.5.1.3 Mechanical Model

The mechanical system consists of:

- A vertical linear axis with a total stroke of 50 mm
- A rotary axis for screwing the cap
- Gripper mass: 1.2 kg (constant mass)
- Moment of inertia of gripper: $55 \times 10^{-5}$ kg·m²
- Cap mass: 2 g, acting only while gripped
- Moment of inertia of cap: $1 \times 10^{-7}$ kg·m²
- Maximum axial pushing force (linear): 70 N
- Required rotation from first thread engagement to fully tightened: approximately 1.1 turns
- Vertical mounting with gravity acting continuously on the linear axis

#### 2.5.1.4 Motion Sequence and Segmentation

The application cycle is modeled using coordinated linear and rotary motion segments:

| Step | Linear | Rotary |
|---|---|---|
| 1 | Move down (10 mm) | - |
| 2 | Wait for Gripper to grip cap (100 ms). | - |
| 3 | Move up (-10 mm) | - |
| 4 | Wait for Motor to be moved to the right position (300 ms). | - |
| 5 | Move down quickly to just above the bottle (45 mm). | - |
| 6 | Push down further (5 mm), so the cap is following down with the screwing application. | Move quickly to screw on as fast as possible. |
| 7 | | Right before the cap is tighten; move very slow. (This is necessary in order to make the tightening with torque accurate.) |
| 8 | | Tighten with 2 Nm |
| 9 | | Wait for conformation that the cap has been properly tightened (~30 ms). |
| 10 | - | Wait for gripper to be released (100 ms). |
| 11 | Move up to initial position (-50 mm). | - |
| 12 | Wait for Motor to be moved to the right position (300 ms). | - |

#### 2.5.1.5 Purpose of the Example

Based on the defined boundary conditions and mechanical model, this example illustrates how to configure and evaluate a complete linear-rotary application in LinMot MX-Designer using a PR02 motor. It demonstrates how to:

- Set up and coordinate linear and rotary axes within a single project
- Define global and local load conditions for mass and inertia
- Implement torque-controlled motion using motor current
- Model complex multi-segment pick-and-screw processes
- Evaluate force, torque, thermal load, and regeneration behavior
- Verify feasibility of fast cycles with accurate torque control
- Select an appropriate motor, drive, and power supply for combined linear-rotary applications

The scenario reflects a typical real-world capping application and provides a structured, end-to-end workflow for designing and validating linear-rotary systems.

### 2.5.2 Global Settings

The Global Settings define the key motor, load, and system parameters used throughout the project. These values form the basis for all simulations and configuration checks in LinMot Designer.
A detailed explanation of each parameter is provided in Section 4.1. This example describes only the parameters that are new and therefore not explained in Application Example 1: Horizontal Pusher.

#### 2.5.2.1 Motor Selection

Navigate to Global Settings → Motor and apply the following selections:

##### 2.5.2.1.1 Linear

For the linear motor:

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Motor Type | PR02-52x60/37x120F-HP-100-MS01 (Pull -30N) | If you already have a rough idea of the required motor type, you may proceed with this selection. Otherwise, ensure that the chosen motor provides **at least 50 mm stroke** and a **30 N integrated MagSpring** for the application. |
| Category | Linear Rotary Motor (Linear Part) | |
| Group | PR02 | |
| Family | PR02-52x60/37x120 | |
| Variant | High Performance (HP) | |
| Winding | F-Type | |
| Type | PR02-52x60/37x120F-HP-100-MS01 (Pull -30N) | |
| Cooling Method | Passive | |
| Ambient Temperature | 35°C | |
| Drive Type | C1250-MI-XC | |
| Supply Type | 72 V DC | |
| Braking Method | None | |
| Cable Type | K05-… (0.5mm² /AWG 20) | |
| (Cable) Length | 30 m | |

##### 2.5.2.1.2 Rotary

For the rotary motor:

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Motor Type | PR02-52x60/37x120F-HP-100-MSxx | Select the same motor as used for the linear axis. |
| Category | Linear Rotary Motor (Rotary Part) | |
| Group | PR02 | |
| Family | PR02-52x60/37x120 | |
| Variant | Standard | |
| Winding | Standard | |
| Type | PR02-52x60/37x120F-HP-100-MSxx | |
| Cooling Method | Passive | |
| Ambient Temperature | 35°C | |
| Drive Type | C1250-MI-XC | |
| Supply Type | 72 V DC | |
| Braking Method | None | |
| Cable Type | K05-… (0.5mm² /AWG 20) | |
| (Cable) Length | 30 m | |

### 2.5.2.2 Load Selection

Navigate to Global Settings → Load and apply the following selections:

#### 2.5.2.2.1 Linear

For the linear motor:

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Mass | 1200 g | |
| Angle | -90 deg | The motor is mounted vertically. The Visual Load Representation at the bottom of the window illustrates the mounting angle and indicates the positive moving direction. |
| Power Dissipation 2nd Motor | N/A | This value is not available at this stage. It must be added later as soon as the motion segments have been created. See Section 2.5.3.2. |

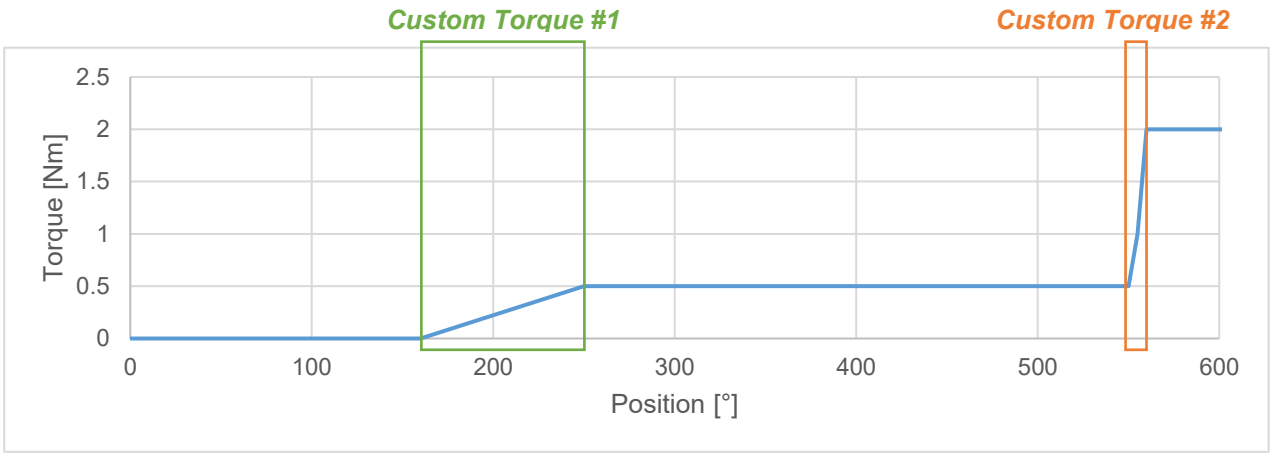
#### 2.5.2.2.2 Rotary

For the rotary motor:

| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Moment of Inertia | 5.5 kg*cm2 | |
| Custom Torque #1 | Enable | Explained in detail in the Custom Torque section below. |
| Custom Torque #2 | Enable | Explained in detail in the Custom Torque section below. |
| Power Dissipation 2nd Motor | N/A | This value is not available at this stage. It must be added later as soon as the motion segments have been created. See Section 2.5.3.2. |

**Custom Torque (Force) Curve**

See Section 4.1.2.2.2 for more information. The Following Curve displays the target torque curve for this example:

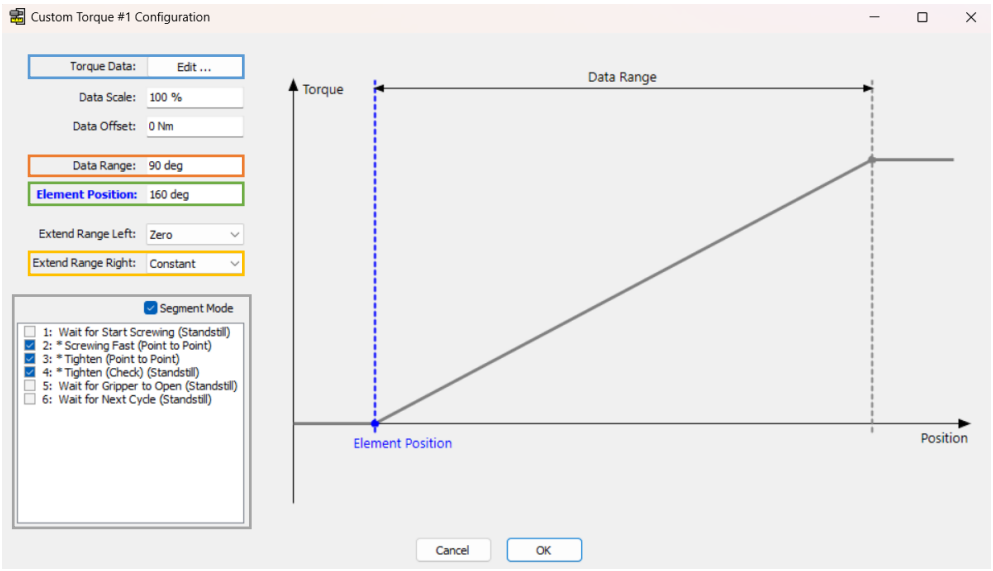



- Initially, the torque is 0 Nm.
- At the beginning of the bottle thread (≈ 160°), torque begins to rise.
- During the screwing phase, the friction torque between cup and bottle is estimated at 0.5 Nm.
- At the very end, the bottle is tightened to 2 Nm.

To implement this in Global Settings → Load, the curve is separated into two Custom Torque elements:

- Custom Torque #1: First rise to 0.5 Nm
- Custom Torque #2: Final rise to 2 Nm

### *Custom Torque #1*



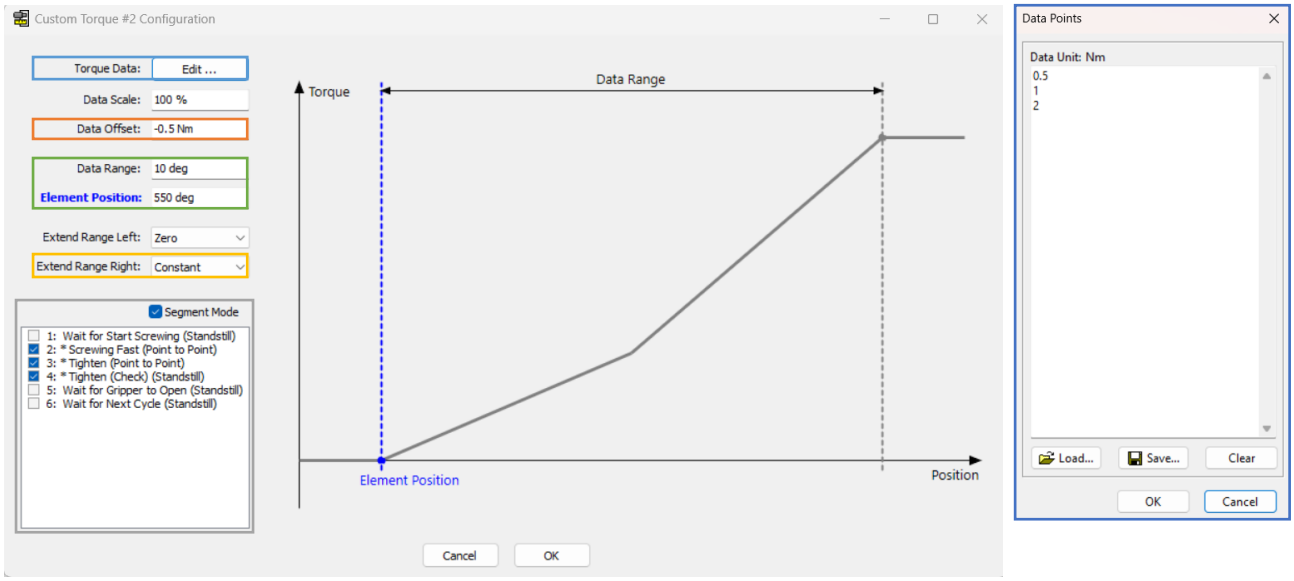




| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Torque Data | Edit… | The torque curve must be defined here. This opens the Data Points editor where the values can be entered or imported. |
| Data Points | 0 Nm<br>0.5 Nm | The first torque increase is from 0 Nm to 0.5 Nm. These are the actual torque values defining the torque curve. |
| Data Scale | 100 % | Multiplies the entire torque curve by a factor. In this example no scaling is required, so the original values are used. |
| Data Offset | 0 Nm | Adds a constant offset to the entire torque curve. No offset is needed in this application. |
| Data Range | 90 deg | Defines the angular range in which the torque curve is applied. Here it is estimated that the cap reaches full screwing torque after 90°. |
| Element Position | 160 deg | Defines where the first data point of the curve is placed in the application's coordinate system. (From this position, it takes roughly 1.1 revolutions until the cap is fully screwed on.) |
| Extend Range Left | Zero | Defines the torque before the defined curve range. “Zero” ensures torque is 0 Nm before the first data point. |
| Extend Range Right | Constant | Defines the torque after the defined curve range. “Constant” keeps the final torque value at 0.5 Nm after the initial rise, as shown in the full Custom Torque Curve. |
| Segment Mode | Enable Segment 2,3,4 | After defining the *Motion Segments*, this setting controls in which segments the torque curve is active. Only Segments 2, 3, and 4 require this torque behavior. |

### *Custom Torque #2*

**Note:**
Because Extend Range Right = Constant in Custom Torque #1, its final value (0.5 Nm) continues indefinitely.
→ The values from Custom Torque #2 are added on top of Custom Torque #1.




| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Torque Data | Edit… | |
| Data Points | 0.5 Nm<br>1 Nm<br>2 Nm | Tightening increases the torque from 0.5 Nm to 2 Nm. The intermediate value (1 Nm) is included only as an example to show that you can define multiple points across the defined angular range. The angle positions are evenly distributed. |
| Data Scale | 100 % | No scaling is required; the torque values are used exactly as defined. |
| Data Offset | -0.5 Nm | Because this curve is added to the torque values from Custom Torque #1, an offset must be introduced so that the combined curves start from the correct physical baseline. |
| Data Range | 10 deg | Defines the angular range within which the tightening torque increase occurs. In this example it is estimated that the tightening takes place in the final 10° of rotation. |
| Element Position | 550 deg | Defines where the first data point of this torque curve is placed in the application's coordinate system. |
| Extend Range Right | Constant | Defines the torque after the defined curve range. “Constant” keeps the final torque value at 2 Nm, although in this case maintaining the constant value is not strictly required. |
| Segment Mode | Enable Segment 2,3,4 | After defining the Motion Segments, this setting controls in which segments the torque curve is active. Only Segments (2,) 3, and 4 require this torque behavior. |

### 2.5.2.3 Info Tab

Entering project information in the Info tab is not required, but it may be helpful for future reference or documentation purposes.

### 2.5.3 Motion Segments

Motion segments define the complete movement cycle by breaking it into clear, individually configurable steps. Designing for the most demanding case ensures safe motor sizing and provides sufficient performance reserves.

This example represents a simplified version of a screwing process. A more advanced and accurate sequence would not include a stop between Segment 5 and 6 of the linear motor or Segment 2 and 3 of the rotary motor.

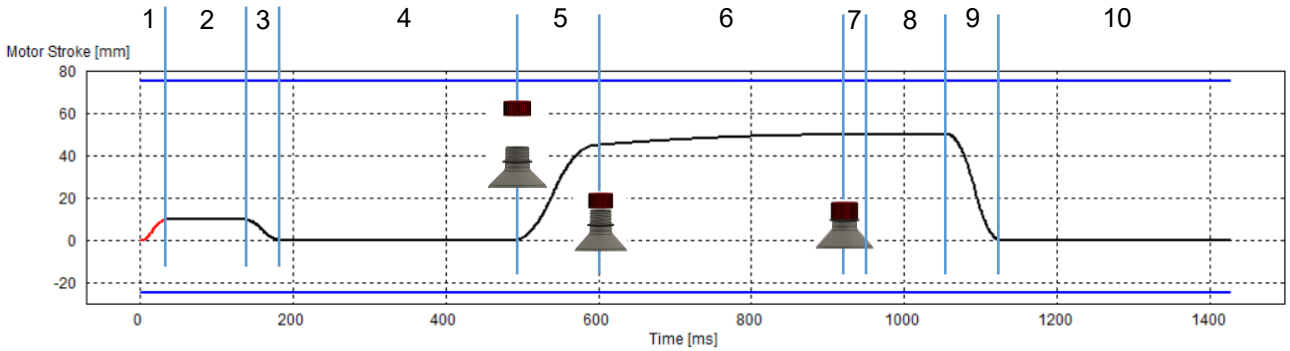
The challenge in this example is that segment selection depends on the configuration of the other motor. For instance, the standstill duration of the rotary motor depends on the process time of the linear motor.



**Attention:**
Do not use a Sine motion profile unless you are absolutely certain the customer can and will implement it in the final machine.

#### 2.5.3.1.1 Linear

The following graph shows the stroke of one cycle with each motion segment marked separately. It also illustrates the cap's position relative to the bottle during the screwing process.



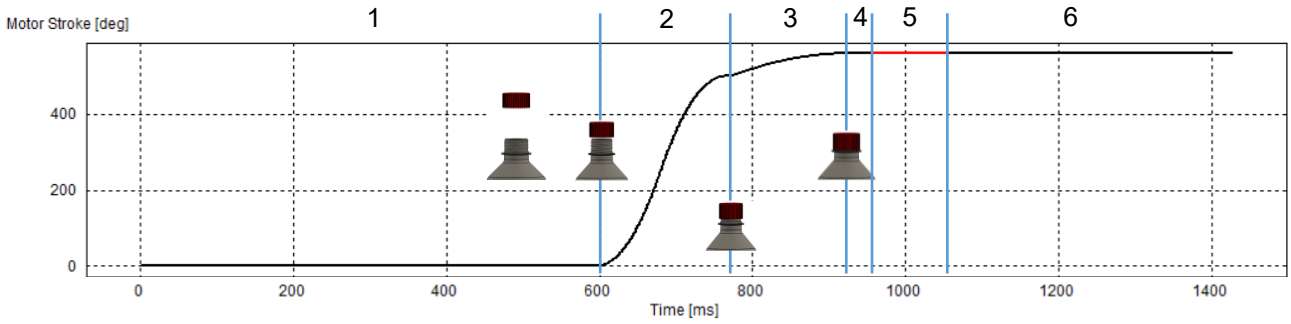

A detailed explanation of each parameter can be found in Section 4.2.

| Seg. | Name | Type | Stroke / Duration | Dynamics | Local Mass | External Force | Description |
|---|---|---|---|---|---|---|---|
| 1 | Move to Pick Position | Point to Point | 10 mm | vel: 2 m/s<br>acc: 40 m/s²<br>dcc: 30 m/s² | - | - | Downward movement toward the pickup position |
| 2 | Grip Part | Standstill | 100 ms | - | - | - | Waiting phase while the gripper closes around the part |
| 3 | Lift Part | Point to Point | -10 mm | vel: 1 m/s<br>acc: 15 m/s²<br>dcc: 15 m/s² | 2 g | - | Upward movement back to the initial position, creating space for the part delivery system to retract |
| 4 | Wait for Clearance | Standstill | 300 ms | - | 2 g | - | Waiting phase while the part delivery system retracts |
| 5 | Move Down Quickly | Point to Point | 45 mm | vel: 1 m/s<br>acc: 15 m/s²<br>dcc: 15 m/s² | 2 g | - | Quick movement to the position immediately before the screwing starts |
| 6 | Press Down (Follow Screwing) | Point to Point | 5 mm | vel: 0.5 m/s<br>acc: 40 m/s²<br>dcc[2]:<br>0.0911 m/s² | 2 g | 70 N | Pressing movement to follow the thread during screwing. This segment must take exactly as long as Segments 2 and 3 of the rotary motor (2.5.3.1.2). |
| 7 | Wait for Tightening | Standstill | 30 ms | - | - | 70 N | Additional pressing time for the PLC to verify the part is fully tightened |
| 8 | Wait for Gripper to Open | Standstill | 100 ms | - | - | - | Short waiting phase while the gripper opens and releases the part |
| 9 | Retract to Home Position | Point to Point | -50 mm | vel: 2 m/s<br>acc: 40 m/s²<br>dcc: 40 m/s² | - | - | Fast upward motion back to the initial position |
| 10 | Wait for Next Part | Standstill | 300 ms | - | - | - | Waiting phase while the part delivery system brings the next part |

[2] In order to be able to calculate with a 4-Digit-Number, the "Significant Digits" in "Measurement Settings" (Section 2.2.1.2) has to be adjusted to 4.

#### 2.5.3.1.2 Rotary

The following graph shows the rotation profile of one cycle with each motion segment marked separately. It also illustrates the cap's position relative to the bottle during the screwing process.




A detailed explanation of each parameter can be found in Section 4.2.

| Seg. | Name | Type | Stroke / Duration | Dynamics | Moment of Inertia | Custom Force #1 & #2 | Description |
|---|---|---|---|---|---|---|---|
| 1 | Wait for Start Screwing | Standstill | 595.34 ms | - | - | - | Wait for the linear motor to move into position. This segment must take exactly as long as Segments 1–4 of the linear motor (2.5.3.1.1). |
| 2 | Screwing Fast | Point to Point | 500° | vel: 8 kdeg/s<br>acc: 70 kdeg/s$^2$<br>dcc: 70 kdeg/s$^2$ | 0.001 kg*cm2 | Enable | Rapid initial screwing motion |
| 3 | Tighten | Point to Point | 60° | vel: 0.7 kdeg/s<br>acc: 50 kdeg/s$^2$<br>dcc: 5 kdeg/s$^2$ | 0.001 kg*cm2 | Enable | Slow, controlled movement just before the fully tightened position |
| 4 | Tighten (Check) | Standstill | 30 ms | - | - | Enable | Verification phase to ensure the cap has been fully tightened |
| 5 | Wait for Gripper to Open | Standstill | 100 ms | - | - | - | Short waiting phase while the gripper opens and releases the part |
| 6 | Wait for Next Cycle | Standstill | 370.7 ms | - | - | - | Wait for the linear motor to finish its cycle. This segment must take exactly as long as Segments 9 and 10 of the linear motor (2.5.3.1.1). |

### 2.5.3.2 Power Dissipation 2nd Motor

After defining the motion segments for both motors, it is necessary to enter the Power Dissipation 2nd Motor value for each motor.

To do this, the Actual (Power Dissipation) value—displayed in the Parameter Window (see Section 2.2.2.2) must be transferred to the other motor via: Global Settings → Load → Power Dissipation 2nd Motor (see also figure below).

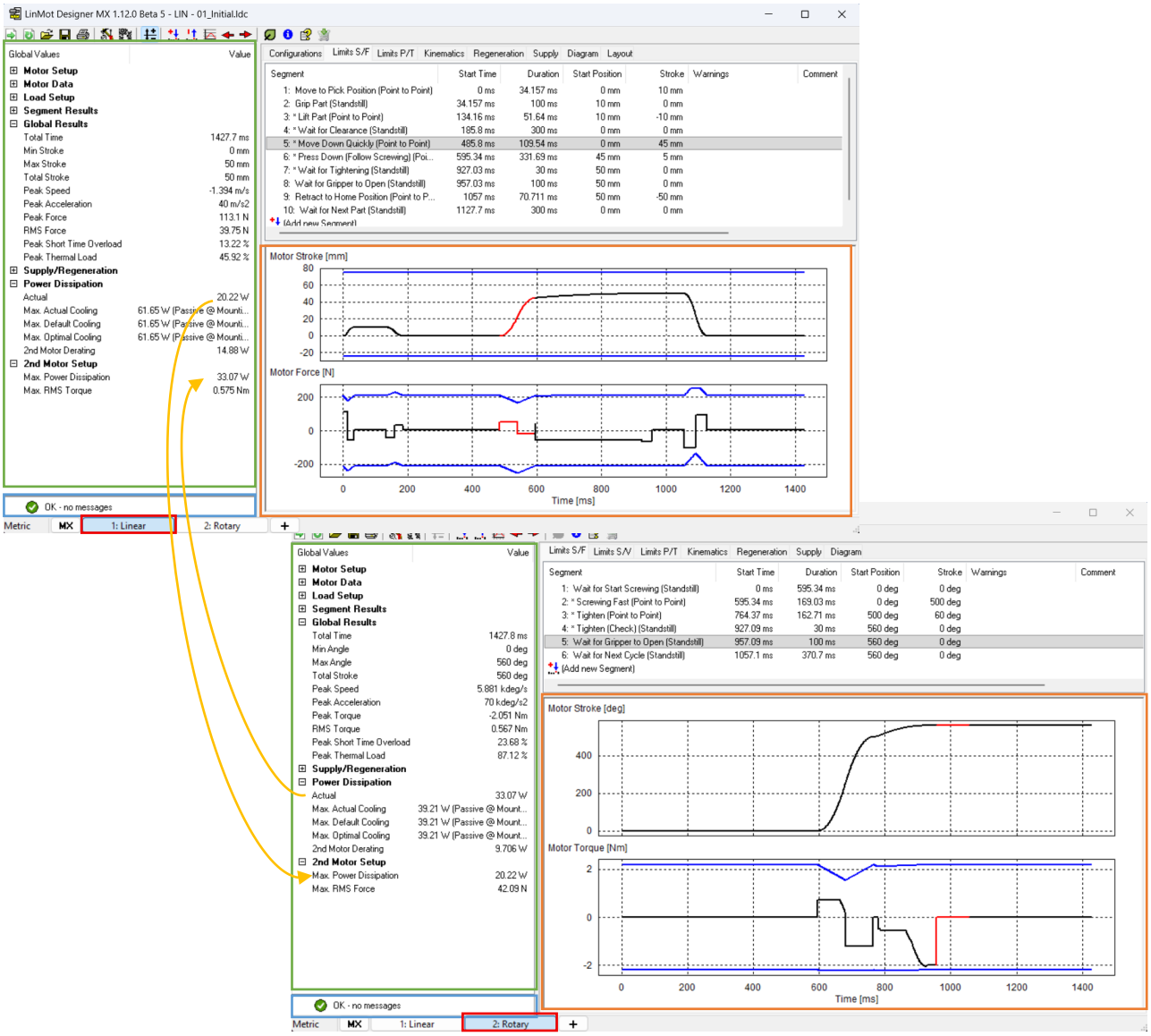
This ensures correct thermal coupling between the two axes, as the permissible thermal load of one motor depends on the power dissipation of the other.

### 2.5.4 Evaluation

A detailed explanation of evaluation logic and messages description can be found in Section 4.3.

#### 2.5.4.1 Evaluating Design

After completing the motion and load setup, LinMot Designer automatically recalculates the simulation results:




A typical evaluation sequence consists of the following steps:

**1. Check for Errors or Warnings**

Errors, warnings, and notes appear in the message area and must always be reviewed first.

- In this design, no errors are present for both motors.

**2. Review the Global Values**

The Global Values window shows peak, RMS, and mean values of all relevant physical parameters.

- In this design, all parameters are below their maximum permissible limits.

**3. Analyze Critical Parameters in the Diagram Windows**

All diagram windows provide time-based visualizations of motion, force, speed, thermal load, and other system behaviors.

- Both Motors show that the Force / Torque graphs are right at the limit (blue line) of the motors.

#### 2.5.4.2 Results

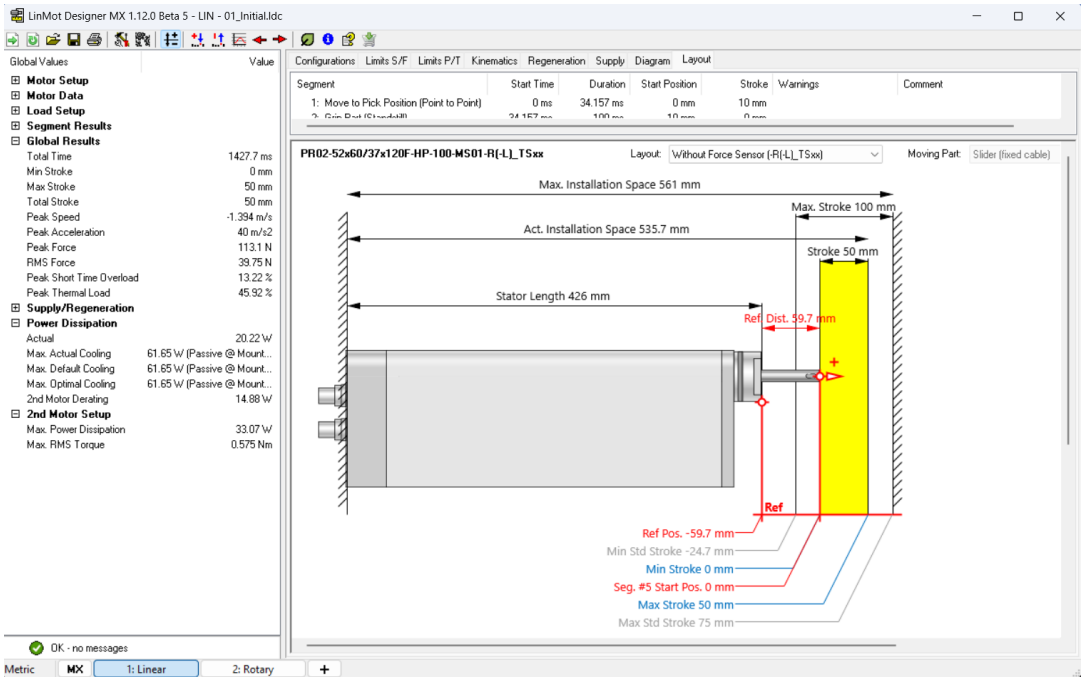
Based on the simulation results, the selected motor is just right. The thermal values for the linear motor are in a good range, whereas the Peak Thermal Load for the rotary motor is a bit on the higher side with 87.12%. The force / torque values are at the limit and have not much room for improvements (like decrease the cycle time, or tighten with higher torque).

### 2.5.5 Corrective Actions

No corrective actions are necessary for this application.

### 2.5.6 Layout Check

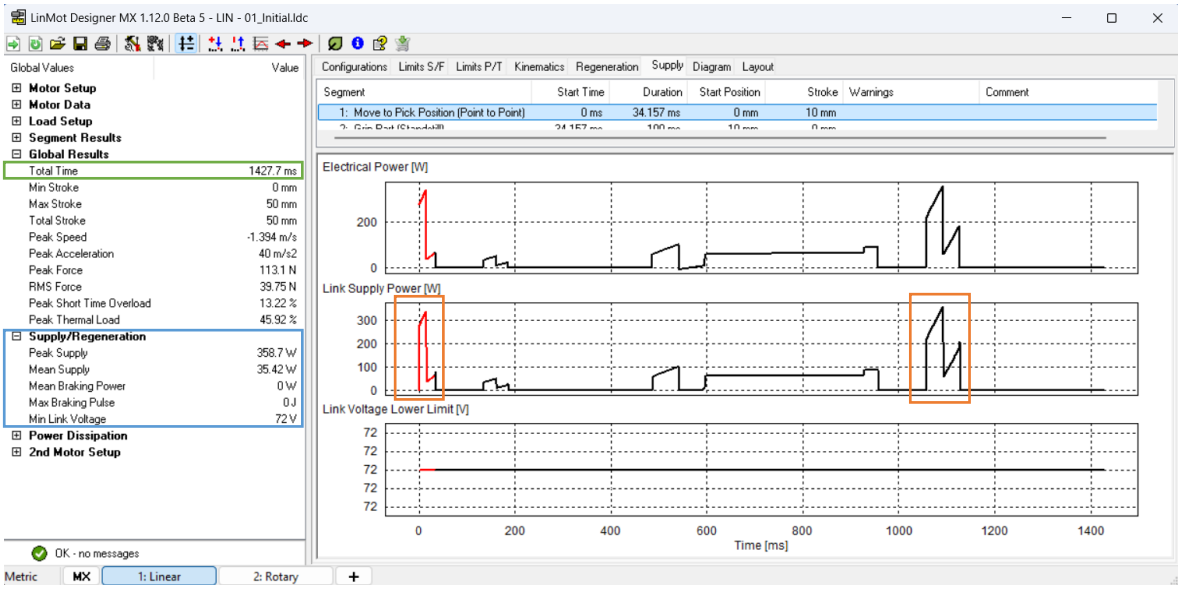
The Layout Tab provides a visual overview of the mechanical dimensions, positions, and installation space of the selected motor. It is a key tool for verifying whether the chosen configuration fits the mechanical constraints of the application and whether the motion profile stays within the physical stroke limits of the motor. It is only available for the Linear Motor configuration, but displays the whole motor including the rotary part.

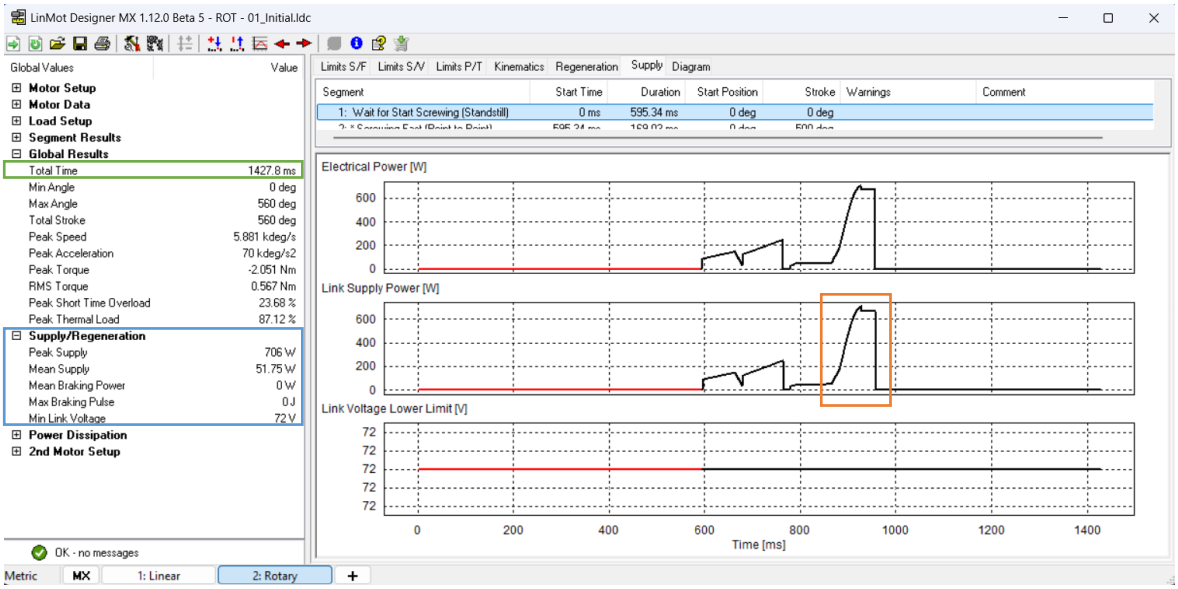



The Layout tab provides all relevant dimensional information required to ensure proper installation, including stroke limits, component lengths, and the total installation space. This information is essential for the customer's machine design.

### 2.5.7 Power Supply Selection

To ensure reliable operation of the axis, the power supply must be selected based on voltage level, mean power demand, and peak power / energy demand of the motion profile.
In this example, it is assumed that only these two motors are connected to the power supply.




The following values are relevant from the figure above:

| Description | Linear | Rotary | Total / Relevant |
|---|---|---|---|
| Min Link Voltage | 72 V | 72 V | 72 V |
| Total Cycle Time | 1427.7 ms | 1427.7 ms | 1427.7 ms |
| Mean Supply | 35.42 W | 51.75 W | 87.17 W |
| Peak Supply | ~358.7 W for ~17 ms<br>~358.7 W for ~40 ms | ~706 W for ~60 ms | Simplified:<br>~706 W for ~117 ms |

1. **Match the DC Output Voltage**
   Select a power supply whose nominal DC output voltage matches the required DC bus voltage of the drive.
   For this application, both axes require a 72 V DC supply. The power supply type S02-72/600 provides a fixed output of 72 V DC ±1% at 100% load and is therefore suitable from a voltage perspective.

2. **Check Continuous (Mean) Power Requirement**
   The calculated mean power demand of both axis is:
   - Mean Supply Power: 87.17 W

   The power supply must provide at least 110% of the Mean Supply:
   - $P_{required,\ continuous} \approx 1.1 \times 87.17\ W \approx 95.9\ W$

   The selected power supply must provide a continuous output power greater than this value.
   - The S02-72/600 offers a continuous output power of 600 W, which is significantly higher than the required 95.9 W. This ensures ample margin for continuous operation and additional consumers on the DC bus if needed.
3. **Check Peak Power and Energy Requirement**
   The motion profile requires a peak power of:
   - Peak Supply Power: 706 W
   - Peak Duration: 117 ms
   - Total Cycle Time: 1427 ms

   For peak evaluation, both peak power and boost energy must be within the capabilities of the power supply:
   - The S02-72/600 supports Powerboost up to 250% of nominal power for 2 s, i.e. up to 1500 W for 2 s (1500 Ws).
   - The energy required by the application peak is approximately:
     $$E_{peak} \approx 706\ W \times 0.117\ s \approx 82.6\ Ws$$
     This is far below the available 1500 Ws boost capability.
   - According to the load behaviour specification, overloads up to 500 Ws within 4 s do not require a cool-down phase. The required ~82.6 Ws is well within this limit, so no additional cool-down is necessary within the 1427.7 ms cycle time.

   Thus, the peak power and energy demands of the axis are safely covered by the boost capability of the selected power supply.

4. **Check Installation and Environmental Conditions**
   See Application Example 1: Horizontal Pusher for more details.

5. **Recommendation**
   A supply in the S02-72/600 or S02-72/1000 class is fully suitable, depending on your preferred vendor/spec.

### 2.5.8 Export / Print Project Data

See Chapter 4.6 for more information.

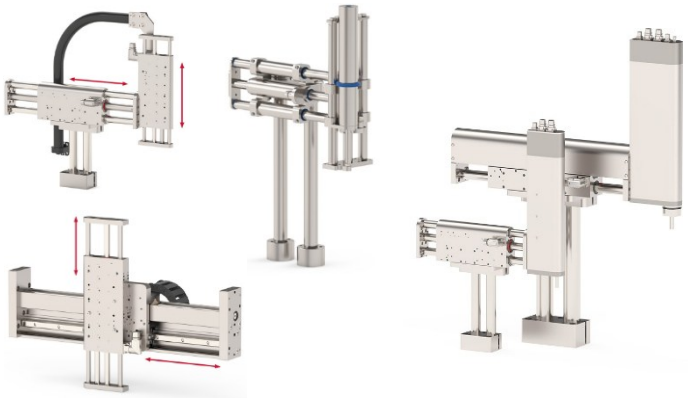
# 3 Multi Axis (MX) Mode

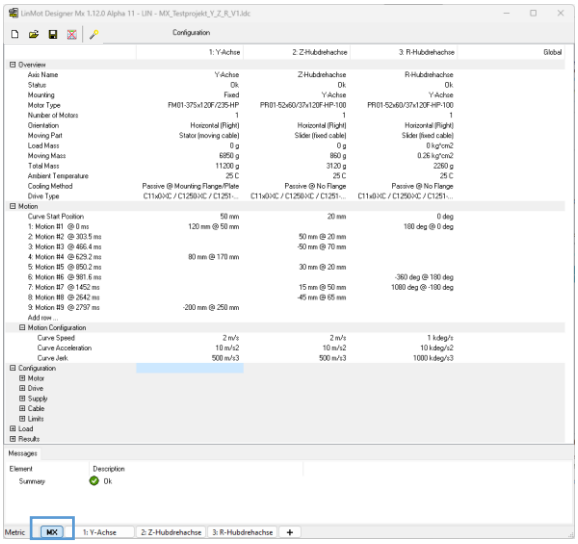
## 3.1 Introduction

MX Mode is designed for systems where multiple LinMot axes are mechanically connected — such as gantry robots, flat robots, or multi-station handling systems. Unlike SX Mode, where each axis is independent, MX Mode treats the axes as a linked system: changing the motor on one axis changes the moved mass on the axes that carry it.

Key differences from SX Mode:

- **Automatic mass propagation.** The software calculates each axis's total moved mass from the mounting configuration, including the weight of dependent axes and their motors.
- **Coordinated motion planning.** All axes share a single motion table, so you can synchronize movements and optimize for minimum total cycle time.
- **Centralized editing.** All parameter changes must be made in the MX Tab. You may inspect individual axis results in their own tabs, but editing an axis directly will break the MX links.

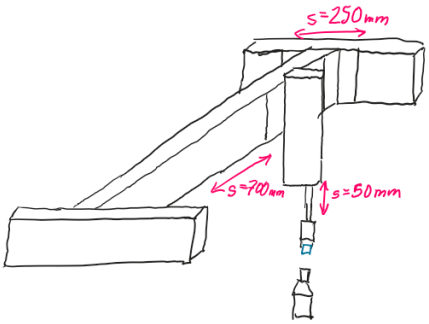


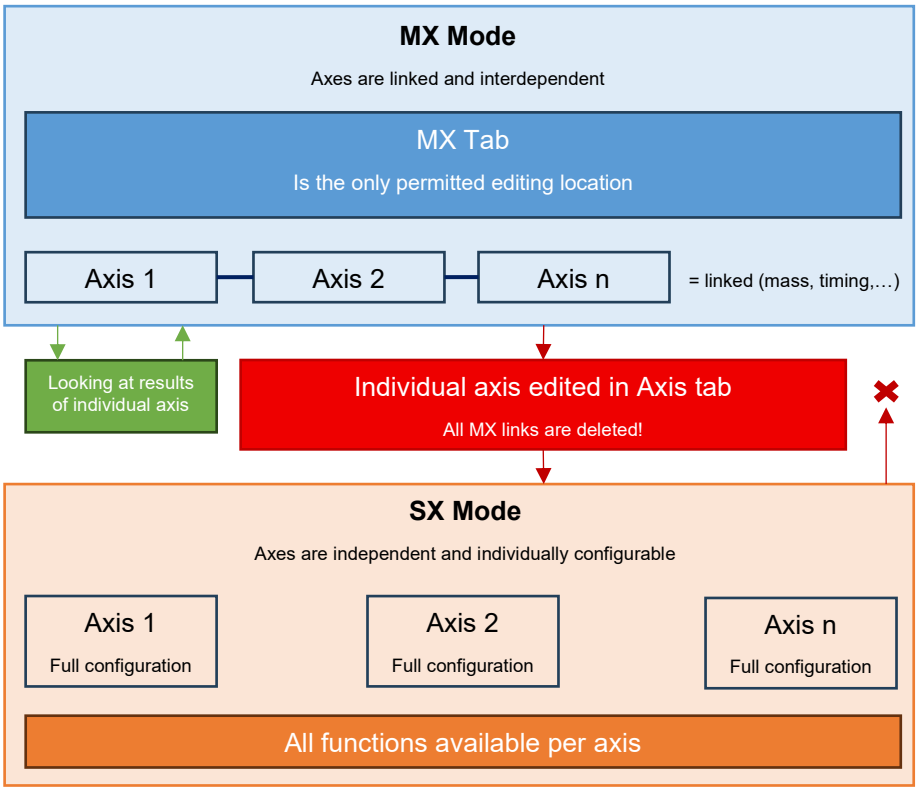


**Assumptions and limitations of MX Mode**
The use of MX Mode implies the following restrictions:

- **No segment-specific load definitions**
  Loads are defined at system level. Segment-dependent mass changes are not supported.
- **Motion defined as VAIJ profiles**
  Motions are described using velocity, acceleration, jerk, and interpolation parameters, rather than freely editable segment shapes.
- **Identical motion parameters for all segments**
  Acceleration, deceleration, and jerk settings apply globally per axis and cannot vary per segment.
- **Mechanical coupling is mandatory**
  The physical relationship between axes must be clearly defined via the mounting configuration.
- **Reduced per-axis flexibility**
  Individual axis optimization is intentionally limited in favor of system-level consistency and simplicity.

This chapter walks through two complete examples of increasing complexity:

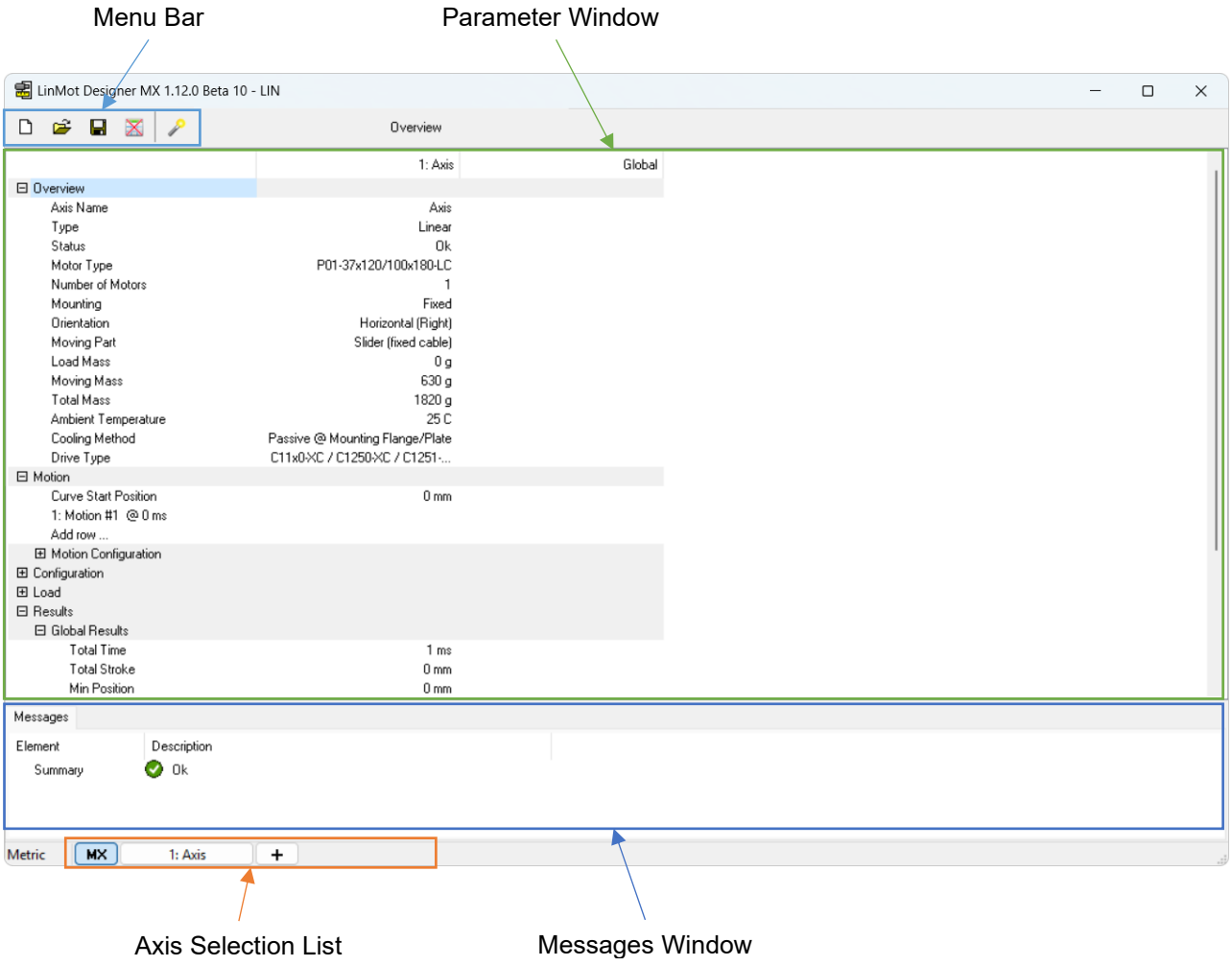
| **Application Example 1: Pick and** Place | **Application Example 2: Full** Gantry | |
|---|---|---|
|  |  | |
| A two-axis handling system with a stacked vertical and horizontal axis for fast pick-and-place operations.<br><br>Focus areas:<br>• Pick and Place configuration with two motors<br>• Coordinated motion sequencing<br>• Power-supply sizing for multi-axis peak loads | A complex multi-axis gantry system with linear and rotary motion for automated bottle capping.<br><br>Focus areas:<br>• Gantry axis configuration with multiple motors<br>• Synchronized linear and rotary motion<br>• Custom Force and Custom Torque curves<br>• Power-supply sizing for multi-axis peak loads | |



## 3.2 Main Window Overview for MX Mode

The main window in MX Mode is divided into four primary areas, which are described in more detail in this section.

**Attention:**
When working with the MX-Designer, adjust parameters only in the MX-Tab. New axes may be created in the *Axis Selection List* and detailed graphs may be analyzed, but no changes are permitted within the individual axis tabs.



### 3.2.1 Menu Bar

The menu bar provides all global project commands and essential MX-Mode functions. Settings apply to all axes in the *Axis Selection List*.




#### 3.2.1.1 Project Management



**New**
Opens a new MX-Designer window to start a new project.

**Open**
Opens a previously created project.

**Save**
Saves the current project progress (see Section 4.6.1).

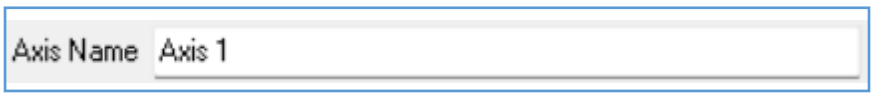
#### 3.2.1.2 Multi Axis Tools



**Add / Delete Motion Table**
In SX Mode Add Motion Table will switch to MX Mode and add the table in the Motion section.
In MX Mode Delete Motion Table will switch to SX Mode and delete the table in the Motion section.

**AI Auto-Calc**
The AI Auto-Calc feature automatically optimizes the total motion time by intelligently adjusting each axis's Motion Configuration parameters. Additional details can be found in the Examples Section 3.3.3.1 and 3.4.3.2.

#### 3.2.1.3 Parameter Adjustment




**Inline Parameter Adjustment**
Parameters whose adjustment does not open a separate window can be modified here. These parameters are described in detail in Section 3.2.2.

### 3.2.2 Parameter Window

This window contains all input parameters necessary for a MX-Project and numerical simulation results.

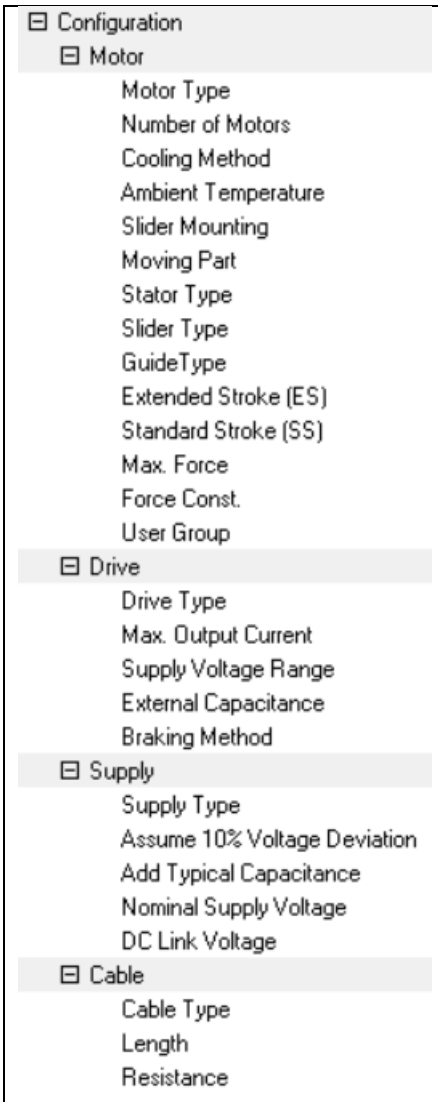



#### 3.2.2.1 Input Parameters

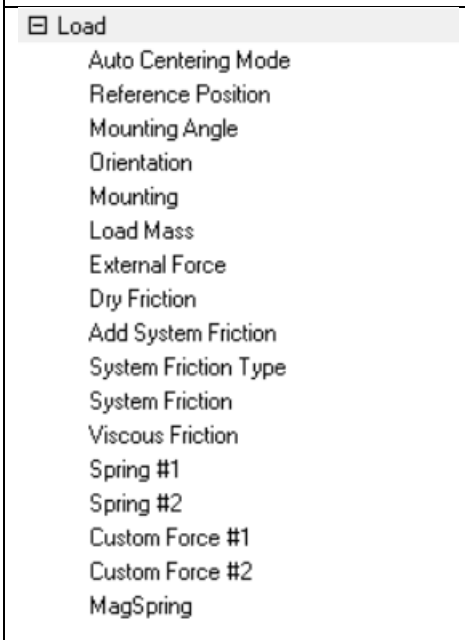
This section displays the Input parameters, which define each axis. Most of the parameters can be adjusted, but some are displayed as a result of a selection and cannot be changed.

**Hint:**
A double-click on most parameters opens its corresponding settings window, or the parameter can be adjusted directly using Inline Parameter Adjustment (see Section 3.2.1.3).

| | |
|---|---|
| Overview<br>Axis Name<br>Type<br>Status<br>Motor Type<br>Number of Motors<br>Mounting<br>Orientation<br>Moving Part<br>Load Mass<br>Moving Mass<br>Total Mass<br>Ambient Temperature<br>Cooling Method<br>Drive Type | **Overview**<br>The Overview section defines the most important parameters of an MX-Project. Here, the motor configuration is selected, and the relationships between the individual axes - such as mounting, orientation, and mass distribution - are established. |
| Motion<br>Curve Start Position<br>Add row ...<br>Motion Configuration<br>Curve Speed<br>Curve Acceleration<br>Curve Jerk | **Motion**<br>In the Motion section, the motion sequence for the project is defined. It allows creating as many motion segments as needed to accurately represent the application. Each segment uses the Limited Jerk curve type, which is currently the only supported curve shape in MX-Mode (see 4.2.1.2.1). |




**Configuration**
The Configuration section provides detailed access to all Motor, Drive, Supply, and Cable parameters used in the project. It corresponds to the options available in the Motor tab of the Global Settings window (see 4.1.1).




**Load**
The Load section provides detailed access to the load parameters used in the project. It corresponds to the options available in the Load tab of the Global Settings window (see 4.1.2).

### 3.2.2.2 Simulation Results

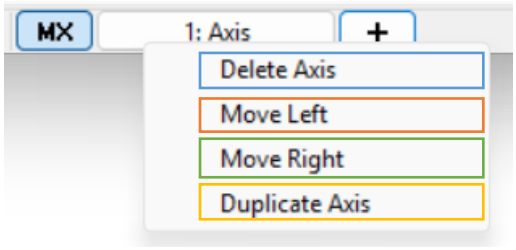
| | |
|---|---|
| ⊟ Results<br>⊟ Global Results<br>Total Time<br>Total Stroke<br>Min Position<br>Max Position<br>Peak Speed<br>Peak Acceleration<br>Peak Force<br>RMS Force<br>Peak Short Time Overload<br>Peak Thermal Load | **Global Results**<br>These parameters provide an overall summary of the system's motion performance. Together, they give a quick assessment of whether the defined motion stays within mechanical, electrical, and thermal limits. |
| ⊟ Supply/Regeneration<br>Peak Supply Power<br>Mean Supply Power<br>Mean Braking Power<br>Max Braking Pulse<br>Min Link Voltage | **Supply/Regeneration**<br>These parameters summarize the electrical power demand and regeneration behavior of each axis. Together, they help assess if the selected power supply, drive, and braking method are suitable for the defined motion. |
| ⊟ System Limits<br>Max. Force<br>Max. Current<br>Max. RMS Stall Force<br>Max. Speed<br>Max. Electrical Power | **System Limits**<br>These parameters define the maximum mechanical, electrical, and thermal capabilities of the selected motor and drive system. |

### 3.2.3 Axis Selection List

The Axis Selection List is used to manage the individual axes.

#### 3.2.3.1 Axis Options

Right-click the tab of an existing axis to open the axis context menu.




**Delete Axis**
Removes the selected axis from the application.

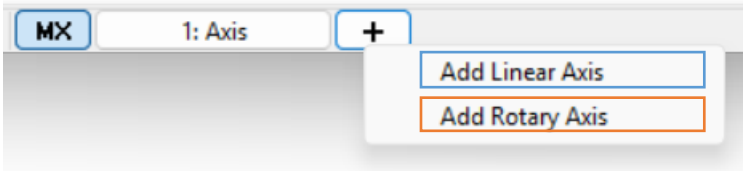
**Move Left**
Moves the selected axis one position to the left in the Axis Selection List.

**Move Right**
Moves the selected axis one position to the right in the Axis Selection List.

**Duplicate Axis**
Creates a copy of the selected axis.

#### 3.2.3.2 Adding Options

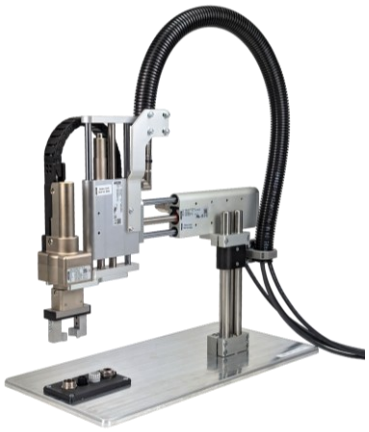
To add another axis to the application, click the + button next to the Axis Selection List.




**Add Linear Axis**
Adds a new axis for a linear motion application.

**Add Rotary Axis**
Adds a new axis for a rotary motion application.

## 3.3 Application Example 1: Pick and Place



### 3.3.1 Requirements

#### 3.3.1.1 Application Overview

This example describes a two-axis pick-and-place application implemented in LinMot MX-Designer. The system consists of a horizontal Y-Axis for positioning and a vertical Z-Axis for picking and placing parts using a gripper.

The Z-Axis moves vertically to pick up a part, while the Y-Axis transports the part horizontally to the target position. After placement, both axes return to their initial positions to start the next cycle.

The complete pick-and-place cycle must be executed within approximately 1.3 s, while maintaining acceptable thermal reserves on both axes.

#### 3.3.1.2 Boundary Conditions and Assumptions

- Ambient temperature is assumed to be 35°C, representing a typical industrial environment.
- Two linear motors are used and configured within one MX-Designer project.
- The Z-Axis is mechanically mounted on the moving part of the Y-Axis.
- Gripper actuation times are modeled as standstill segments:
  - 100 ms for gripping
  - 100 ms for releasing

#### 3.3.1.3 Mechanical Model

The mechanical system consists of:

- A horizontal Y-Axis, fixed to ground
- A vertical Z-Axis, mounted on the Y-Axis
- A gripper and trailing chain mounted on the Z-Axis with a total load of 1200 g
- The handled part has a load of 50 g

#### 3.3.1.4 Purpose of the Example

This example demonstrates how to configure and evaluate a multi-axis pick-and-place application in LinMot MX-Designer. It shows how to:

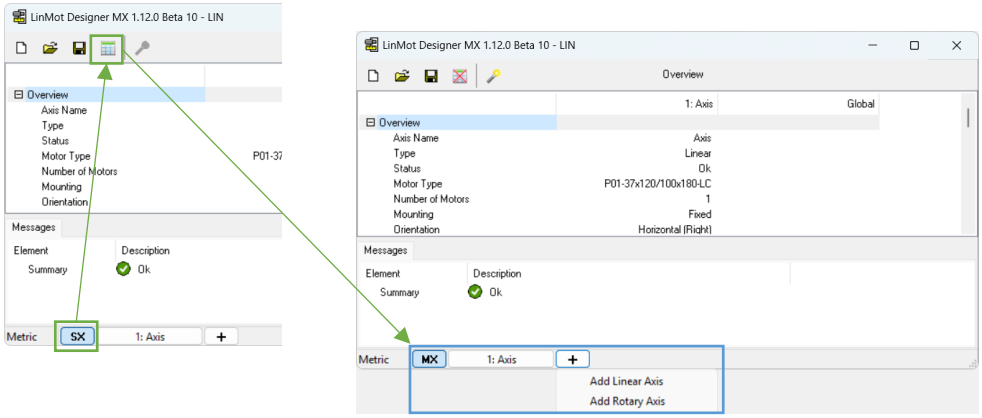
- Set up multiple linear axes within one project
- Define axis mounting relationships and resulting load propagation
- Create a segmented pick-and-place motion sequence
- Optimize cycle time using AI Auto-Calc
- Evaluate force, speed, and thermal utilization of each axis
- Assess thermal limits and implement corrective actions
- Select a suitable power supply based on calculated mean and peak power demands

The scenario reflects a typical real-world pick-and-place task and provides a structured starting point for designing stacked multi-axis systems in MX-Designer.

### 3.3.2 Global / Load Settings

These settings define the key motor, load, and system parameters used throughout the project. These values form the basis for all simulations and configuration checks in LinMot Designer.

A detailed explanation of each parameter is provided in Section 4.1.




*Add Motion Table* to switch from SX Mode to MX Mode.

Because this application requires two motors, an additional linear axis must be added in the *Axis Selection List*.

#### 3.3.2.1 Overview

| | 1: Y-Axis | 2: Z-Axis | Global |
|---|---|---|---|
| ⊟ Overview | | | |
| Axis Name | Y-Axis | Z-Axis | |
| Type | Linear | Linear | |
| Status | Ok | Ok | |
| Motor Type | DM01-23x160H/80-XP | DM03-23x80F/100-XP_MS13 (Pull -22N) | |
| Number of Motors | 1 | 1 | |
| Mounting | Fixed | Y-Axis | |
| Orientation | Horizontal (Right) | Vertical (Down) | |
| Moving Part | Slider (fixed cable) | Slider (fixed cable) | |
| Load Mass | 0 g | 1250 g | |
| Moving Mass | 3485 g | 690 g | |
| Total Mass | 4635 g | 2825 g | |
| Ambient Temperature | 35 C | 35 C | |
| Cooling Method | Passive @ Mounting Flange/Plate | Passive @ Mounting Flange/Plate | |
| Drive Type | C1250-MI-XC | C1250-MI-XC | |

| Setting Name | Selection:<br>Axis1 \| Axis2 | Reason / Guidance |
|---|---|---|
| Axis Name | Y-Axis<br>Z-Axis | Assign a descriptive name to each axis. |
| Type | Linear<br>Linear | Two linear axes are required for this application. The motor type must be chosen when creating the axis (see Section 3.3.2) and cannot be changed here. |
| Motor Type | DM01-23x160H/80-XP<br>DM03-23x80F/100-XP-MS13 | If you already have a rough idea of the required motor type, you may proceed with this selection. Otherwise, ensure that the selected motor provides enough stroke for the application. It is acceptable to use a motor with slightly longer stroke to allow mechanical safety margins. The exact motor type will be verified and, if necessary, adjusted after the first simulation. |

| | | |
|---|---|---|
| Number of Motors | 1<br>1 | Each axis requires only one motor. |
| Mounting | Fixed<br>Y-Axis | Defines how each axis is mechanically connected or stacked. The Y-Axis is fixed to ground; the Z-Axis is mounted on the moving part of the Y-Axis. |
| Orientation | Horizontal (Right)<br>Vertical (Down) | Orientation reflects installation direction. In this application, the Y-Axis moves horizontally; the Z-Axis moves vertically with positive direction downwards. |
| Moving Part | Slider (fixed cable)<br>Slider (fixed cable) | Specifies whether stator or slider moves. This is predetermined by the selected motor module. |
| Load Mass | 0 g<br>1250 g | Additional payload mounted on the axis. The gripper, part, and trailing chain are mounted on the Z-Axis. |
| Ambient Temperature | 35°C<br>35°C | Environmental temperature defined by the application. |
| Cooling Method | Passive<br>Passive | Cooling strategy predefined by the motor type. |
| Drive Type | C1250-MI-XC<br>C1250-MI-XC | Recommended drive type for this motor class at the time of writing. |

### 3.3.2.2 Configuration

The parameters defined in the Overview already set all required configurations; therefore, no further adjustments are necessary in the Configuration section for this project.

| | 1: Y-Axis | 2: Z-Axis | Global |
|---|---|---|---|
| ⊞ Overview | | | |
| ⊞ Motion | | | |
| ⊟ Configuration | | | |
| ⊟ Motor | | | |
| Motor Type | DM01-23x160H/80-XP | DM03-23x80F/100-XP_MS13 (Pull -22N) | |
| Number of Motors | 1 | 1 | |
| Cooling Method | Passive @ Mounting Flange/Plate | Passive @ Mounting Flange/Plate | |
| Ambient Temperature | 35 C | 35 C | |
| Slider Mounting | Reversed | Regular | |
| Moving Part | Slider (fixed cable) | Slider (fixed cable) | |
| Stator Type | Integrated | Integrated | |
| Slider Type | Integrated | Integrated | |
| GuideType | Integrated | Integrated | |
| Extended Stroke (ES) | 80 mm | 100 mm | |
| Standard Stroke (SS) | 74.75 mm | 97.75 mm | |
| Max. Force | 148.7 N | 72.43 N | |
| Force Const. | 13.52 N/Apk | 9.658 N/Apk | |
| User Group | Std | Std | |
| ⊟ Drive | | | |
| Drive Type | C1250-MI-XC | C1250-MI-XC | |
| Max. Output Current | 28 Apk | 28 Apk | |
| Supply Voltage Range | 24 V - 85 V | 24 V - 85 V | |
| External Capacitance | 0 uF | 0 uF | |
| Braking Method | None | None | |
| ⊟ Supply | | | |
| Supply Type | DC Link 72 V | DC Link 72 V | |
| Assume 10% Voltage Deviation | No | No | |
| Add Typical Capacitance | Yes | Yes | |
| Nominal Supply Voltage | 72 V | 72 V | |
| DC Link Voltage | 72 V | 72 V | |
| ⊟ Cable | | | |
| Cable Type | None | None | |
| Length | 0 m | 0 m | |
| Resistance | 0 Ohm | 0 Ohm | |

### 3.3.2.3 Load

The parameters defined in the Overview already set all required configurations; therefore, no further adjustments are necessary in the Load section for this project.

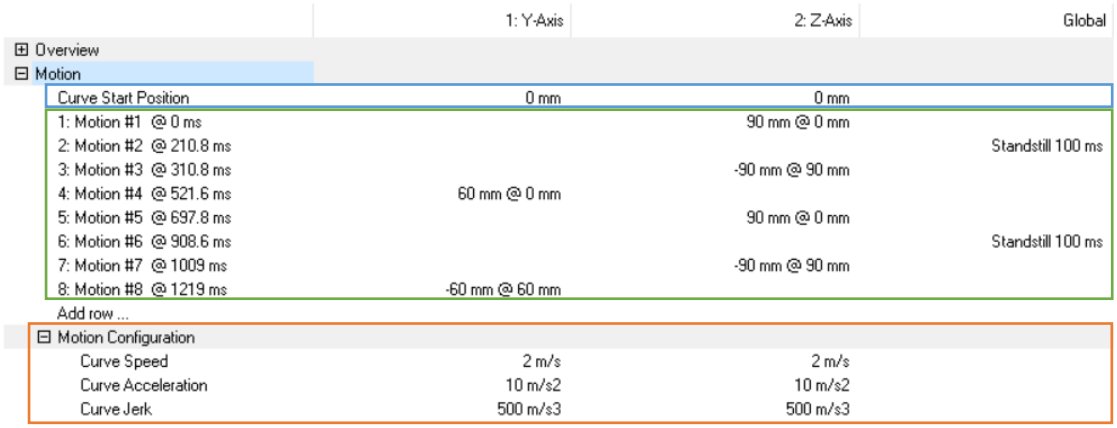
| | 1: Y-Axis | 2: Z-Axis | Global |
|---|---|---|---|
| ⊞ Overview | | | |
| ⊞ Motion | | | |
| ⊞ Configuration | | | |
| ⊟ Load | | | |
| Auto Centering Mode | Yes | Yes | |
| Reference Position | -15.75 mm | -13.75 mm | |
| Mounting Angle | 0 deg | -90 deg | |
| Orientation | Horizontal (Right) | Vertical (Down) | |
| Mounting | Fixed | Y-Axis | |
| Load Mass | 0 g | 1250 g | |
| External Force | 0 N | 0 N | |
| Dry Friction | 0 N | 0 N | |
| Add System Friction | Yes | Yes | |
| System Friction Type | No Wipers | No Wipers | |
| System Friction | 4 N | 8 N | |
| Viscous Friction | 0 N/(m/s) | 0 N/(m/s) | |
| Spring #1 | not defined | not defined | |
| Spring #2 | not defined | not defined | |
| Custom Force #1 | None | None | |
| Custom Force #2 | None | None | |
| MagSpring | None | None | |

### 3.3.3 Motion

The motion sequence defines the ordered set of movements and standstill periods for each axis. Each entry below corresponds to one segment in the motion profile.

More information can be found in chapter 4.2.

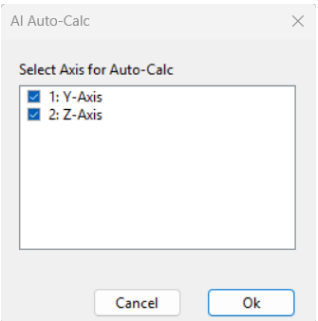
#### 3.3.3.1 Motion Segments



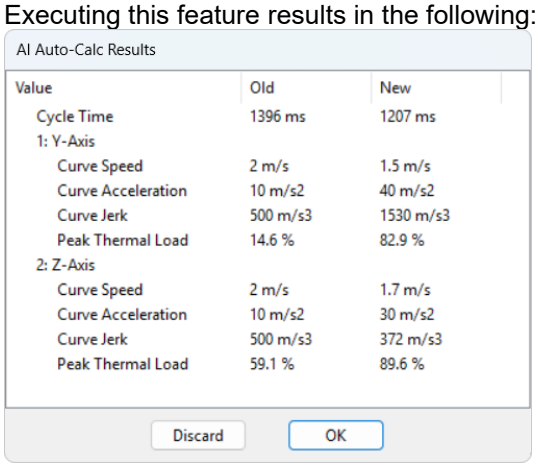

| Curve | Stroke / Standstill | Reason / Guidance |
|---|---|---|
| Start Position | Y-Axis = 0 mm<br>Z-Axis = 0 mm | Defines the initial reference position of both axes before motion begins. |
| 1 | Z-Axis = 90 mm | Move the Z-Axis 90 mm in the positive direction (down).<br>Each segment completes before the next begins. |
| 2 | 100 ms | Wait 100 ms to allow the gripper to close. |
| 3 | Z-Axis = -90 mm | Move the Z-Axis 90 mm upward (negative direction). |
| 4 | Y-Axis = 60 mm | Move the Y-Axis 60 mm in the positive direction. |
| 5 | Z-Axis = 90 mm | |
| 6 | 100 ms | Wait 100 ms to allow the gripper to open. |
| 7 | Z-Axis = -90 mm | |
| 8 | Y-Axis = -60 mm | |
| Curve Speed | | These parameters define the dynamic behavior—speed, acceleration, and jerk—applied to each motion segment of the associated axis.<br>These values represent initial settings and will be optimized in the next design step (see 3.3.3.2). |
| Curve Acceleration | | |
| Curve Jerk | | |

#### 3.3.3.2 AI Auto-Calc

Using the AI Auto-Calc button (see 3.2.1.2) automatically and iteratively adjusts the Curve Speed, Acceleration, and Jerk for each axis to minimize the Total Time shown in the Global Results. Throughout this optimization, the tool ensures that the motor remains in a fully operable state by avoiding any Errors or Warnings. When pressed, the AI Auto-Calc button opens a dialog window in which the user can select the individual axes that should be included in the optimization process.



Executing this feature results in the following:

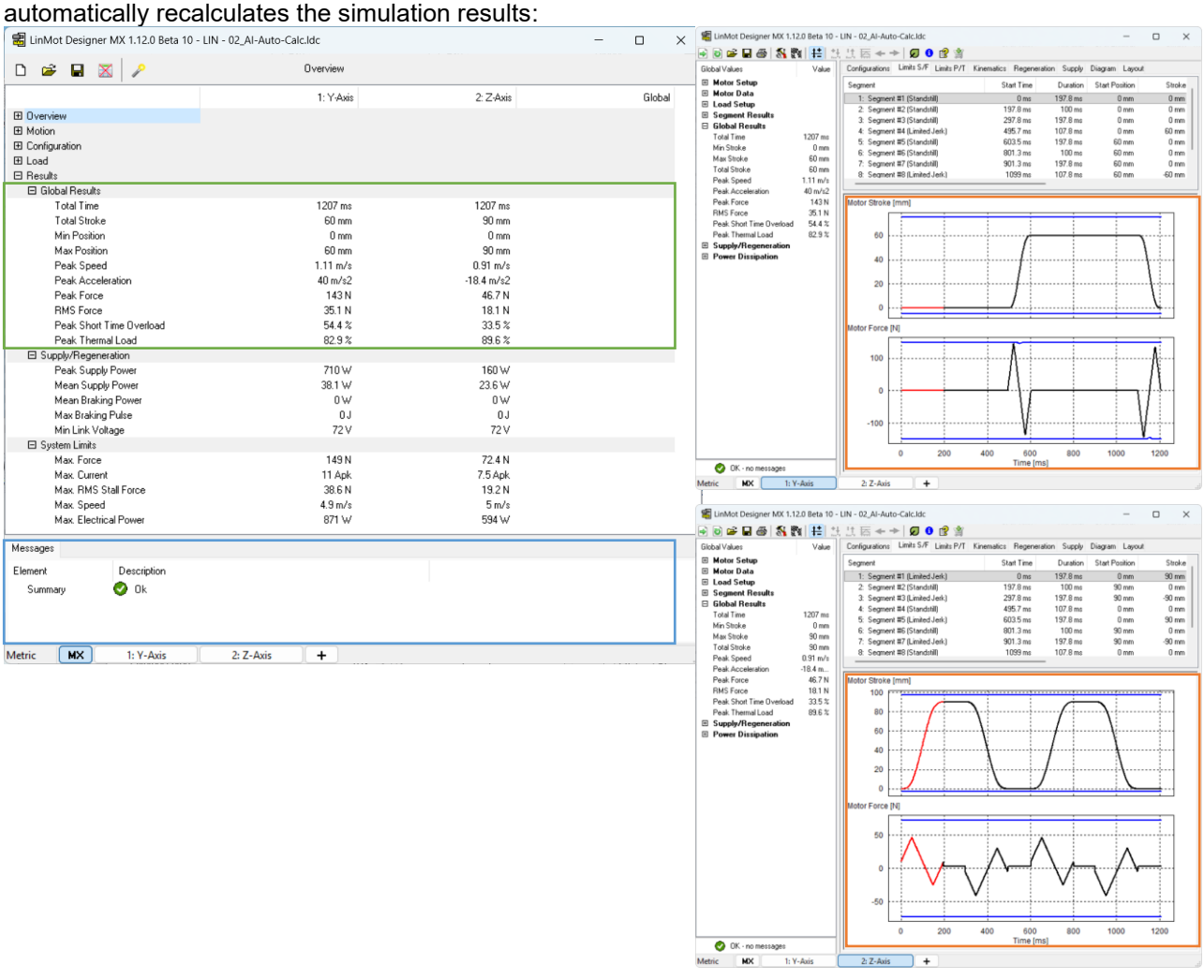



### 3.3.4 Evaluation

A detailed explanation of evaluation logic and messages description can be found in Section 4.3.

#### 3.3.4.1 Evaluating Design

After completing the motion and load setup and maybe executing the AI Auto-Calc feature, LinMot Designer automatically recalculates the simulation results:




A typical evaluation sequence consists of the following steps:

### 1. Check for Errors or Warnings

Errors, warnings, and notes appear in the message area and must always be reviewed first.

- In this design, no errors are present for any axis.

### 2. Review the Global Values

The Global Results window shows peak, RMS, and mean values of all relevant physical parameters.

- In this design, all parameters are below their maximum permissible limits.

### 3. Analyze Critical Parameters in the Diagram Windows

All diagram windows inside of the individual axes provide time-based visualizations of motion, force, speed, thermal load, and other system behaviors.

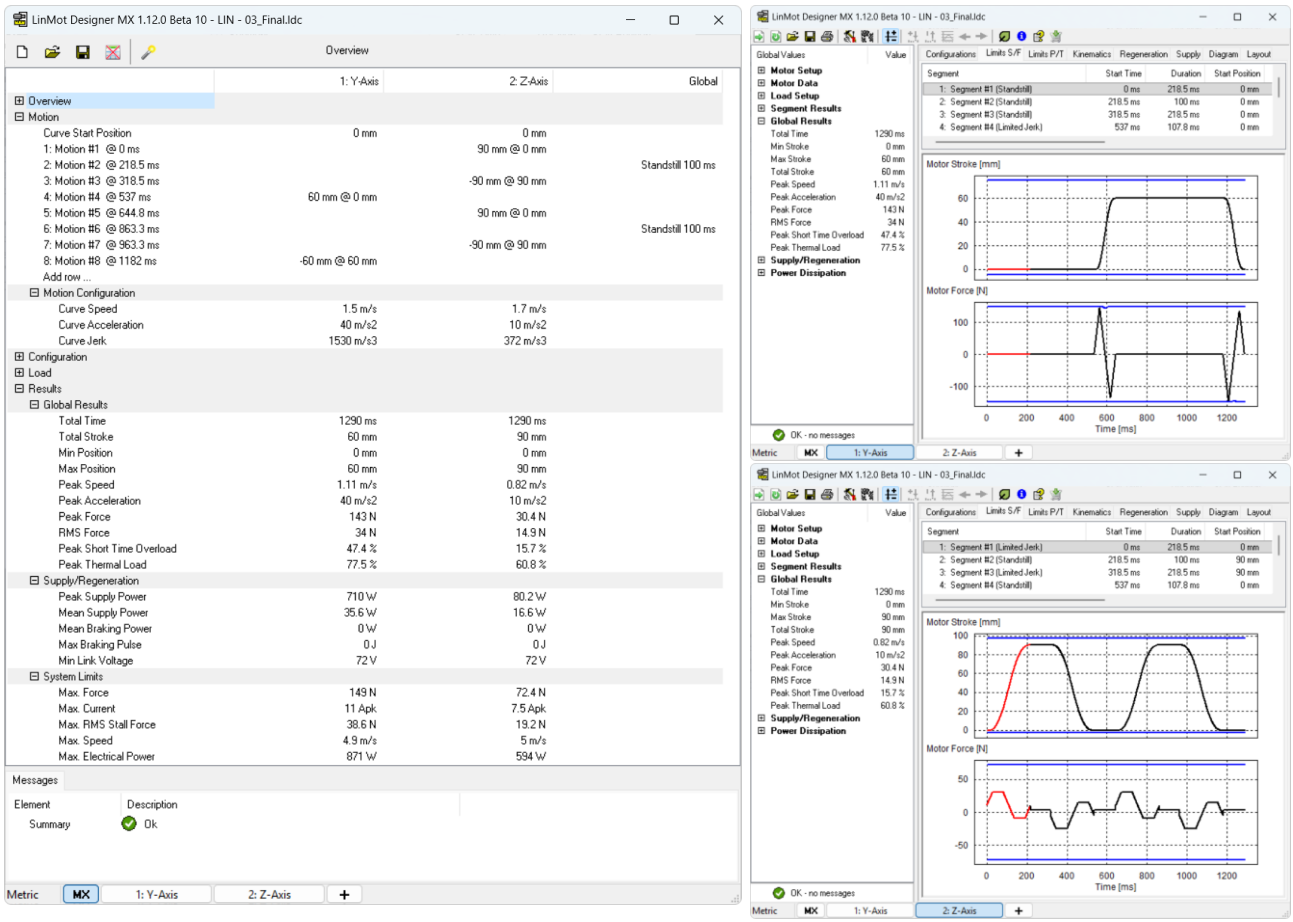
- In this design, the diagrams show clean profiles with minimal performance reserves.

#### 3.3.4.2 Results

Having used the AI Auto-Calc button the design is calculated with one or more motors at their thermal limit. This results in a cycle time of 1.2 seconds and Peak Thermal Load of the Z-Axis of 89.6%. The task defines a cycle time of at least 1.3 seconds. Therefore it can be tested if this cycle time has higher thermal reserves.

### 3.3.5 Corrective Actions

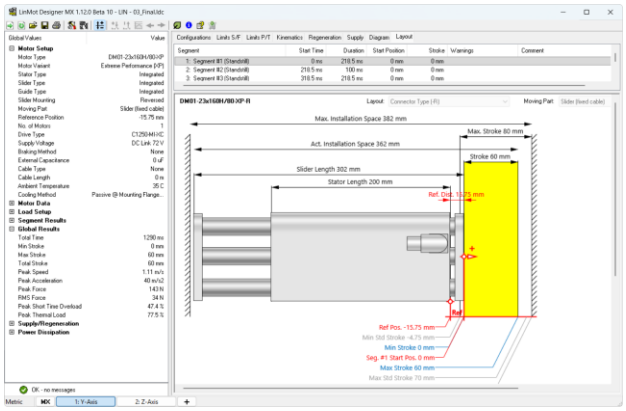
In order to see how the design performs at a cycle time of 1.3 s, the motor, which is at the limit (Z-Axis) can be made to move slower. Therefore the *Curve Acceleration* in *Motion Configuration* is reduced to 10 $m/s^2$ which results in a Cycle time of 1290 s and a thermal Load of 60.8 %.

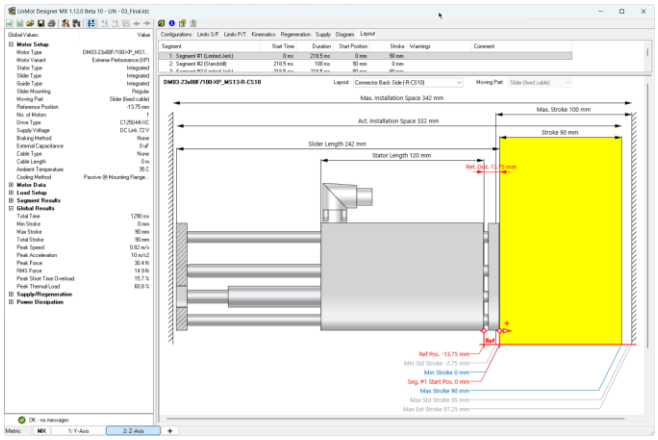



This design can be used for the application.

### 3.3.6 Layout Check

The *Layout Check* in the MX part is best used in combination with the full assembly of this system. Especially because of how the parts are mounted together. Nevertheless the information in these Layouts are still relevant.

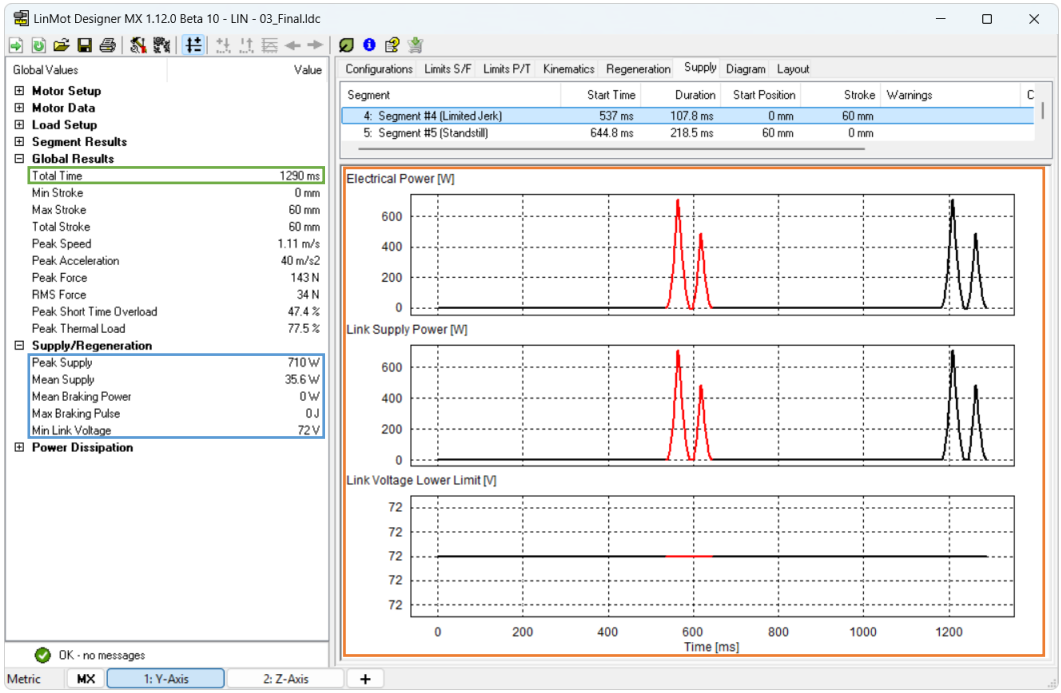


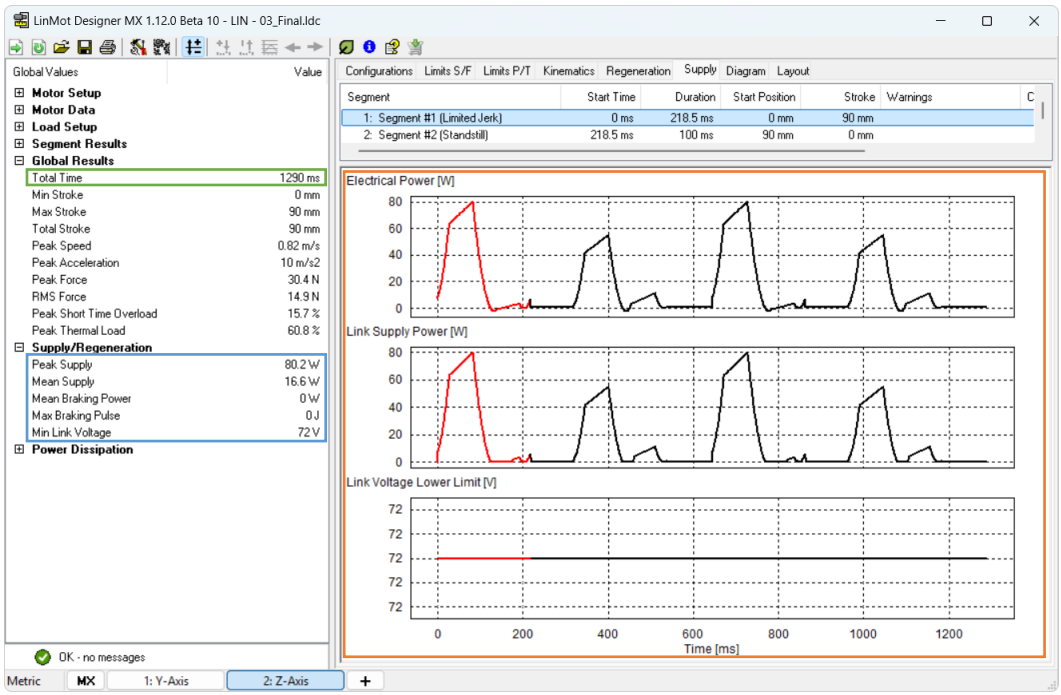


### 3.3.7 Select Power Supply

To ensure reliable operation of the axis, the power supply must be selected based on voltage level, mean power demand, and peak power / energy demand of the motion profile.

In this example, it is assumed that only these two motors are connected to the power supply.






In this example some values have been simplified in order to make the calculation easier. The most important thing is to display the worst case scenario. The following values are relevant from the figure above:

| Description | Y-Axis | Z-Axis | Total / Relevant |
|---|---|---|---|
| Min Link Voltage | 72 V | 72 V | 72 V |
| Total Cycle Time | 1290 ms | 1290 ms | 1290 ms |
| Mean Supply | 35.6 W | 80.2 W[3] | 115.8 W |
| Peak Supply | ~710 W for ~2x100 ms | Simplified | ~790.2 W for ~200 ms |

3. **Match the DC Output Voltage**
   Select a power supply whose nominal DC output voltage matches the required DC bus voltage of the drive.
   For this application, both axes require a 72 V DC supply. The power supply type S02-72/600 provides a fixed output of 72 V DC ±1% at 100% load and is therefore suitable from a voltage perspective.

4. **Check Continuous (Mean) Power Requirement**
   The calculated mean power demand of both axis is:
   - Mean Supply Power: 115.8 W

   The power supply must provide at least 110% of the Mean Supply:
   - $P_{required,\ continuous} \approx 1.1 \times 115.8\ W \approx 127.4\ W$

   The selected power supply must provide a continuous output power greater than this value.
   - The S02-72/600 offers a continuous output power of 600 W, which is significantly higher than the required 127.4 W. This ensures ample margin for continuous operation and additional consumers on the DC bus if needed.

6. **Check Peak Power and Energy Requirement**
   The motion profile requires a peak power of:
   - Peak Supply Power: 790.2 W
   - Peak Duration: 200 ms
   - Total Cycle Time: 1290 ms

[3] In this simplification the *Peak Supply* value is used as the *Mean Supply*. The main reason is that the duration of the peak load is quite long during the cycle.

For peak evaluation, both peak power and boost energy must be within the capabilities of the power supply:

- The S02-72/600 supports Powerboost up to 250% of nominal power for 2 s, i.e. up to 1500 W for 2 s (1500 Ws).
- The energy required by the application peak is approximately:
  $$E_{\text{peak}} \approx 790.2\ \text{W} \times 0.2\ \text{s} \approx 158.0\ \text{Ws}$$
  This is far below the available 1500 Ws boost capability.
- According to the load behaviour specification, overloads up to 500 Ws within 4 s do not require a cool-down phase. The required ~158.0 Ws is well within this limit, so no additional cool-down is necessary within the 1290 ms cycle time.

Thus, the peak power and energy demands of the axis are safely covered by the boost capability of the selected power supply.

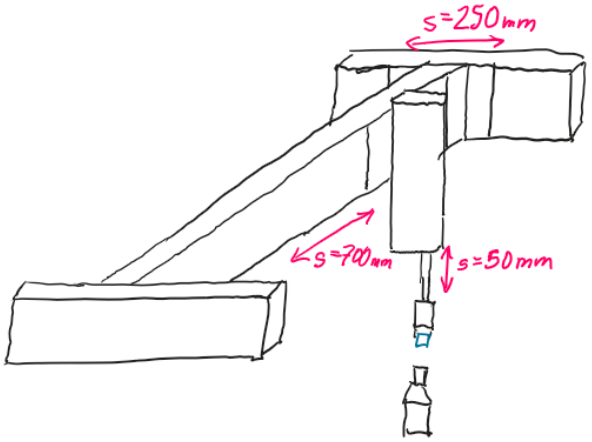
7. **Check Installation and Environmental Conditions**
   See Application Example 1: Horizontal Pusher for more details.

8. **Recommendation**
   A supply in the S02-72/600 or S02-72/1000 class is fully suitable, depending on your preferred vendor/spec.

### 3.3.8 Export / Print Project Data

See Chapter 4.6 for more information.

## 3.4 Application Example 2: Full Gantry




### 3.4.1 Requirements

#### 3.4.1.1 Application Overview

This example describes a multi-axis bottle-capping application consisting of three linear axes (X, Y, Z) and one rotary axis integrated into the Z-axis. A bottle cap is picked from a feeder, transported to the capping position, pressed onto the bottle, and screwed on using a synchronized linear and rotary motion.

The complete cycle - including picking, positioning, screwing, releasing, and returning to the start position - must be executed in less than 3 s, while maintaining sufficient thermal and force reserves on all axes.

#### 3.4.1.2 Boundary Conditions and Assumptions

The following boundary conditions and assumptions apply to this example:

- Ambient temperature is assumed to be 35 °C, representing a typical industrial environment.
- The application consists of four motors: two linear motors for the X-axis (gantry configuration), one linear motor for the Y-axis, and a combined linear-rotary motor for the Z-axis.
- Motor-drive cables are routed through trailing chain, resulting in increased effective cable lengths.
- The friction torque during the screwing process is estimated and modeled as a constant torque once the cap thread is fully engaged.
- The cap does not have to be tightened, only screwed on.
- The weight of the gripper and handled part is fully assigned to the Z-axis (linear and rotary components).

#### 3.4.1.3 Mechanical Model

The mechanical system is modeled as follows:

- X-Axis: Gantry axis with two linear motors to ensure symmetric force distribution and prevent torsional loads. Required stroke: 250 mm
- Y-Axis: Single linear axis carrying the Z-axis assembly. Required stroke: 700 mm
- Z-Axis (Linear): Vertical axis responsible for picking, pressing, and releasing the bottle cap. Required stroke: 50 mm
- Z-Axis (Rotary): Integrated rotary axis used to apply the screwing motion.
- Mass and Inertia of gripper: 1200 g | 5.5 kg*cm$^2$
- Mass and Inertia of cap: 2 g | 0.001 kg*cm$^2$
- A defined axial pressing force of 70 N during the screwing process.
- A defined friction torque of 0.5 Nm applied during cap tightening.

#### 3.4.1.4 Motion Sequence and Segmentation

The application cycle is represented by a segmented motion profile:

- Move Z-Axis downward to pick the cap (10 mm)
- Standstill while the gripper closes (60 ms)
- Move Z-Axis upward to clear the feeder (10 mm)
- Move X-Axis to the capping position (250 mm)
- Move Y-Axis to the capping position (700 mm)
- Move Z-Axis downward to the thread engagement position (45 mm)
- Synchronized motion: linear Z-Axis pressing combined with rotary Z-Axis screwing (5 mm & 500°)
- Standstill while the gripper opens (60 ms)
- Move Z-Axis upward to a safe position (50 mm)
- Simultaneous return motion of X- and Y-Axes to the start position (250 mm & 700 mm)

#### 3.4.1.5 Purpose of the Example

Based on the defined boundary conditions, mechanical model, and motion sequence, this example demonstrates how to design and validate a complex multi-axis screwing application in LinMot Designer.

It shows how to:

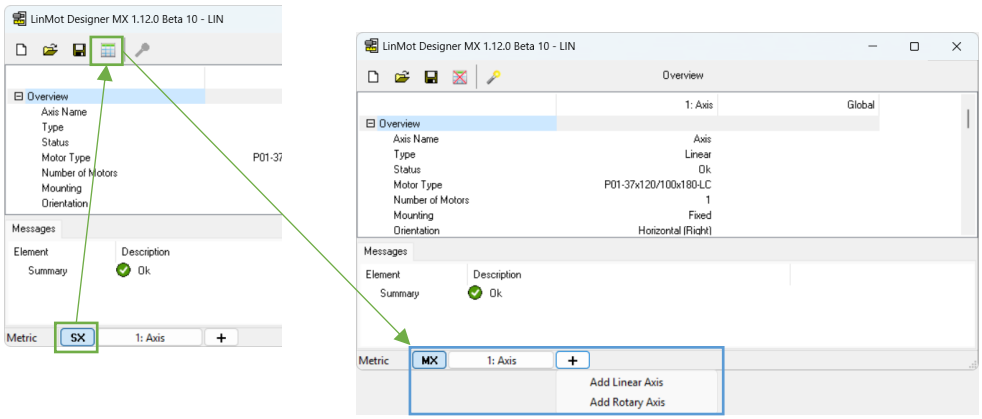
- Configure and evaluate multi-axis systems with mixed linear and rotary motion
- Model gantry axes with multiple motors
- Implement force-controlled pressing and torque-controlled screwing without external sensors
- Apply Custom Force and Custom Torque curves
- Handle synchronization effects between linear and rotary axes
- Evaluate thermal limits, force reserves, and cycle time
- Select suitable motors, drives, and power supply configurations

The scenario reflects a typical real-world bottle-capping or assembly application and provides a structured, reproducible workflow for advanced system sizing and validation in LinMot Designer.

### 3.4.2 Global / Load Settings

These settings define the key motor, load, and system parameters used throughout the project. These values form the basis for all simulations and configuration checks in *LinMot Designer*.

A detailed explanation of each parameter is provided in Section 4.1.




*Add Motion Table* to switch from SX Mode to MX Mode.

Because this application requires four motors, **three additional linear axis** and **one rotary** must be added in the *Axis Selection List*.

#### 3.4.2.1 Overview

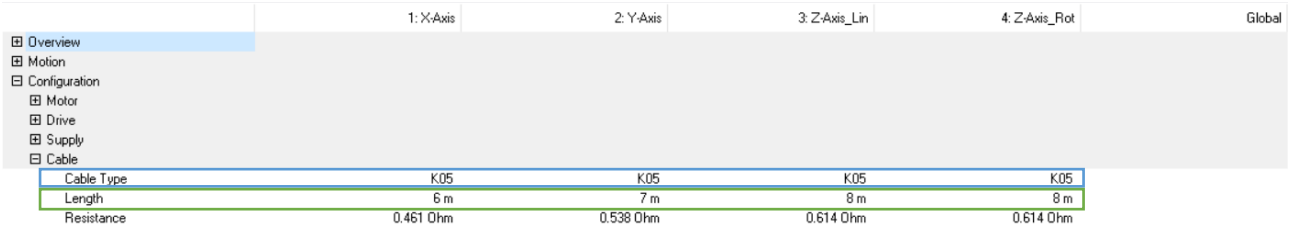
| Overview | 1: X-Axis | 2: Y-Axis | 3: Z-Axis_Lin | 4: Z-Axis_Rot | Global |
|---|---|---|---|---|---|
| Axis Name | X-Axis | Y-Axis | Z-Axis_Lin | Z-Axis_Rot | |
| Type | Linear | Linear | Linear | Rotary | |
| Status | 1 Warning | 1 Warning | Ok | Ok | |
| Motor Type | FM01-37Sx120F/335-HP | EM01-37Sx120F/1235-HP | PR02-52x60/37x120F-HP-100-M... | PR02-52x60/37x120F-HP-100-M... | |
| Number of Motors | 2 | 1 | 1 | 1 | |
| Mounting | Fixed | X-Axis | Y-Axis | Y-Axis | |
| Orientation | Horizontal (Right) | Horizontal (Right) | Vertical (Down) | Horizontal (Right) | |
| Moving Part | Stator (moving cable) | Stator (moving cable) | Slider (fixed cable) | Slider (fixed cable) | |
| Load Mass | 1400 g | 2800 g | 1202 g | 5.501 kg*cm2 | |
| Moving Mass | 39660 g | 10710 g | 1220 g | 0.4 kg*cm2 | |
| Total Mass | 51590 g | 35840 g | 7652 g | 5230 g | |
| Ambient Temperature | 35 C | 35 C | 35 C | 35 C | |
| Cooling Method | Passive @ Mounting Flange/Plate | Passive @ Mounting Flange/Plate | Passive @ Mounting Flange/Plate | Passive @ Mounting Flange/Plate | |
| Drive Type | C1250-MI-XC | C1250-MI-XC | C1250-MI-XC | C1250-MI-XC | |

| Setting Name | Selection:<br>Axis1 \| Axis2 \| … | Reason / Guidance |
|---|---|---|
| Axis Name | X-Axis<br>Y-Axis<br>Z-Axis_Lin<br>Z-Axis_Rot | Assign a clear and descriptive name to each axis to reflect its physical direction or function within the system. |
| Type | Linear<br>Linear<br>Linear<br>Rotary | The axis type defines the fundamental motion principle used in the application. |
| Motor Type | FM01-37Sx120F/335-HP<br>EM01-37Sx120F/1235-HP<br>PR02-52x60/37x120F-HP-100-MS01 (Pull -30N)<br>PR02-52x60/37x120F-HP-100-MSxx | If you already have a rough idea of the required motor type, you may proceed with this selection. The chosen motor types represent the recommended configuration for this application. |
| Number of Motors | 2<br>1<br>1<br>1 | The X-Axis is configured as a full gantry system with two motors to ensure mechanical symmetry, load distribution, and positional accuracy. This is required because the Y-Axis length is relatively long, and a single-motor solution would introduce torsional loads and positioning errors. |

| | | |
|---|---|---|
| Mounting | Fixed<br>X-Axis<br>Y-Axis<br>Y-Axis | The mounting definition specifies which axis carries the motor mass and how it interacts mechanically with the rest of the system. E.g.: The PR02-Motor (Lin and Rot) is attached to the Y-Axis. |
| Orientation | Horizontal (Right)<br>Horizontal (Right)<br>Vertical (Down)<br>Horizontal (Right) | Axis orientation defines the direction of motion relative to gravity. Gravitational forces do not act on the rotary component and therefore cannot be configured for the rotary axis (default: Horizontal). |
| Load Mass[4] | 1400 g<br>2800 g<br>1202 g<br>5.501 kg*cm$^2$ | The load mass represents the total moving mass or rotational inertia acting on each axis. In MX-Designer, the weight of moving components cannot be distributed segment-wise; therefore, all relevant masses must be included in the global load mass settings.<br>• The weight of the gripper and handled part is assigned to the Z-Axis (Linear and Rotary).<br>• The X- and Y-Axes additionally include the mass of the trailing cable chain. |
| Ambient Temperature | 35°C (for all) | |
| Cooling Method | Passive (for all) | |
| Drive Type | C1250-MI-XC (for all) | Recommended at the time of writing. |

### 3.4.2.2 Configuration

For this application, the majority of relevant parameters are configured in the *Overview* (see 3.4.2.1). The only required adjustment concerns the cable length, which must be defined in the *Cable* settings:




| Setting Name | Selection:<br>Axis1 \| Axis2 \| … | Reason / Guidance |
|---|---|---|
| Cable Type | K05 (for all) | For the selected motors, K05 cables are sufficient. However, if larger motors are required at a later project stage, the cable type must be reviewed and potentially adapted to ensure compatibility and compliance with electrical requirements. |
| Length | 6 m<br>7 m<br>8 m<br>8 m | The customer-specified cable length from the system to the drive is 5 m. In this application, the cables must be routed through one or more trailing chains, which increases the required cable length. Therefore, additional length is added depending on the number of trailing chains involved and their respective lengths, ensuring sufficient slack and reliable operation over the full stroke. |

[4] In order to be able to insert a 4-digit-number, the *Significant Digits* in *Measurement Settings* (see 2.2.1.2) need to be adjusted to 4. This can be changed in any one of the Axis and will be applied to the whole project.

### 3.4.2.3 Load

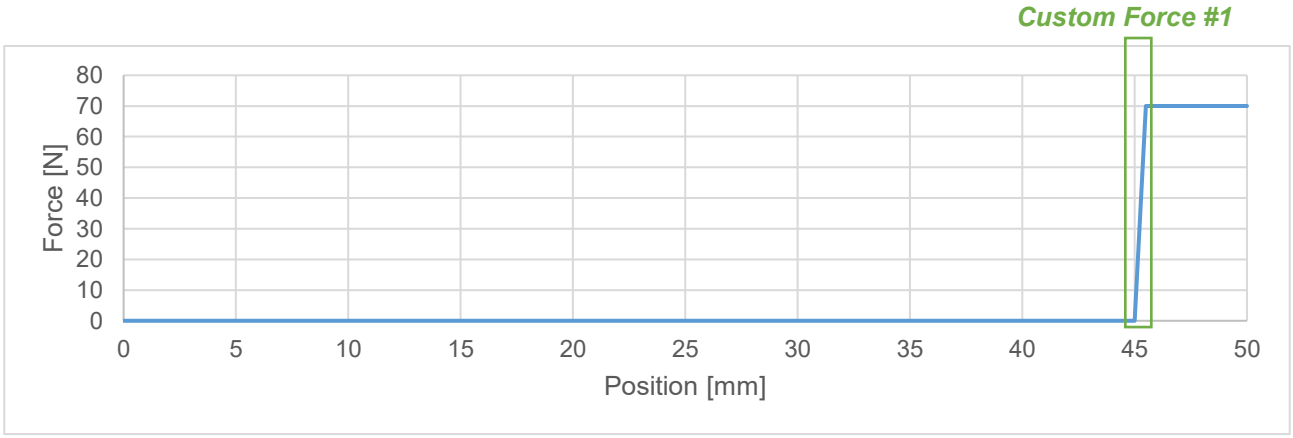
For this application, the majority of relevant parameters are configured in the *Overview* (see 3.4.2.1). The required adjustments concern the trailing chain friction and the additional force caused by the screwing process, which must be defined in the *Load* settings:

| | 1: X-Axis | 2: Y-Axis | 3: Z-Axis_Lin | 4: Z-Axis_Rot | Global |
|---|---|---|---|---|---|
| ⊞ Overview | | | | | |
| ⊞ Motion | | | | | |
| ⊞ Configuration | | | | | |
| ⊟ Load | | | | | |
| Auto Centering Mode | Yes | Yes | Yes | No | |
| Reference Position | -315 mm | -769 mm | -59.7 mm | 0 deg | |
| Mounting Angle | 0 deg | 0 deg | -90 deg | 0 deg | |
| Orientation | Horizontal (Right) | Horizontal (Right) | Vertical (Down) | Horizontal (Right) | |
| Mounting | Fixed | X-Axis | Y-Axis | Y-Axis | |
| Load Mass | 1400 g | 2800 g | 1202 g | 5.501 kg*cm2 | |
| External Force | 0 N | 0 N | 0 N | 0 Nm | |
| Dry Friction | 1.5 N | 5 N | 0 N | 0 Nm | |
| Add System Friction | Yes | Yes | Yes | Yes | |
| System Friction Type | No Wipers | No Wipers | No Wipers | No Wipers | |
| System Friction | 14 N | 22 N | 10 N | 0.001 Nm | |
| Viscous Friction | 0 N/(m/s) | 0 N/(m/s) | 0 N/(m/s) | 0 Nm/(deg/s) | |
| Spring #1 | not defined | not defined | not defined | not defined | |
| Spring #2 | not defined | not defined | not defined | not defined | |
| Custom Force #1 | None | None | 0..70 N @ [45..45.5 mm> | 0..0.5 Nm @ [160..250 deg> | |
| Custom Force #2 | None | None | None | None | |
| MagSpring | None | None | None | None | |

| Setting Name | Selection:<br>Axis1 \| Axis2 \| Axis3 \| Axis4 | Reason / Guidance |
|---|---|---|
| Dry Friction | 2.5 N<br>5 N<br>-<br>- | The system friction is included by default. Additional friction is caused by the trailing chains in this system. Please be aware that the X-Axis needs two trailing chains. |
| Custom Force | None<br>None<br>See below (3.4.2.3.1)<br>See below (3.4.2.3.2) | The forces caused by the screwing process can be applied segment-wise using the Custom Force. |

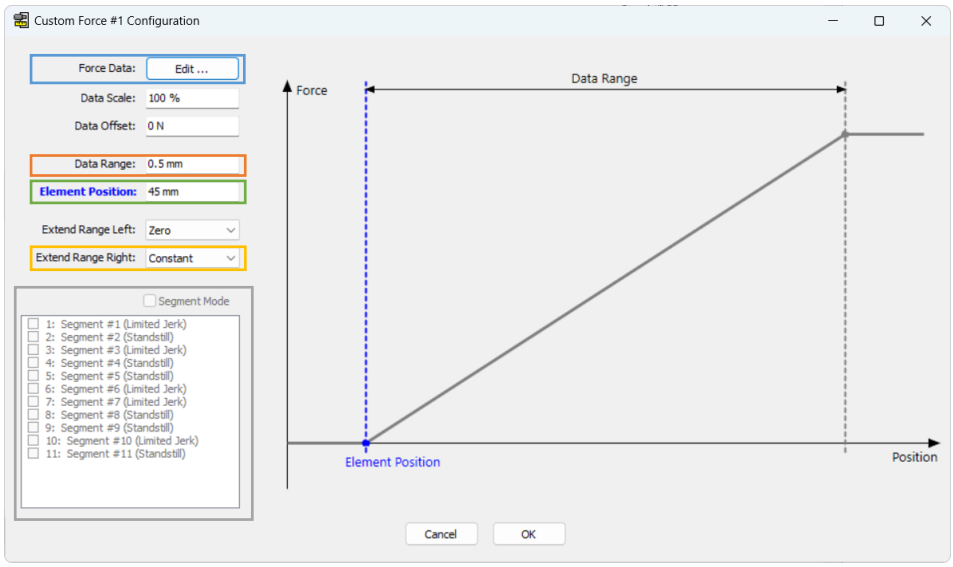
#### 3.4.2.3.1 Custom Force Z-Axis_Lin

See Section 4.1.2.2.2 for more information.
The following curve represents the target force profile applied to the Z-Axis_Lin during the bottle-capping process.




- Initially, the applied force is 0 N.
- At the beginning of the bottle thread (≈ 45 mm), the force increases rapidly.
- During the screwing phase, the cap is pressed onto the bottle with a constant force of 70 N.

### *Custom Force #1*





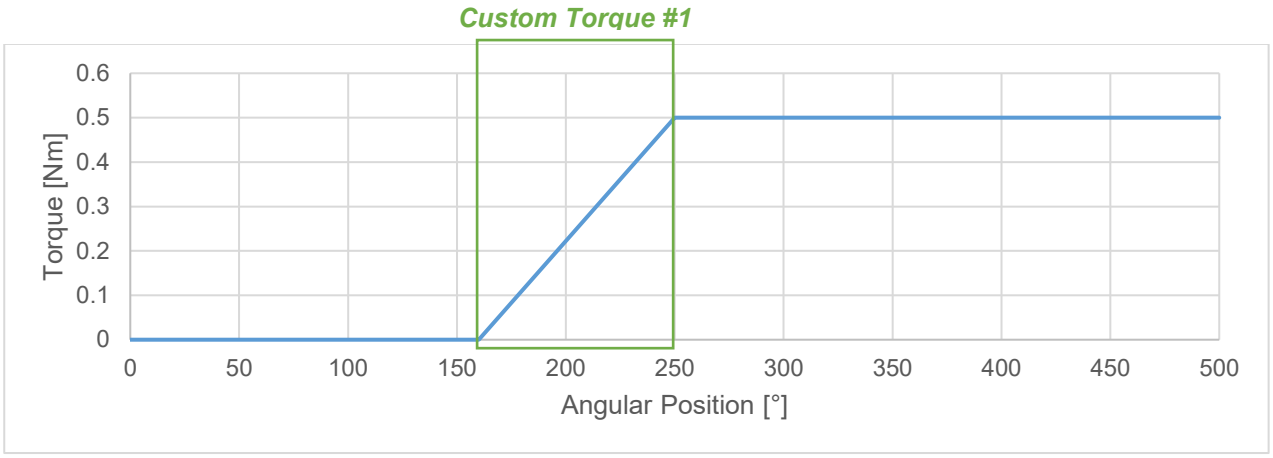


| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Torque Data | Edit… | The force curve is defined here. Selecting Edit… opens the Data Points Editor, where the force values can be entered manually or imported. |
| Data Points | 0 N<br>70 N | Defines the force increase from 0 N to 70 N, representing the transition from initial contact to the screwing phase. |
| Data Scale | 100 % | |
| Data Offset | 0 Nm | |
| Data Range | 0.5 mm | Defines the distance over which the force ramps up from 0 N to 70 N. In this application, it is assumed that the full force is reached within 0.5 mm after thread engagement. |
| Element Position | 45 mm | Specifies the position in the application coordinate system where the first data point of the force curve is applied (start of the bottle thread). |
| Extend Range Left | Zero | |
| Extend Range Right | Constant | After the defined curve range, the force is held constant at 70 N, maintaining the required pressing force during the screwing process. |
| Segment Mode | None | Defines in which *Motion Segments* the *Custom Force* curve is active. In MX Mode the *Custom Force* is applied to all segments. |

**Hint:**
Applying the *Custom Force* to all segments represents the worst-case scenario. To apply *Custom Force* to individual segments, first complete the layout in MX mode, through section 3.4.7. Then switch to SX mode, which allows configuration of Segment Mode in the individual axes.

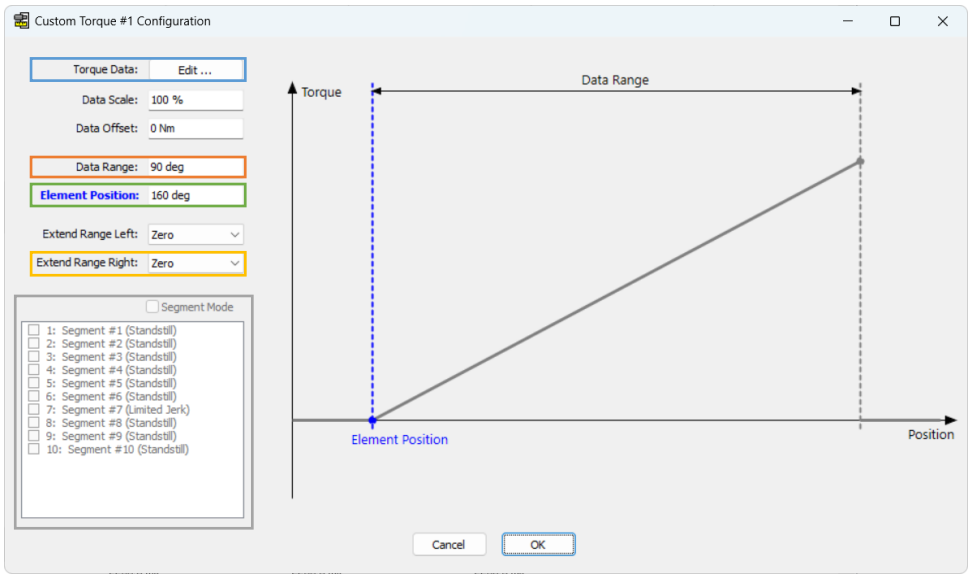
### 3.4.2.3.2 Custom Torque Z-Axis_Rot

See Section 4.1.2.2.2 for more information. The following curve represents the target torque profile for this example.




- Initially, the applied torque is 0 Nm.
- At the beginning of the bottle thread (≈ 160°), the torque starts to increase over the next 90°.
- During the screwing phase, the friction torque between the cap and the bottle is estimated at 0.5 Nm.

***Custom Torque #1***







| Setting Name | Selection | Reason / Guidance |
|---|---|---|
| Torque Data | Edit… | The torque curve is defined here. Selecting Edit… opens the Data Points Editor, where the torque values can be entered manually or imported. |
| Data Points | 0 Nm<br>0.5 Nm | Defines the torque increase from 0 Nm to 0.5 Nm. These values represent the actual torque levels used to generate the custom torque curve. |
| Data Scale | 100 % | |
| Data Offset | 0 Nm | |
| Data Range | 90 deg | Defines the angular range over which the torque increases from 0 Nm to 0.5 Nm. In this application, it is assumed that the cap reaches its full screwing torque after 90°. |
| Element Position | 160 deg | Specifies the position in the application coordinate system where the first data point of the torque curve is applied (start of the bottle thread). |

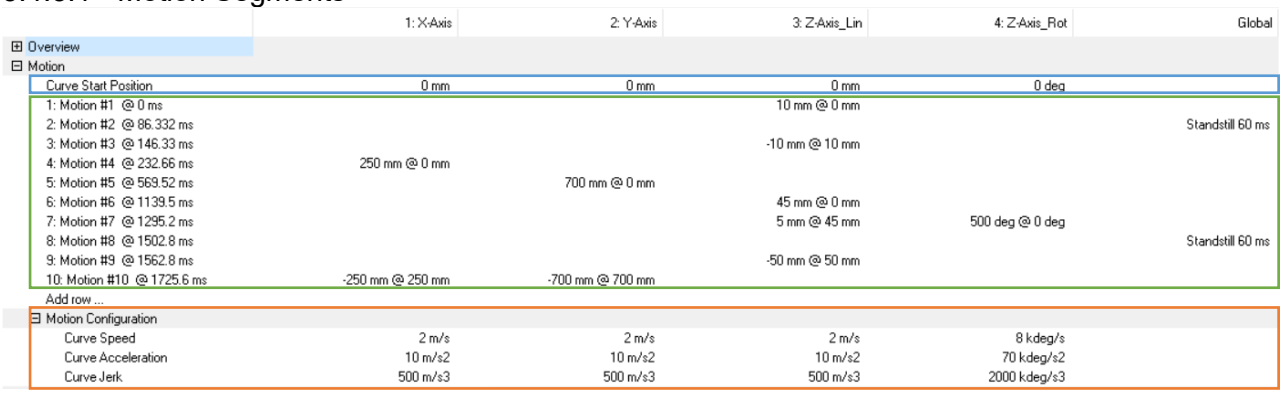
| | | |
|---|---|---|
| Extend Range Left | Zero | |
| Extend Range Right | Constant | After the defined curve range, the torque is held constant at 0.5 Nm, maintaining the required friction torque during the screwing process. |
| Segment Mode | None | Defines in which motion segments the custom torque curve is active. In MX Mode the *Custom Force* is applied to all segments. |

### 3.4.3 Motion

The motion sequence defines the ordered set of movements and standstill periods for each axis. Each entry below corresponds to one segment in the motion profile.

More information can be found in chapter 4.2.

#### 3.4.3.1 Motion Segments

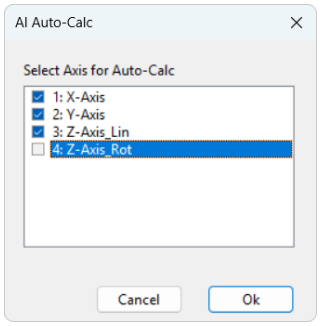



| Curve | Stroke / Standstill | Reason / Guidance |
|---|---|---|
| Start Position | All axes start at 0 | Defines the initial reference position of all axes before motion begins. |
| 1 | Z-Axis_Lin = 10 mm | Moves the Z-axis 10 mm downward (positive direction). |
| 2 | 60 ms | Waiting time of 60 ms to allow the gripper to close. |
| 3 | Z-Axis_Lin = -10 mm | Moves the Z-axis 10 mm upward (negative direction). |
| 4 | X-Axis = 250 mm | Moves the X-axis 250 mm in the positive direction. |
| 5 | Y-Axis = 700 mm | Moves the Y-axis 700 mm in the positive direction. |
| 6 | Z-Axis_Lin = 45 mm | Moves the Z-axis 45 mm downward to the position just before the thread engagement starts. |
| 7 | Z-Axis_Lin = 5 mm<br>Z-Axis_Rot = 500° | Moves the Z-axis 5 mm downward while rotating 500°. This simulates the screwing process. |
| 8 | 60 ms | Waiting time of 60 ms to allow the gripper to open. |
| 9 | Z-Axis_Lin = -50 mm | Moves the Z-axis 50 mm upward. |
| 10 | X-Axis = -250 mm<br>Y-Axis = -700 mm | Moves the X-axis (−250 mm) and Y-axis (−700 mm) simultaneously back to the start position. |
| Curve Speed | Z-Axis_Rot = 8 kdeg/s<br>Others: Default | These parameters define the dynamic behavior—speed, acceleration, and jerk—applied to each motion segment of the associated axis.<br>The values of the rotary axis are fixed and are defined here. All other values represent initial settings and will be optimized in the next design step (see Section 3.4.3.2). |
| Curve Acceleration | Z-Axis_Rot = 70 kdeg/s$^2$<br>Others: Default | |
| Curve Jerk | Z-Axis_Rot = 2000 kdeg/s$^3$<br>Others: Default | |

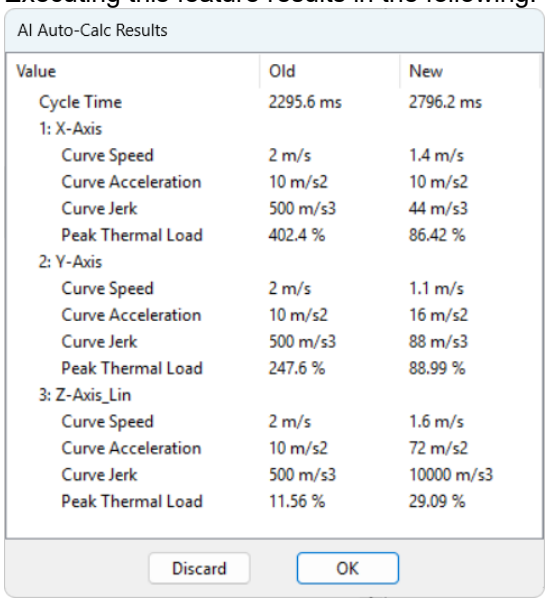
#### 3.4.3.2 AI Auto-Calc

Using the AI Auto-Calc button (see 3.2.1.2) automatically and iteratively adjusts the Curve Speed, Acceleration, and Jerk for each axis to minimize the Total Time shown in the Global Results. Throughout this optimization, the tool ensures that the motor remains in a fully operable state by avoiding any Errors or Warnings.

When the AI Auto-Calc button is pressed, a dialog window opens in which the user can select the individual axes to be included in the optimization process. In this application, the Z-Axis_Rot must be excluded, as its motion parameters have already been fully defined in the previous section.




Executing this feature results in the following:




### 3.4.3.3 Segment Allocation Custom Force

Segment allocation for the *Custom Force* is not currently possible in MX mode, but the steps are explained for choosing segments which would use *Custom Force*.

The main area of interest is *Motion #7* as two axes move together. The orange box indicates the time range during which *Motion #7* is executed. The rotary axis requires a relatively long execution time of 207.6 ms to complete the 500° rotation, whereas the linear axis completes its 5 mm motion in only 25.2 ms. As a result, an additional segment (*Motion # 8*) is automatically added to the linear axis as a standstill segment.

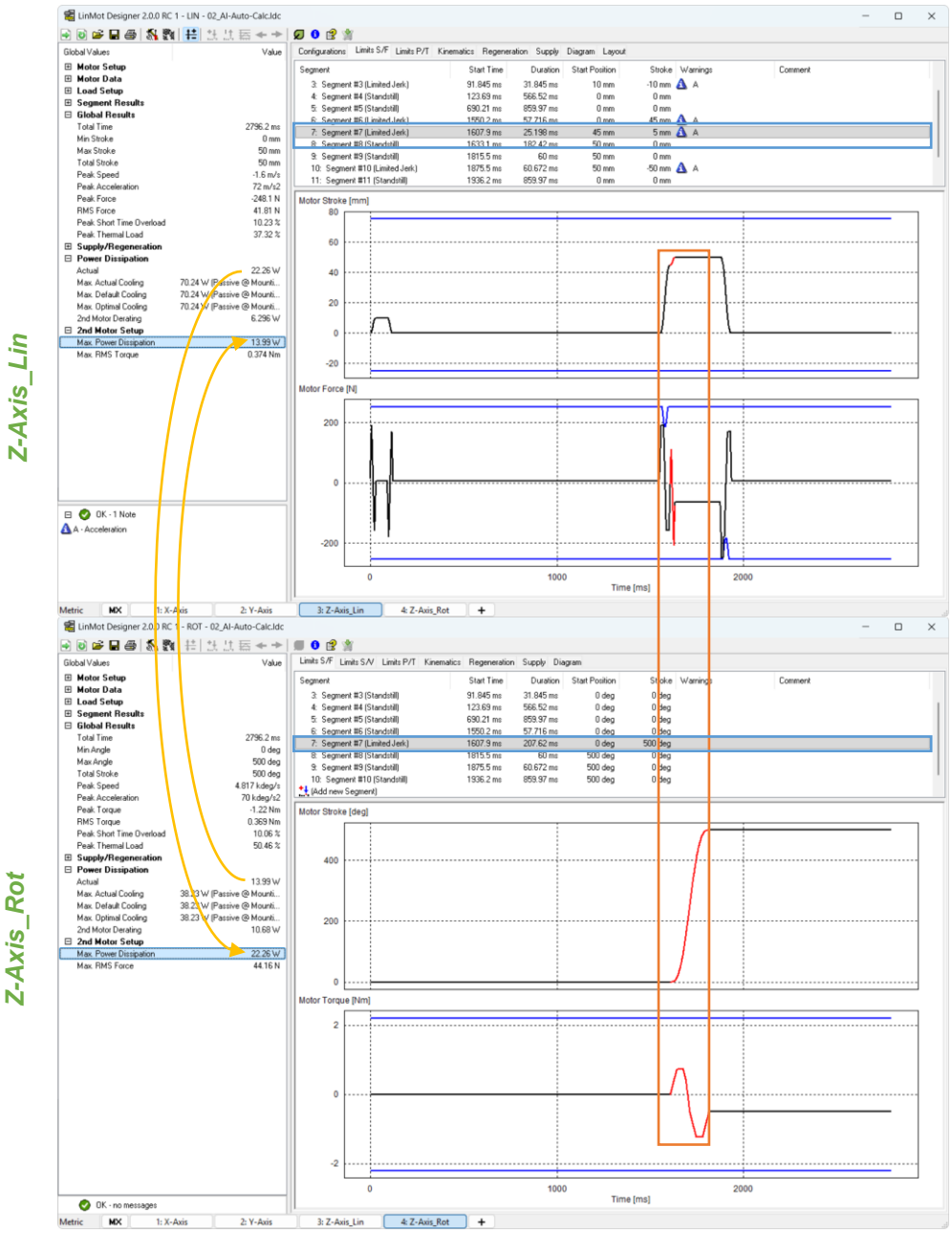
#### Custom Force Z-Axis_Lin

The most reliable approach to determine which segments are relevant for this *Custom Force* (designed in Section 3.4.2.3.1) is to analyze the motion profile of the individual axis. The *Motion Segments* can be reviewed directly in the axis-specific view (see figure above).

For this application, the relevant segments are Segments 6, 7, and 8, which represent the screwing process up to the point at which the gripper releases the cap.

#### Custom Force Z-Axis_Rot

The rotary axis is easier to interpret, as the *Custom Force* (designed in Section 3.4.2.3.2) acts exclusively during the screwing process (see figure above). Therefore, the *Custom Force* needs to be applied only to Segment 7.




### 3.4.3.4 Power Dissipation

This feature will be implemented to the MX tab in the future, but currently it has to be done in the individual axes of the motor.

To do this, the Actual (Power Dissipation) value—displayed in the Parameter Window (see Section 2.2.2.2) must be transferred to the other motor via: Global Settings → Load → Power Dissipation 2nd Motor (see also figure above).

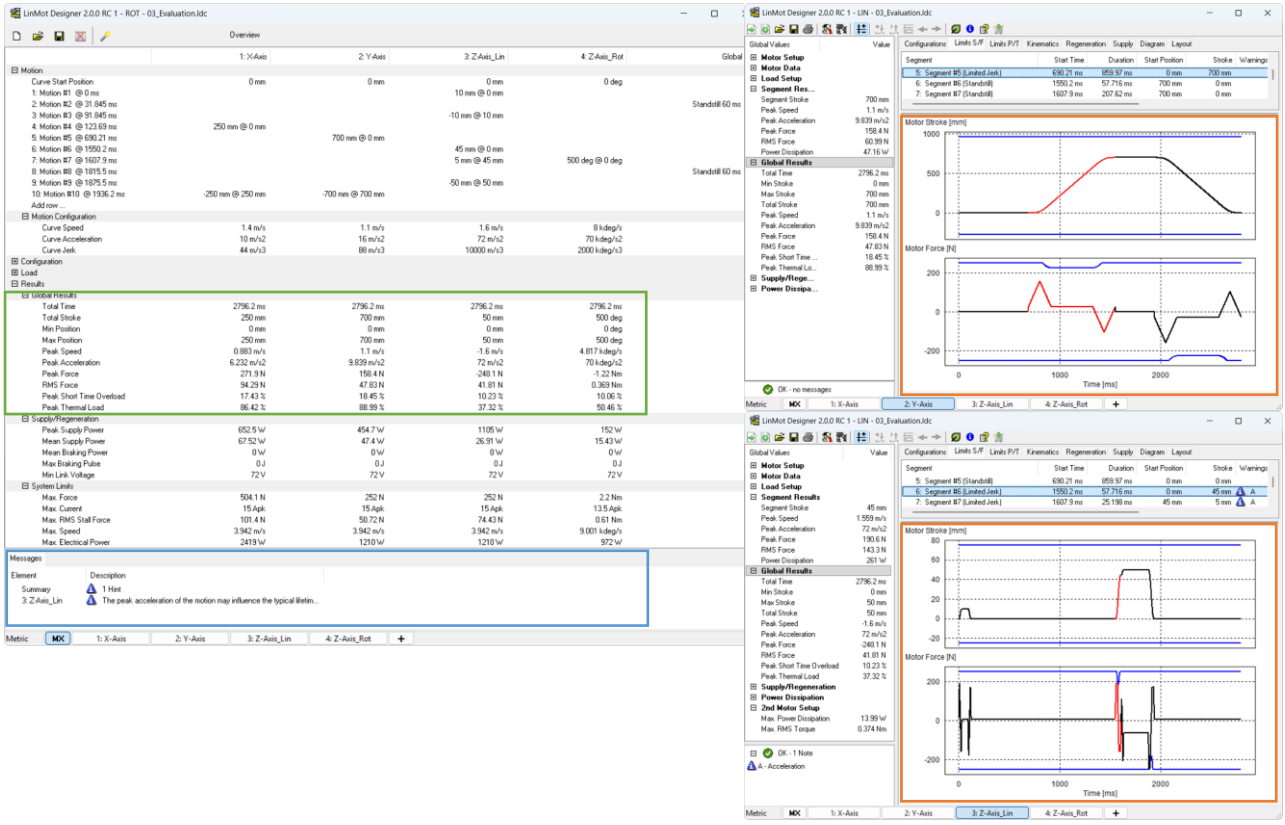
This ensures correct thermal coupling between the two axes, as the permissible thermal load of one motor depends on the power dissipation of the other.

### 3.4.4 Evaluation

A detailed explanation of evaluation logic and messages description can be found in Section 4.3.

#### 3.4.4.1 Evaluating Design

After completing the motion and load setup and, if desired, executing the AI Auto-Calc feature, LinMot Designer automatically recalculates the simulation results:



A typical evaluation sequence consists of the following steps:

**1. Check for Errors or Warnings**

Errors, warnings, and notes appear in the message area and must always be reviewed first.

- In this design, an *Acceleration* note is reported for the Z-Axis_Lin.

**2. Review the Global Values**

The Global Results window shows peak, RMS, and mean values of all relevant physical parameters.

- In this design, the X-Axis and Y-Axis are operating at a *Peak Thermal Load* limit around 85-90%.
- All other parameters remain well below their maximum permissible limits.

**3. Analyze Critical Parameters in the Diagram Windows**

The diagram windows of the individual axes provide time-based visualizations of motion, force, speed, thermal load, and other system behaviors.

- According to the *Force* diagram, the Z-Axis_Lin is operating close to its limit, but still within an acceptable operating range.
- The diagrams of the other axes show clean profiles with sufficient performance reserves.

#### 3.4.4.2 Results

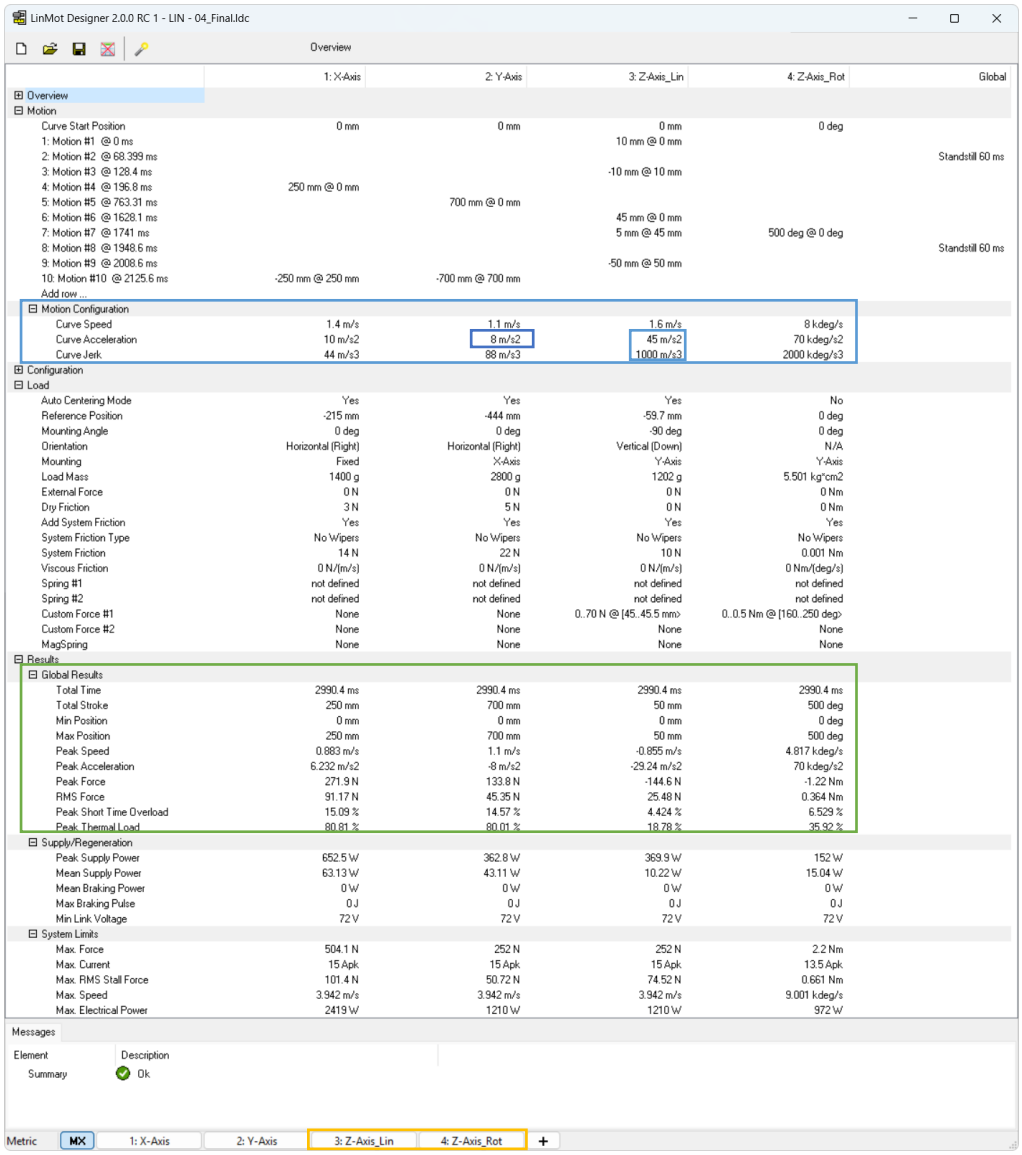
The *Acceleration* note for the Z-Axis_Lin should be addressed, as operating the system in this condition may reduce the motor's lifetime.

If the application cycle time can still be reached, reducing the *Peak Thermal Load* of X-Axis and Y-Axis to 80% would increase thermal reserves and allow margin for changes in machine operation longer-term.

Check the force limit on the Z-axis after the other adjustments. If the force remains at the limit, this indicates that the load (gripper and part) cannot be increased in future design iterations.

### 3.4.5 Corrective Actions

The following actions were implemented to improve the design:




1. The acceleration and jerk of the Z-Axis_Lin were reduced to 45 m/s² and 1000 m/s³. This removes the acceleration note. The lower jerk reduces the wear on the mechanical parts and increases the standstill time for X-Axis and Y-Axis, which reduces their peak thermal load.
2. The acceleration of the Y-Axis was reduced to 8 m/s² which reduces the peak thermal load to approx. 80%.
3. The *Power Dissipation* of the PR02 motor was updated as described in 3.4.3.4

As a result, the *Total Cycle Time* is 2.99 seconds, which remains below the required 3 seconds. According to the evaluation logic, there are no remaining warnings or notes. In addition, the force reserves for the Z-Axis_Lin have increased.

This confirms that the design is suitable for the given application.

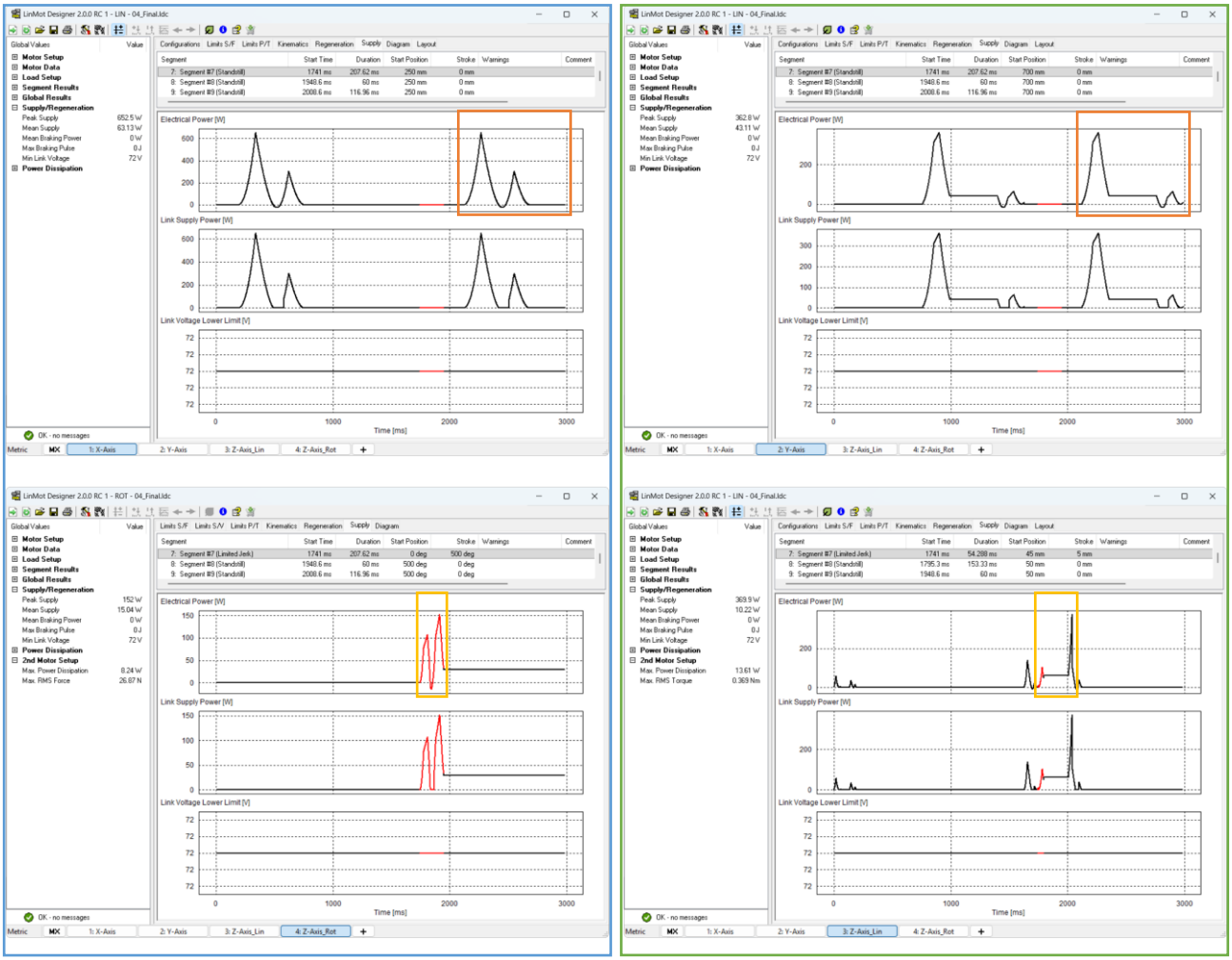
### 3.4.6 Layout Check

See Section 3.3.6 for further information.

### 3.4.7 Select Power Supply

To ensure reliable operation of the axes, the power supply must be selected based on the voltage level, mean power demand, and peak power and energy demand of the motion profile.

In this example, it is assumed that only these four motors are connected to the power supply(s) system.



As shown in the diagrams, the application contains a significant amount of standstill time, during which almost no power is required. Two relevant peak-load combinations can be identified:

- The X-Axis and Y-Axis move back to the initial position simultaneously, resulting in overlapping power peaks.
- During the screwing process, the Z-Axis_Lin and Z-Axis_Rot draw power at the same time.

Based on these peak combinations, the following two power supply options are possible:

**Option 1:**

The preferred solution is to connect all motors to a single LinMot S02-72/1000 power supply (1000 W with 300% Power Boost capability).
If detailed calculations are required, refer to Section 3.3.7.

**Option 2:**

An alternative solution is to connect the X-Axis and Z-Axis_Rot to one LinMot S02-72/600 power supply, and the Y-Axis and Z-Axis_Lin to a second S02-72/600 power supply.
This option is relevant if the customer has only a 230 V system voltage available.
If detailed calculations are required, refer to Section 3.4.7.

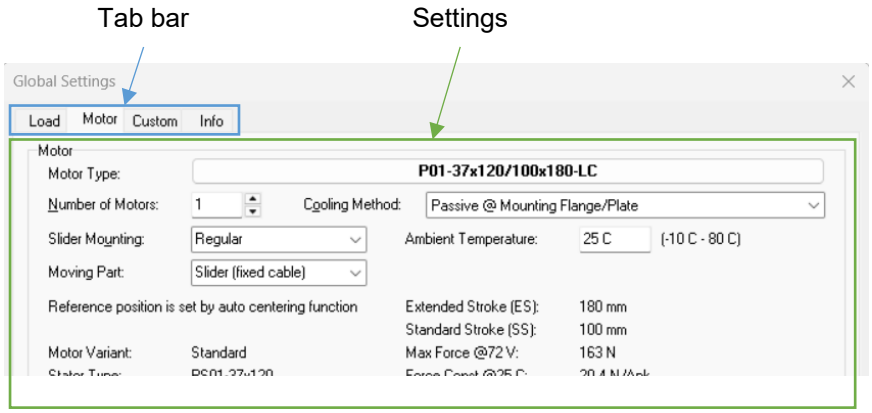
### 3.4.8 Export / Print Project Data

See Chapter 4.6 for more information.

# 4 Additional Features & Information

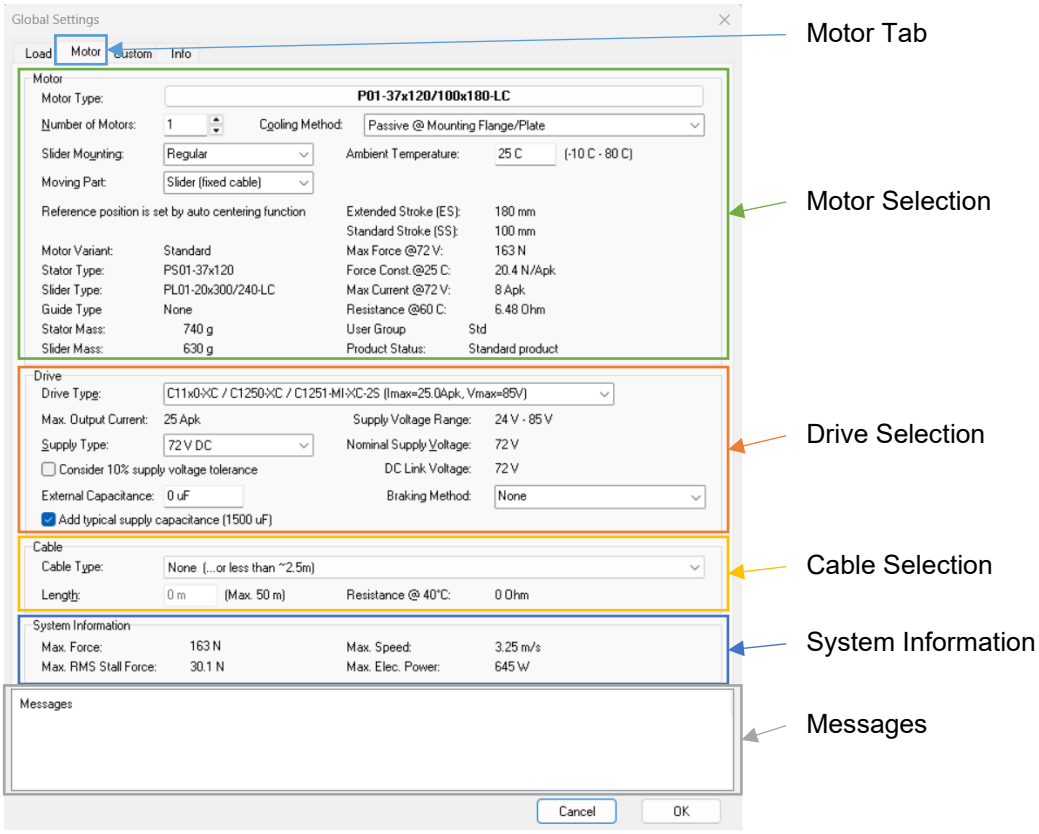
## 4.1 Global Settings

The Global Settings dialog is used to define the motor, drive, cable, load configuration, and custom supply configurations. These settings are globally valid, over all segments.



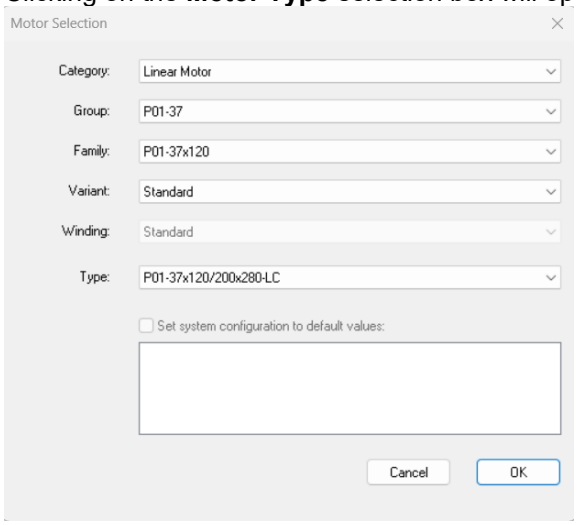

### 4.1.1 Motor Tab

The Motor tab in the Global Settings allows you to define and adjust all motor-related parameters used for simulation and sizing. It consists of the following sections:



#### 4.1.1.1 Motor Selection

Clicking on the **Motor Type** selection box will open the Motor Selection window.




There the following selection can be done:

- The *Category* consists of the following selection:
  - Linear Motor
  - Linear Motor with Guide (Module)
  - Linear Rotary Motor
- Group
- Family
- Variant
- Winding
- Type
- The bottom window displays values, which are by default different for this motor. It will automatically select the settings to be set to default when continuing. Please review the selection.

Back to Global Setting the following selections can be done:

- **Number of Motors**
  This selects the number of parallel motors which are working on this load. For this example only one is needed.
- **Cooling Method**
  This selection consists of the following options:
  - *Passive*
    The motor cools naturally via convection and its mounting surface. No additional airflow or medium is used.
    - Characteristics:
      - Default cooling method used when nothing else is selected.
      - Simplest and lowest-cost solution.
      - Limited continuous force due to natural heat dissipation.
    - When to use:
      - Low thermal load applications
      - Longer cycle times
      - When motor surface temperature stays well below limits
  - *Fan*
    Active air cooling using a mounted fan to increase airflow and heat transport.
    - Characteristics:
      - Strongly improves heat dissipation
      - Reduces thermal load significantly
      - Increases allowable continuous force
      - Enables faster cycle times and shorter standstill phases
    - When to use:
      - Applications approaching thermal limits

        - High speed cycles (repeated pushing/pulling)
        - When thermal warnings appear with Passive cooling
    - *Fluid*
      Cooling lines allow water or coolant to circulate through the motor housing, extracting heat efficiently.
        - Characteristics:
            - Highest cooling performance
            - Best for high continuous-force applications
            - Most stable thermal behavior
            - Requires external fluid cooling infrastructure
        - When to use:
            - Very high duty cycles
            - High ambient temperatures
            - Applications where Fan cooling is insufficient
    - *Sealing Air (This is a custom solution)*
      Air is blown through the motor to provide cooling and prevent contamination.
        - Characteristics:
            - Provides moderate cooling improvement
            - Protects motor internals from dust and particles
            - Often used in dusty environments
        - When to use:
            - Environments requiring protection from contamination
            - Applications with moderate thermal loads
- **Slider Mounting**
  It defines the orientation of the moving component (slider) relative to the fixed component (stator). This setting affects the motor's stroke limits, which can be visually inspected in the Layout tab.
- **Ambient Temperature / Fluid Temperature**
  Defines the surrounding air (or fluid with Fluid Cooling Method) temperature in which the motor operates. The ambient temperature influences the motor's thermal behavior and affects the available continuous (RMS) force.
- **Moving Part**
  Defines which component of the motor or module performs the linear movement — either the slider or the stator. The selected moving part affects the moved mass, mechanical setup, and suitability for applications with radial forces.
- **Reference Position** *(Activity depends on "Auto Centering Mode" selection 2.2.1.2):*
  Defines the position between the stator and the slider. It determines how both components are placed relative to each other in the application layout (2.2.3.8).
- ***Motor Specifications***
  This section summarizes the key mechanical and electrical specifications of the selected motor configuration.
  It includes: Motor Variant, Stator Type, Slider Type, Guide Type, Stator Mass, Slider Mass, Extended Stroke (ES), Standard Stroke (SS), Max Force @72 V, Force Const.@25 C, Max Current @72 V, Resistance @60 C, User Group, Product Status

#### 4.1.1.2 Drive Selection

First, the **Drive Type** can be selected. The list only shows drives that are technically suitable for the current configuration. Once selected, several drive-relevant parameters are displayed, such as the Max. Output Current and the Supply Voltage Range.

The **Supply Type** also shows all supply options compatible with the current motor configuration. For some motors, a *Custom* selection is available, which can be configured in detail in the Custom tab (4.1.3.2). After selecting a supply, additional parameters such as Nominal Voltage Supply and DC Link Voltage are shown.

You can also **Consider 10% supply voltage tolerance** to include voltage fluctuations in the calculation.

If additional capacitance is installed between supply and drive, the **External Capacitance** must be entered here. This increases the DC-link energy buffer and helps reduce voltage fluctuations during regenerative phases.

For a DC Supply Type, LinMot Designer selects by default the box **Add typical supply capacitance (1500 uF)**. If this box is cleared, a regeneration warning may appear because DC-link buffering is reduced. This is important when using non-LinMot power supplies, which may have significantly lower output capacitance.

The **Braking Method** defines how regenerative energy is dissipated when the motor acts as a generator during braking phases. One of the following options can be selected:

- *None*
  No method is chosen; regenerated energy may cause a Regeneration Warning if the DC-link voltage rises too high.
- *Motor Winding* (Motor Regeneration Mode)
  The drive dissipates the extra energy inside the motor itself. Because the motor itself absorbs the additional energy, it may heat up a bit more.
- *Braking Resistor*
  Excess energy is sent to an external braking resistor, which converts it into heat, but only if the selected drive supports this special mode.

#### 4.1.1.3 Cable Selection

The "Cable Type" defines which motor cable is used between the drive and the motor. Different cable types have different electrical properties—primarily cable resistance—which directly influence the system's performance. Higher cable resistance reduces the available motor force, especially with longer cables.

For this reason, both the "Cable Type" and "Cable Length" must be specified correctly. This will display the Resistance @ 40°C of the Cable and consider it in the simulation.

#### 4.1.1.4 System Information

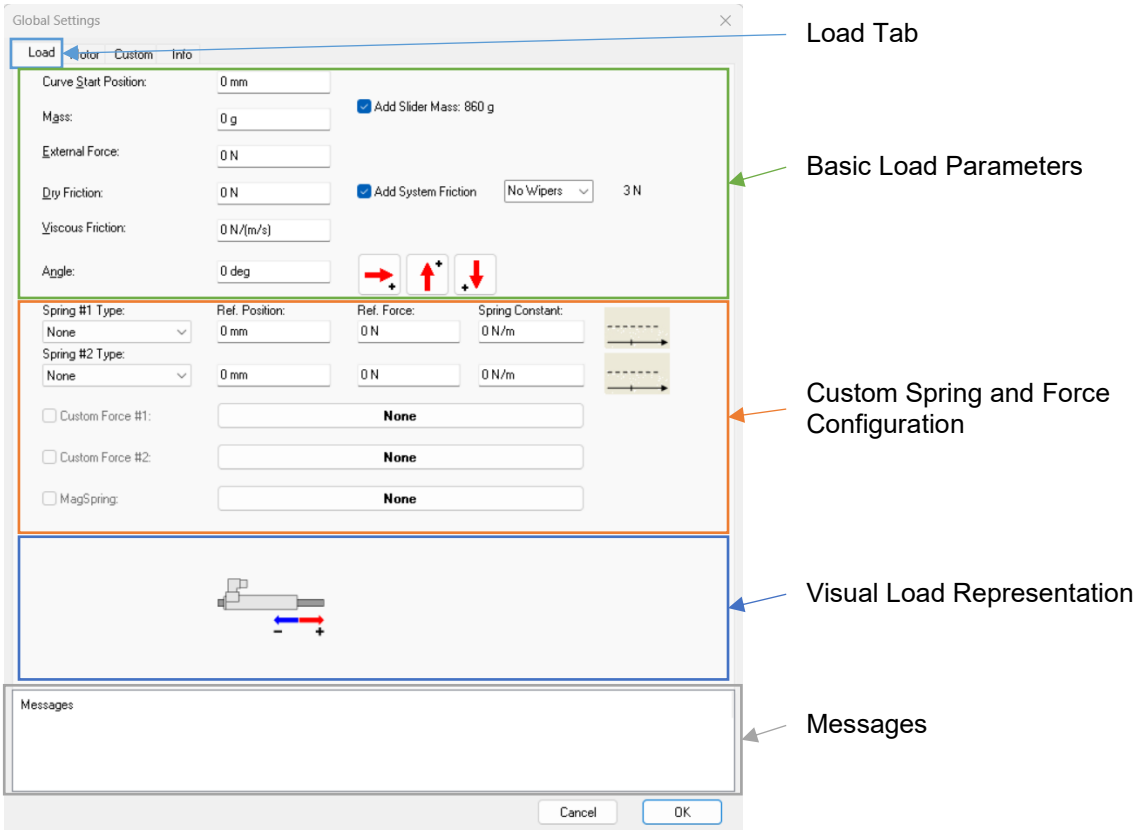
The System Information section provides a quick overview of the key performance limits of the currently selected motor-drive configuration. It displays the achievable "Max. Force", the continuous "Max. RMS Stall Force", the highest possible "Max. Speed", and the corresponding "Max. Elec. Power" required.

#### 4.1.1.5 Messages

Messages provide feedback related to the Motor Tab. They indicate invalid selections, warn about unintended or conflicting configurations, and offer recommendations to guide the user toward valid and optimal motor settings.

### 4.1.2 Load Tab

The Load tab in the Global Settings allows you to define all global load-related parameters that affect the entire motion cycle. It consists of the following sections:



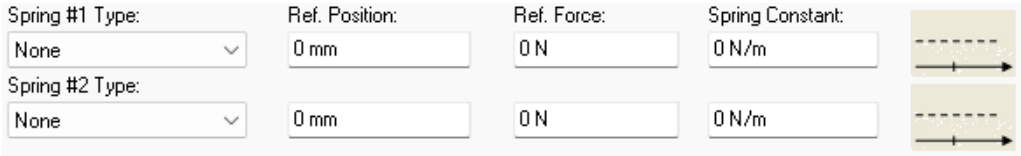

#### 4.1.2.1 Basic Load Parameters

- **Curve Start Position**
  Defines the reference start position of the motion profile in the application coordinate system. It allows shifting the entire curve so it can be placed correctly in the mechanical layout.
- **Mass**
  Specifies the global moving load mass that the motor must accelerate. This includes everything that is attached to the moving part of the Motor.
  The load mass strongly influences force, acceleration, RMS values, and thermal load. Therefore it must be set as accurately as possible.
- **Add Slider / Stator / Flange Mass**
  Adds the mass of the motor's moving part automatically to the total moving mass. This must be enabled if the components are mechanically part of the moving load, which is typically the case.
- **External Force**
  Defines an externally acting constant force on the load, either assisting or opposing the motion. This can represent: gravitational components, process forces (if active globally and not segment-wise), and preloads or counterloads.
  This force is applied across the entire motion unless overridden locally in segments.
- **Dry Friction**
  Represents a constant, velocity-independent friction force that opposes motion. It is added to the load model to simulate real mechanical friction in guides or external mechanics.
- **Viscous Friction**
  Represents velocity-dependent friction proportional to the speed of the moving part. It models systems where resistance increases with motion velocity (like Pneumatic or hydraulic-like damping behaviors).
- **Angle**
  Defines the mounting orientation of the axis relative to gravity (can be seen live in the Visual Load Representation (4.1.2.2.4)). The angle affects load behavior (e.g., vertical vs. horizontal mounting), and certain system elements—including MagSpring—may behave differently depending on orientation. The Load tab (4.1.2) also updates its directional graphics based on this angle.

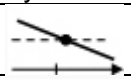
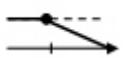
### 4.1.2.2 Custom Spring and Force Configuration

#### 4.1.2.2.1 Spring

Two different mechanical springs can be defined (Spring #1 and #2).



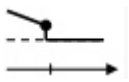

There are 3 different **Spring Types** of springs which can be selected:

| Spring Type | Description | Symbol |
|---|---|---|
| **Standard** | Linear force curve throughout the full range |  |
| **Single-Sided Positive** | Linear force curve up to a specific point, then maintains a constant force of 0N |  |
| **Single-Sided Negative** | Maintains a constant force of 0N up to a specific point, after which it follows a linear force curve |  |

While the Spring Type and the Spring Constant define the spring characteristic, the reference values are used to place the spring characteristic in the user's coordinate system. The spring characteristic is positioned so that the specified reference spring force acts at the reference position.

**Ref. Position**
This is represented (in the Symbols above) by a black dot on the force curve or a vertical line on the X-Axis. It's crucial for determining the next parameter.

**Ref. Force**
Defines the force at the Ref. Position.
In case of a Single-Sided Spring type, the linear force will end at the Ref. Force, and from there on jump to 0N and maintain this force. Example for a symbol of a Single-Sided Positive Spring Type:

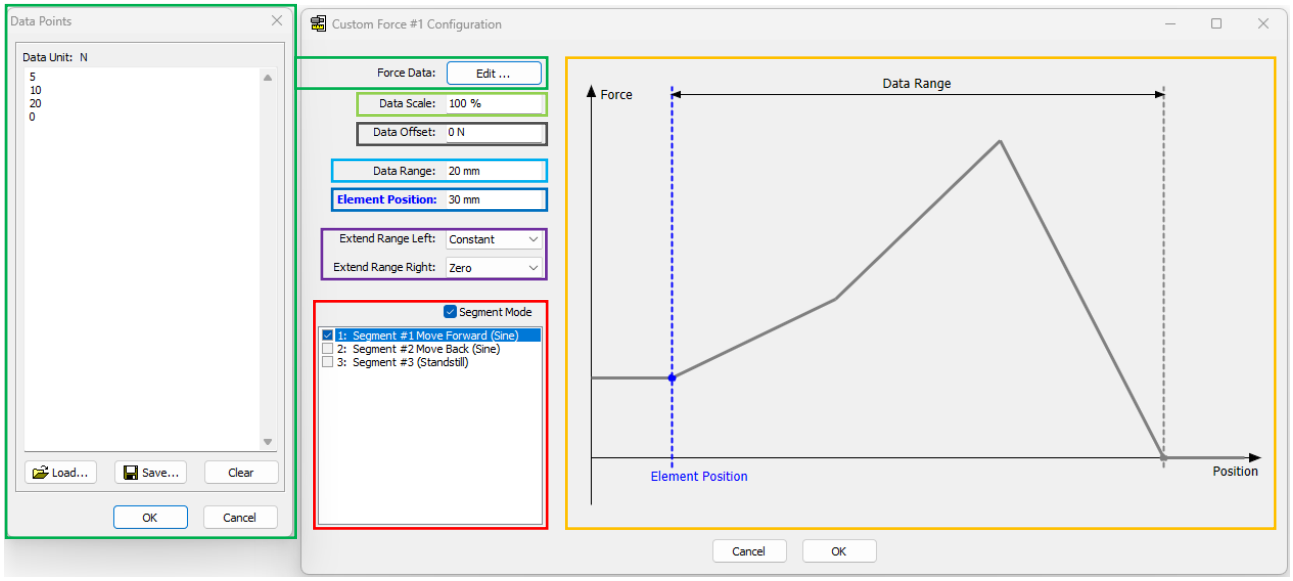


**Spring Constant**
Defines the stiffness of the spring.

#### 4.1.2.2.2 Custom Force

Two different custom forces can be included (Custom Force #1 and #2).

In the following figure, the “Custom Force #1 Configuration” is shown, displaying an example.

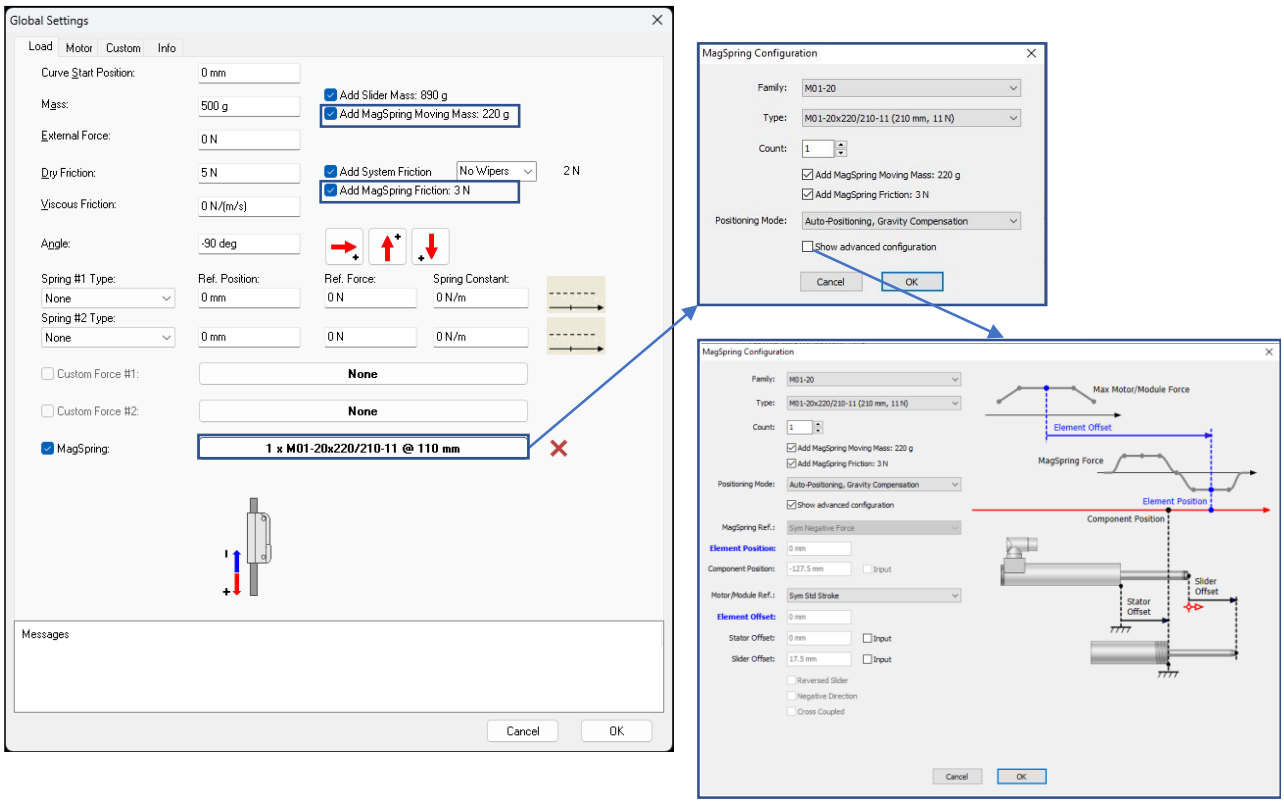



- **Force Data / Data Points**
  Editing the **Force Data** will open the Data Points window. Here, the force curve can be defined by either typing in the force values or importing a file that includes the force profile. Note that the data points must be equidistant over a specified position range.
- **Data Scaling**
  The magnitude of the original data can be subsequently changed.
- **Data Offset**
  An offset can be defined to adjust the baseline from the original data.
- **Data Range**
  In this field, the stroke can be defined in which the force curve has an effect. This will place the data equidistantly within the stroke, as shown in the example above.
- **Element Position**
  If this force does not start at 0 mm stroke, the starting position can be adjusted in this setting.
- **Extend Range Left / Right**
  The Extend Range feature defines what happens to the force before and after the defined stroke.
  - **Option Zero**: Assumes that the additional force will stay constant at zero afterwards/beforehand.
  - **Option Constant**: Uses the first/last data point and keeps this force beforehand/afterwards.
- **Segment Mode**
  By default, the "Custom Force" is active for the entire defined movement. With activated "Segment Mode", the segments in which the custom force is active/inactive can individually be selected/deselected. (It is also possible to activate it in individual segments: Section 4.2.2.3)
  The individual force control can be used, for example, in a pressing application where the pressing force only needs to be applied during the forward movement but not during the backward movement.
- **Graphical Feedback**
  The visualization of the force progression helps the user to check the definition. This representation aids in fine-tuning and ensures accurate implementation of the custom force.

#### 4.1.2.2.3 MagSpring

A MagSpring is often used to passively compensate for gravity.

When selecting a MagSpring, its moving mass and friction are added automatically to the load model. The configuration window also shows its force and stroke range.




In the “**MagSpring Configuration**” window it is possible to select the MagSpring Family and Type. For each MagSpring type the stroke and force are shown in brackets and, in addition, the moving mass and friction are automatically added and displayed in the configuration dialog.

To place the MagSpring in the application, various “**Positioning Modes”** are available:

- Auto Positioning, Gravity Compensation (Default)
- Auto Positioning, Negative Force
- Auto Positioning, Positive Force
- Manual, relative to Motor/Module
  The MagSpring moves together with the motor’s reference position. Positioning is defined using Stator Offset or Slider Offset.
- Manual, absolute
  The MagSpring keeps a fixed position in the coordinate system, independent of motor movements. Placement uses Element Position or Component Position.

Correct simulation requires accurate placement of the MagSpring’s stroke-force characteristic, which can be defined via:

- Element Position / Element Offset, or
- Component Position (for the stator) and Slider/Stator Offset (for the moving part)
  When one of these values is defined, the Designer automatically calculates the remaining related parameters.

Advanced configuration also allows viewing and adjusting the offsets and reference points between motor and MagSpring (e.g., midpoint of motor stroke vs. midpoint of MagSpring force range).

#### 4.1.2.2.4 Visual Load Representation

The Load tab includes a visual representation of the axis. Depending on the mounting angle, LinMot Designer automatically updates the direction graphics of the motor or module to reflect the real installation situation.

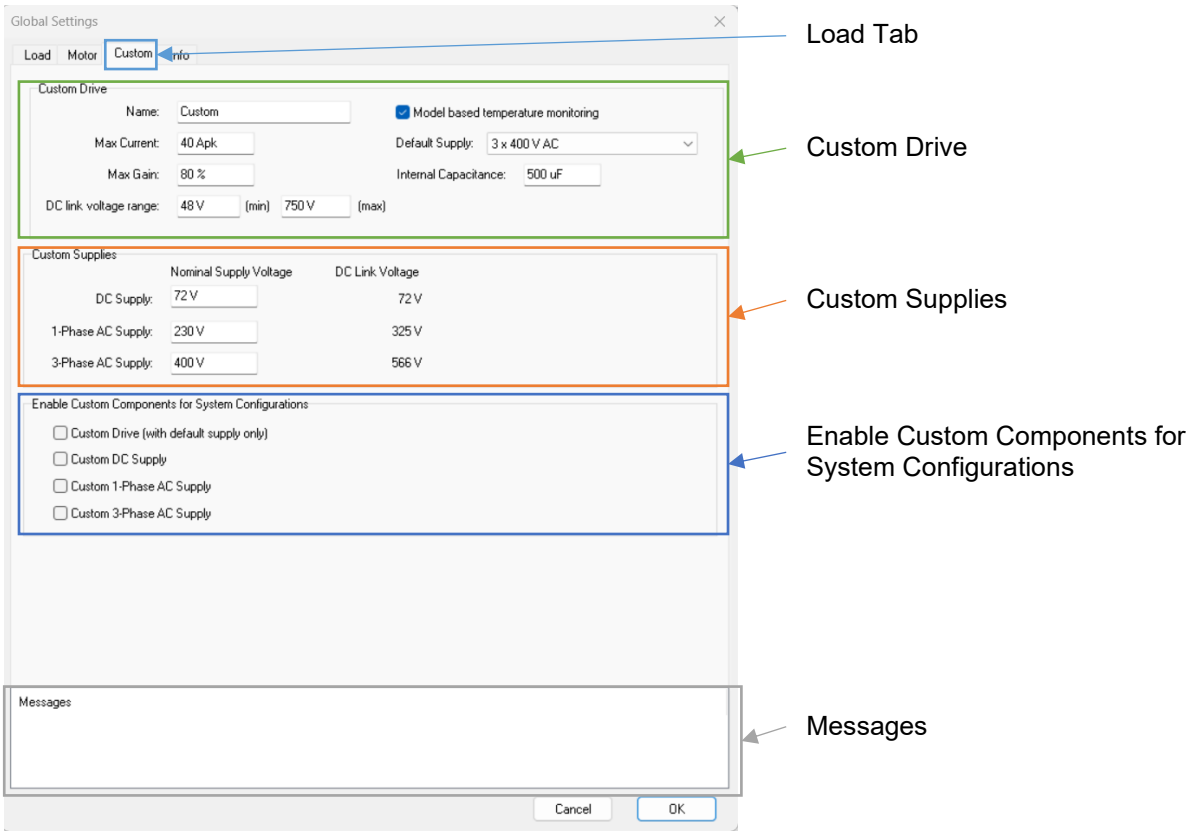
#### 4.1.2.2.5 Messages

Messages related to the Load Tab provide feedback on invalid or conflicting load settings, warnings about unintended configurations, and recommendations for correct placement of load elements. These messages help ensure that the load definition is valid and behaves correctly during simulation.

**Example:**
When using MagSpring in Auto-Positioning, Gravity Compensation, it only activates when the mounting angle is not horizontal (0°). If the MagSpring is disabled or cannot operate (e.g., in horizontal mode or in modules with integrated MagSpring), a message appears.

### 4.1.3 Custom Tab

The Custom tab in the Global Settings allows you to define and configure custom drive and custom supply components when using non-LinMot hardware or when system-specific electrical parameters are required. It consists of the following sections:




#### 4.1.3.1 Custom Drive

This section is only active when a Custom Drive is enabled in the Motor Tab (Section 4.1.1.2).

- **Name**
  The User can define an informational label for the custom drive (e.g., manufacturer or type). Used only for identification and documentation.
- **Max Current**
  Specifies the maximum output current (peak motor phase current) the drive can deliver. This directly influences the motor's available peak force.
- **Max Gain**
  Defines the maximum output voltage of the drive as a percentage of the DC-link voltage. This affects the maximum achievable motor speed.
- **DC-link Voltage Range** (Min/Max)
  Sets the allowable minimum and maximum DC-link voltage. These limits are used to calculate performance boundaries such as speed capability.

- **Model-Based Temperature Monitoring**
  Enables the internal thermal model. If disabled, the Designer applies a conservative derating (approx. −40%) because the drive cannot provide temperature feedback.
- **Default Supply**
  Selects which supply type (predefined or custom) is used as the default for simulations involving this custom drive. Possible selections are:
  - Custom DC, 1 × 230 V AC
  - Custom 1-Phase AC
  - 3 × 400 V AC
  - 3 × 480 V AC
  - Custom 3-Phase AC
- **Internal Capacitance**
  Defines the internal DC-link capacitance of the custom drive. This affects supply buffering and regeneration behavior.

#### 4.1.3.2 Custom Supplies

This section is only active when a Custom Supply is enabled in the Motor Tab (Section 4.1.1.2) and the corresponding Custom Drive is enabled (Section 4.1.3.3).

Depending on which supply types the selected drive supports, the corresponding Nominal Supply Voltage values must be entered. The DC-Link Voltage for each supply type is then automatically calculated based on the entered values and the internal supply configuration (Section 4.1.1.2).The following supply types are configurable:

- DC Supply
- 1-Phase AC Supply
- 3-Phase AC Supply

#### 4.1.3.3 Enable Custom Components for System Configurations

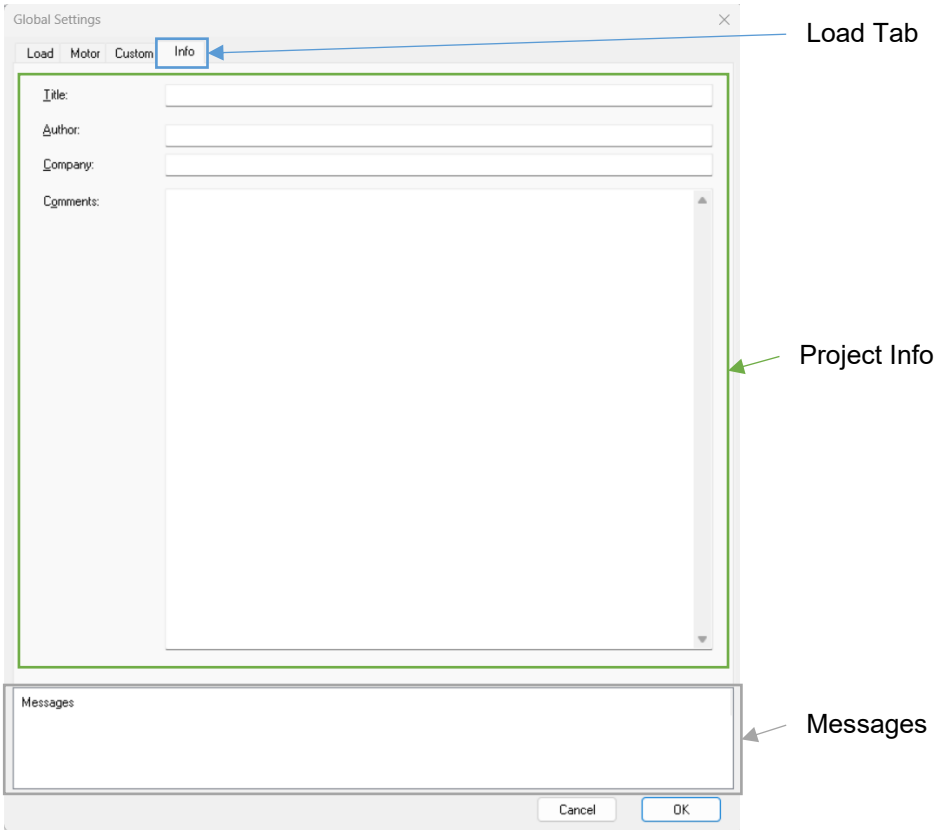
This section is only active when a Custom Supply is enabled in the Motor Tab (Section 4.1.1.2).

- **Custom Drive** (with default supply only)
  Makes the defined Custom Drive available in the configuration list and filters. The drive can then be chosen like any standard drive.
- **Custom DC Supply**
  Enables the custom DC supply so it can be selected as a supply type in system configurations and used for simulation.
- **Custom 1-Phase AC Supply**
  Allows the custom single-phase AC supply to appear in the supply selection list. Useful when the application uses a non-standard AC source.
- **Custom 3-Phase AC Supply**
  Makes the defined three-phase AC supply available in the configuration list for use in system selection and simulation.

#### 4.1.3.4 Messages

The Messages window in the Custom Tab provides feedback related to custom drive and custom supply configurations. Messages help identify incorrect values, unsupported combinations, or missing settings.

### 4.1.4 Info Tab




These fields allow you to add optional metadata to the project file. They are intended for documentation and traceability.

- **Title**
  The name or descriptive title of the project. Used to identify the design file in reports or internal documentation.
- **Author**
  The person who created or edited the project.
- **Company**
  The organization or department associated with the project.
- **Comments**
  A text field for additional notes, version information, design considerations, or any context relevant to the project.

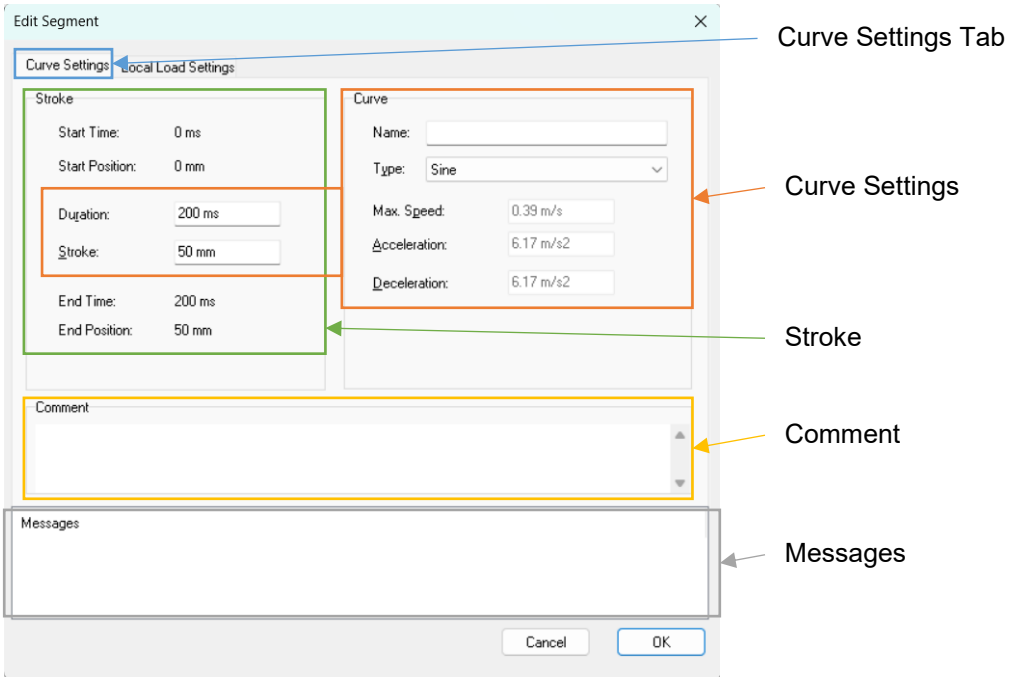
## 4.2 Motion Segments

In LinMot Designer, a motion profile is composed of a sequence of motion segments, each representing a defined phase such as travel, return, or standstill. Together, these segments describe one complete motion cycle, which LinMot Designer simulates as repeating continuously to reflect real machine operation. This continuous repetition is essential for correctly evaluating RMS force, thermal load, and system limits.

Each segment is configured independently, allowing precise control of stroke, timing, velocity, acceleration, loads, and external forces. This segmented approach enables accurate modeling of the mechanical and dynamic behavior of the application. Based on the full, cyclic motion profile, LinMot Designer automatically verifies motor suitability, including duty-cycle-dependent thermal limits and performance reserves, forming the foundation for a reliable and optimized motion design.

### 4.2.1 Curve Settings

The Curve Settings can be found in Edit Segment of each segment individually.




#### 4.2.1.1 Stroke

The Stroke field include the following information.

- **Start Time**
  Defines the time at which the motion segment begins within the motion cycle.
- **Start Position**
  Specifies the absolute position at the beginning of the motion segment.
- Duration
  Description in next Section.
- Stroke
  Description in next Section.
- **End Time**
  Indicates the time at which the motion segment ends within the motion cycle. The end time is determined by the start time plus the segment duration.
- **End Position**
  Specifies the absolute position reached at the end of the motion segment.

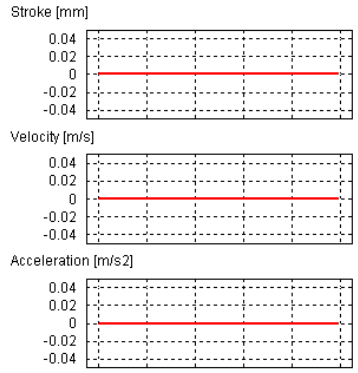
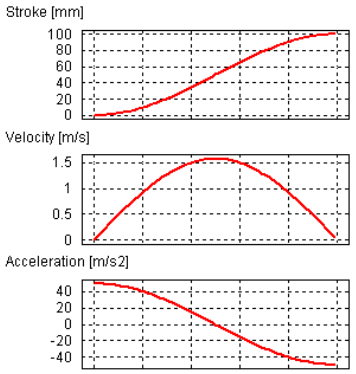
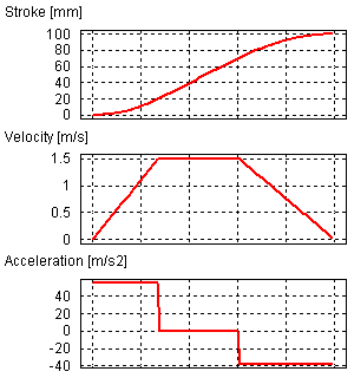
#### 4.2.1.2 Curve

For the Curve definition the following parameters are relevant:

- **Name**
  User-defined identifier for the motion segment.
- **Type**
  Defines the curve type used to generate the motion profile (detailed description in Section 4.2.1.2.1 and 4.2.1.2.2). The curve type determines the shape of the position, velocity, acceleration, and jerk trajectories.
- **Duration**
  Defines the total time required to execute the motion segment from start to end.
  This parameter may not be available for modification for certain curve types.
- **Stroke**
  Specifies the distance traveled during the motion segment. The stroke is calculated from the difference between start and end position and defines the direction of movement.
  This parameter may not be available for modification for certain curve types.
- **Parameters**
  The parameter displayed or available for modification depend on the curve type (Section 4.2.1.2.1).

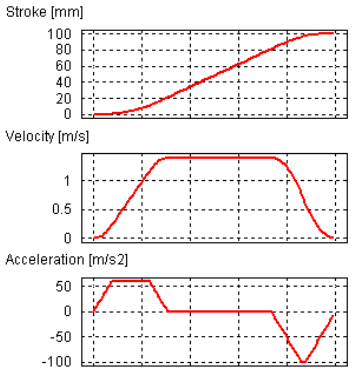
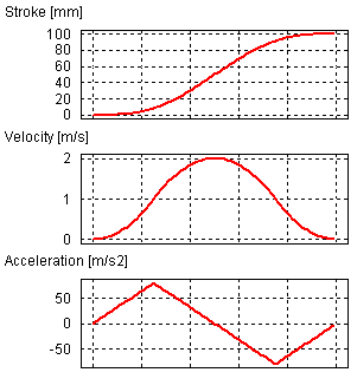
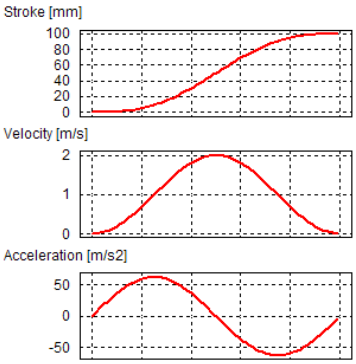
##### 4.2.1.2.1 Curve Types

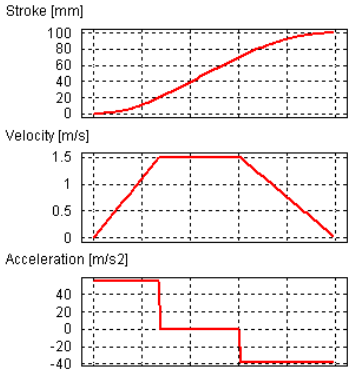
To define the motion profile, LinMot Designer provides different curve types that can be modified by a few parameters:

| **Standstill** | **Sine** | **Point to Point** |
|---|---|---|
| Parameters: • Time | Parameters: • Time<br>• Stroke | Parameters: • Stroke<br>• Max. velocity<br>• Acceleration<br>• Deceleration |
|  |  |  |



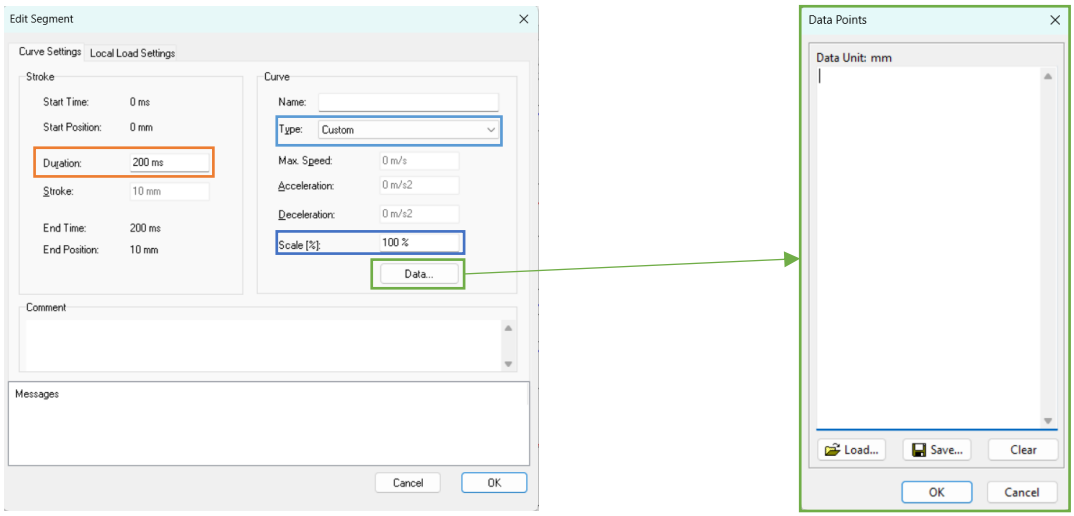
**Attention:**
Do not use a Sine motion profile unless you are absolutely certain the customer can and will implement it in the final machine.

| Limited Jerk | Minimal Jerk | Bestehorn |
|---|---|---|
| Parameters:<br>• Stroke<br>• Max. velocity<br>• Max. acceleration<br>• Max. deceleration<br>• Jerk | Parameters:<br>• Time<br>• Stroke | Parameters:<br>• Time<br>• Stroke |
|  |  |  |

| Speed Change Linear | Custom |
|---|---|
| Parameters:<br>• Time<br>• End Velocity | Parameters:<br>• Data Points<br>• Duration<br>• Scale |
|  | More information in Section 4.2.1.2.2 |

#### 4.2.1.2.2 Custom Curve

It is also possible to import a custom motion profile or just a segment of it into LinMot Designer. To do that, choose the Custom curve type.




Open the Data Points window to define the custom position vector. There are two possibilities to do that:

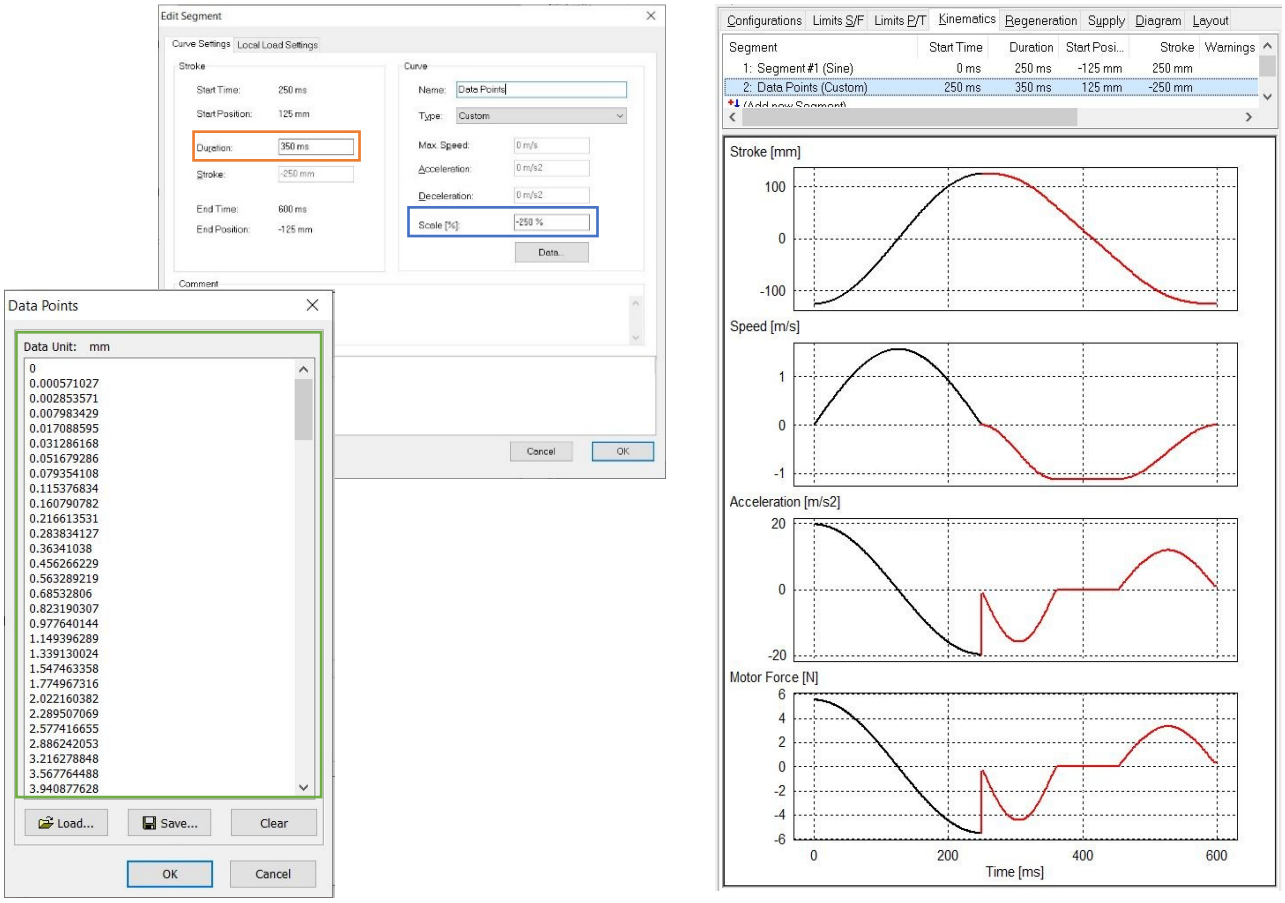
1. Load the csv-File, where only the numerical values of the position vector are saved.
2. Copy the vector from any other program and paste it into the Data Points window

The numerical data vector is interpreted in the measurement unit as it is defined under Measurement Settings (Section 2.2.1.2).

The following parameters must be defined to fully describe a custom curve:

- **Duration**
  It defines the total time over which the custom curve is executed.
- **Scale [%]**
  This adjusts the amplitude of the curve relative to its original definition, allowing the motion to be proportionally increased or reduced without modifying the underlying curve shape. (Can also be a negative value.)

**Example**




In this example a Custom curve (Segment 2) follows on a Sine curve (Segment 1). The data vector of the custom curve was imported (loaded) from a csv-file. With a (negative) Scale value of -250%, the curve data points (forward motion from 0…100 mm) are scaled to a backward motion from 0…-250 mm, starting at the end of Segment 1. The entire curve is executed within a Duration of 350 ms.

### 4.2.1.3 Comment

User-defined comment which will be visible in the segment overview.

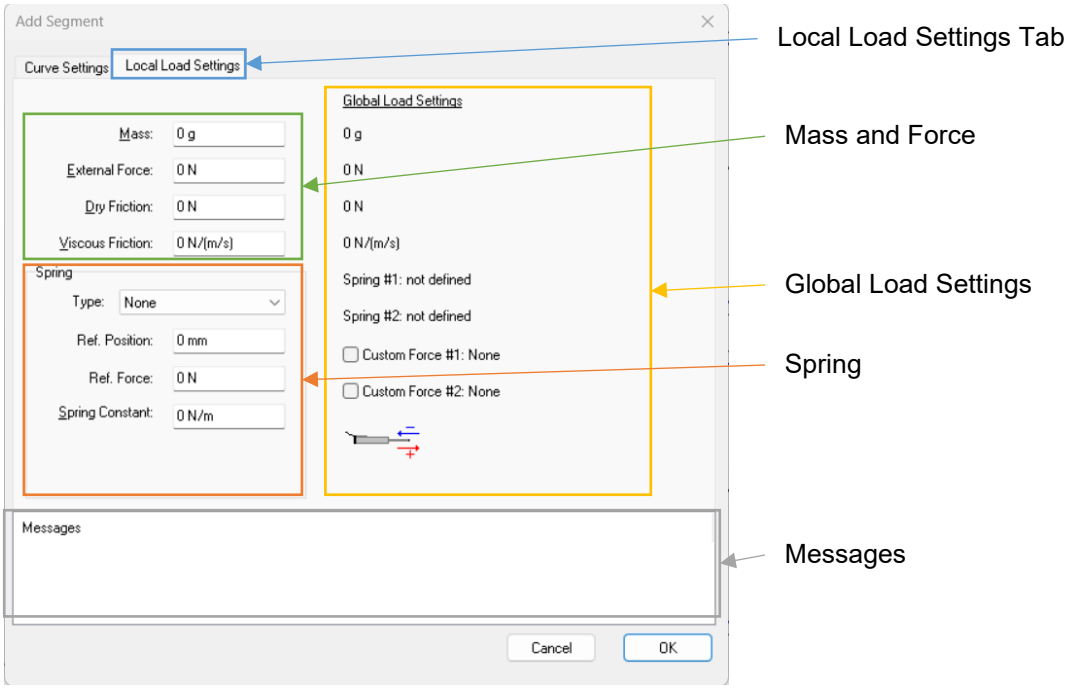
### 4.2.1.4 Messages

The Messages window in Curve Settings provides feedback related to curve configurations. Messages help identify incorrect values, unsupported combinations, or missing settings.

### 4.2.2 Local Load Settings

The Local Load Settings allow motion-segment-specific definition and activation of load parameters that differ from the global load configuration. Local values are added to the Global Settings, allowing accurate representation of real application conditions during each phase of motion.

The following parameters can be adjusted:




#### 4.2.2.1 Mass and Force

This section allows the definition of additional mass and force values locally for the selected motion segment. These values are added to the existing global load settings. Descriptions of these parameters can be found in Section 4.1.2.1.

- Mass
- External Force
- Dry Friction
- Viscous Friction

#### 4.2.2.2 Spring

This section allows the definition of spring parameters locally for the selected motion segment. These values are added to the existing global spring / force settings. Descriptions of these parameters can be found in Section 4.1.2.2.1.

- Type
- Ref. Position
- Ref. Force
- Spring Constant

#### 4.2.2.3 Global Load Settings

This section displays the load values that are defined globally. Descriptions of these parameters and instructions on how to modify them can be found in Section 4.1.2.

- Mass
- External Force
- Dry Friction
- Viscous Friction
- Spring #1

- Spring #2
- Custom Force #1
  Can also be activated specifically for this segment in this setting (Section 4.1.2.2.2)
- Custom Force #2
  Can also be activated specifically for this segment in this setting (Section 4.1.2.2.2)

#### 4.2.2.4 Messages

The Messages window in Local Load Settings provides feedback related to external local force configurations. Messages help identify incorrect values, unsupported combinations, or missing settings.

## 4.3 Evaluation of the Design

The Evaluation of the Design provides a complete system check of the configured axis, load, motion segments, and motor/drive/supply configuration.

All relevant dynamic and thermal parameters are simulated and compared against their allowed limits. Whenever a limit is exceeded, an error, warning, or note is generated.

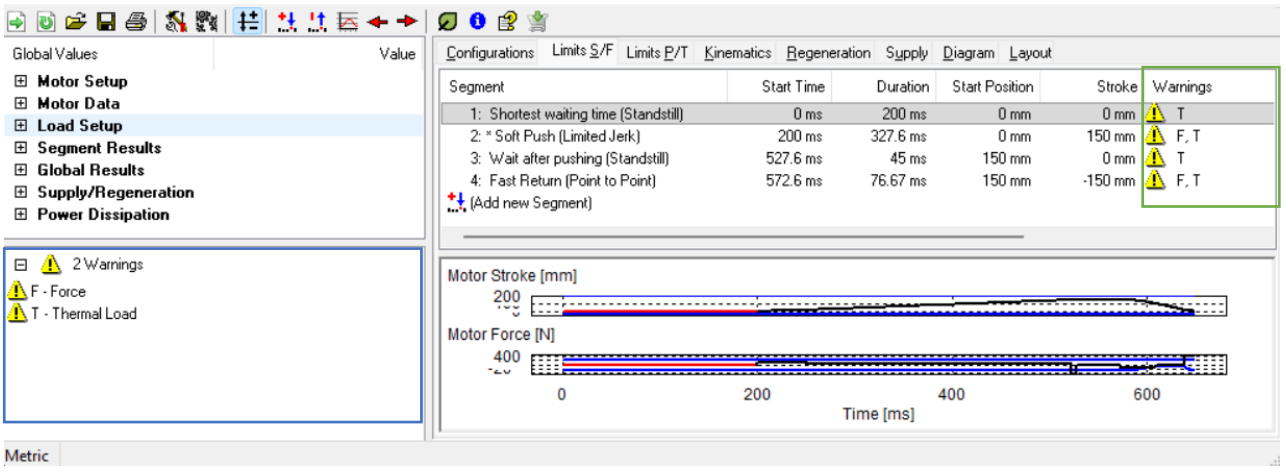
### 4.3.1 Overview of Evaluation Logic

After every user action that affects the design the Designer automatically performs the following checks:

1. **Simulation recalculation** of the full motion sequence
   - Stroke, speed, acceleration
   - Motor force, peak force limits
   - Power dissipation, short-time overload, thermal load
   - Electrical power, DC link voltage, regeneration behaviour
2. **Dynamic limit check**
   The following dynamic parameters are compared against their respective limits on a per-segment basis:
   Stroke, Force, Short-Time Overload Protection Value, Thermal Load, Regeneration, Acceleration Reserve, Speed Jump, End Position, Acceleration, Motor Support.
3. **System compatibility check**
   - Verifies whether the selected motor is compatible with the selected drive
   - If incompatible, a Motor Support error is shown

4. **Message generation**
   - OK → No errors/warnings
   - Warning → A limit is exceeded, design must be modified
   - Error → Simulation invalid or motor/drive combination impossible
   - Note → Soft limit exceeded or unusual condition detected

5. **Segment flagging**
   When a limit violation happens, a flag is shown in the Curve Settings window to indicate which segment(s) cause the issue.



### 4.3.2 Messages

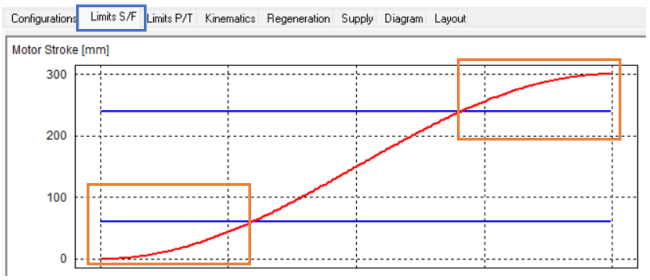
This chapter explains all message types and dynamic parameter flags that may appear during the design evaluation. It also provides corrective actions to resolve each issue.

**Dynamic Parameters and Flags**

| | Dynamic Parameter | Flag | Description |
|---|---|---|---|
| | Stroke | S | Checks whether the stroke stays within the motor/module stroke limits. |
| | Force | F | Validates that required dynamic force stays below motor peak force limits. |
| | Short Time Overload Protection Value | O | Protects the motor from excessive coil heating due to very high instantaneous power dissipation. |
| | Thermal Load | T | Monitors steady-state thermal heating based on continuous power dissipation. |
| | Regeneration | R | Checks DC link voltage rise and brake energy pulses during generator phases. |
| | Acceleration Reserve | Ar | Ensures that the system's maximum achievable force/mass ratio exceeds minimum requirements. |
| | Speed Jump | J | Detects discontinuities in speed between segments. |
| | End Position | E | Ensures that the final segment ends at the starting position (closed motion cycle). |
| | Acceleration | A | Checks if acceleration exceeds soft mechanical limits of guided modules. |
| | Motor Support | - | Indicates whether the motor is supported by the selected drive. |

#### 4.3.2.1 Stroke (S)

A Stroke Error occurs when the motion exceeds the maximum allowed stroke of the selected motor/module. The stroke of the requested motion (black-red curve) must remain within the blue stroke limit lines.




**Common Causes**

- Motion segment defines a travel larger than the motor's max stroke
- Incorrect origin or start-position definition
- Accumulated position errors between segments

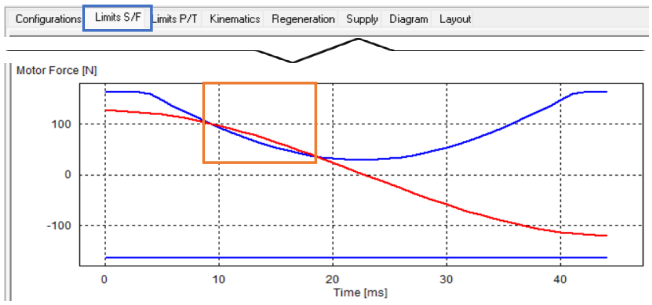
**How to Fix**

- Select a motor/module with a longer maximum stroke
- Adjust segment definitions to shorten stroke
- Correct start/end positions to avoid unintended offset

#### 4.3.2.2 Force (F)

Indicates that the required motor force exceeds the motor's peak force capability at the corresponding speed and stroke position.

Peak force limits depend on both slider position and velocity.




**Common Causes**

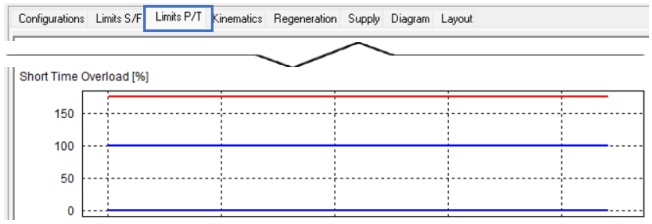
- Payload too high
- Motion time too short (too aggressive acceleration)
- Friction or external forces underestimated
- Motor type too small for the application

**How to Fix**

- Increase motion time (slower acceleration reduces peak force)
- Reduce payload or friction
- Select a larger motor or stronger drive
- Check that correct orientation and load direction are entered

#### 4.3.2.3 Short Time Overload Protection (O)

Triggered when instantaneous winding heating rises too quickly. This protection value (0–100%) prevents damage from excessive short bursts of current.




**Common Causes**

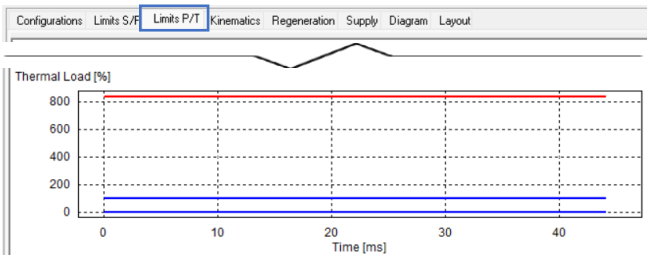
- Very short, aggressive segments
- High acceleration combined with high payload
- Insufficient cooling

**How to Fix**

- Increase segment durations
- Reduce payload
- Improve cooling method (Fan instead of Passive)

#### 4.3.2.4 Thermal Load (T)

Represents the thermal steady-state load of the motor based on continuous RMS power dissipation. At 100% the real motor would shut down due to over-temperature.




**Common Causes**

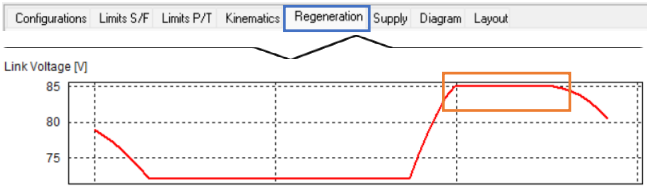
- Rapid cycle times
- High RMS force
- Poor cooling/ambient temperature too high

**How to Fix**

- Select a more efficient cooling method (Fan / Fluid)
- Increase cycle time or segment durations
- Choose a motor with higher continuous force rating

#### 4.3.2.5 Regeneration (R)

Occurs when braking phases feed energy back into the drive, increasing DC link voltage and generating Link Brake Energy Pulses. If the drive cannot dissipate the energy, a warning appears.




**Common Causes**

- Insufficient DC link capacitance
- No braking resistor selected
- Highly dynamic stop/brake movements

**How to Fix**

- Increase external DC link capacitance
- Enable/use braking resistor or motor winding brake mode
- Smooth deceleration by adjusting motion profile
- Confirm supply capacitance settings in Global Settings

#### 4.3.2.6 Acceleration Reserve (Ar)

A warning occurs if the acceleration reserve falls below 10 N/kg. It represents max force divided by moving mass and indicates whether the system can still accelerate the load sufficiently.

**Common Causes**

- Moving mass too high
- Motor too small
- Incorrect load definition

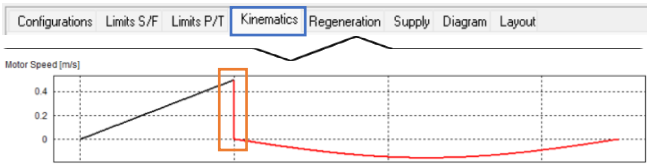
**How to Fix**

- Reduce load mass
- Select a stronger motor or drive
- Check orientation and friction entries again

#### 4.3.2.7 Speed Jump (J)

Generated when segment transitions result in discontinuous velocity (speed does not match between end of segment A and start of segment B).

Occurs primarily with Speed Change Linear curve type.




**Common Causes**

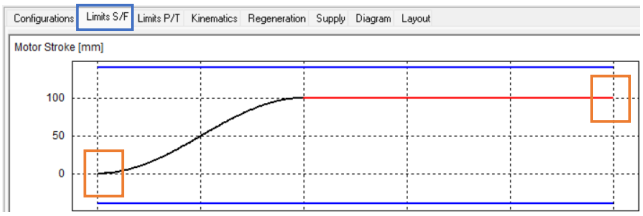
- Incorrect use of curve types
- Mismatched end/start speeds of consecutive segments

**How to Fix**

- Ensure end speed = next segment start speed
- Replace curve type with Sine / Minimal Jerk / Limited Jerk where appropriate
- Redesign segment sequence

#### 4.3.2.8 End Position (E)

Final segment does not end at the initial position, causing a discontinuity in stroke for the cyclic simulation. This is most relevant for linear motors.




**Common Causes**

- Position drift across segments
- Wrong manually entered start/end positions

**How to Fix**

- Ensure last segment end = first segment start
- Re-calculate motion segment chain

#### 4.3.2.9 Acceleration (A)

A soft warning (Note) when acceleration exceeds the recommended limit for guided modules (ball-bearing wear risk).

**How to Fix**

- Reduce acceleration
- Select other Module / Motor Type
- Design your own guidance system with a motor (no module)
- Re-evaluate cycle time requirements

#### 4.3.2.10 Motor Support

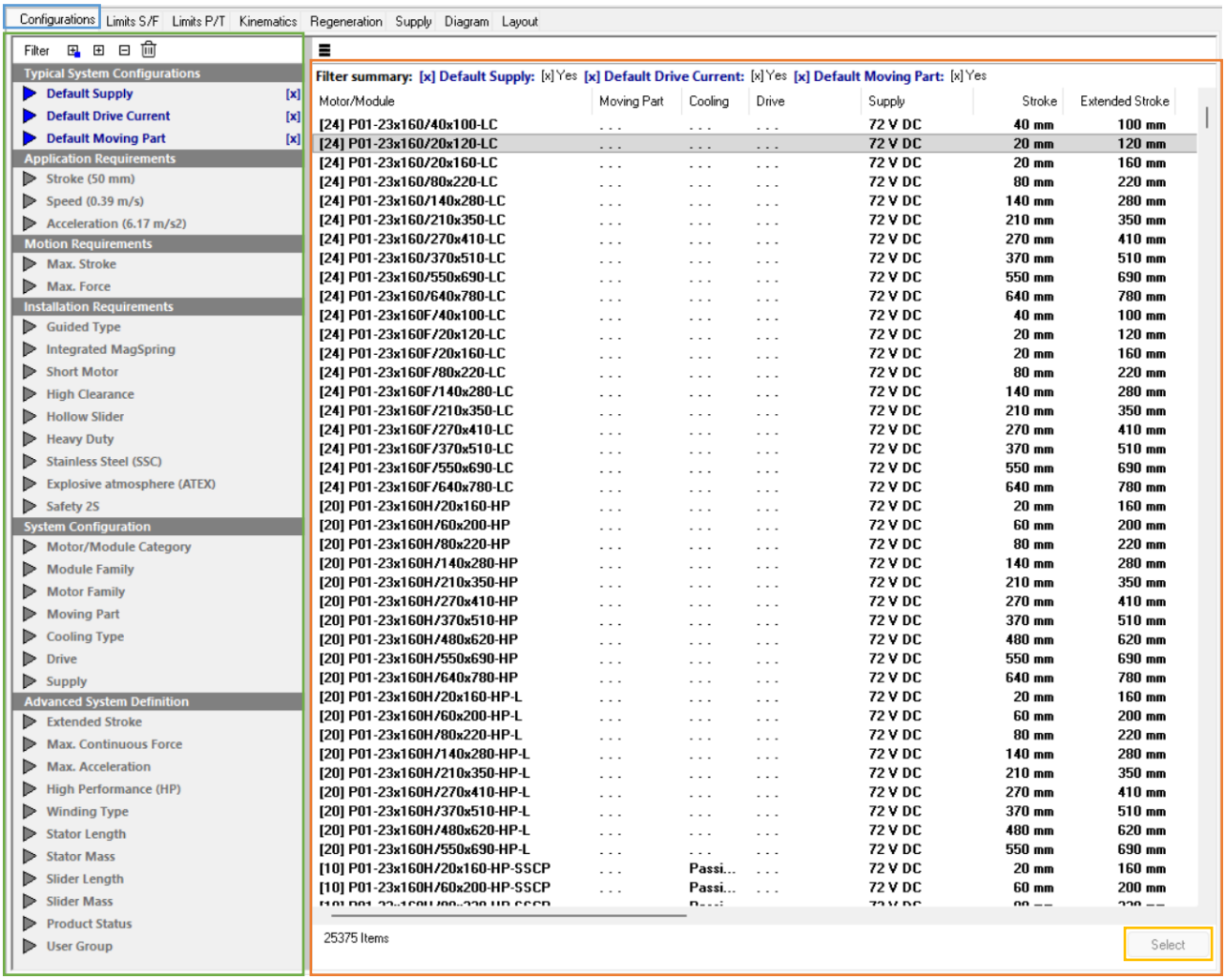
Error generated when the selected motor is not supported by the selected drive.

**How to Fix**

- Select a supported drive
- Choose another motor compatible with the drive
- Check default supply and drive current settings

## 4.4 Motor Selection with Configuration Tab

The Configuration tab serves as a central tool for identifying the most suitable LinMot motor configuration for a given application. LinMot systems offer thousands of possible combinations of motor type, moving part, cooling method, drive type, … each with its own performance characteristics. The purpose of this tab is to efficiently narrow down these numerous combinations and guide users toward a configuration that matches the technical requirements of their motion profile and load setup.




To achieve this, the tab provides a powerful filtering system that reduces the full configuration list to a smaller set of feasible options based on measurable application criteria.

Once filtering is applied, users can compare the remaining configurations and select a specific motor setup. Selecting a configuration automatically updates all related system components. This allows for a seamless transition from selection to simulation, where the Designer immediately calculates performance limits, warnings, and feasibility indicators.

### 4.4.1 The Filter System

#### 4.4.1.1 Filter Menu




**Expand active filters**

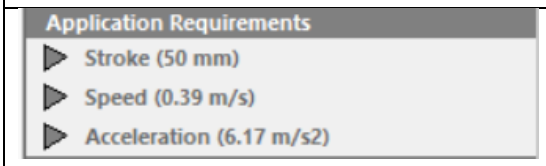
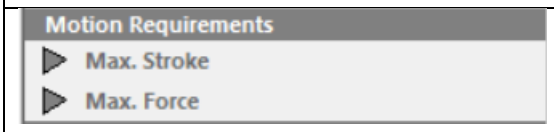
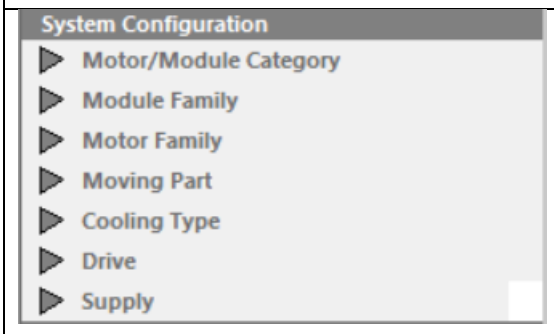
Expands only the filters that are currently active—i.e., filters where at least one criterion is set. This helps users quickly identify which parameters are influencing the filtered configuration list. Active filters are highlighted in blue and listed in the filter summary.

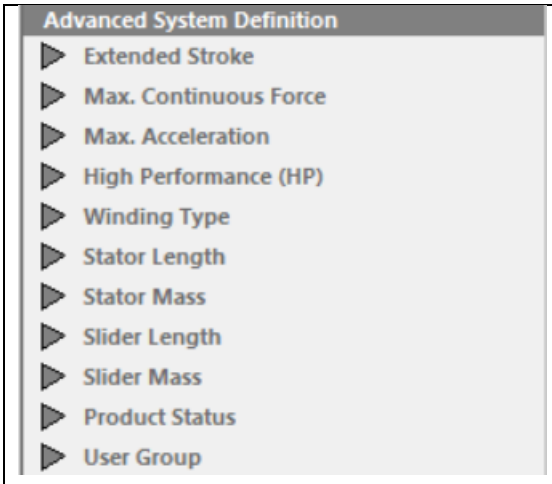
**Expand all filters**
Opens and displays the full set of available filters.

**Collapse all filters**
Closes all filter sections, giving the user a clean, compact view of the filter panel.

**Reset all filters**
Clears every applied filter and restores the filter panel to its default state. After this action, no criteria remain active, and the configuration list displays all available motor/module configurations again.

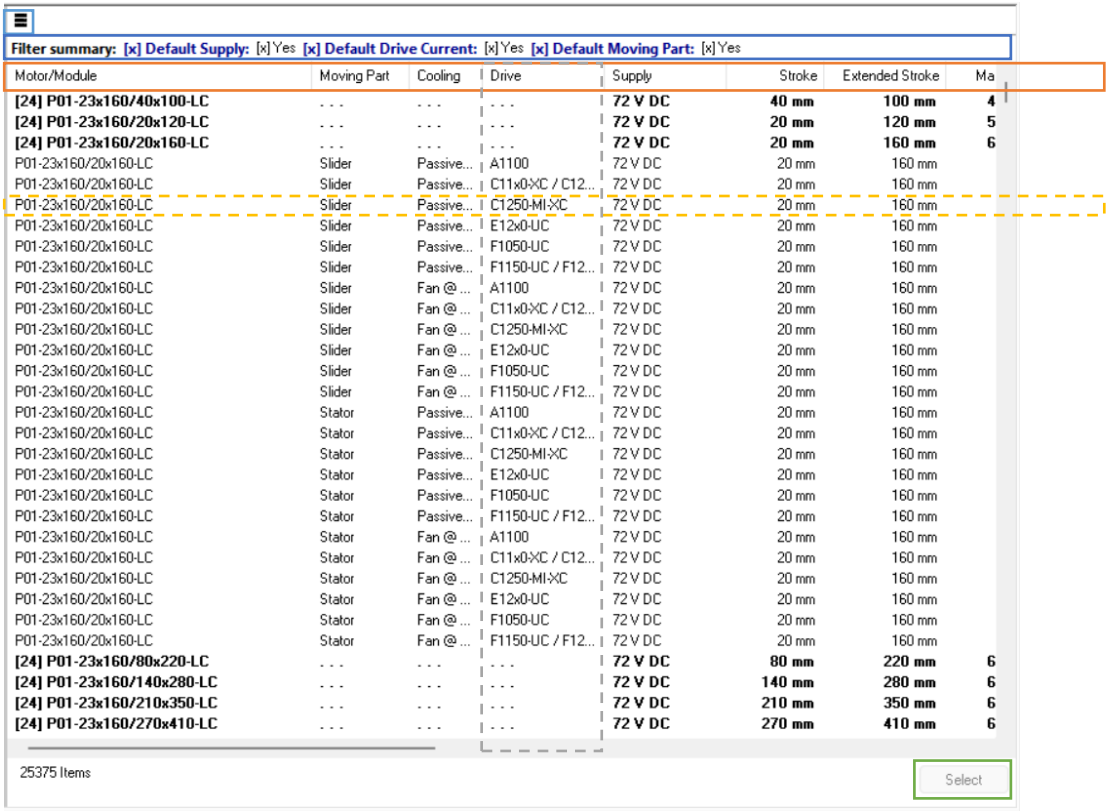
#### 4.4.1.2 Filters

| | |
|---|---|
|  | **Typical System Configurations**<br>This filter group provides quick access to predefined default settings. These defaults reflect the standard recommended configuration for the selected motor/module and can be enabled or disabled to influence the filtering results. |
|  | **Application Requirements**<br>This filter group allows users to narrow down the available motor/module configurations according to the required stroke, speed, and acceleration of the application. |
|  | **Motion Requirements**<br>This filter group allows users to restrict the available motor/module configurations based on maximum stroke and maximum force limits required by the application. |
|  | **Installation Requirements**<br>This filter group allows users to specify mechanical, environmental, or design-specific constraints that the selected motor/module must meet. |
|  | **System Configuration**<br>This filter group allows users to define the fundamental system characteristics of the motor/module configuration. By selecting motor category, moving part, drive type, … users can narrow the configuration list to only those system architectures that match their technical and mechanical requirements. |

| | |
|---|---|
|  | **Advanced System Definition**<br>This filter group provides advanced filtering options that allow users to fine-tune their motor/module selection based on performance, geometry, winding type, and product classification. |

### 4.4.1.3 Filtered Configuration List

The Filtered Configuration List presents all motor and module configurations that match the currently active filter criteria. It is the central decision-making table within the Configurations tab, allowing users to compare technical attributes across thousands of possible LinMot systems and select a configuration suitable for simulation and further refinement. The list updates dynamically whenever filters are changed, ensuring that only feasible configurations remain visible.



Filter summary: [x] Default Supply: [x] Yes [x] Default Drive Current: [x] Yes [x] Default Moving Part: [x] Yes

| Motor/Module | Moving Part | Cooling | Drive | Supply | Stroke | Extended Stroke | Ma |
|---|---|---|---|---|---|---|---|
| **[24] P01-23x160/40x100-LC** | . . . | . . . | . . . | **72 V DC** | **40 mm** | **100 mm** | **4** |
| **[24] P01-23x160/20x120-LC** | . . . | . . . | . . . | **72 V DC** | **20 mm** | **120 mm** | **5** |
| **[24] P01-23x160/20x160-LC** | . . . | . . . | . . . | **72 V DC** | **20 mm** | **160 mm** | **6** |
| P01-23x160/20x160-LC | Slider | Passive... | A1100 | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Passive... | C11x0-XC / C12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Passive... | C1250-MI-XC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Passive... | E12x0-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Passive... | F1050-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Passive... | F1150-UC / F12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | A1100 | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | C11x0-XC / C12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | C1250-MI-XC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | E12x0-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | F1050-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Slider | Fan @ ... | F1150-UC / F12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | A1100 | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | C11x0-XC / C12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | C1250-MI-XC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | E12x0-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | F1050-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Passive... | F1150-UC / F12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | A1100 | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | C11x0-XC / C12... | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | C1250-MI-XC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | E12x0-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | F1050-UC | 72 V DC | 20 mm | 160 mm | |
| P01-23x160/20x160-LC | Stator | Fan @ ... | F1150-UC / F12... | 72 V DC | 20 mm | 160 mm | |
| **[24] P01-23x160/80x220-LC** | . . . | . . . | . . . | **72 V DC** | **80 mm** | **220 mm** | **6** |
| **[24] P01-23x160/140x280-LC** | . . . | . . . | . . . | **72 V DC** | **140 mm** | **280 mm** | **6** |
| **[24] P01-23x160/210x350-LC** | . . . | . . . | . . . | **72 V DC** | **210 mm** | **350 mm** | **6** |
| **[24] P01-23x160/270x410-LC** | . . . | . . . | . . . | **72 V DC** | **270 mm** | **410 mm** | **6** |

25375 Items Select

#### Structured vs. Non-Structured View

By default, the list appears in a structured view. Configurations are grouped under bold headings representing the Motor/Module family, making it easy to collapse or expand large families for clarity.

#### Filter Summary

The Filter Summary lists all currently active filters, each with a blue [x] symbol allowing quick removal. This summary gives users an immediate overview of the selection constraints currently applied.
Active filters appear with a blue label, while filters that eliminate all configurations turn grey.

#### Table Column Header

The header includes the following column titles:

Motor/Module, Moving Part, Cooling, Drive, Supply, Stroke, Extended Stroke, Max Force, Cont. Force, Max. Accel, Guided, Short Motor, High Clearance, SSC, ATEX, High Performance, Extended Stroke, Slider Length, Slider Mass, Stator Length, Stator Mass

**Table Structure and Content**
Each row in the table represents a complete motor configuration, including all defining characteristics. All these data points are derived from LinMot's internal system database and correspond to real article variants.

**Sorting Configurations**
All columns support sorting. Clicking a column header rearranges the list according to the selected attribute. Sorting always switches the table to the non-structured view.

**Selecting a Configuration**
A configuration can be selected in two ways:

- Double-clicking the desired row, or
- Choosing a row and pressing the "Select" button.

Once selected:

- The Global Values panel updates immediately with the configuration's parameters.
- All simulation results refresh automatically.
- If any limits are exceeded (force, thermal load, stroke, regeneration), the Designer presents warnings or errors.

Bold group rows (in structured view) cannot be selected; users must choose one of the specific configurations within the group.

### 4.4.2 Practical Use Case

**Open the Configurations Tab**
Begin by navigating to the Configurations tab. This tab displays all available base configurations derived from every valid combination of motor/module type, moving part, cooling method, drive type, and supply type.

**Apply Filters to Narrow the Configuration List**
The Configurations tab includes a powerful filter system designed to reduce the configuration list to a manageable subset. The Filters are described in Section 4.4.1.2. Each filter becomes active once at least one criterion is selected, and all active filters appear in the Filter Summary at the top of the window.

Use the following recommended approach:

1. Start with high-impact filters such as Motor/Module Category, Moving Part, and Cooling Type.
2. Apply Application Requirements to eliminate configurations that cannot achieve needed stroke or dynamics.
3. Refine further with installation-specific needs or advanced system constraints.

**Interpret the Filtered Configuration Table**
After filtering, the table displays only the configurations that satisfy all selected criteria. Each row represents one complete configuration, including all values described in Table Column Header in Section 4.4.1.3.

**Sort and Compare Configurations**
Click any column header to sort by that parameter:

- Sort by Max. Force to identify high-force candidates.
- Sort by Cooling Method to compare thermal options.
- Sort by Extended Stroke when long travel distances are required.

Sorting automatically reduces the view to a non-structured list for direct comparison.

**Select a Configuration**
Once you identify a configuration that matches your application requirements, select it by:

- Double-clicking the row, or
- Selecting the row and pressing the Select button.

Upon selection:

- The Global Values panel is updated.
- All dependent simulation results (force, thermal, acceleration, regeneration) refresh instantly.
- Inconsistent or unsafe configurations generate warnings or errors, allowing further refinement.

**Modify and Re-Evaluate as Needed**
If simulation results show limits exceeded (e.g., thermal load or force), you can:

- Adjust the motion profile,
- Modify Global Settings (cooling, drive, supply),
- Reapply filters to find a more suitable configuration, or
- Manually choose another motor category or family in the Motor Selection window.

Motor Selection is an iterative process: filter → compare → select → simulate → refine.

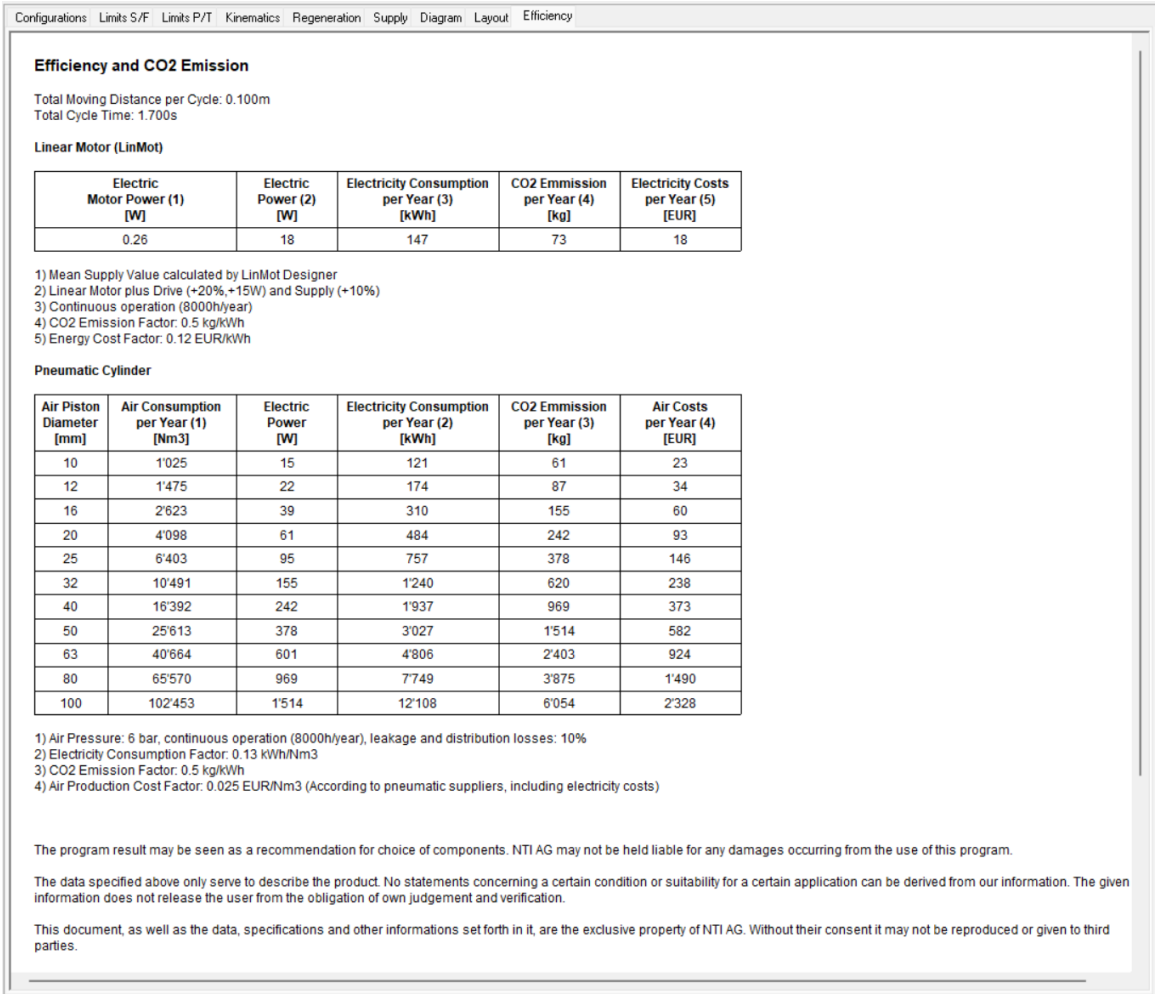
**Best Practices for Effective Motor Selection**

- Start with the broadest filters and progressively narrow down criteria.
- Use the stroke and dynamic requirement filters early—they eliminate most unsuitable configurations.
- Consider cooling method carefully; thermal limits often define feasibility.
- Use the table sorting functions to compare performance parameters side-by-side.
- Revisit the simulation results after each selection to validate the system's viability.

## 4.5 Efficiency

The *Efficiency* tab in LinMot Designer provides a quantitative comparison between a LinMot linear motor and an equivalent pneumatic cylinder for the same application. The tab is available only for linear motor designs and can be shown or hidden using the green *Efficiency Leaf* icon in the menu bar (Section 2.2.1.4).

The tab is designed to support engineers, machine builders, and project planners in making informed decisions when evaluating whether an application should continue to use pneumatic actuation or be replaced with an electric linear motor. The comparison includes not only energy consumption but also environmental and financial impacts.



Configurations | Limits S/F | Limits P/T | Kinematics | Regeneration | Supply | Diagram | Layout | Efficiency

**Efficiency and CO2 Emission**

Total Moving Distance per Cycle: 0.100m
Total Cycle Time: 1.700s

**Linear Motor (LinMot)**

| Electric Motor Power (1) [W] | Electric Power (2) [W] | Electricity Consumption per Year (3) [kWh] | CO2 Emmission per Year (4) [kg] | Electricity Costs per Year (5) [EUR] |
|---|---|---|---|---|
| 0.26 | 18 | 147 | 73 | 18 |

1) Mean Supply Value calculated by LinMot Designer
2) Linear Motor plus Drive (+20%,+15W) and Supply (+10%)
3) Continuous operation (8000h/year)
4) CO2 Emission Factor: 0.5 kg/kWh
5) Energy Cost Factor: 0.12 EUR/kWh

**Pneumatic Cylinder**

| Air Piston Diameter [mm] | Air Consumption per Year (1) [Nm3] | Electric Power [W] | Electricity Consumption per Year (2) [kWh] | CO2 Emmission per Year (3) [kg] | Air Costs per Year (4) [EUR] |
|---|---|---|---|---|---|
| 10 | 1'025 | 15 | 121 | 61 | 23 |
| 12 | 1'475 | 22 | 174 | 87 | 34 |
| 16 | 2'623 | 39 | 310 | 155 | 60 |
| 20 | 4'098 | 61 | 484 | 242 | 93 |
| 25 | 6'403 | 95 | 757 | 378 | 146 |
| 32 | 10'491 | 155 | 1'240 | 620 | 238 |
| 40 | 16'392 | 242 | 1'937 | 969 | 373 |
| 50 | 25'613 | 378 | 3'027 | 1'514 | 582 |
| 63 | 40'664 | 601 | 4'806 | 2'403 | 924 |
| 80 | 65'570 | 969 | 7'749 | 3'875 | 1'490 |
| 100 | 102'453 | 1'514 | 12'108 | 6'054 | 2'328 |

1) Air Pressure: 6 bar, continuous operation (8000h/year), leakage and distribution losses: 10%
2) Electricity Consumption Factor: 0.13 kWh/Nm3
3) CO2 Emission Factor: 0.5 kg/kWh
4) Air Production Cost Factor: 0.025 EUR/Nm3 (According to pneumatic suppliers, including electricity costs)

The program result may be seen as a recommendation for choice of components. NTI AG may not be held liable for any damages occurring from the use of this program.

The data specified above only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The given information does not release the user from the obligation of own judgement and verification.

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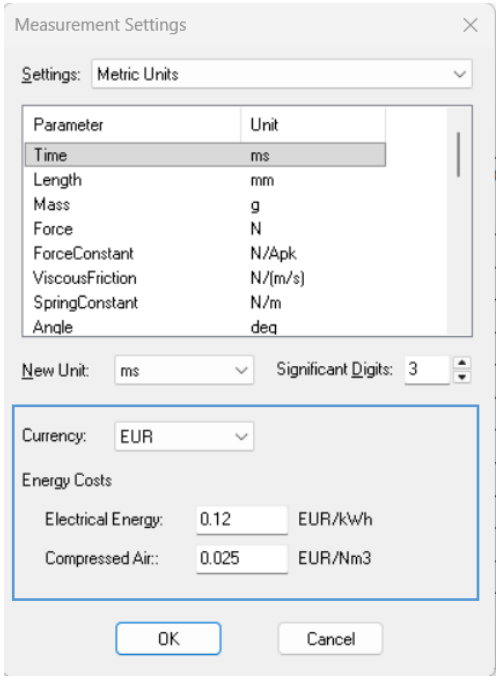
### 4.5.1 Input Data

The following parameters are automatically transferred from the active project into the *Efficiency* tab:

- Total Moving Distance per Cycle
- Total Cycle Time
- Electric Motor Power

Several cost- and energy-related parameters are configurable through the Measurement Settings dialog, allowing adjustments to reflect regional or customer-specific conditions.




### 4.5.2 Result Overview – Linear Motor vs. Pneumatic Cylinder

This section provides a direct comparison between the energy consumption, yearly operating costs, and $CO_2$ emissions of the selected LinMot linear motor and an equivalent pneumatic cylinder performing the same application.

#### 4.5.2.1 Linear Motor

The Linear Motor table shows all calculated yearly performance values for the currently selected LinMot motor in the project. It includes:

- **Electric Motor Power**
  The value is taken directly from the simulation results of the current LinMot configuration.
- **Electric Power**
  The electrical input power required by the LinMot system to generate the necessary mechanical output power. It accounts for motor (20%), drive (15%) and supply (10%) losses and reflects how much electrical energy the motor draws under continuous use.
- **Electricity Consumption per Year [kWh]**
  This column shows the motor's annual energy consumption. With a predefined assumption of continuous operation of 8'000 h/year.
- **$CO_2$ Emission per Year [kg]**
  This value is obtained by multiplying the yearly electrical energy consumption with a standard $CO_2$ emission factor (0.5 kg/kWh) for electricity.
- **Electricity Costs per Year**
  This is the annual operating cost of powering the linear motor. The currency and electricity price can be configured (Section 4.5.1).

The values help quantify the running cost and ecological footprint of the electric solution.

#### 4.5.2.2 Pneumatic Cylinder

The Pneumatic Cylinder table provides an equivalent evaluation for a compressed-air-driven solution. It calculates them depending on different Air Piston Diameters [mm] and includes:

- **Air Consumption per Year [Nm³]**
  Indicates the total volume of compressed air required annually for the defined motion cycle. It is

calculated using standard assumptions such as: 6-bar operating pressure and includes distribution and leakage losses (10%).

- **Electric Power (of the Compressor) [W]**
  Shows the electrical power needed by the air compressor to generate the required compressed air. The value reflects typical compressor efficiency assumptions and represents the primary energy demand of the pneumatic system.
- **Electricity Consumption per Year [kWh]**
  Calculates yearly electrical energy use of the compressor based on its power rating and assumed operating hours (8'000 h/year). This allows a direct comparison with the linear motor's electrical consumption.
- **$CO_2$ Emission per Year [kg]**
  Represents the annual $CO_2$ output linked to the pneumatic system's electricity use. It uses a standard $CO_2$ emission factor for electricity.
- **Air Costs per Year**
  Shows total annual operating cost for compressed air. The currency and electricity price can be configured (Section 3.5.1).

This allows users to compare the pneumatic alternative directly with the linear motor and quickly determine when a pneumatic system becomes less efficient or more expensive to operate.

### 4.5.3 Interpreting the Results and Making Design Decisions

The *Efficiency* tab provides a compact but powerful basis for evaluating whether a pneumatic axis should be replaced by a LinMot linear motor.

Typical Decision Questions the *Efficiency* Tab Helps Answer

- Is it economically reasonable to replace a pneumatic axis with a linear motor?
- How long is the payback time?
- What is the environmental benefit?

Practical Use of the Results

- Compare total yearly costs
- Estimate long-term savings
- Communicate benefits to end-customers
  - Lower operating and energy costs
  - Reduced $CO_2$ footprint
  - Elimination or reduction of compressed-air infrastructure
  - Higher efficiency and improved sustainability



**Printing and Export**
The *Efficiency* tab's content is only included in printouts and exports when the tab is activated.

## 4.6 Export Project

Exporting a project in LinMot Designer ensures that all relevant configuration data, motion definitions, and system parameters can be archived, shared, or further processed.

### 4.6.1 Exporting the Project File (.ldc)



The Save button in the menu bar saves the entire project as a .ldc file. This project file is the native format used by LinMot Designer to store all configuration settings, motor/module selections, motion profiles, load definitions, and simulation results.

**Info**
LinMot Designer asks to load the last opened project on startup.

### 4.6.2 Generating Technical Reports

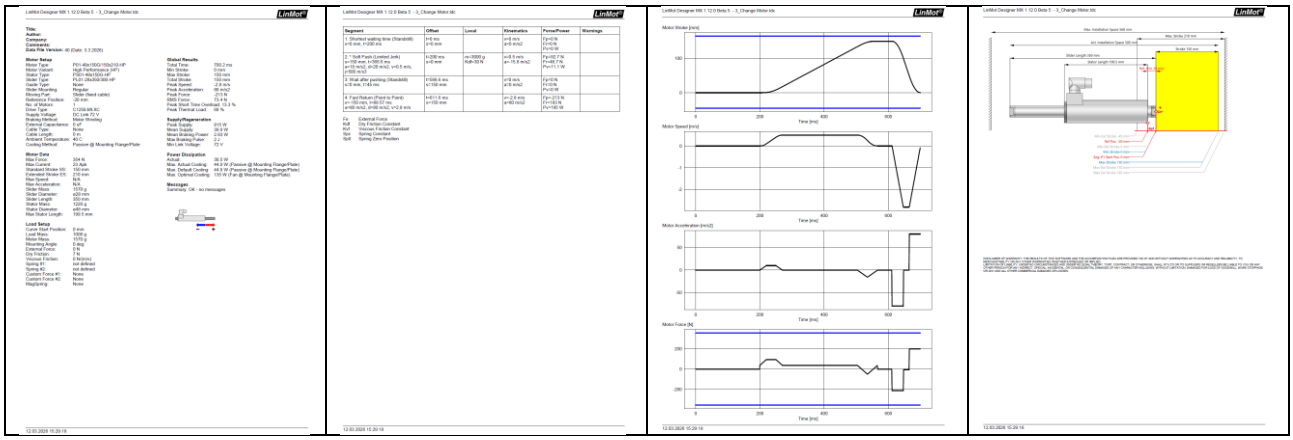


The Print button in the menu bar provides extensive reporting capabilities that summarize the complete system configuration and simulation results. Reports are particularly helpful for documentation, customer communication, validation steps, and internal review processes.

Reports typically include:

- Project information from the Global Settings, Info tab (Section 4.1.4)
- Motor/module configuration and all associated input parameters (Section 2.2.2.1).
- All Simulation Results (Section 2.2.2.2).
- A detailed messages list including errors, warnings, and notes generated during simulation (Section 4.3.2).
- List of all *Motion Segments* with information about:
  - Segment
    - Name
    - Curve Type
    - Curve Settings
  - Offset
    - Start Time
    - Start Position
  - Local
    - Local Loads
  - Kinematics
    - Max. Velocity
    - Max. Acceleration
  - Force/Power
    - Peak Force (Fp)
    - RMS Force (Fr)
    - Power Dissipation (Pv)
  - Warnings
    - Segment specific Information, Warnings, Errors
- Motion profile graphs showing:
  - Motor Stroke
  - Motor Speed

  - Motor Acceleration
  - Motor Force.
- The physical Layout of the motor/module (Section 2.2.3.8)
- Optional content:
  - efficiency comparisons (if activated)



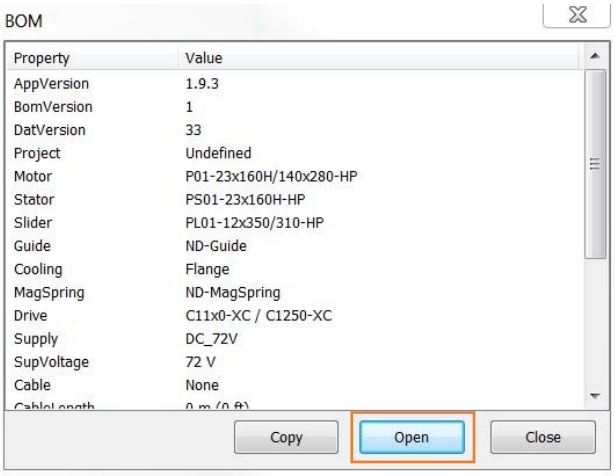
### 4.6.3 Exporting BOM (Bill of Material)



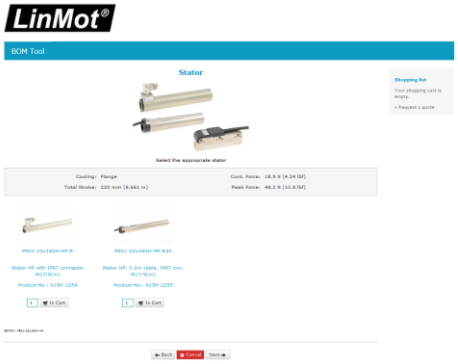
LinMot Designer includes a dedicated BOM export function for generating a structured list of all motor, module, drive, and supply components used in the project.

Using the Show BOM function:

1. Select Show BOM to open the BOM window.




2. By clicking Open, the BOM wizard launches in the web browser.
3. This displays the BOM wizard, which displays the Bill of Material for the selected configuration.




4. After reviewing the BOM, users can:
    - Export the BOM as a CSV file.
    - Export it as a text file.
    - Request a quotation directly via the LinMot e-catalogue platform.

This export option is essential for procurement, sales quotations, and preparing system component orders.

# ALL LINEAR MOTION
# FROM A SINGLE SOURCE


### Europe / Asia Headquarters

**NTI AG - LinMot & MagSpring**
Bodenaeckerstrasse 2
CH-8957 Spreitenbach
Switzerland

Sales / Administration: +41 56 419 91 91
office@linmot.com

Tech. Support: +41 56 544 71 00
support@linmot.com

Web: https://www.linmot.com/

### North / South America Headquarters

**LinMot USA Inc.**
N1922 State Road 120, Unit 1
Lake Geneva, WI 53147
USA

Sales / Administration: 262.743.2555
usasales@linmot.com

Tech. Support: 262.743.2555
usasupport@linmot.com

Web: https://www.linmot-usa.com/


Visit https://linmot.com/contact/ to find a distributor near you.

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