FT Motion Analyzer

User Guide

Version 3.0

MOTION-UM004F-EN-P

Rockwell Automation

Original Instructions

Contents

Overview **6**

Additional Resources **7**

Legal Notices **8**

Welcome to FactoryTalk Motion Analyzer **10**

Menu Bar 10

File Menu 11

View Menu 11

Tools Menu 12

Help Menu 13

Quick Access Toolbar 13

User Profile 14

Personal Information 14

Units Settings 15

Inertia Calculator 16

Tab Bar 18

Home Tab 19

Left-hand Panel 19

Library 20

Right-hand Panel 23

Project **26**

Manage Projects 27

Create New Folder 28

Copy Project-Folder 29

Move Project-Folder 30

Delete Project-Folder 32

Project-Folder View 33

Rename Project-Folder 34

Search 35

Project Preferences **36**

Architecture Overview **37**

Axis 38

Bus 40

Cluster 43

Power Interface Module - PIM 44
Dual Axis 49
Merge Dual-Axis 50
Split Dual-Axis 52
Split Option on Architecture Overview Page 52
Add New Drive 52
Delete Drive 53
Delete Axis 54
Duplicate Architecture Overview Items 55
Standalone Axis 55
Dual-Axis 56
Cluster 57
Power Bus 57
Define Your Profile 59
Set up Axis 59
Rotary Complex Template 60
Carriage Cut Off Template 62
Crank Slider Template 65
Cutter Knife Drive Template 71
Power Speed Template 74
Press Roll Feed (Time) Template 75
Press Roll Feed (Angle) Template 79
Unbalanced Load Template 82
Winder/Unwinder 85
Profile Editor Toolbar 89
Action Toolbar 89
Edit Graph 91
Edit Segment 92
Acceleration/Deceleration 93
Index 94
Cruise/Dwell 95
CAM 96
Index Advance 99
Inertia 100
Torque 102

Friction....103
Troubleshooting....104
Import Motion Profile....105
Prerequisites....105
General Data....105
Columns Explanation....106
Loads....106
Motion....107
Index segments....108
Requirements....108
CAM Segments....108
Components....110
Mechanism....110
Change Motion Type....110
Integrated Actuators....111
Linear servo Motors....112
Custom Mechanisms....114
Lead Screw....114
Rack & Pinion....115
Belt Drive....116
Chain & Sprocket....116
Choose Your Motor....117
Custom Motor....117
Catalog Motors....119
DSM Motor....121
Add DSM Motor....121
Choose Your Drive....123
Pre-filter Drives....126
Transmission....128
Solution....132
Solution Search Results....132
Axis Analysis....132
Expand Graph....137
Ratio Analysis....138
Size Up and Size Down....143

Power Analysis **146**
Power Analysis Setup 146
Profile Sequencing 147
Project Summary 147
Calculate 148
Power Analysis Result 149
Power Sharing 150
Limitations 150
PIM Summary 154
Operation Range Error 155
Bill of Materials **156**
View by Axis 156
View by Type 156
Export Bill of Materials 157
Project Report **158**
Generate Project Report 158
Refresh 160
Save the report 160

Overview

FactoryTalk® Motion Analyzer™ is a comprehensive motion-application design tool used for the analysis, optimization, selection, and validation of your motion control system. This software simplifies the machine design process, letting you quickly design and validate new machine concepts without purchasing or installing physical equipment. You can select from a wide range of Kinetix motors and drives, PowerFlex drives, and motors and gearboxes from our Technology Partners. The tool recommends solutions based on your application requirements and generates a bill of materials that can be exported into ProposalWorks for procurement.

Additional Resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
FactoryTalk Motion Analyzer User Guide	Provides complete instructions for using FactoryTalk Motion Analyzer.

View or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact the local Rockwell Automation distributor or sales representative.

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http://www.rockwellautomation.com/global/about-us/contact/contact.page

Please include "Open Source" as part of the request text.

A full list of all open-source software used in this product and their corresponding licenses can be found in the OPENSOURCE folder. The default installed location of these licenses is `C:\Users\<Username>\AppData\Local\Programs\FactoryTalk Motion Analyzer\resources \assets\documents\MALicenses.pdf`.

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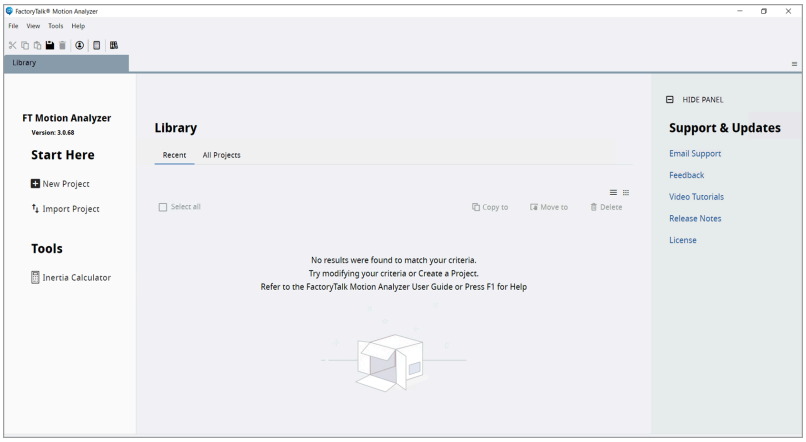
Welcome to FactoryTalk Motion Analyzer

Double-click the [ ] icon to launch the application. The application home page displays.

NOTE: User can also launch the application from the Start menu.

Figure 1. FactoryTalk Motion Analyzer Home Screen



On the welcome screen, the Menu bar, Quick Access toolbar, Tab bar, and Home tab are displayed.

Menu Bar

The Motion Analyzer menu bar is a graphical control element that contains drop-down menus. It provides four main options: File, View, Tools, and Help which are accessible across the application.

Figure 2. Menu Bar

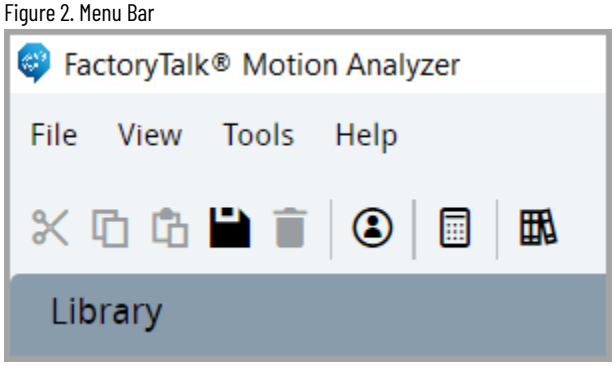


Table 1. Menu Bar

Options	Description
File	Standard File menu options
View	Options related to application appearance
Tools	Additional tools
Help	Options related to support contact and documentation

File Menu

The File menu is similar to the file menu in many computer applications. These files are stored in the local database and do not behave like normal files.

Figure 3. File Menu

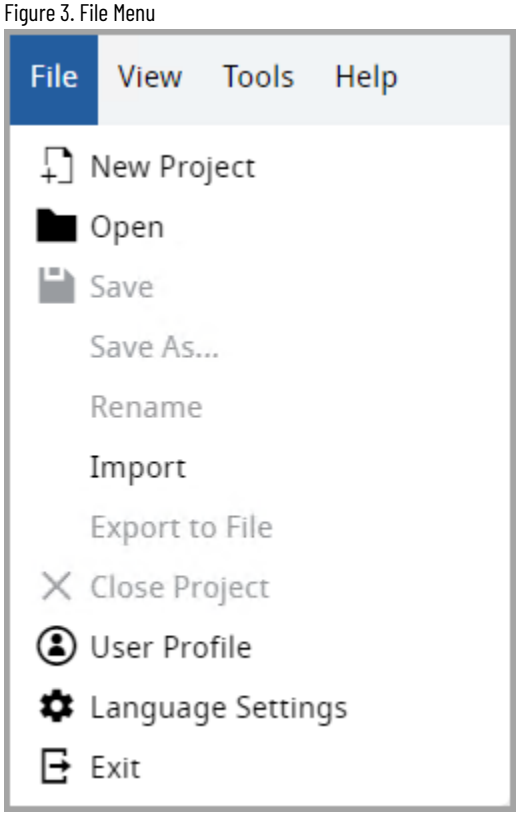


Table 2. File Menu

Options	Description
New project	Create a new project
Open	Open Projects
Save	Save project
Save As	Save As the Project to make a copy with a different name
Rename	Rename the project name
Import	Import a project name
Export to File	Exports a project to an XML file
Close Project	Close the currently opened project
User Profile	View and edit the User Profile
Language Settings	Edit the Language Settings. By default, English is selected.
Exit	Exit the application.

View Menu

The View menu allows user to change the application appearance and layout.

Figure 4. View Menu

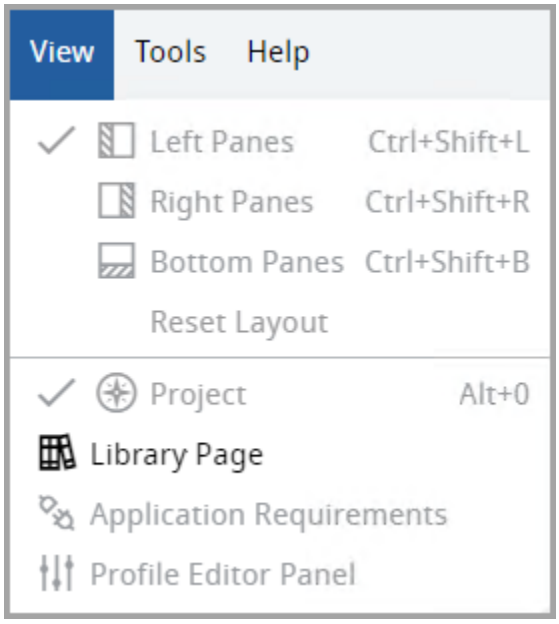


Table 3. View Menu

Options	Description
Left Panes	Enable/disable left panes while a project is open
Right Panes	Enable/disable right panes while a project is open
Bottom Panes	Enable/disable bottom panes while a project is open
Reset Layout	Reset layout to default settings while a project is open
Project	Enable/disable the Project Tree panes while a project is open
Home Page	Open the Home Tab
Application Requirements	Enable/disable Application Requirements while project is open
Profile Editor Tool	Enable/disable the Profile Editor tool panel while project is open

Tools Menu

The Tools drop-down menu allows user to open additional tools.

Figure 5. Tools Menu

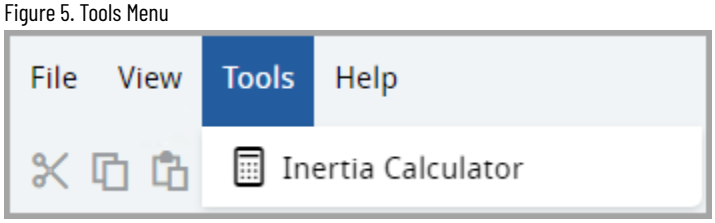


Table 4. Tools Menu

Options	Description
Inertia Calculator	To open Inertia Calculator. Refer to Inertia Calculator on page 16.

Help Menu

The Help menu allows user to read through the help content (User Manual), import the sample project files/templates, view the application license and version, and to provide feedback.

Figure 6. Help Menu

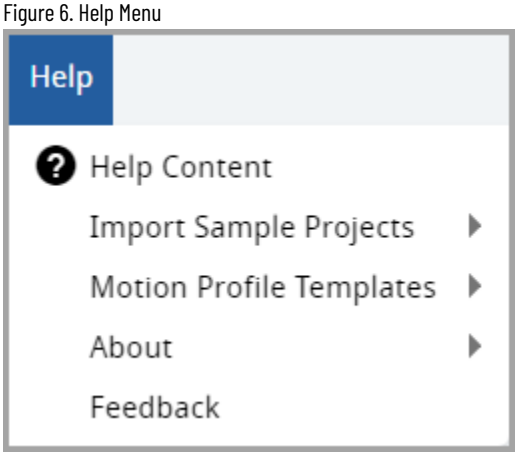


Table 5. Help Menu

Options	Description
Help Content	Open application help document
Import Sample Projects	A list of sample projects displays. User can import these projects into the application.
Motion Profile Templates	To import Motion Profile Templates and sample templates
About	To get the current application details: License: Displays the document with licenses in a PDF. If Adobe Reader is not installed, the PDF is opened in a browser. Version: Displays the application and database version being used at the bottom of the page.
Feedback	Open questionnaire regarding Motion Analyzer feedback

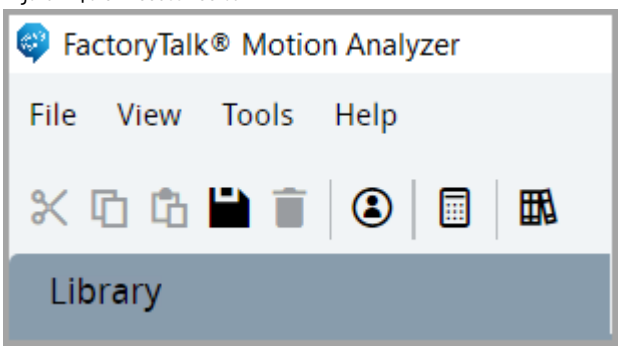
Quick Access Toolbar

The Quick Access toolbar contains:

- **Actions Toolbar**: To cut, paste, copy, save, and delete the data.
- **User Profile**: To set User profile.
- **Inertia Calculator**: To calculate the inertia of objects with different shapes.

- **Library Page:** To go to the Library page.

Figure 7. Quick Access Toolbar



User Profile

The user profile allows user to view the personal information of your company and the unit settings used in the application. User profile consists of two sections:

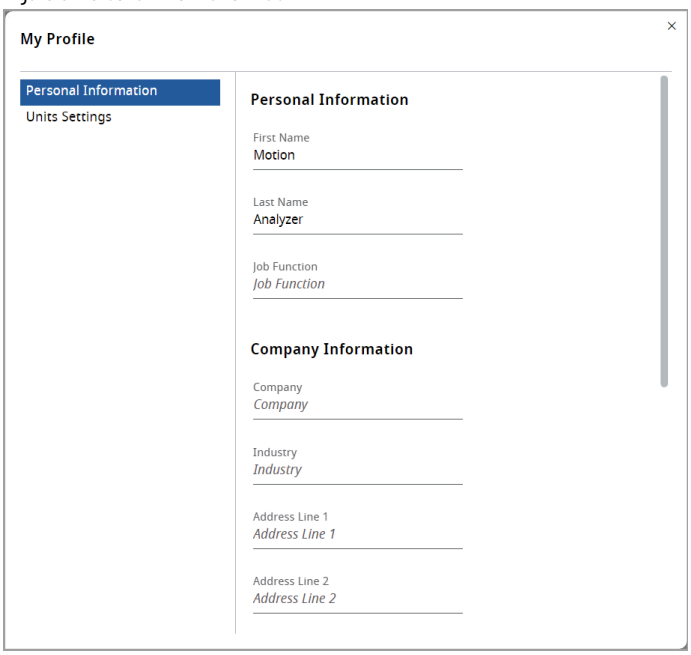
- Personal Information on page 14
- Units Settings on page 15

Personal Information

1. In the personal information tab, provide the following information:
    - First Name
    - Last Name
    - Job Function
    - Company information:
    - Company
    - Industry
    - Address
    - City
    - State
    - Postal code
    - Country
    - Phone

- Location

Figure 8. Personal Information Tab

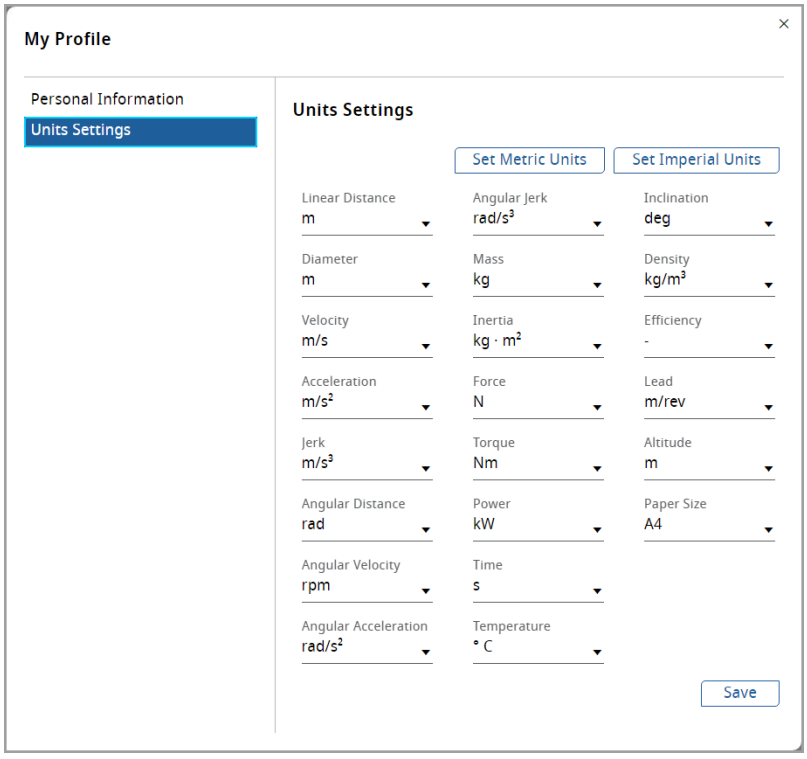


2. On the Quick Access bar, click the [ ] icon for the changes to take effect.

Units Settings

In the units settings tab, the global default units can be set. It is possible to set all units to one of two predefined sets: metric or imperial or modify specific units selected by the user.

Figure 9. Unit Settings Tab



After changing the default units, click the Save icon for the changes to take effect.

Inertia Calculator

The Inertia Calculator has several options for input parameters to calculate the Inertia for an application. There are two modes of Inertia Calculators in Motion Analyzer application.

- **Standard Inertia Calculator**: It can be accessed from the Tools Menu on page 12 and it can be used always in any place but does not save the calculation.
- **Contextual Inertia Calculator**: It can be used only in the place where is defined (currently on Transmission's page). It saves the calculation as well as the project and it can be reopened.

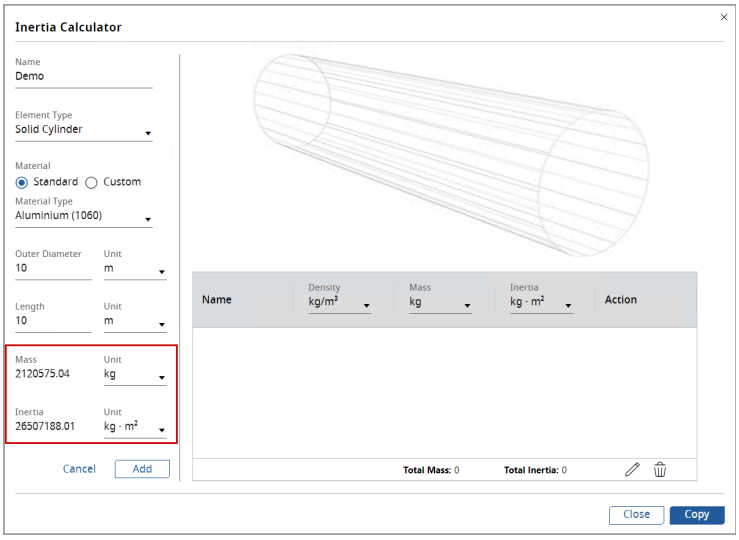
Perform the following steps to calculate the Inertia:

1. Click the [ ] icon or the Inertia Calculator from the Tools menu.
2. Provide the following details:

Table 6. Inertia Calculator

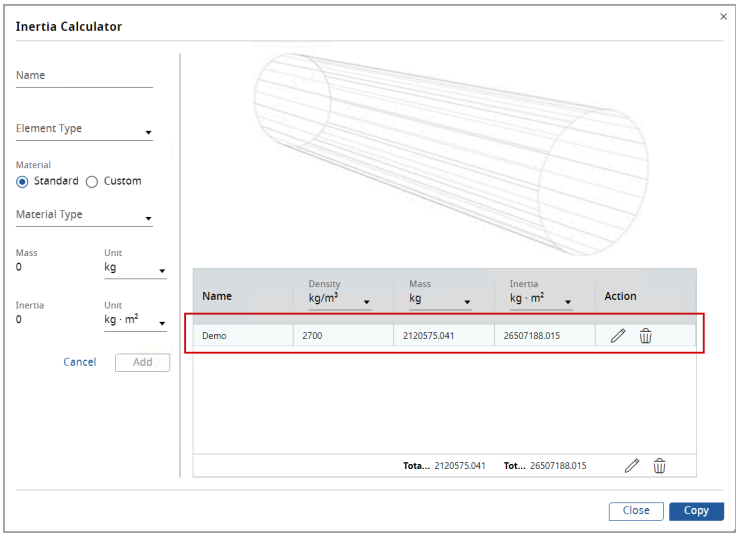
Field	Description
Name	Enter a name for the element.
Element Type	Select the type of the element (solid cylinder or hollow cylinder).
Material	Select the material of the cylinder: Standard or Custom. If the user selects Custom as the material, then the density value needs to be provided.
Material Type	Select the material type of the cylinder.
Density	Enter the density of the material.
Outer Diameter	Enter the outer diameter of the inertia element.
Inner Diameter	Enter the inner diameter of the inertia element if it is a hollow cylinder.
Length	Enter the length of the inertia element.
Mass	The mass of the cylinder is calculated based on the parameters.
Inertia	The Inertia of the cylinder is calculated based on the parameters.

Figure 10. Inertia Calculator



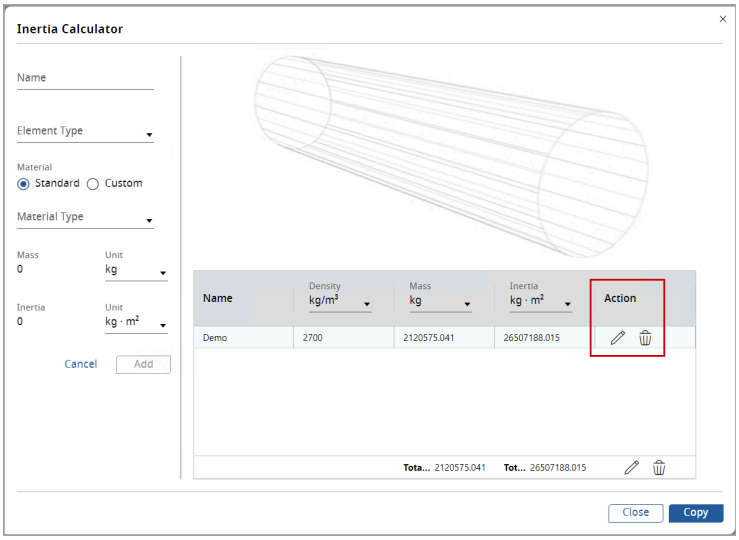
3. Click [Add]. The relevant values get saved to the project and reflected in the right panel as shown in the following image:

Figure 11. Right Panel



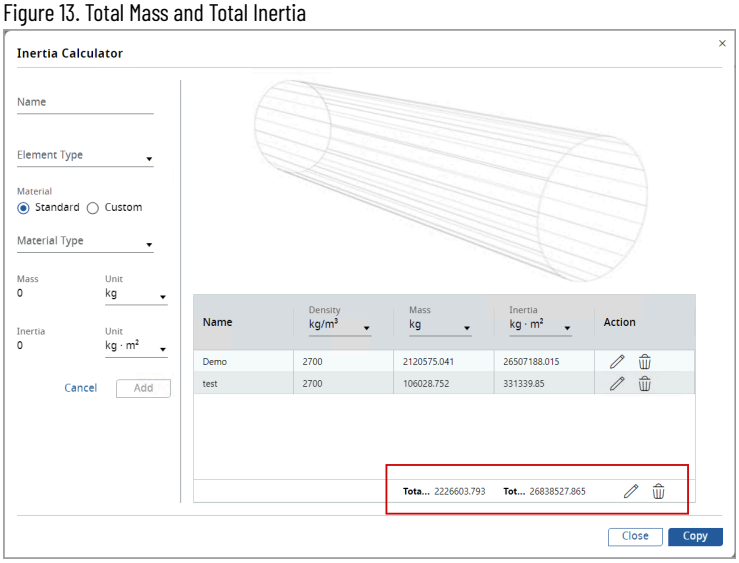
4. User can edit or delete the existing Inertia, or user can also add a new Inertia to the same element.

Figure 12. Edit or Delete



The Total Mass and the Total Inertia are displayed as shown in the following image:

Figure 13. Total Mass and Total Inertia

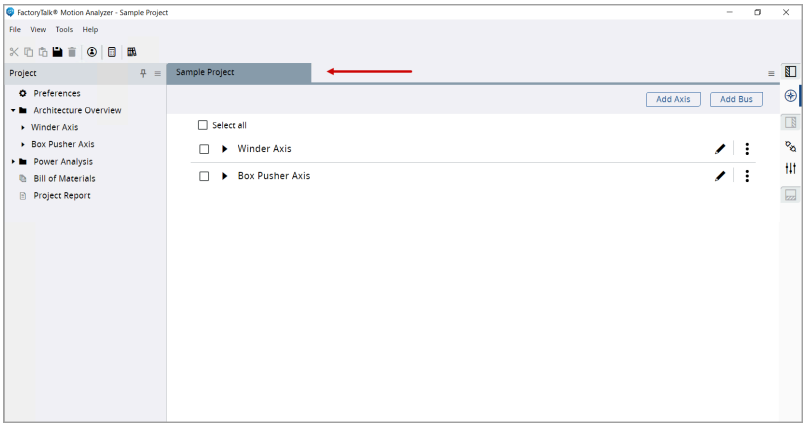


5. Click [Copy] to copy the Total Mass and the Total Inertia values to a clipboard.

Tab Bar

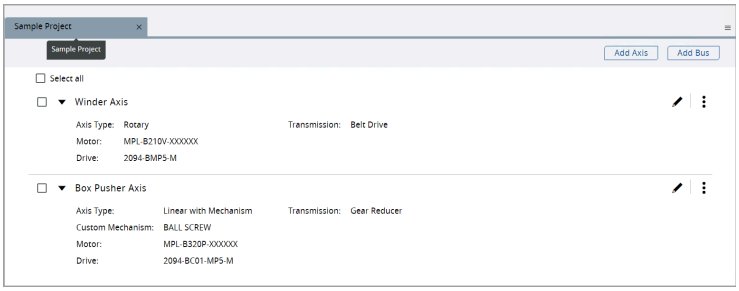
The tab bar is located under the Quick Action Toolbar and allows user to switch between the opened tabs.

Figure 14. Tab Bar



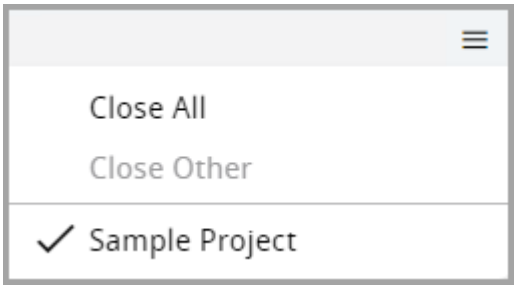
- To close the tab, hover the mouse on the tab and click the [X] icon.

Figure 15. Closing Tab



- On the right side of the tab bar, click the [☰] icon to check the list of opened tabs.
- The tick denotes the current tab. User can click on any tab name to view.

Figure 16. Opened Tabs List



- User can drag and drop the tabs to move them across the tab bar.

Home Tab

The home tab consists of a left-hand panel with a **Start Here** and **Tools**, a middle area with the **Library** view, and a right-hand panel with **Support and Updates**.

Left-hand Panel

The left panel allows user to create new empty project, import project XML and open Motion Analyzer additional tools.

Figure 17. Left Panel

Table 7. Left Panel

Options	Description
New Project	Create new empty project
Import project	Import project from XML
Inertia Calculator	Open Inertia Calculator. Refer to Inertia Calculator on page 16.

Library

The library section consists of two tabs: Recent and All projects. On the recent tab, the list of 10 recently modified projects is displayed. On the All-Projects tab, a list of all projects is available along with search input and pagination.

Figure 18. Recent Tab

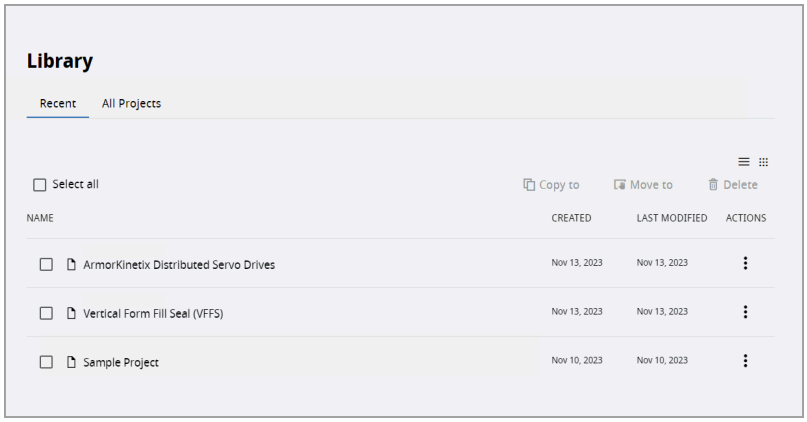
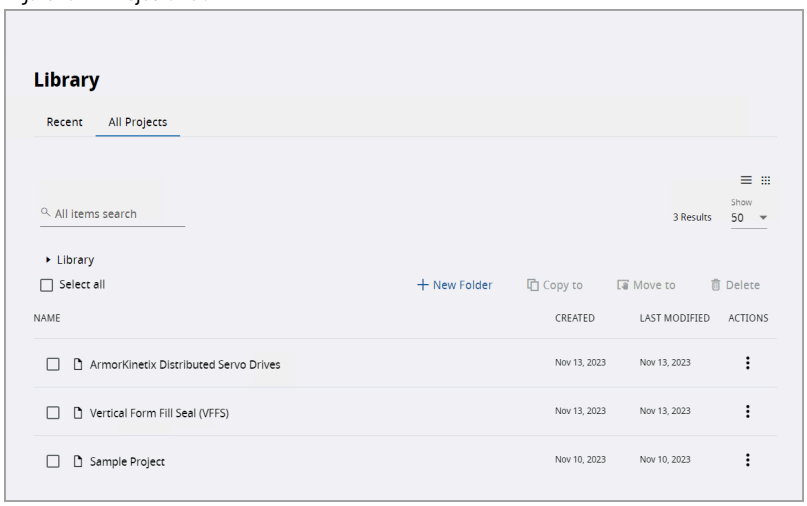


Figure 19. All Projects Tab



Projects and components are listed on library tabs in the grid with name, created, and last modified details. Click the ellipsis icon on a specific row will pop up the context menu with delete and shared options.

Figure 20. Project/Component Actions Context Menu

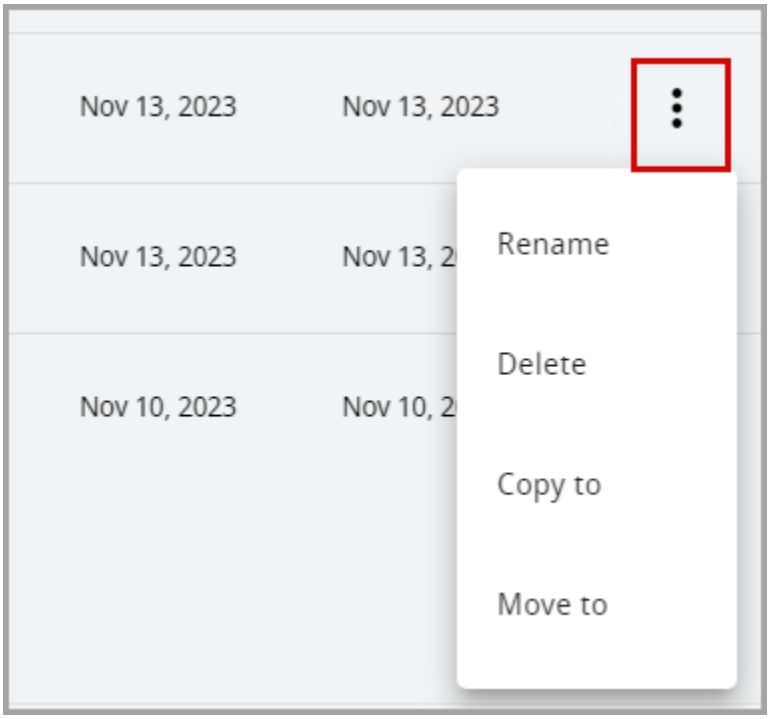
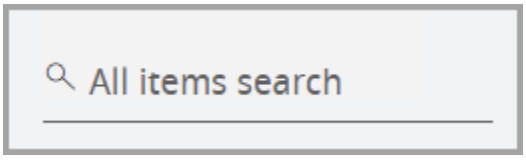


Table 8. Left Panel

Options	Description
Rename	Rename the project/component
Delete	Delete project/component from library
Copy to	To copy the project/component
Move to	To move the project/component.

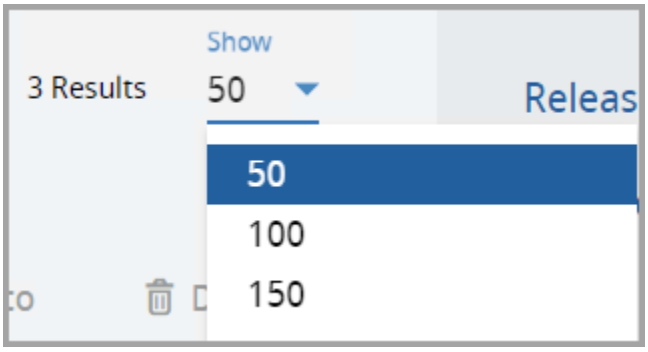
Search input is available on all projects tab and components tab and allows the user to find a project with a specific name.

Figure 21. Search Input



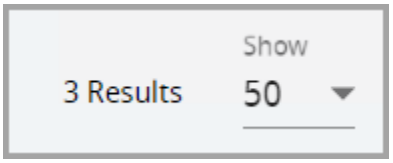
The pagination component displayed on those tabs changes dynamically depending on a number of results. The number of displayed results per page can be changed by selecting the value in the Show select input.

Figure 22. Pagination Show Select Input



If there are less or equal results to the value selected in show select input the pagination will be displayed in simplified form with the results number and show select input displayed.

Figure 23. Pagination Simplified Form



When there are more results than selected in show input, the pages numbers, pagination arrows, and jump to input will be displayed. Entering the page number to jump to input and confirming it by pressing enter will change the current page. If there are more than 6 pages on the pagination "..." button will appear allowing the user to jump to the first page not visible on the pagination.

Figure 24. Pagination Extended Form

Right-hand Panel

The right panel allows the user to check the application's version release notes, send emails to Motion Analyzer support, provide feedback regarding the application, and view Motion Analyzer licenses. Click [- Hide Panel] to hide the right panel and to view the right panel, click the [+ Show Panel].

Figure 25. Right Panel

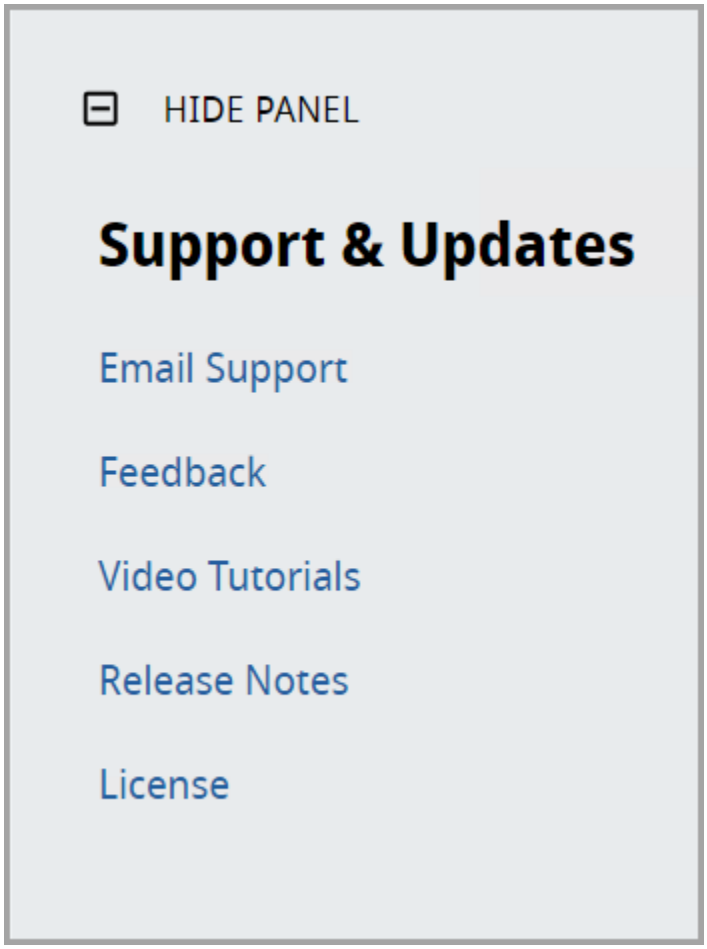
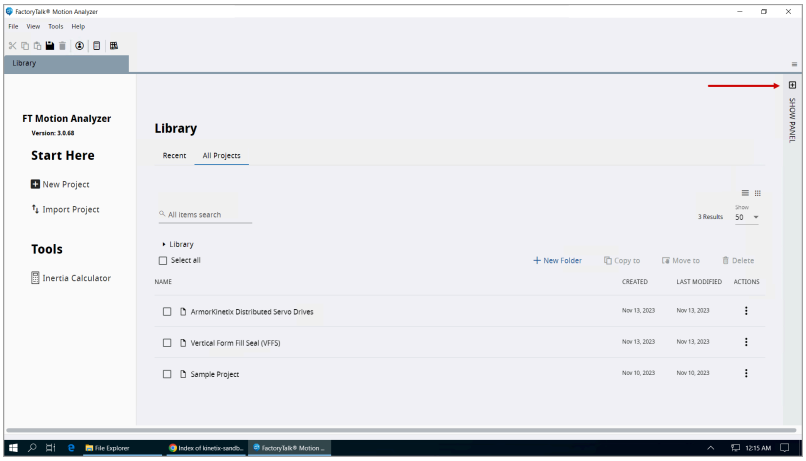


Table 9. Right Panel

Options	Description
Show/Hide Panel	Open/collapse right panel
What's new	Open document with release notes
Support	Create new e-mail to Motion Analyzer support
Feedback	Opens a link to provide feedback to the Motion Analyzer Team
License	Open document with licenses

Figure 26. Collapsed Right Panel



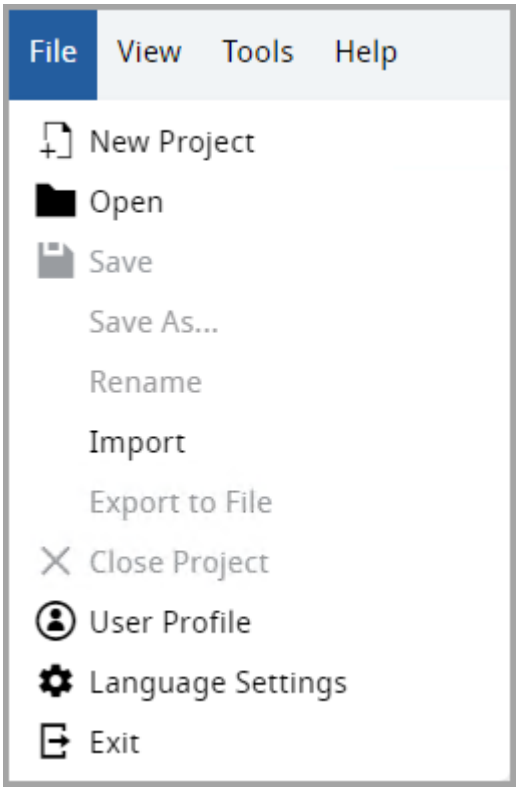
Project

The Project Pane provides a Windows Explorer-style graphical user interface for navigating through the Motion Analyzer project.

Create Project

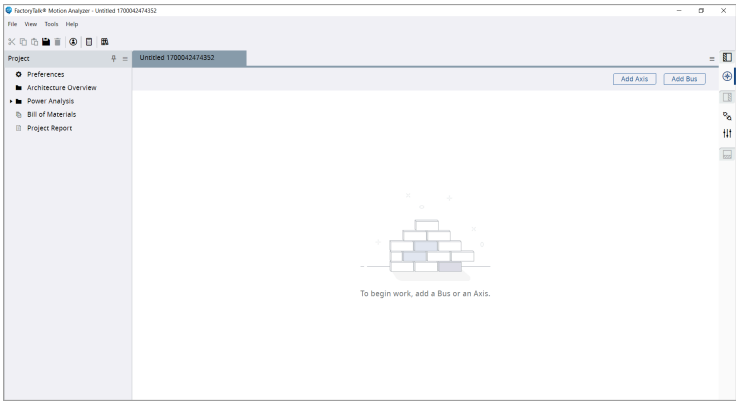
1. Open the File menu, and click [New Project].

Figure 27. Create New Project



A new Project homepage displays with a sample project name.

Figure 28. New Project



2. On the Quick access tool bar, click the [ ] icon.
3. The Save Project dialog displays. Provide the Project name and Click [Save].

Figure 29. Save Project

The project pane tree displays the following features:

Table 10. Project Pane Main

Node	Description
Preferences	Open the project preference.
Architecture Overview	Open the architecture overview
Power Analysis	To calculate the Power Analysis of a power supply for the selected power bus.
Bill of Materials	Open the bill of materials
Project Report	Open the project report

Tip: While editing a Project, the user can use the Save As functionality in the File menu to save the Project as a new one in a predefined folder without modifying the original Project.

Manage Projects

Motion Analyzer allows users to manage the Projects by creating folders and storing them inside in groups. User can move and delete the Projects or the Folders.

On the Library page, the following tab displays:

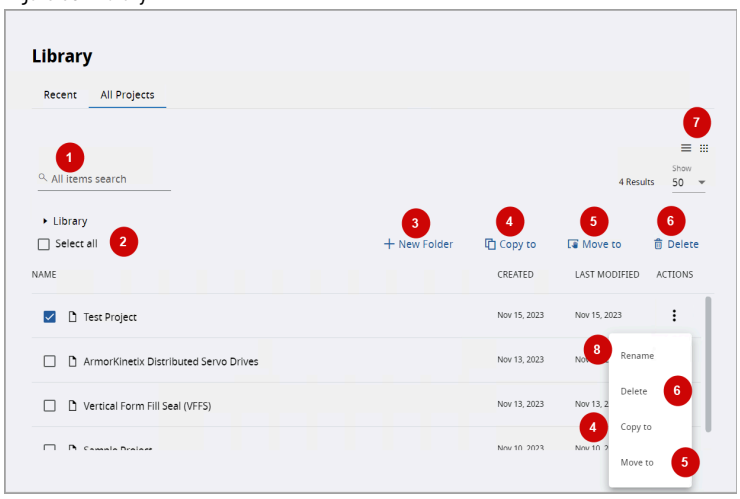
- Recent: Displays the recent projects.
- All Projects: Displays the list of all available Projects and Folders.

Motion Analyzer provides the following functionalities to manage Projects, refer to image below for the callouts:

1. Search: To search for a Folder or Project.
2. Select All: To select or deselect all the Project(s) or Folder(s).
3. New Folder: To create new folders to store the Projects/sub Folders. This feature is only enabled in the "All Projects" tab view.
4. Copy to: To copy the selected Projects/Folders to respective folders.
5. Move to: To move the selected Projects/Folders to respective folders.
6. Delete: To delete the selected Project or Folder.
7. View: List View or Tile View

8. Rename: To rename the Project or the Folder.

Figure 30. Library

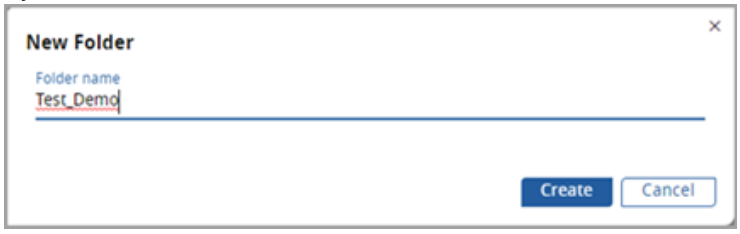


Create New Folder

Perform the following steps to create a Folder:

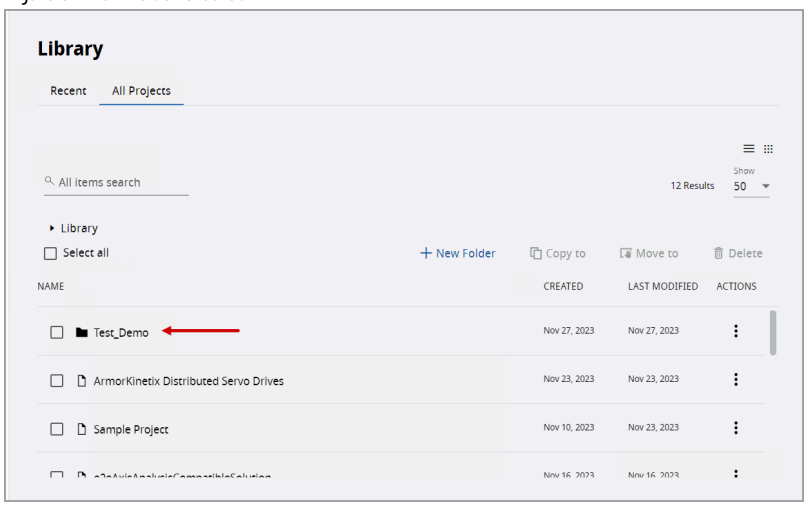
1. Click [+New Folder].
2. The New Folder dialog displays. Provide a folder name and click [Create].

Figure 31. New Folder



The new folder will be created on the Library page as shown in the following image:

Figure 32. New Folder Created



User can create multiple folders and sub folder based on the requirement.

Copy Project-Folder

Perform the following steps to copy the Project or Folder:

1. Select the Project or Folder from the list.
2. Right-click on the row and click [Copy to].

   Or click [Copy to].

   OR click the [⋮] icon of the selected Project(s) or Folder(s) and click [Copy to].

Figure 33. Copy To Option 1

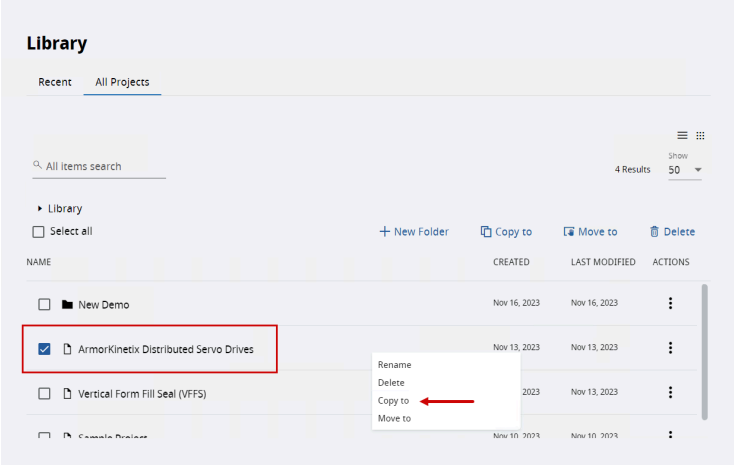


Figure 34. Copy to: Option 2

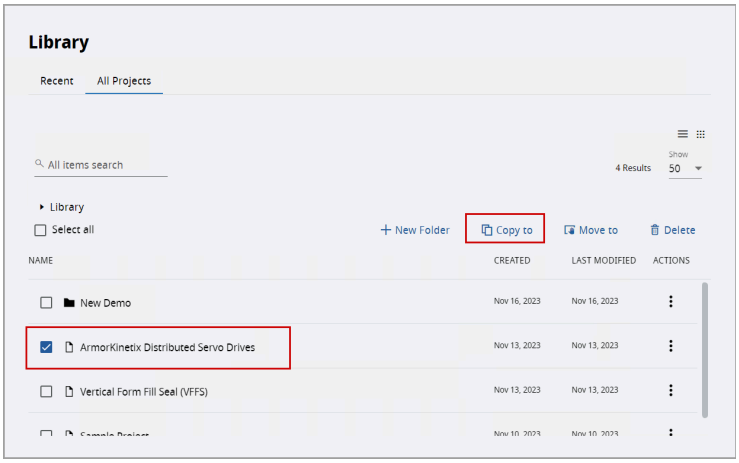
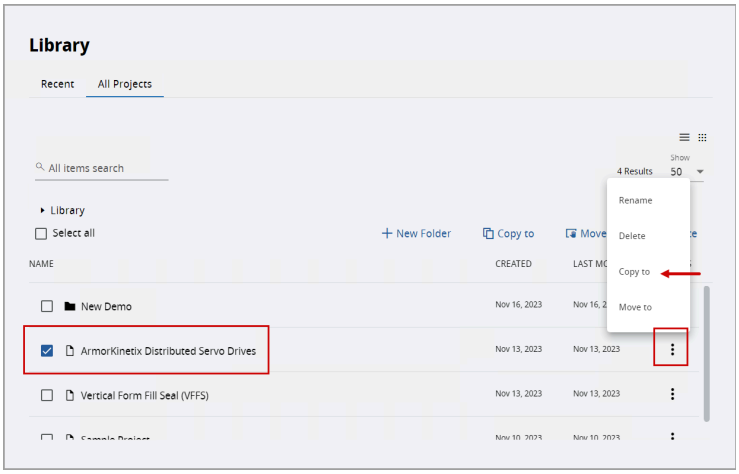
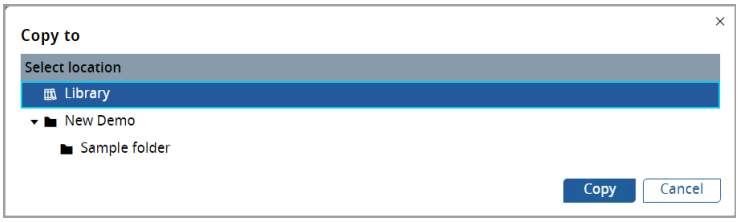


Figure 35. Copy to: Option 3



3. The 'Copy to' dialog displays. Select the destination folder from the list and click [Copy].

Figure 36. Copy To Dialog



The Project will be copied to the destination folder.

NOTE: User can select multiple folders and Projects at the same time and copy them to a dedicated location. User can also right-click on one of the folders/projects and copy them. Once a folder is copied, all the contents inside the folder are also copied. Note:

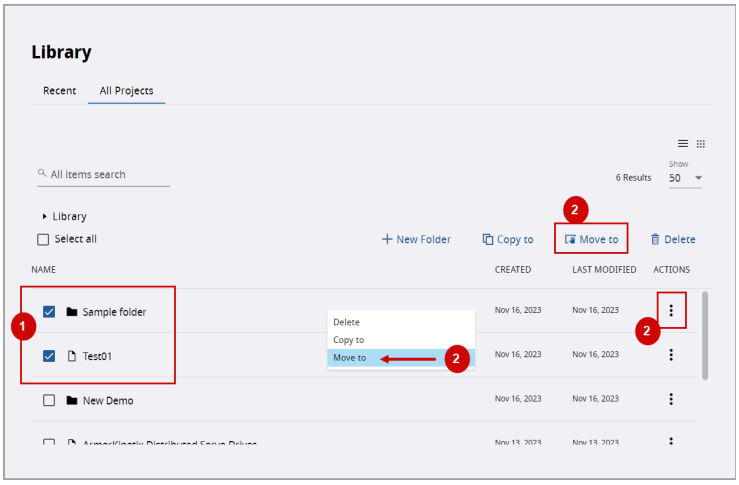
NOTE: While importing the Projects, the user can select the destination location to save the Project.

Move Project-Folder

Perform the following steps to move the Project or Folder:

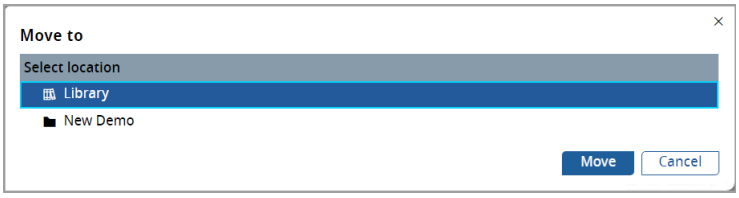
1. Select the Project or Folder from the list.
2. Right-click on the row and click [Move to].
   Or click [Move to].
   Or click the [⋮] icon and click [Move to].

Figure 37. Move To



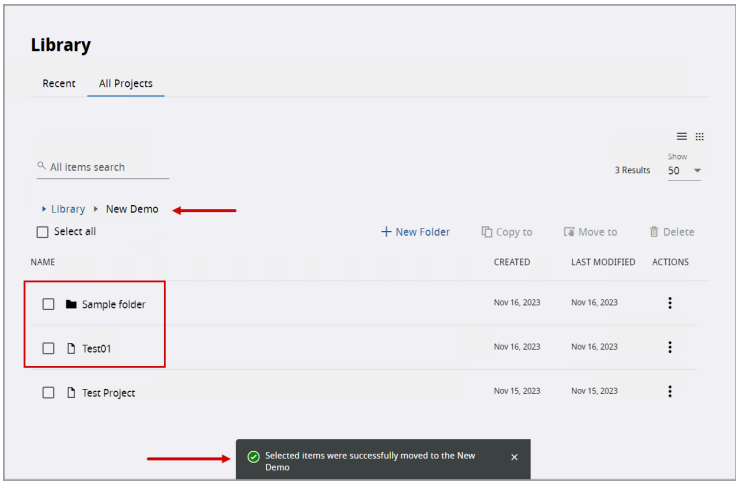
3. The 'Move to' dialog displays. Select the destination folder from the list and click [Move].

Figure 38. Move To Dialog



The "Project was successfully moved to the library" message displays. If multiple projects are selected and moved then "Selected items were successfully moved to the Library" message displays.

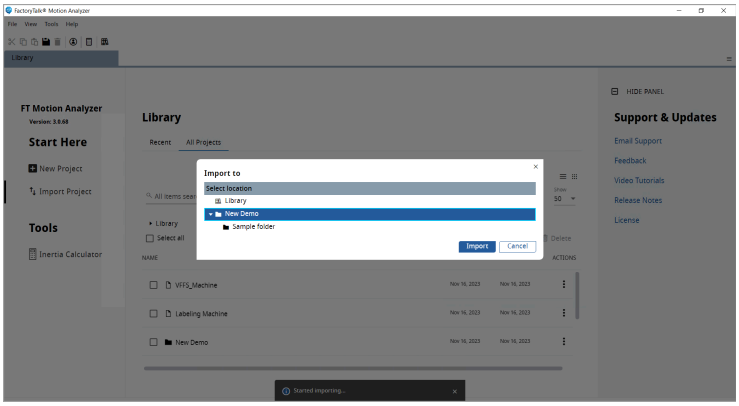
Figure 39. Multiple Components Moved Successfully



Both the Folder and the Project can be moved to the destination Folder.

NOTE: While importing the Projects, user can select the destination location to save the Project.

Figure 40. Import To

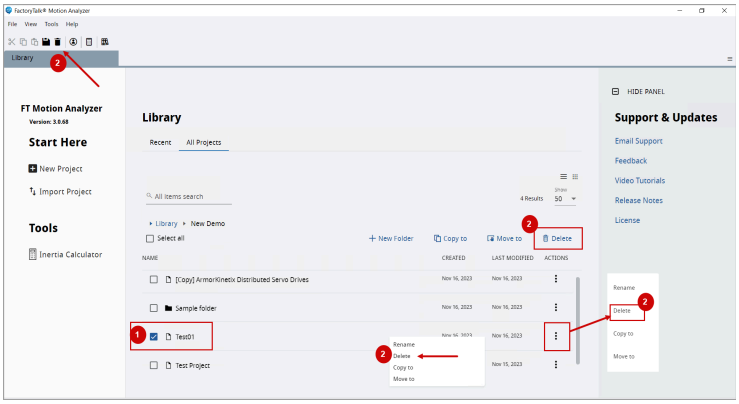


Delete Project-Folder

Perform the following steps to delete the selected Project or Folder:

1. Select the Project/Folder from the list.
2. Click [Delete].
   Or click the [⋮] icon and click [Delete].
   Or right-click on the selected row and click [Delete].
   Or user can also delete the selected Folder/Project from the main toolbar.

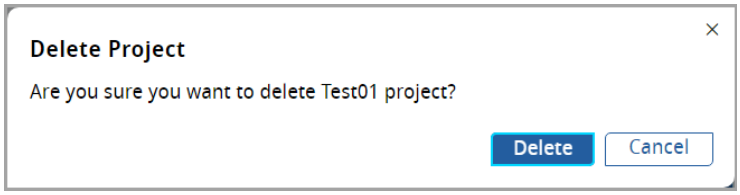
Figure 41. Delete



3. The 'Delete Project' or 'Delete Folder' dialog displays. Click [Delete].

NOTE: Be careful while deleting the Folders. This action will delete the entire content under the Folder and there is no backup option to retrieve the data.

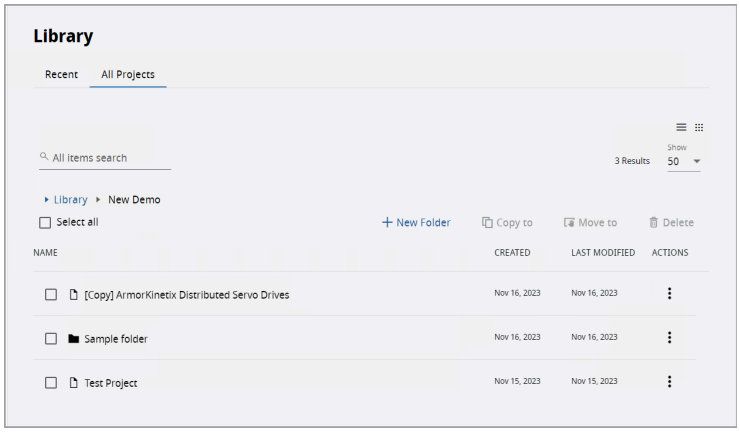
Figure 42. Delete Dialog



NOTE: User can select the Folders and Projects at the same time and delete them.

The component is deleted from the application library.

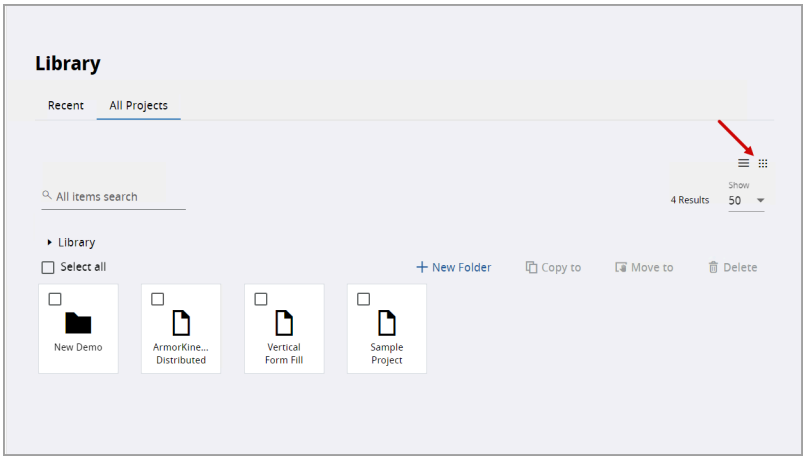
Figure 43. Deleted Component



Project-Folder View

User can switch between the List view and Tile view.

Figure 44. Library View



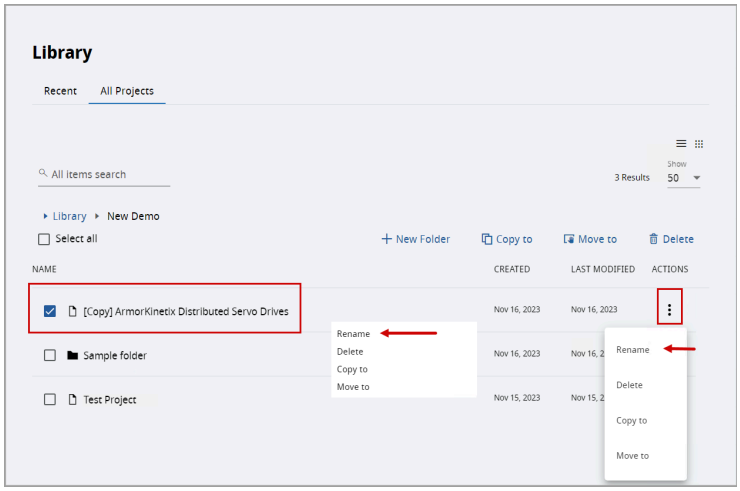
NOTE: In the Tile view, user need to right-click on the tile to view the actions.

Rename Project-Folder

Perform the following steps to rename the Project/Folder:

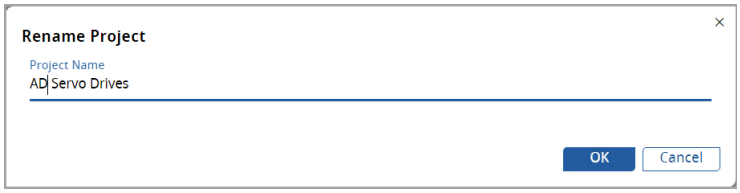
1. Select the Project/Folder.
2. Click the [⋮] icon under Actions and click [Rename].
   Or right-click on the selected row and click [Rename].

Figure 45. Rename Component



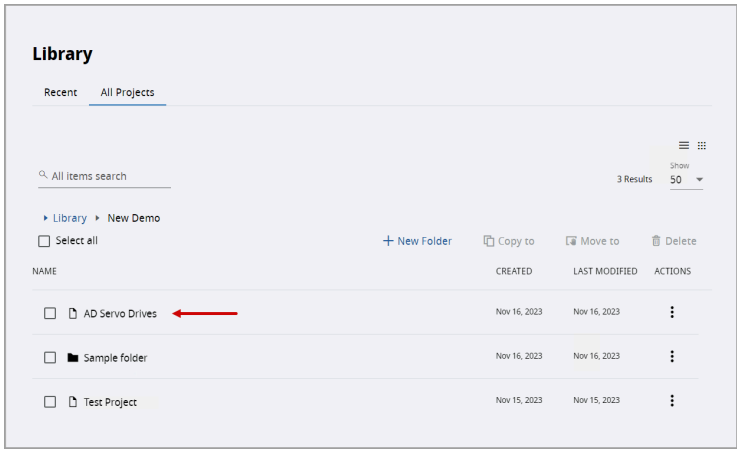
3. The Rename Project or Rename Folder dialog displays. Rename the Project/Folder and click [OK].

Figure 46. Rename Dialog



4. The component with the updated name is displayed.

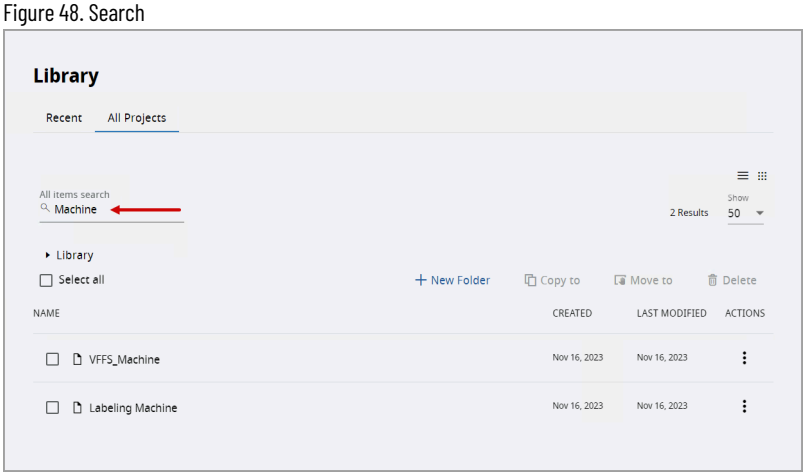
Figure 47. Rename Successful



Search

User can preform search operation to find a Project or Folder by name. This search operation is carried in the entire repository from the Homepage library and display the results.

Figure 48. Search



Project Preferences

The Project Preferences menu allows the user to store the Customer Information.

1. On the left panel, double-click the [Preferences] menu and the Project Preferences screen is displayed.
2. Provide the following information:

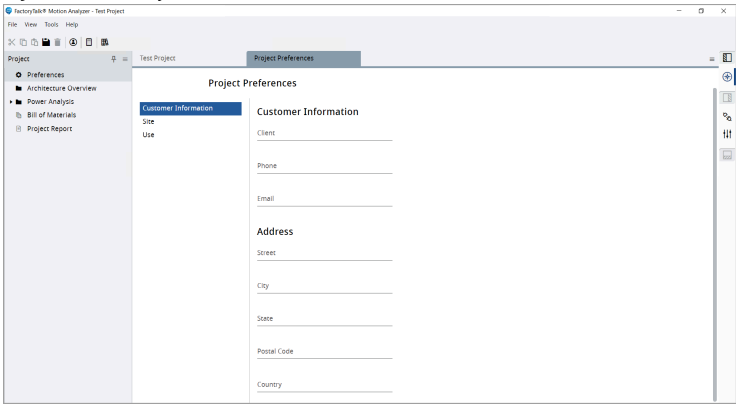
Table 11. Project Preferences

Field	Description
Customer Information	
Client	Name of the client.
Phone	The phone number of the customer.
Email	The Email ID of the customer.
Address	The address with street, city, state, postal code, and country.
Site	
Altitude	The altitude of the client's location.
Temperature	The temperature of the client's location.
Use	
Industry	Provide the type of Industry where the project is used. Click [Add] to add the new records.
Application	Provide the application name, the project is used for. Click [Add] to add the new records.

Tip: In the Customer Information section, all the fields are limited to 50 characters.

3. Click the [ ] icon on the Quick Access toolbar in the top left corner to save the changes.

Figure 49. Save Project Preferences



Architecture Overview

Architecture Overview provides a user interface to access, add, remove, or modify components like axes, buses, dual axes, and clusters in the Motion Analyzer project. Each component is presented in a hierarchical manner.

Figure 50. Sample Project Tree

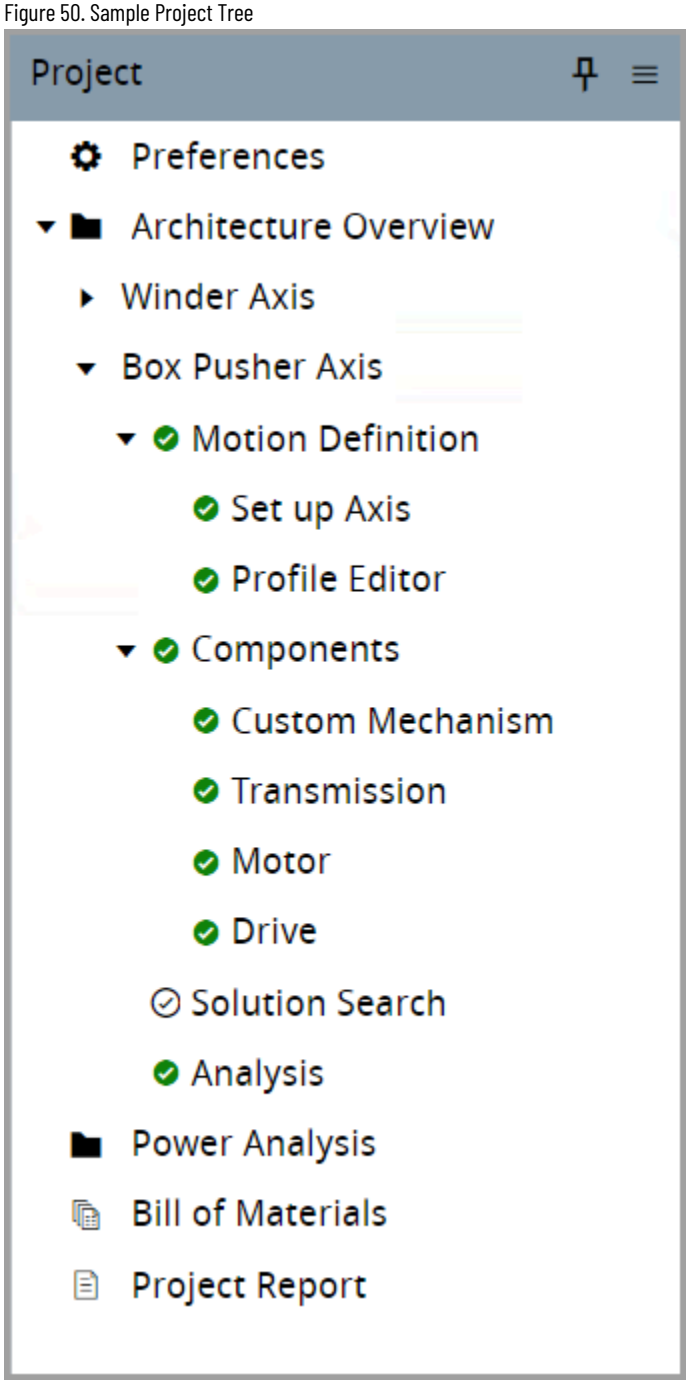


Table 12. Project Pane Description

Feature	Description
Overview	Open the axis overview
Motion Definition	Open motion definition Set up Axis: open Set up axis

Table 12. Project Pane Description (continued)

	Profile Editor: Open Profile Editor
Components	Open the following components: Custom Mechanism: Provides the list of available Mechanisms to configure. Transmission: Provides the list of available transmissions to configure. Motor: Provides the list of available motors to configure. Drive: Provides the list of available Drive to configure.
Solution Search	Open solution search
Analysis	Open axis analysis

Right-click on the components to view their context menus available. From the Architecture Overview tab, the user can access the Library allowing them to import axes created within the scope of the current project or save axes from the current project to the Library allowing them to reuse them in the other projects. Click the [Select all] checkbox or the individual component's checkbox to select the components in the project.

Figure 51. Architecture Overview

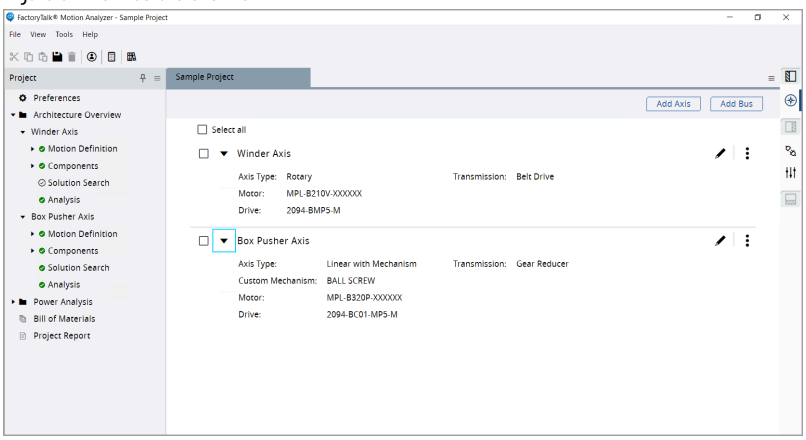


Table 13. Architecture Overview

Options	Description
Add axis	Add a new axis
Add bus	Add a new bus
Library	Open the library
Select all	Select all components

Axis

Axis is the base element in Motion Analyzer and can be added to the project, click [add axis] or import it from the user's library. Axis can be a standalone component, can be added to the bus (more in Bus on page 40), cluster (more in Cluster on page 43), or be merged with another axis into a dual axis (more in Dual Axis on page 49). Axes can only be merged into dual-axis containers if the drive family has dual-axis drives. Double-click on the axis name or

select the rename option from the axis context menu to rename the Axis. Click [Edit] from the axis context menu to edit the axis.

Figure 52. Standalone Axis

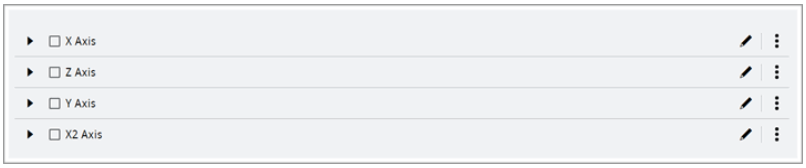


Table 14. Axis Options Description

Options	Description
▶	Show/collapse axis details
Axis name	Double-click to rename the axis
✎	Edit the axis
⋮	Show the axis context menu

1. Click [⋮] or right-click on the axis to open the Axis context menu.

Figure 53. Axis Context Menu

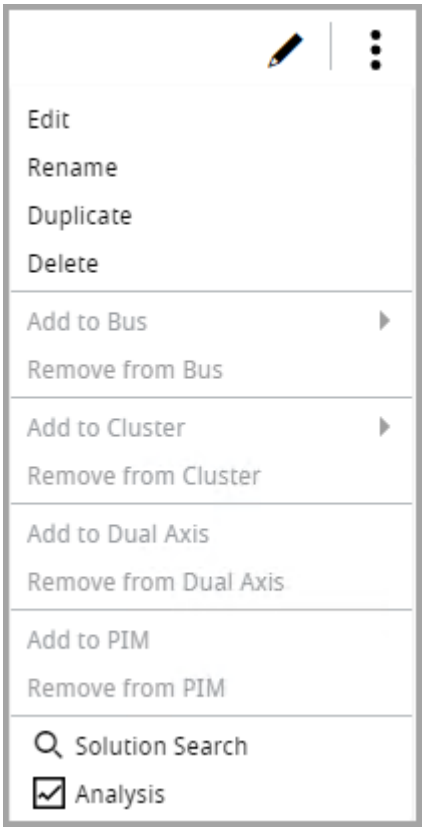


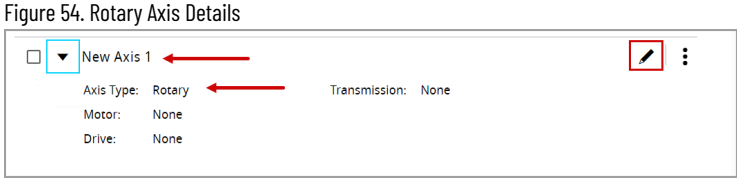
Table 15. Axis Context Menu

Options	Description
Edit	Click to edit the axis
Rename	Click to rename the axis
Duplicate	Click to duplicate the axis

Delete	Click to delete the axis
Add to bus	Click to display a list of buses to which the axis can be moved (disabled if none of the buses meet the requirements or there is no bus added)
Remove from bus	Click to remove the axis from the bus (disabled if selected axis is not in the bus)
Add to cluster	Click to display a list of clusters to which the axis can be moved or add the axis to a new cluster (disabled if axis does not meet the requirements)
Remove from cluster	Click to remove the axis from the cluster (disabled if selected axis is not in the cluster)
Add to Dual Axis	Click to add the axis to Dual Axis
Remove from Dual Axis	Click to remove the axis from the Dual Axis
Add to PIM	Click to add the axis to PIM
Remove from PIM	Click to remove the axis from the PIM
Solution search	Click to open to solution search tab
Analysis	Click to open the axis analysis tab

2. On the axis, click [▶] to toggle the Axis details. They consist of selected axis types and components e.g., for rotary axis: transmission, motor, and drive. For the new axis by default, the rotary motion type is selected.
3. On the axis, click [✎] to change the rotary motion type in the set-up axis section.

Figure 54. Rotary Axis Details

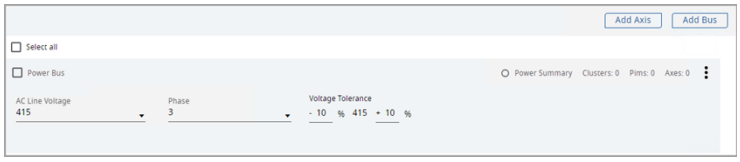


Bus

Perform the following steps to add a bus:

1. Click [Add bus] to add Bus to a project.
2. Double-click the new Bus to rename or select the rename option from the bus context menu.

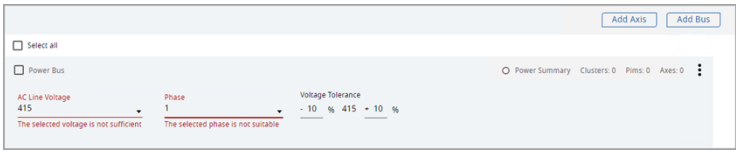
Figure 55. New Bus



3. In the bus section, the user can select AC line voltage, phase, and voltage tolerance. The Motion Analyzer validates the power requirements based on the selected voltage against the phase and vice versa.
   The bus section also displays information about power summary status and the number of clusters and axes inside the bus.

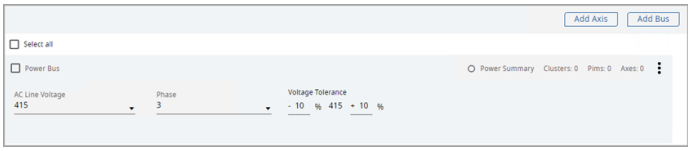
NOTE: Ensure to provide valid voltage and phase, else an error message displays as shown in the following image:

Figure 56. Power Requirements



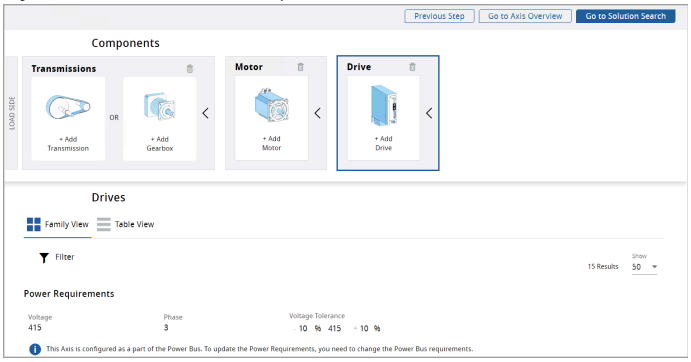
4. After the user selects the phase, the AC line voltages are filtered.
   - If the AC line voltage is selected and the user selection does not match the phase, the AC line voltage value gets reset. After adding a new empty axis to the bus its drive power requirements are inherited from bus values if selected and the edition of them in the axis is disabled.
   - If the axis with filled drive power requirements is moved to a new bus without AC line voltage and phase selected the values are copied from axis drive power requirements and the edition of them in axis is disabled.
   - If the axis and bus have different voltages and phases selected then the axis cannot be moved to the bus.

Figure 57. Axis in the bus with selected Voltage and Phase



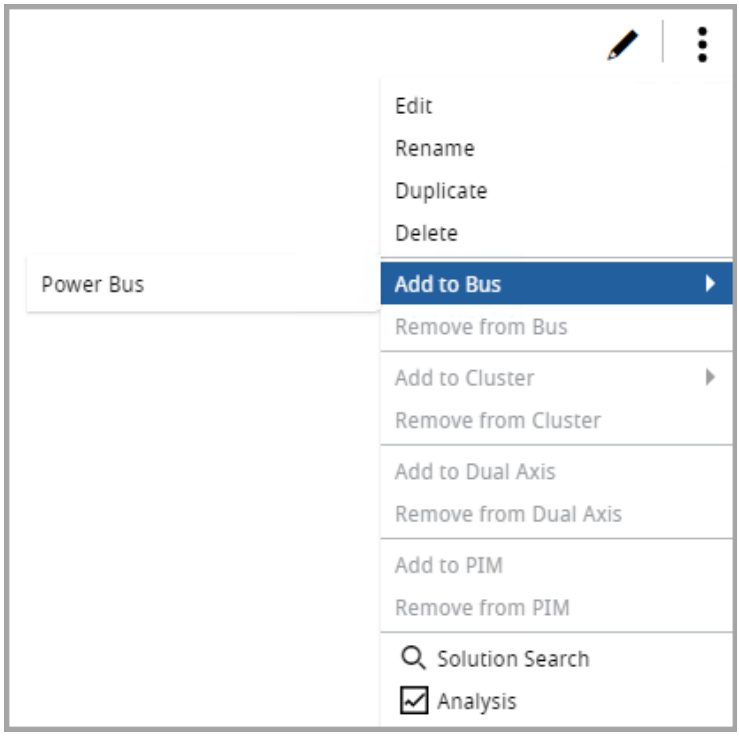
NOTE: The power requirement validation of Voltage and Phase also depends upon the validation of axes power requirements that are children of the selected bus. These power requirements are also validated even though no axes are added to the bus.

Figure 58. Locked Drive Power Requirements for Axis in Bus



1. On the axis context menu, click [Add to bus] and select the matching bus to meets the requirements mentioned above for the Moving axis.

Figure 59. Add to Bus



2. The Axis is added to the Power Bus. Right-click on the bus to open the Bus context menu.

Figure 60. Bus Context Menu

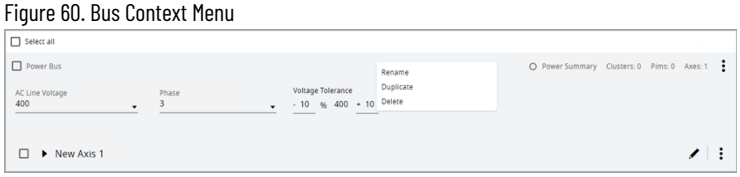


Table 16. Bus Context Menu

Options	Description
Rename	Rename the bus
Duplicate	Duplicate the bus
Delete	Delete the bus

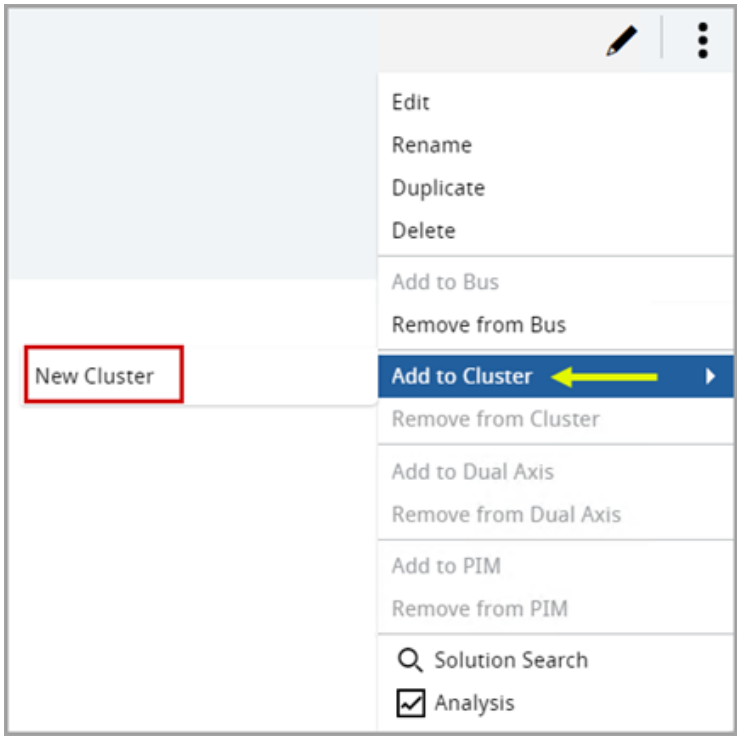
Power Inheritance: If the power requirements are not defined in the axis and the axis is added to the bus, the axis inherits the power requirements from the bus. Also, if the axis with defined power requirements is added to a bus with no power requirements, then the bus inherits the power requirements from the axis.

Cluster

To create a new cluster the bus, and the axis with K5700 drive must be created first and the axis must be moved to the bus. When those requirements are met add to cluster option in the axis context menu is enabled.

1. On a selected axis, click [⋮].
2. In the context menu, click [Add to cluster]. This displays a new cluster option or an existing matching cluster.
3. Click [New cluster] to move the axis to the new cluster and click the existing cluster name to move the selected axis to that cluster.
4. On the axis context menu, click [Remove] to remove the Axis from the cluster.
5. In the cluster context menu, under the add to bus option, click the bus name to move the Cluster to another bus with the same power.
6. On the cluster or in the cluster's context menu, click [Split] to split the Cluster.
   The splitting cluster will remove it and move all its children to the parent node which in this case always will be a bus in which the cluster was.

Figure 61. Add to Cluster



7. Right-click on the cluster title bar to open the Cluster context menu.

Figure 62. Cluster Context Menu

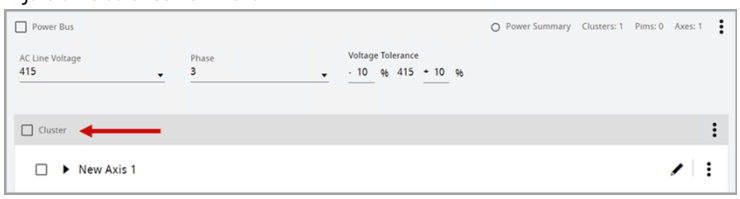


Table 17. Cluster Context Menu

Options	Description
Rename	Rename the Cluster
Duplicate	Duplicate the Cluster
Delete	Delete the Cluster with all its children
Split	Delete the cluster and move the children to the bus
Add to bus	Display a list of buses to which the cluster can be moved (disabled if none of the buses meet the requirements or there is no other bus added)

Power Interface Module - PIM

Power Interface Module - PIM

ArmorKinetix® Power Interface Modules (PIM) provide the interconnectivity between the Kinetix® 5700 common DC bus architecture (in-cabinet) and the On Machine™ decentralized units (DSM, DSD). The PIM mounting is similar to other Kinetix® 5700 modules (e.g. DAI) and connects to a common DC bus. It provides the interconnect for both power and communications to the first DSM or DSD unit as part of a daisy chain arrangement. Multiple PIMs can be used within a common DC bus arrangement with each servicing up to 24 DSD/DSM units mounted on a machine.

As the DSM motor contains a drive inside and cannot be powered directly, we need to connect the DSM Motor to a power supply through a PIM module.

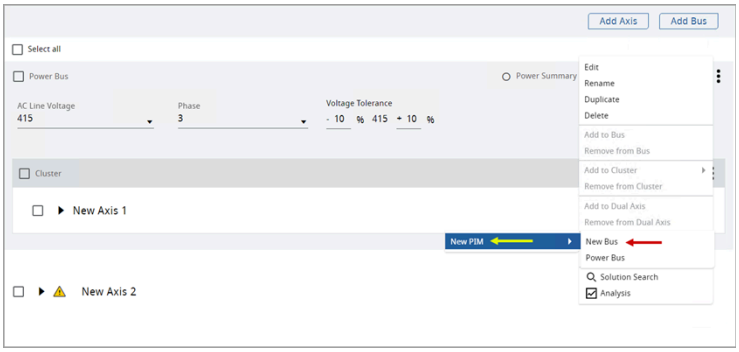
Perform the following steps to add the DSM-configured axes to the PIM module:

NOTE: Ensure that the axis contains DSM components. For an axis without a DSM component, the PIM feature is disabled.

---

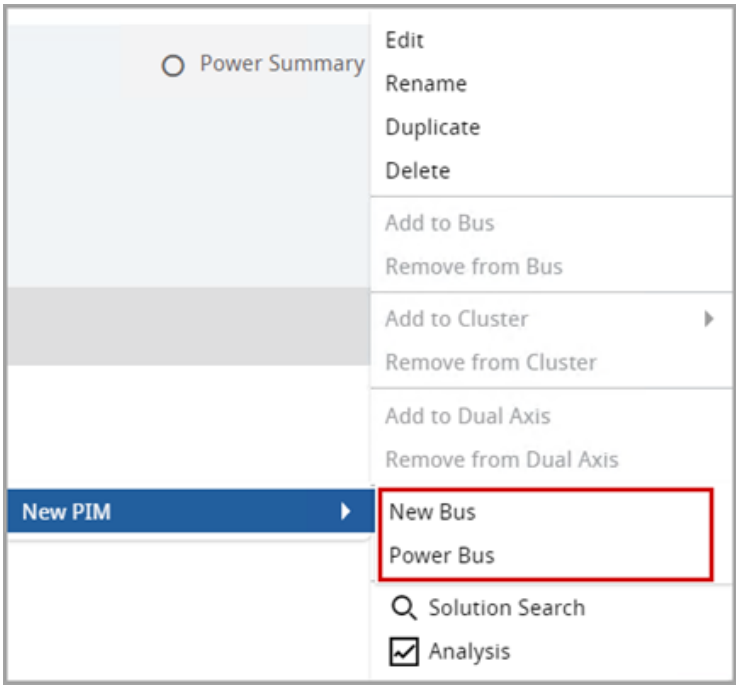
1. On the architectural overview page, click the ellipsis icon [⋮] of the axis containing any DSM components.
2. Click [Add to PIM] and then click [New PIM].

Figure 63. Add to PIM



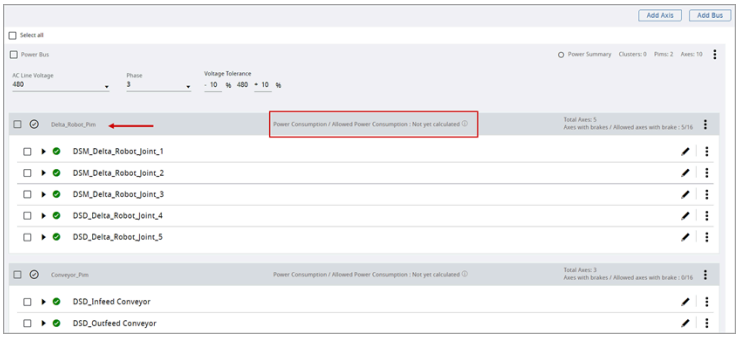
3. Select the list of the available buses.

Figure 64. New PIM



4. The respective axis is added to the selected PIM module. The PIM name along with the Power Consumption displays.

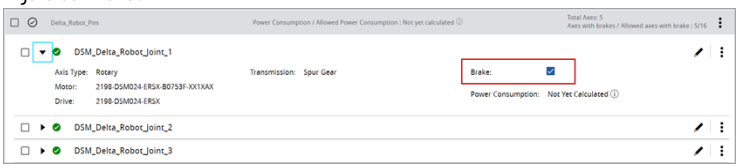
Figure 65. Axis added to PIM



NOTE: If a bus is present inside the PIM, the user can add the PIM and Power Bus at the same time.

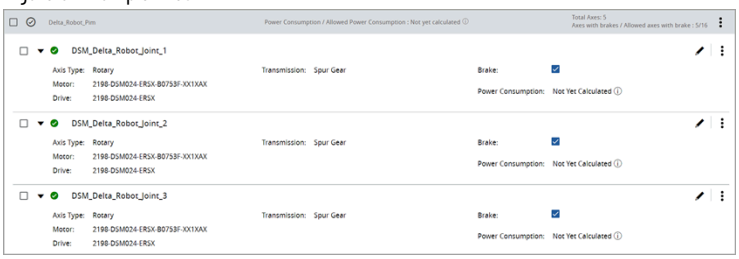
5. When the axis is added to the PIM, the [Brake] checkbox is enabled and user can brake, if required.

Figure 66. Brakes



6. User can add multiple axes to a PIM.

Figure 67. Multiple Axes

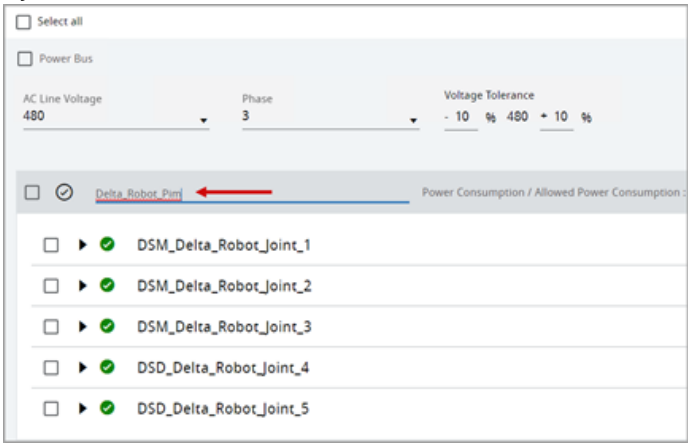


NOTE: User can internally move the axis from one PIM to another PIM.

7. Other Features:

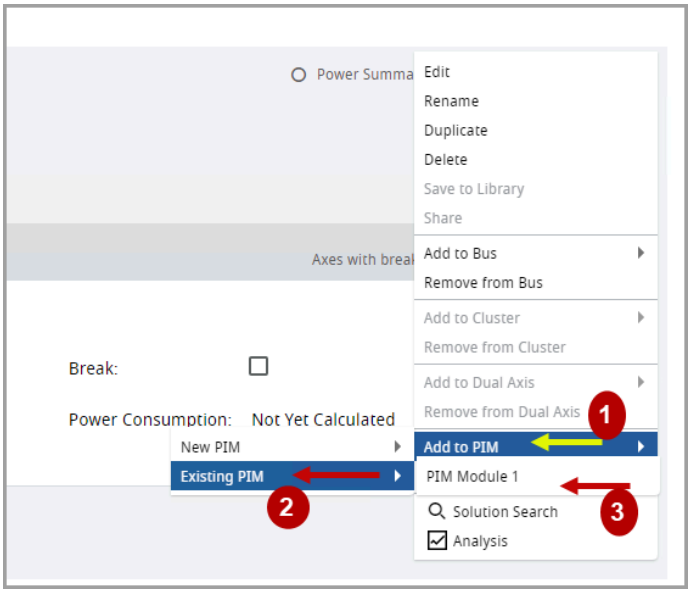
a. Rename: To rename the PIM, double-click on the PIM name and rename it.

Figure 68. Rename PIM



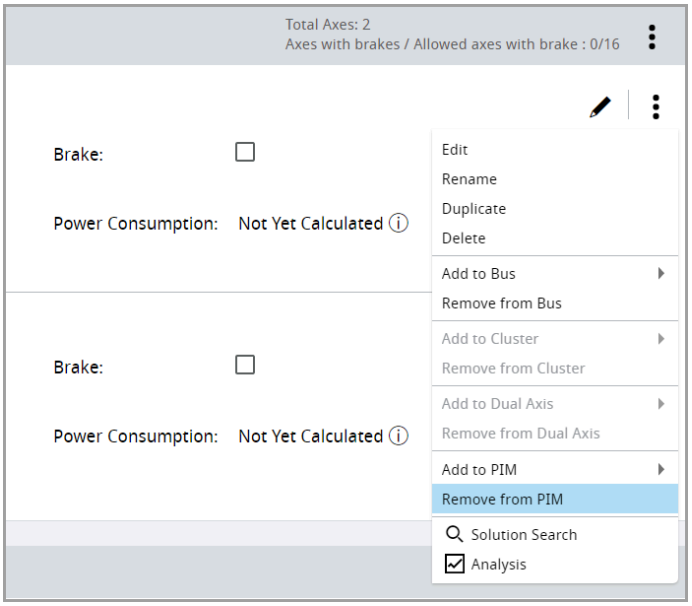
b. Existing PIM: Once a PIM module is created, the user can assign axis to the existing PIM modules.

Figure 69. Existing PIM



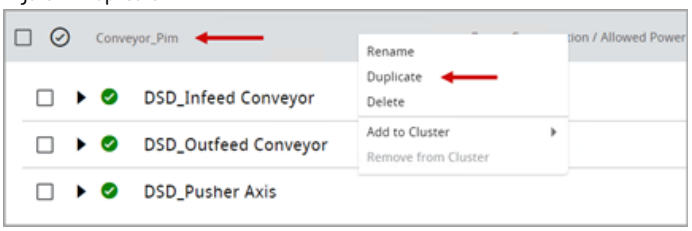
c. Remove from PIM: To remove the axis from the PIM module.

Figure 70. Remove from PIM



d. Duplicate PIM: User can duplicate the PIM module. Right-click on the PIM section and click [Duplicate].

Figure 71. Duplicate PIM



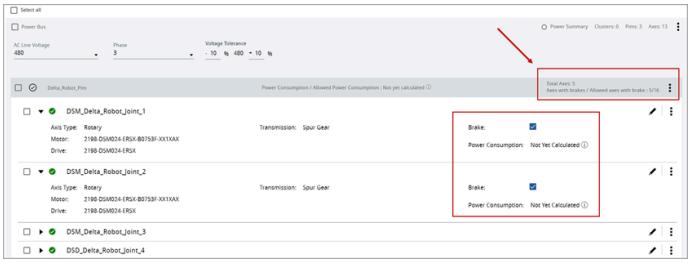
The duplicated PIM module displays on the Architecture Overview page as a copy.

Figure 72. Architecture Overview

User can double-click on the PIM name and rename it.

e. Brake: To provide brakes for a given number of axes into groups in a PIM considering power consumption.

Figure 73. Brakes



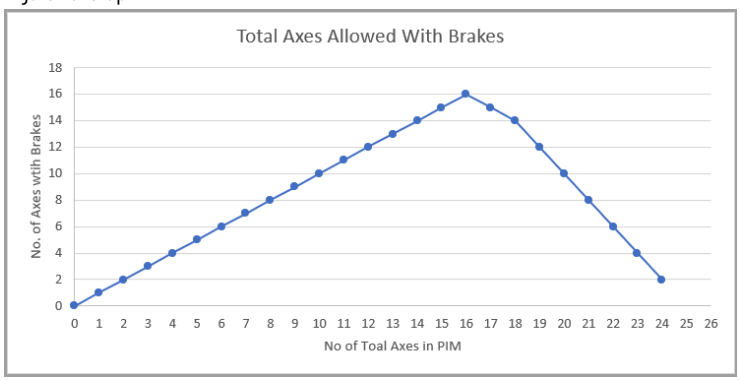
8. The maximum number of axes allowed in a PIM module is 16.
9. In a PIM module, 16 axes can contain a maximum of 16 brakes, and brake validation is not required.
10. The following table describes the number of brakes allowed in a PIM module along with the brake validation:

Figure 74. Brake Validation

No of Axes in PIM	Total Axes Allowed With Brakes	Brake Validation
0	0	Not required
1	1	Not required
2	2	Not required
3	3	Not required
4	4	Not required
5	5	Not required
6	6	Not required
7	7	Not required
8	8	Not required
9	9	Not required
10	10	Not required
11	11	Not required
12	12	Not required
13	13	Not required
14	14	Not required
15	15	Not required
16	16	Not required
17	15	Required
18	14	Required
19	12	Required
20	10	Required
21	8	Required
22	6	Required
23	4	Required
24	2	Required

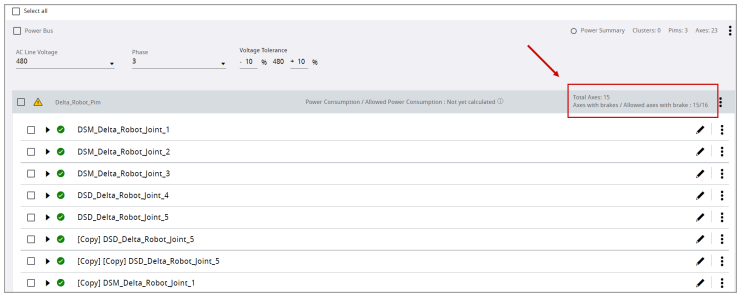
Here is the chart describing the number of brakes allowed in a PIM module.

Figure 75. Graph



11. The allowed brake values automatically change based on the number of axes in a PIM module.

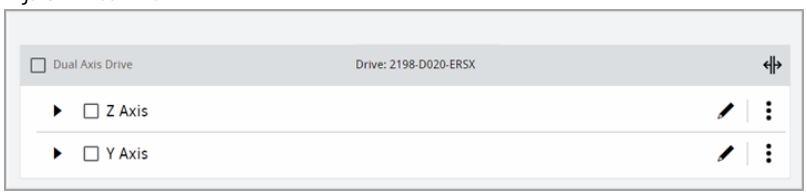
Figure 76. Allowed Brake



Dual Axis

To create dual axis two axes with the same, the K5700 drive model must be created first. When those requirements are met add to dual axis option in the axis context menu is enabled. Dual-axis can be standalone, placed in the bus by clicking the add to bus option and selecting the compatible bus, or in the cluster by the add to cluster option and selecting the compatible cluster or creating a new one. In the dual-axis title bar, there is information about the selected drive for both motors.

Figure 77. Dual Axis



1. Click [Split] or the split option from the dual-axis context menu to split the dual-axis into two separate axes.
2. Right-click on the dual-axis title bar to open the dual-axis context menu.

Figure 78. Split Dual Axis

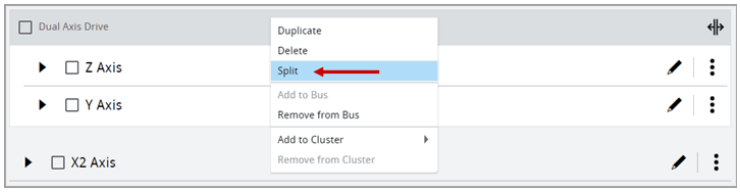


Table 18. Dual-Axis Context Menu

Options	Description
Duplicate	Duplicate the dual axis
Delete	Delete the dual axis with all its children
Split	Split the dual axis into two separate axes
Add to bus	Display a list of buses to which the dual axis can be moved (disabled if none of the buses meet the requirements or there is no bus added)
Remove from bus	Remove the dual axis from the bus (disabled if selected dual axis is not in the bus)
Add to cluster	Display a list of clusters to which the dual axis can be moved or add dual axis to a new cluster (disabled if dual axis does not meet the requirements)
Remove from cluster	Remove the dual axis from the cluster (disabled if selected dual axis is not in the cluster)

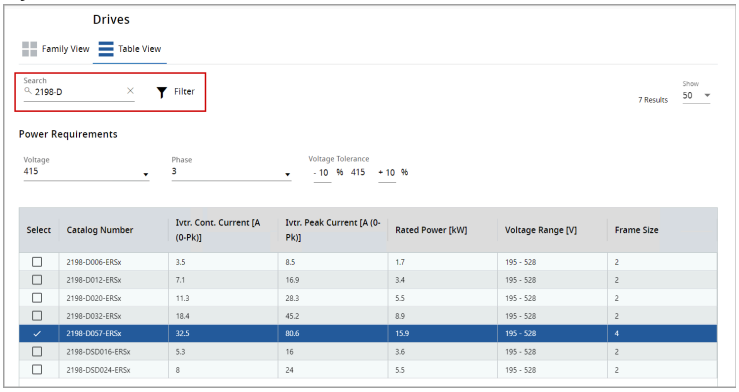
Merge Dual-Axis

User should have a drive that supports dual axis. User should have two axes of the same type of drive and power requirements, then the user can merge them into one dual-axis drive group. This means one drive manages two axes.

Perform the following steps to create a dual-axis:

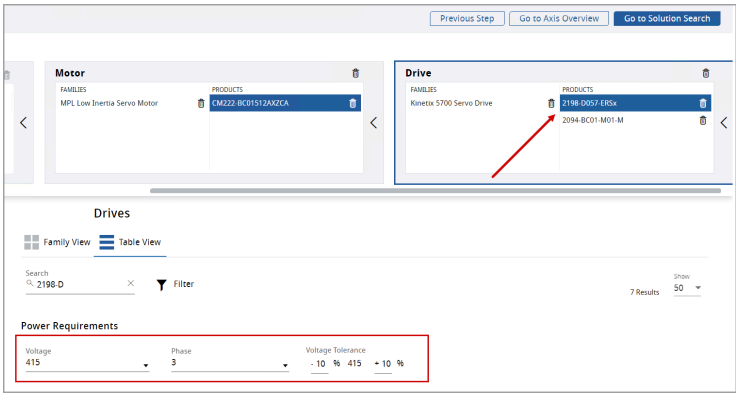
1. Create two axes with different motors and the same drive from the K5700 model family.
   Alphabet "D" in the Drive Product catalog number indicates the Dual-Axis drive.

Figure 79. Drivers



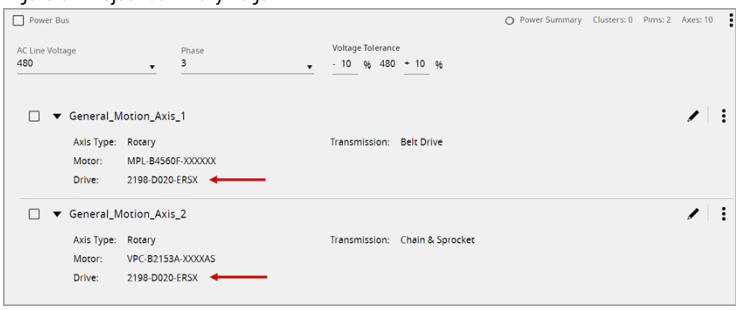
2. Ensure that the Power Requirements are the same for both the axes.

Figure 80. Power Requirement



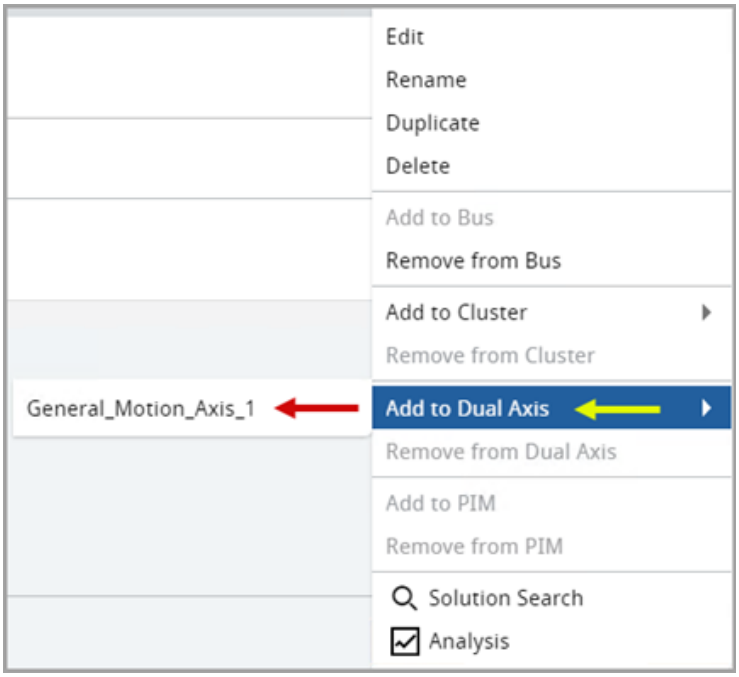
The two axes are displayed in the Project summary page.

Figure 81. Project Summary Page



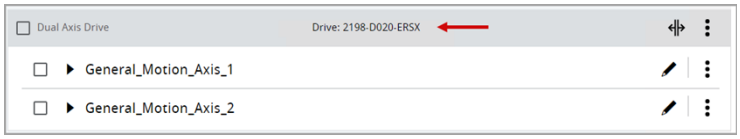
3. Click the ellipsis icon of one axis, the available options display.
4. Click [Add to dual axis] and select the required axis to merge.

Figure 82. Add Dual Axis



5. The two axes are merged and displayed under the same drive as shown in the following image:

Figure 83. Same Dual Axis



This drive manages both axes.

Split Dual-Axis

The Dual-Axis will have one drive to manage, but when the user splits the Dual-Axis, it divides into two separate axes with a drive for each having the same configurations.

The Dual-Axis can be split in the following ways:

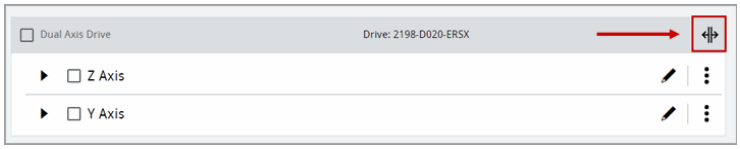
- Split one of the axes on the Architecture Overview Page
- Add a new drive to one of the axes that Dual-Axis consists
- Delete a drive from one of the axes that has dual-axis component
- Delete one of the axes which made up the Dual-Axis

Split Option on Architecture Overview Page

Perform the following steps to split a Dual-Axis:

1. On a Merged Dual-Axis, click the Split icon as shown in the following image:

Figure 84. Merge Dual-Axis



2. The axes are separated as shown in the following image:

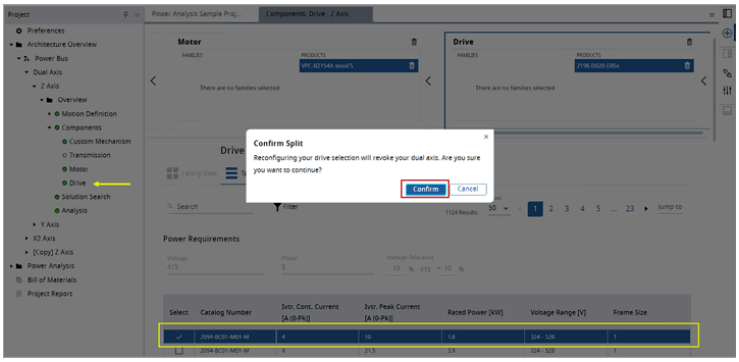
Figure 85. Axes Separated

Add New Drive

Perform the following steps to split the Dual-Axis by adding a new drive for one of the axes of which the Dual-Axis consists:

1. On the Project with Dual-Axis, open the Drive Component page.
2. Add a new drive as shown in the following image:

Figure 86. Confirm Split



The Confirm Split warning dialog will be displayed. This action will split the Dual-Axis.

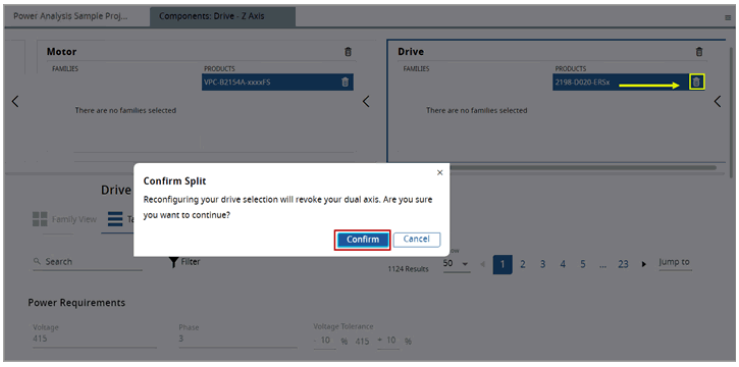
3. Click [Confirm] and the Dual-Axis that are components of Dual-Axis will be separated.

Delete Drive

Perform the following steps to split a Dual-Axis by deleting a drive from one of the axes which is component of Dual-Axis:

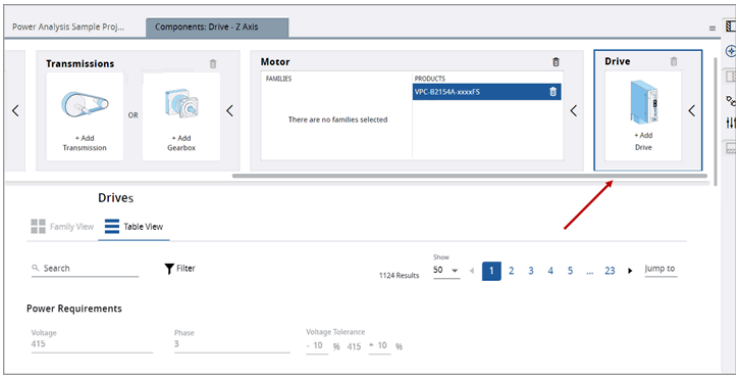
1. On the Drive component page, if the user deletes a drive, the confirm split warning dialog will be displayed.

Figure 87. Confirm Split



2. Click [Confirm] and the driver will be removed.

Figure 88. Driver Deleted



3. The axes which are components of Dual-Axis will be separated.

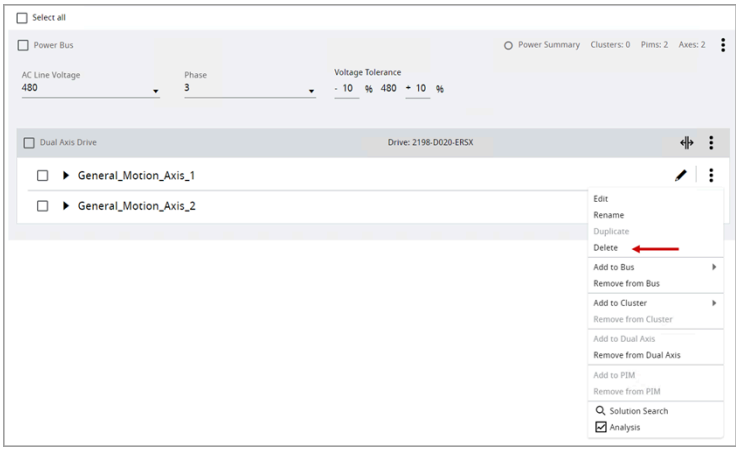
Figure 89. Axes Separated

Delete Axis

Perform the following steps to split a Dual-Axis by deleting either axis of Dual-Axis:

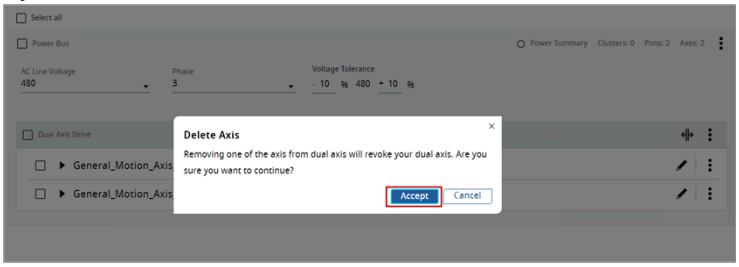
1. Click the ellipsis icon [⋮] of one of the axes which is component the Dual-Axis and click [Delete].

Figure 90. Delete Axis



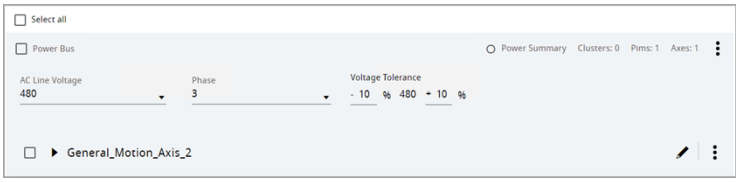
2. The Delete axis warning dialog displays. Click [Accept].

Figure 91. Delete Axis



The axis will be deleted and this action will split the dual-axis.

Figure 92. Axis Deleted



Duplicate Architecture Overview Items

Motion Analyzer allows user to duplicate the following Architectural Overview elements:

- Standalone Axis
- Dual-Axis
- Cluster
- Power Bus

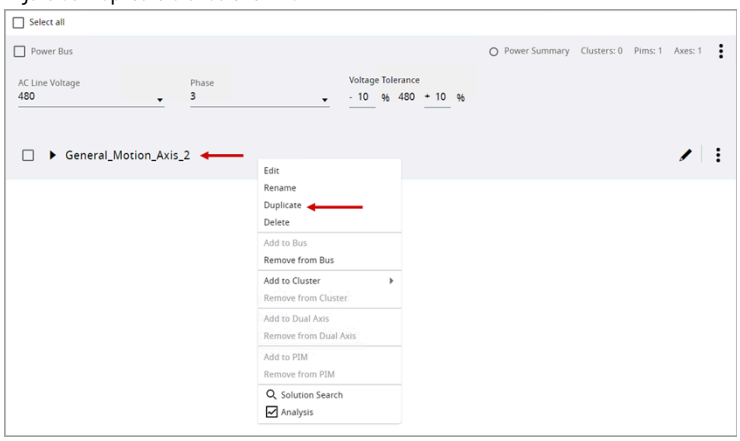
NOTE: This duplicate feature will also copy the Solution Search results and Power Analysis configurations.

Standalone Axis

Perform the following steps to duplicate a standalone Axis:

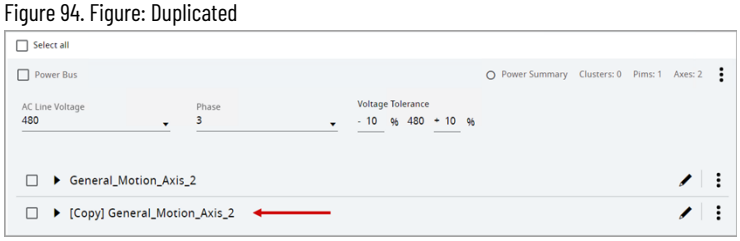
1. Right-click on a selected axis and click [Duplicate].
   (Or)
   Click the ellipsis icon of an axis that needs to be duplicated and click [Duplicate].

Figure 93. Duplicate Standalone Axis



This creates a copy of the selected axis with the same data such as Axis type, Motor family, and Driver details.

Figure 94. Figure: Duplicated



- User can also create a copy of the axis by duplicating a cluster. This creates a copy of all the Axes or Power Buses available in within a Cluster.
- User can also duplicate an element outside the cluster in the same way.

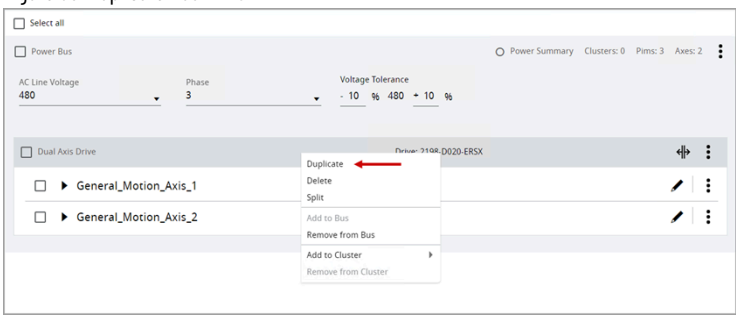
NOTE: It is recommended to rename the copied element.

Dual-Axis

Perform the following steps to duplicate a Dual-Axis:

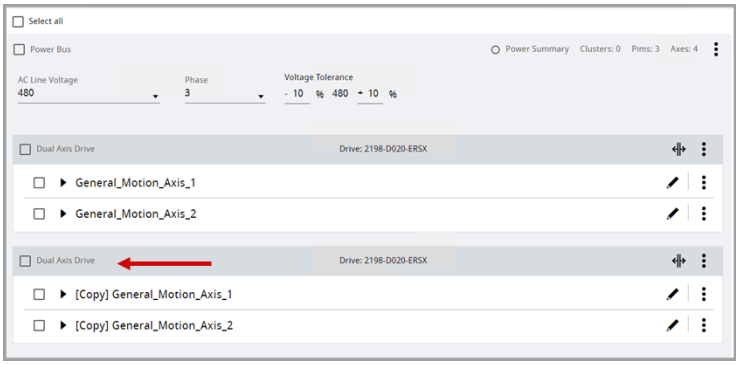
1. Right-click on a selected Dual-Axis header and click [Duplicate].

Figure 95. Duplicate Dual-Axis



A copy of the selected Dual-Axis is generated with the same data.

Figure 96. Duplicated



2. User can also duplicate a Dual-Axis drive within a Cluster.

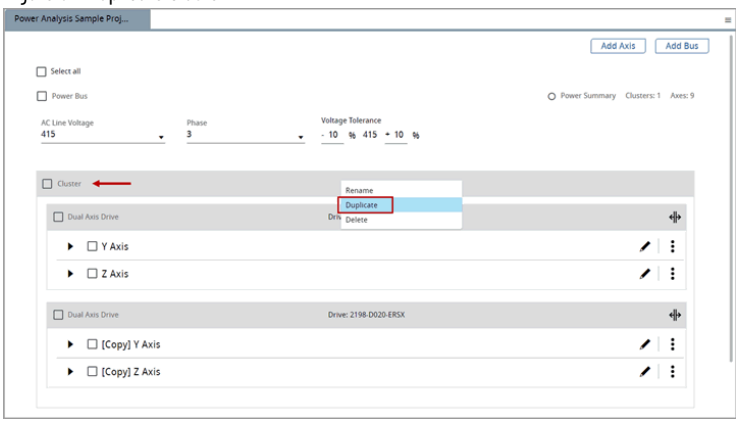
NOTE: It is recommended to rename the copied element.

Cluster

Perform the following steps to duplicate a Cluster:

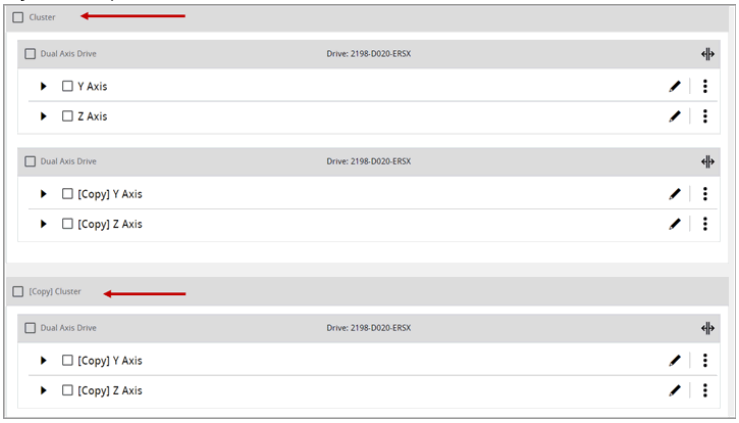
1. Right-click on a cluster header and click [Duplicate].

Figure 97. Duplicate Cluster



A copy of the selected cluster is generated with the same data.

Figure 98. Duplicated Cluster



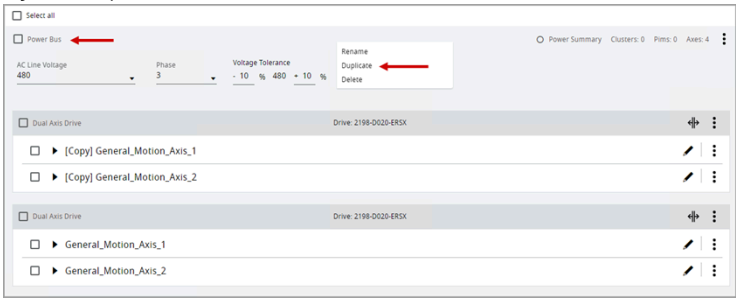
NOTE: It is recommended to rename the copied element.

Power Bus

Perform the following steps to duplicate a Power Bus:

1. Right-click on a Power Bus header and click [Duplicate].

Figure 99. Duplicate Power Bus



A copy of the selected Power Bus is generated with the same data.

Figure 100. Duplicated Power Bus

NOTE: It is recommended to rename the copied element.

Define Your Profile

Profile Editor allows user to create a variety of industry-standard motion profiles to define motion and the load based on the type of axis (linear/rotary) in a project. Motion profile consists of various types of motion segments with some additional loads and units based on the axis type. These profile editor values persist even after the tab is closed and can also be displayed on the Overview page.

Figure 101. Profile Editor

Table 19. Profile Editor Features

Feature	Description
Profile Toolbar	To add, move, and remove profile segments or an entire motion profile
Segment Load Window	Each profile segment type has an associated Segment Parameters window. Highlight a particular profile segment in the motion profile, that segment's parameter window becomes available for entering data. The default profile segment type is an Index profile segment.
Segment Plot Window	Displays a plot for a single profile segment in the motion profile. The x-axis is time, and the y-axis can be adjusted to display various motion curves (for example, Distance, Velocity, or Acceleration).
Profile Plot	Displays the entire motion Profile Plot that consists of a series of profile segments. The plot can be adjusted and analyzed with the two sub-windows that accompany the plot.

Set up Axis

The application templates allow users to provide pre-configured complex mechanism application data. These templates convert the complex mechanisms into Motion Analyzer mechanism data and Motion profiles with additional inertia and loads.

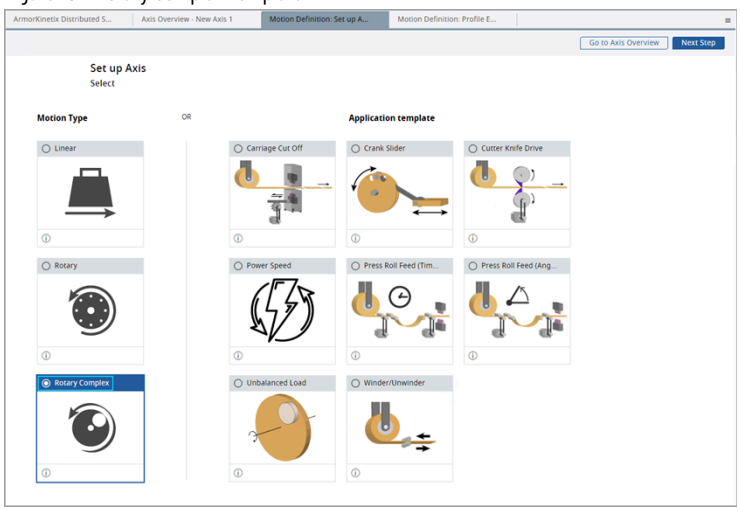
Rotary Complex Template

The Rotary Complex template is used to calculate Complex Load Data for Unbalanced Load and Crank application types.

Perform the following steps to add the Rotary Complex template to the Motion Profile:

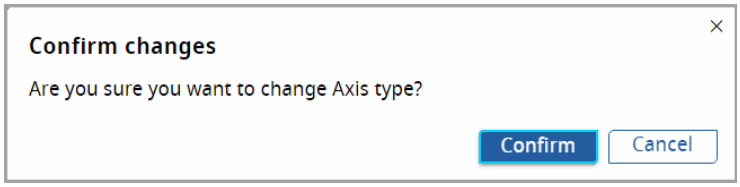
1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Motion Type, select the Rotary Complex template and click [Next Step].

Figure 102. Rotary Complex Template



3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 103. Confirm Changes

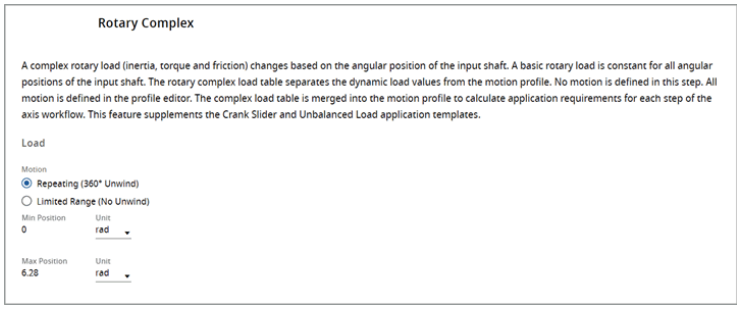


4. The Rotary Complex template page displays along with the template description. Provide the load data details:

Table 20. Rotary Complex Template

Field	Description
Motion Type	Select the Motion type
Repeating (360 ° unwind)	Here the first and last points should be identical so that the motion profile can be repeated (for example, zero and 360 °). Motion Analyzer software assumes that rotation may continue indefinitely in either direction.
Limited range (no Unwind)	The first and last points indicate the maximum and minimum positions permitted.

Figure 104. Rotary Complex



5. The Inertia table displays.

Table 21. Inertia Table

Field	Description
Position	Driving shaft angle with reference to the starting angle.
Inertia	Load inertia for the given shaft angle.
External Torque	Torque applied at the given position.
Friction Torque	Torque loss due to friction.
	To add a row above the selected row. The new row is generated with the average value from the top and bottom rows.
	To add a row below the selected row. The new row is generated with the average value from the top and bottom rows.
	To delete the selected row.
Import	To import load data from an external file (.csv) into the Complex Load Data table.
Export	To export load data as an external file in .csv format from the Complex Load Data table.
Clear	To delete all the rows.
Repopulate Sample date	To repopulate the sample load data.

- **Inertia Table Actions:**
  - User can edit the labels in the Inertia Table and the relevant changes will be affected in the limited range motion type.
  - If the user changes the units in the Position column, the same units are reflected in the limited-range motion type.
  - Every column in the Inertia table has its own unit's selector and the value may change based on the units selected.
  - User can also edit the load data by exporting the load data, editing the fields in a spreadsheet, and re-uploading the Load data by Import option.

Carriage Cut Off Template

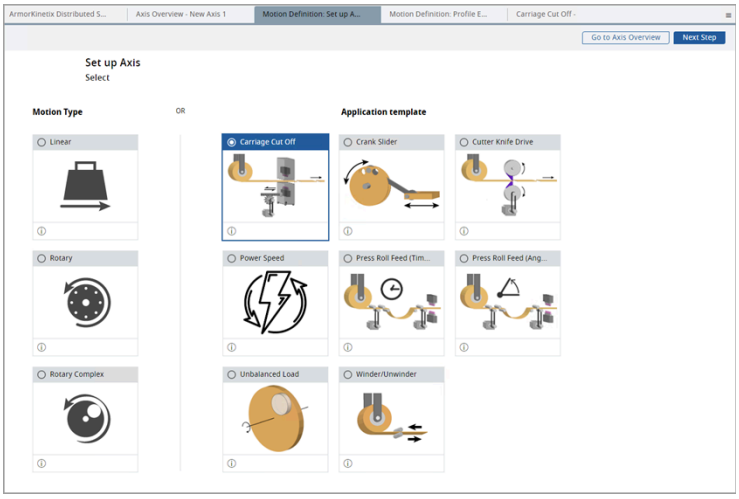
This application is typically cutting strip material into pre-set lengths with a 'Flying Shear' (heavy-duty knife on a moving carriage). The shear must be stationary relative to the material (for example, moving at line speed) when the cut is made, and the cut takes a fixed time.

The strip material is unwound from a reel at constant surface speed and fed via separately driven leveler rolls. After the cut is complete, the shear is stopped and then moved back to its start position. It must accelerate to match the line speed at the correct position to cut the required length of material.

Perform the following steps to add the Carriage Cut Off template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application Template, select the Carriage Cut Off Template and click [Next Step].

Figure 105. Application Template

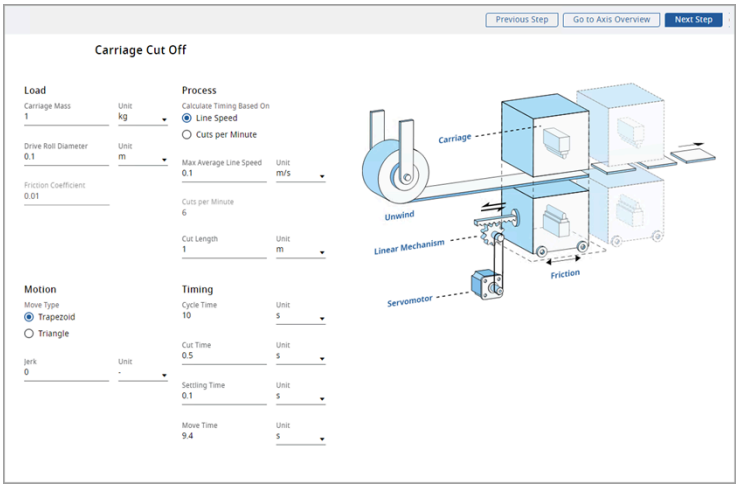


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 106. Confirm Changes

The Carriage Cut Off template page displays.

Figure 107. Carriage Cut Off



4. Provide the load data details:

Table 22. Load Data

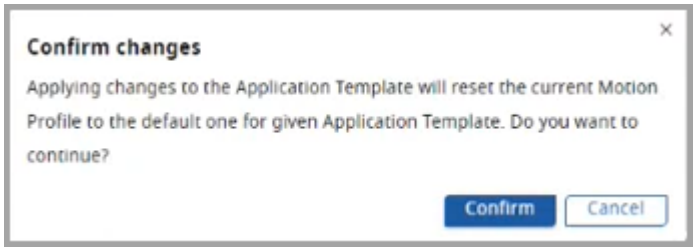
Type	Field	Description
Load	Carriage Mass	Total mass of the linear moving parts.
	Drive Roll Diameter	Diameter of the roll, driven from the motor.
	Friction Coefficient	Coefficient of friction of the sliding bearing.
Process	Calculate Timing Based On	Choose the option on which the timing should be calculated: ◦ Line Speed: The speed of the line. ◦ Cuts per Minute: Number of cuts made per minute.
	Max Average Line Speed	Provide the value when the maximum design speed of the constant-speed sections of the line is known. This speed does not refer to the peak velocity of the feeder section, which is determined by application.
	Cuts per Minute	Provide the value when the number of cuts made by the system per minute is known.
	Cut Length	The length of the cut. To cut longer lengths than this critical length, the line speed must be reduced.
Motion	Move Type	Select the Motion type: ◦ Trapezoid: Select this option when the application needs to accelerate to a maximum velocity

		and then travel at that velocity for a specified time or distance. A trapezoidal move of the virtual axis produces a trapezoidal load profile. ◦ Triangle: Select this option for a Triangular load profile.
	Jerk	This value sets the amount of S-curve of the Load Profile. For Trapezoid, the default Jerk value is 0%.
Timing	Cycle Time	Calculated cycle time for the specified load profile.
	Cut Time	Time required for the carriage to synchronize accurately with the material.
	Settling Time	This is the time required for the system to achieve the required position accuracy before the cut commences. The finer the required accuracy, the longer the settling time value.
	Move Time	Time through which the load profile takes place.

NOTE: Ensure to provide valid parameters to calculate.

5. Click [Next Step]. The Confirm changes dialog displays.
   NOTE: This dialog displays even if the user clicks [Previous Step] on top right corner or the user wanted to leave the application template page.
6. Click [Confirm].

Figure 108. Confirm Changes



7. Based on the given parameters, the Motion Profile is defined on the Profile Editor page.
8. Refer to "Define Your Profile on page 59" section to proceed further.

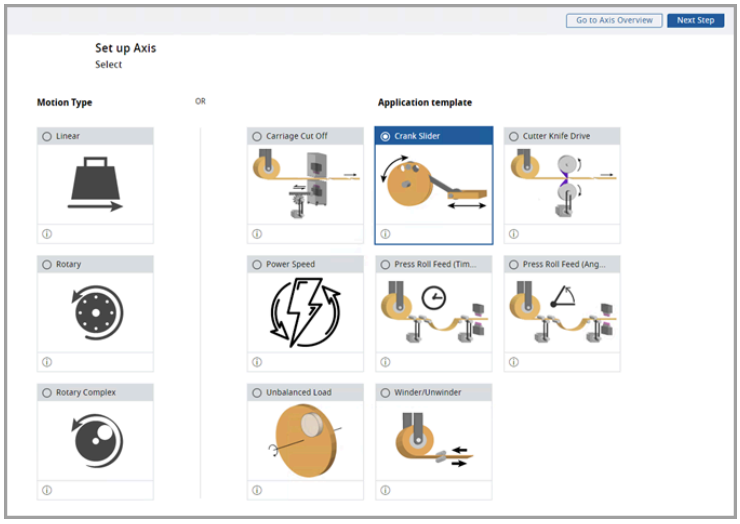
Crank Slider Template

The Crank Mechanism is an arm attached at a right angle to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. The Crank Slider template is used to calculate the load profile for a given application.

Perform the following steps to add the Crank Slider template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application template, select the Crank Slider template and click [Next Step].

Figure 109. Application Template

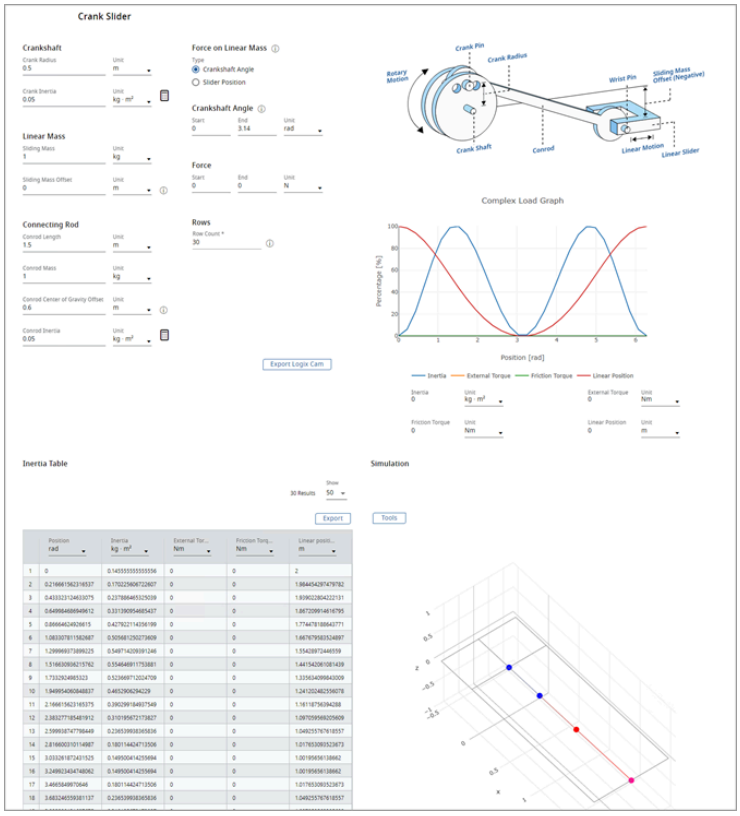


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 110. Confirm Changes

The Crank Slider template page displays.

Figure 111. Crank Slider Template



4. Provide the load data details:

Table 23. Load Data

Type	Field	Description
Crankshaft	Crank Radius	The distance between crankshaft and crank pin.
	Crank Inertia	The inertia of the crank alone when the connecting rod is disconnected. Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator section.
Linear Mass	Sliding Mass	The mass of the load attached to the connecting rod at the gudgeon pin.
	Sliding Mass Offset	The minimum distance between the crankshaft and the path of motion of the slider.
Connecting Rod	Connecting Rod Length	The distance from the crank pin center to the gudgeon (wrist) pin center.
	Connecting Rod Mass	The total mass of the connecting rod.
	Conrod Centre of Gravity Offset	The location of the center of gravity of the connecting rod along its length

		starting from the point where it meets the crank arm
	Conrod Inertia	The inertia of the connecting rod about its own center of gravity. Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator section.
Force on Linear Mass	Determines whether the end force is applied to the sliding mass based on the angular position of the crank shaft or the linear position of the sliding mass.	
	Crankshaft Angle	The angular rotation of the crankshaft at which the force is applied to the sliding mass. The start force must be within one positive or negative revolution and less than the end force angular position. ◦ Start: The starting angle for the Crank load profile. 90° indicates vertical and gravity has no effect. ◦ End: The ending angle for the Crank load profile.
	Slider Position	The linear position at which the over is applied to the sliding mass. The position is measured relative to the crank shaft. The crank shaft is considered 0 position. The start force must be less than the End force position. ◦ Start: The distance between gudgeon (wrist) pin and crank shaft center when force is applied. ◦ End: The distance between the gudgeon (wrist) pin and crank shaft center when force stops.
Force	Start	The magnitude of the force at the start point.
	End	The magnitude of the force at the end point.
Rows	Define the number of rows in the Rotary Complex output.	
Export to Logic Cam	To transfer the geometrical data to the clipboard for pasting into the Logix Cam. The master axis is a virtual axis, and the slave axis is the crank axis. A trapezoidal move of the virtual axis produces a trapezoidal load profile at the gudgeon pin. The master data must increase positively so only that part of the cam that satisfies this requirement is exported.	

Based on the provided parameters, the Motion Analyzer calculates the inertia table, complex graph, and simulation automatically

NOTE: Ensure to provide valid parameters to calculate and animate the simulation. A toast message displays if invalid parameters are provided.

The Inertia table displays.

Figure 112. Inertia Table

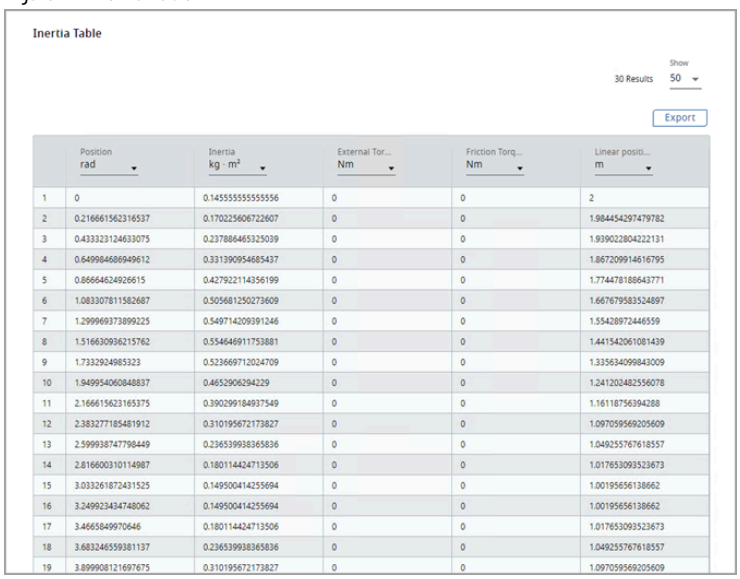


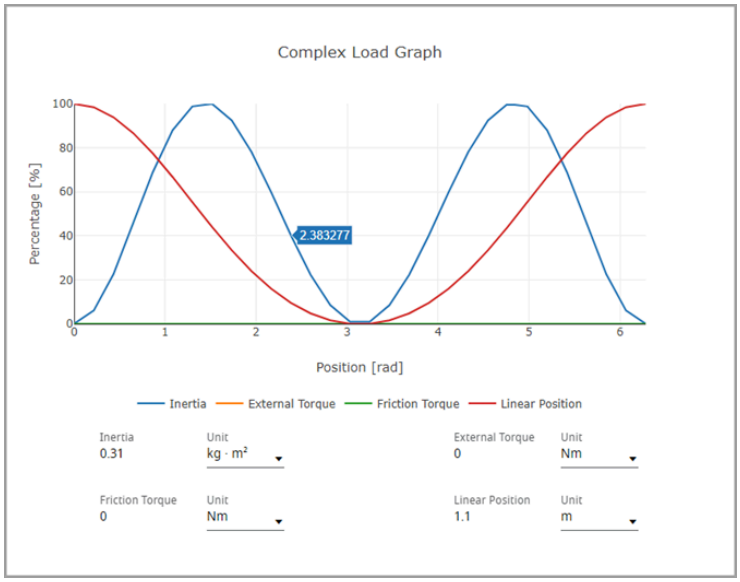
Table 24. Inertia Table

Field	Description
Position	Driving shaft angle with reference to the starting angle.
Inertia	Load inertia for the given shaft angle.
External Torque	Torque applied at the given position.
Friction Torque	Torque loss due to friction.
Linear Position	The motion of a point along a straight line.
Export	To export load data as an external file in .csv format from the Complex Load Data table.

NOTE: User cannot edit the labels and rows in the Inertia Table.

5. The Complex Load Graph displays the data on the graph. Hover the mouse pointer on the graph line to view the values.

Figure 113. Complex Load Graph



6. The simulator displays the animated view of crank slider.
7. Click [Tools] to change the view the slider action .

Figure 114. Tools

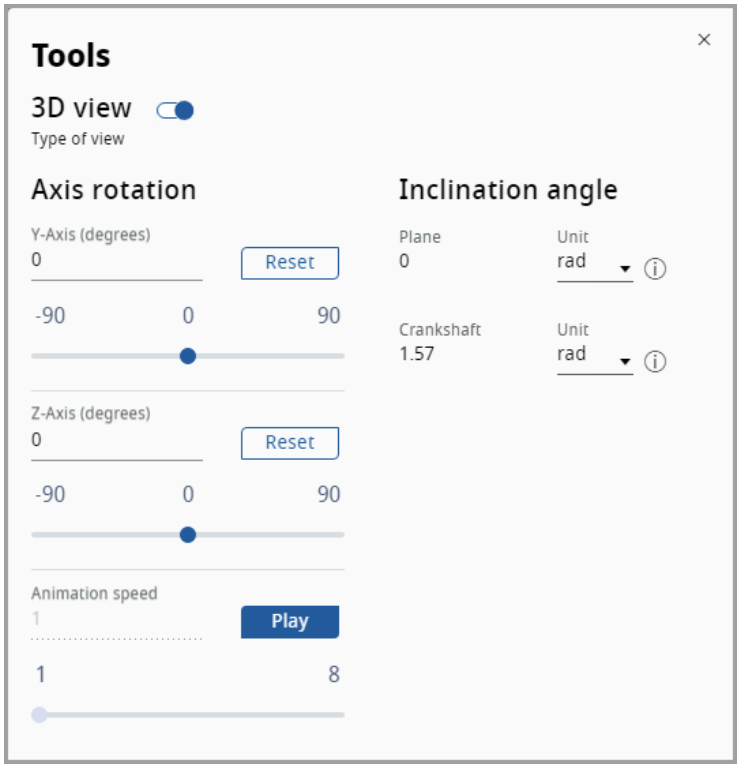


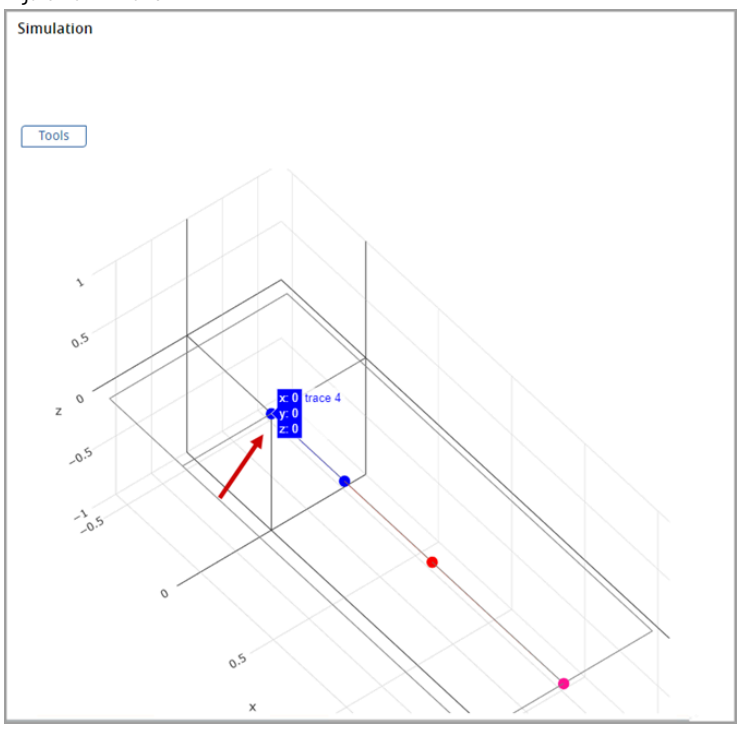
Table 25. Tools

Field	Description
3D view	3D view
Axis rotation	

Y-Axis (degree)	Angle of axis rotation on Y-axis. Use [Reset] to reset the Y-axis view to Zero.
Z-Axis (degree)	Angle of axis rotation on Z-axis. Use [Reset] to reset the Z-axis view to Zero.
Animation speed	The speed of the axis. Range: 1-8.
Play/Stop	To run the simulated crank image through the specified motion profile
Inclination angle	To change the Plane units and Crankshaft units. This action will change the inertia table view.

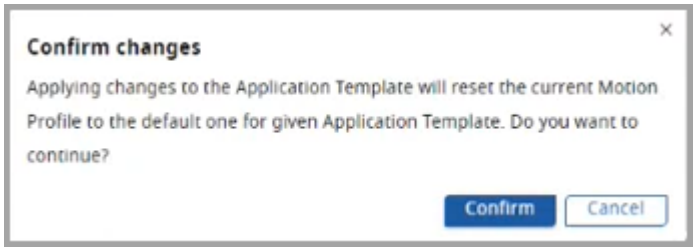
8. On the animation, point the cursor on any entry field, and the Parameter entry details display.

Figure 115. Animation



9. Click [Next Step]. The Confirm changes dialog displays.
   NOTE: This dialog displays even if the user clicks [Previous Step] on top right corner or the user wanted to leave the application template page.
10. Click [Confirm].

Figure 116. Confirm Changes



11. Based on the given parameters, the Motion Profile is defined on the Profile Editor page.
    Refer to the "Define Your Profile on page 59" section to proceed further.

Cutter Knife Drive Template

This application is typically cutting strip material such as steel into pre-set lengths using a rotary knife (heavy-duty knife blades mounted on a pair of rotating drums). The blades must be stationary relative to the material (for example, moving at line speed) when the cut is made and the cut takes place over a fixed drum angle.

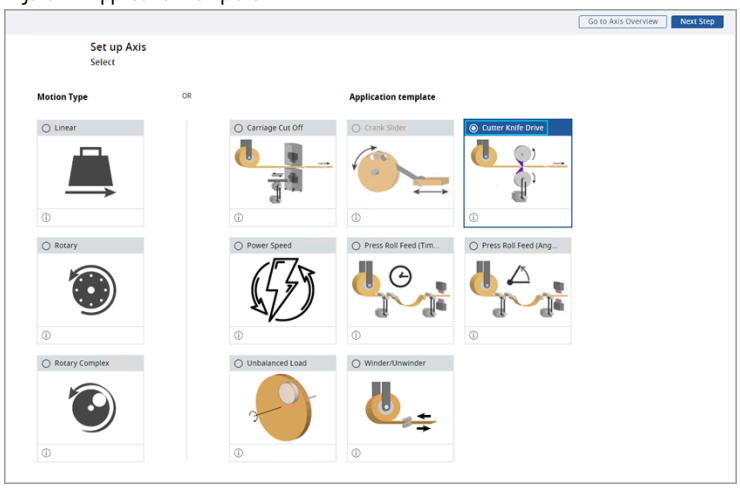
The strip material is unwound from a reel at constant surface speed and fed via separately driven leveler rolls. After the cut is complete, the drum is adjusted forward or backward relative to the material in order to cut the required length. It must return to line speed at the position required to cut the required length of material.

When the cut length is equal to the circumference of the locus of the knife blade tip, it is said to be the synchronous cut length. In this special case, the knife drums rotate at a steady speed.

Perform the following steps to add the Cutter Knife Drive template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application Template, select the Cutter Knife Drive Template and click [Next Step].

Figure 117. Application Template

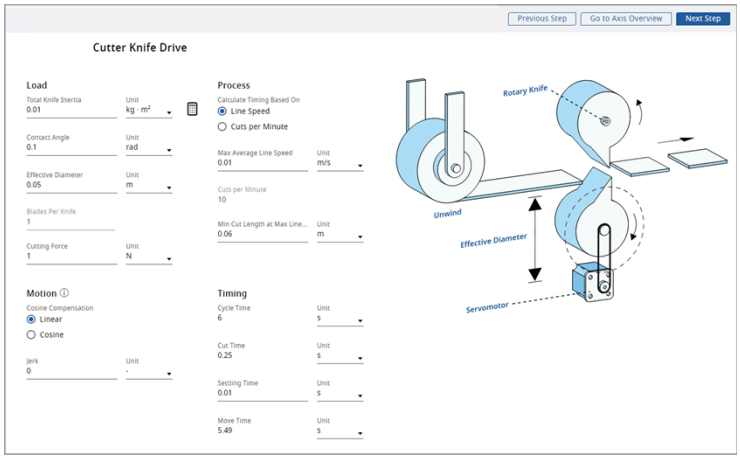


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 118. Confirm Changes

The Cutter Knife Drive template page displays.

Figure 119. Cutter Knife Drive Template



4. Provide the load data details:

Table 26. Load Data

Type	Field	Description
Load	Total Knife Inertia	Inertia of the knife assembly at the drive shaft. Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator section.
	Contact Angle	Time the material must be stationary in an accurate position.
	Effective Diameter	As illustrated in the Cutter Knife Drive (Rotary Knife) diagram, this is the diameter of the circle passing through the cutting edge.
	Blades Per Knife	Number of blades around the circumference of the knife.
	Cutting Force	Maximum force required to cut through the material. Cutting force is essentially constant while maximum torque occurs at the first point of knife contact.
Process	Calculate Timing Based On	Choose the option on which the timing should be calculated: ◦ Line Speed: The speed of the line. ◦ Cuts per Minute: Number of cuts made per minute.
	Max Average Line Speed	Provide the value when the maximum design speed of the constant-speed sections of the line is known. This speed does not refer to the peak

		velocity of the feeder section, which is determined by application.
	Cuts per Minute	Provide the value entry when the number of cuts made by the system per minute is known.
	Min Cut Length at Max line speed	This data is required when you select the option to enter data based on Max Average Line Speed. This is the critical condition on which the sizing process is performed. To cut shorter lengths than this critical length, the line speed must be reduced.
Motion	Cosine Compensation	The Cosine Compensation is used to make sure that while the press cutter knife is in contact with the material being cut, the horizontal component of the knife's velocity matches the material speed.
	Jerk	This value sets the amount of S-curve of the Load Profile. For Trapezoid, the default Jerk value is 0%.
Timing	Cycle Time	Calculated cycle time for the specified load profile.
	Cut Time	Time required for the carriage to synchronize accurately with the material.
	Settling Time	This is the time required for the system to achieve the required position accuracy before the cut commences. The finer the required accuracy, the longer the settling time value.
	Move Time	Time through which the load profile takes place.

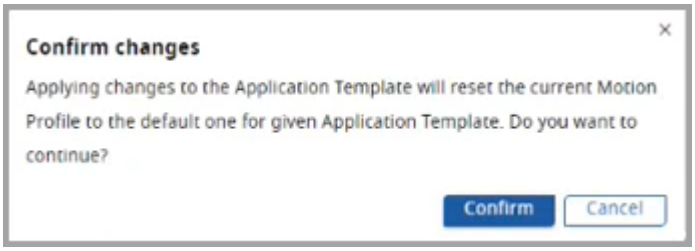
NOTE: Ensure to provide valid parameters to calculate.

5. Click [Next Step]. The Confirm changes dialog displays.

NOTE: This dialog displays even if the user clicks [Previous Step] on top right corner or the user wanted to leave the application template page.

6. Click [Confirm].

Figure 120. Confirm Changes



7. Based on the given parameters, the Motion Profile is defined on the Profile Editor page.
   Refer to the "Define Your Profile on page 59" section to proceed further.

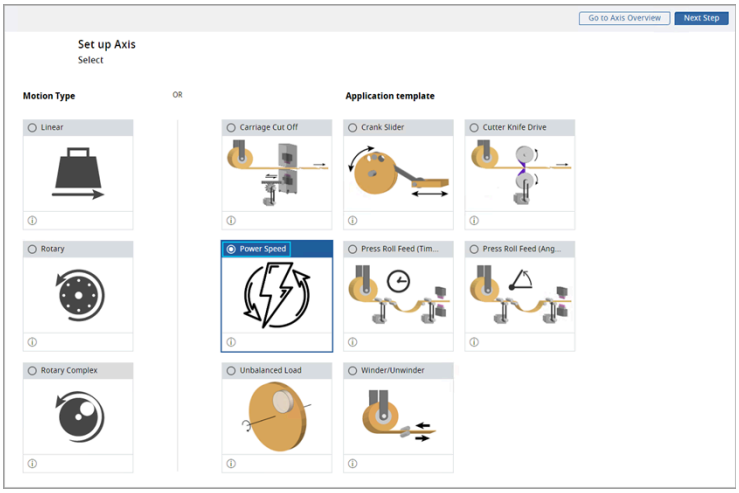
Power Speed Template

The Power Speed template is used to enter torque and speed values that are used to calculate the power requirements for the application.

Perform the following steps to add the Power Speed template to the Motion Profile:

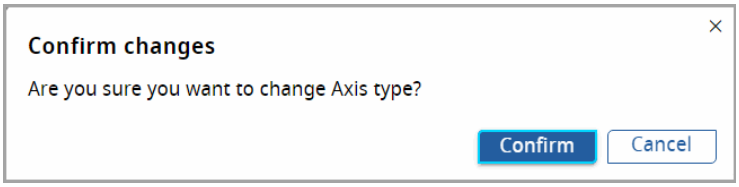
1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application template section, select the Power Speed template and click [Next Step].

Figure 121. Power Speed Template



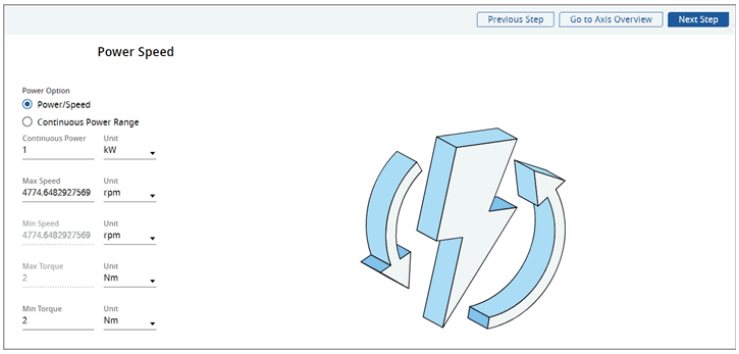
3. The 'Confirm changes dialog displays. Click [Confirm].

Figure 122. Confirm Changes



4. The Power Speed template page displays.

Figure 123. Power Speed Template



5. Provide the Power and speed values:

Table 27. Power Speed Template

Field	Description
Power Option	Select the power option: ◦ **Power/Speed**: Use this template when the torque and speed values are known at the load for the application. ◦ **Continuous Power Range**: Use this template when three of the following values are known: maximum torque, minimum torque, maximum speed, or minimum speed.
Continues Power	Provide the Continues Power value along with their units.
Max Speed	Maximum speed for the application.
Min Speed	Minimum speed for the application. Ensure that this value doesn't exceed the Max speed. This field is disabled if the Power option is Power/Speed.
Max Torque	Maximum torque value for the application. This field is disabled if the Power option is Power/Speed.
Min Torque	Minimum torque value for the application.

6. Click [Next Step] on the top right corner. Based on the provided parameters, the Motion Profile is defined on the Profile Editor page.
7. Refer to "Define Your Profile on page 59" section to proceed further.

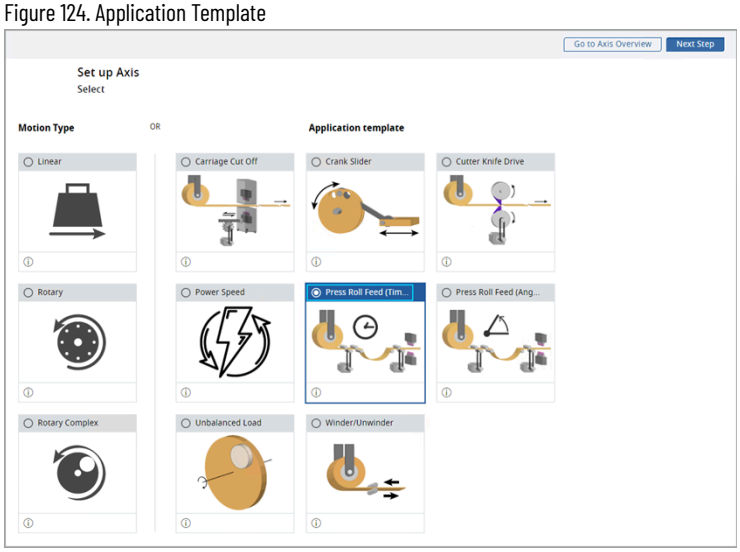
Press Roll Feed (Time) Template

This application is typically cutting strip material such as steel into pre-set lengths by means of a press shear (heavy-duty knife). The material must be stationary when the cut is made, and the cut takes place over a fixed amount of time of the driving crank whose speed is varied to match the cut rate. Strip material is unwound from a reel at constant surface speed and fed via separately driven leveler rolls into one end of a looping pit (a free-hanging loop of material providing storage). On the other side of the loop, a pair of feeder rolls grips the material and moves it forward the required cut length and then stops. After the cut is complete, the material is moved again. The average velocity of the nip/feeder rolls must be equal to the constant velocity of the unwinder and leveler rolls.

Perform the following steps to add the Press Roll Feed (Time) template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application Template, select the Press Roll Feed (Time) Template and click [Next Step].

Figure 124. Application Template

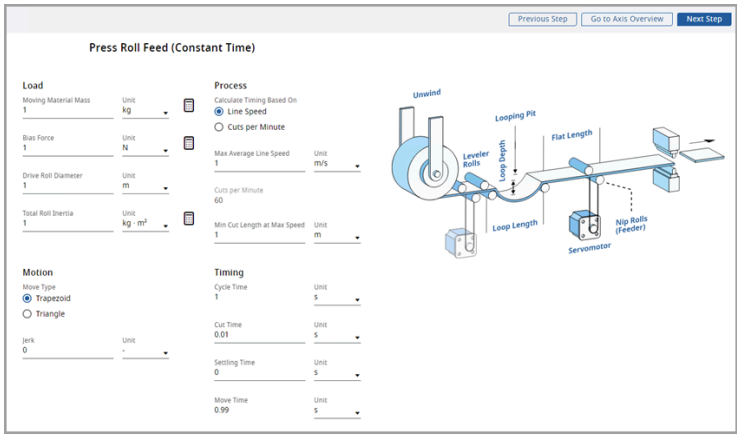


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 125. Confirm Changes

The Press Roll Feed (Constant Time) template page displays.

Figure 126. Press Roll Feed (Constant Time) Template



4. Provide the load data details:

Table 28. Load Data

Type	Field	Description

Load	Moving Material Mass	The mass of the material in the loop and on the flat before the Nip/Feed rolls.
	Bias Force	The force required to overcome the force of gravity on the loop.
	Drive Roll Diameter	The diameter of the roll in direct contact with the strip, driven from the motor.
	Total Roll Inertia	The total inertia of the strip material at the drive shaft. Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator section.
Process	Calculate Timing Based On	Choose the option on which the timing should be calculated: ◦ Line Speed: The speed of the line. ◦ Cuts per Minute: Number of cuts made per minute.
	Max Average Line Speed	Select this option for data entry when the maximum design speed of the constant-speed sections of the line is known. This speed does not refer to the peak velocity of the feeder section, which is determined by Motion Analyzer software.
	Cuts per Minute	Provide this value when the number of cuts made by the system per minute is known.
	Max. Cut Length at Max Speed	This data is required when you select the option to enter data based on Max Average Line Speed. This is the critical condition on which the sizing process is performed. To cut shorter lengths than this critical length, the line speed must be reduced.
Motion	Move Type	Select the Motion type: ◦ Trapezoid: Select this option when the application needs to accelerate to a maximum velocity and then travel at that velocity for a specified time or distance. A trapezoidal move of the virtual

		axis produces a trapezoidal load profile ◦ Triangle: Select this option for a Triangular load profile.
	Jerk	This value sets the amount of S-curve of the Load Profile. The default Jerk value is 0%.
Timing	Cycle Time	Calculated cycle time for the specified load profile.
	Cut Time	Time required for the carriage to synchronize accurately with the material.
	Settling Time	This is the time required for the system to achieve the required position accuracy before the cut commences. The finer the required accuracy, the longer the settling time value.
	Move Time	Time through which the load profile takes place.

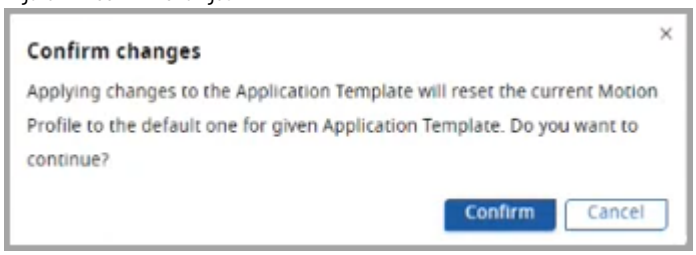
NOTE: Ensure to provide valid parameters to calculate.

5. Click [Next Step]. The Confirm changes dialog displays.

NOTE: This dialog displays even if the user clicks [Previous Step] on top right corner or the user wanted to leave the application template page.

6. Click [Confirm].

Figure 127. Confirm Changes



7. Based on the given parameters, the Motion Profile is defined on the Profile Editor page.
Refer to "Define Your Profile on page 59" section to proceed further.

Press Roll Feed (Angle) Template

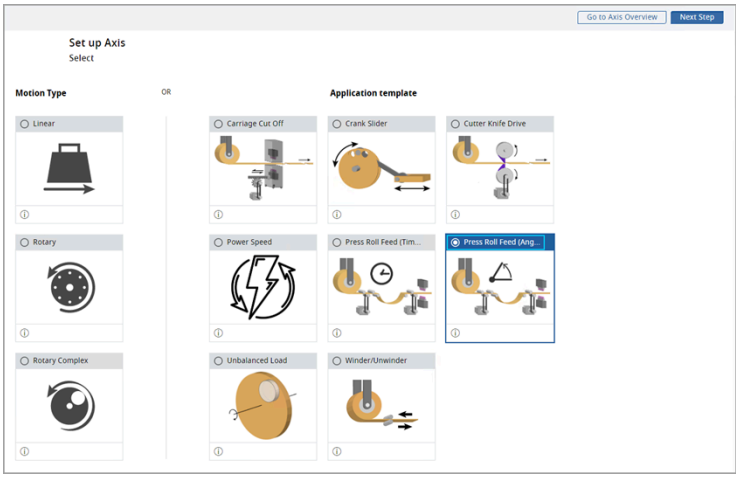
This application is typically cutting strip material such as steel into pre-set lengths by means of a press shear (heavy-duty knife). The material must be stationary when the cut is made and the cut takes place over a fixed angle of the driving crank whose speed is varied to match the cut rate.

The strip material is unwound from a reel at constant surface speed and fed via separately driven leveler rolls into one end of a looping pit (a free-hanging loop of material providing storage). On the other side of the loop, a pair of feeder rolls grips the material and moves it forward the required cut length, and then stops. After the cut is complete, the material is moved again. The average velocity of the nip/feeder rolls must be equal to the constant velocity of the unwinder and leveler rolls.

Perform the following steps to add the Press Roll Feed (Angle) template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application Template, select the Press Roll Feed (Angle) Template and click [Next Step].

Figure 128. Press Roll Feed (Angle) Template

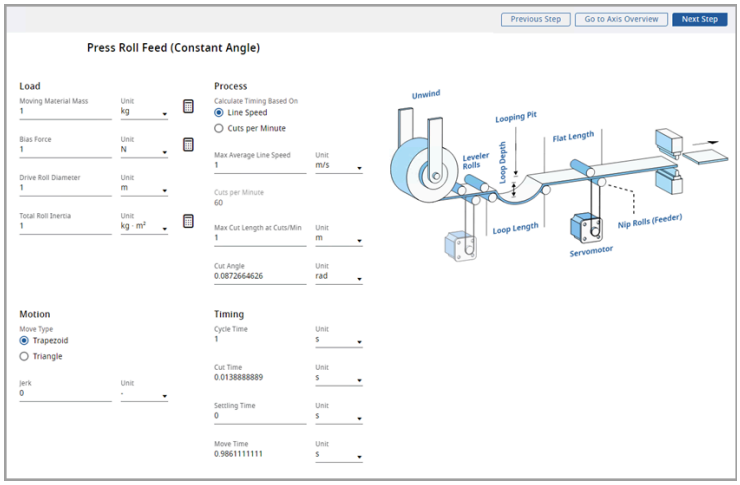


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 129. Confirm Changes

The Press Roll Feed (Constant Angle) template page displays.

Figure 130. Press Roll Feed (Constant Angle)



4. Provide the load data details:

Table 29. Load Data

Type	Field	Description
Load	Moving Material Mass	The mass of the material in the loop and on the flat before the Nip/Feed rolls.
	Bias Force	The force required to overcome the force of gravity on the loop.
	Drive Roll Diameter	The diameter of the roll in direct contact with the strip, driven from the motor.
	Total Roll Inertia	The total inertia of the strip material at the drive shaft. Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator section.
Process	Calculate Timing Based On	Choose the option on which the timing should be calculated: ◦ Line Speed: The speed of the line. ◦ Cuts per Minute: Number of cuts made per minute.
	Max Average Line Speed	Select this option for data entry when the maximum design speed of the constant-speed sections of the line is known. This speed does not refer to the peak velocity of the feeder section, which is determined by Motion Analyzer software.

	Cuts per Minute	Provide this value when the number of cuts made by the system per minute is known.
	Max. Cut Length at Cuts/Min	This data is required when you select the option to enter data based on Cuts/min. This is the critical condition on which the sizing process is performed. To cut longer lengths than this critical length, the line speed must be reduced.
	Cut Angel	The crank angle during which the material must be stationary in an accurate position. This value is only required for Press Roll Feed - Constant Angle applications.
Motion	Move Type	Select the Motion type: ◦ Trapezoid: Select this option when the application needs to accelerate to a maximum velocity and then travel at that velocity for a specified time or distance. A trapezoidal move of the virtual axis produces a trapezoidal load profile ◦ Triangle: Select this option for a Triangular load profile.
	Jerk	This value sets the amount of the S-curve of the Load Profile. The default Jerk value is 0%.
Timing	Cycle Time	Calculated cycle time for the specified load profile.
	Cut Time	Time required for the carriage to synchronize accurately with the material.
	Settling Time	This is the time required for the system to achieve the required position accuracy before the cut commences. The finer the required accuracy, the longer the settling time value.
	Move Time	Time through which the load profile takes place.

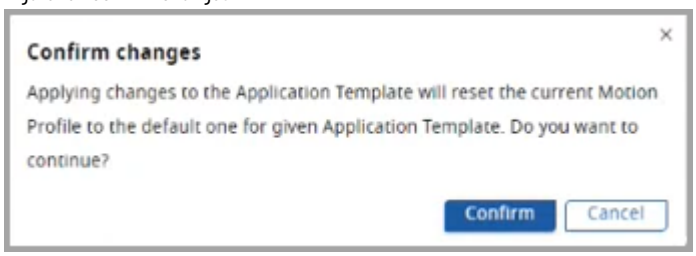
NOTE: Ensure to provide valid parameters to calculate.

5. Click [Next Step]. The Confirm changes dialog displays.

NOTE: This dialog displays even if the user clicks [Previous Step] on the top right corner or the user wants to leave the application template page.

6. Click [Confirm].

Figure 131. Confirm Changes



7. Based on the given parameters, the Motion Profile is defined on the Profile Editor page. Refer to "Define Your Profile on page 59" section to proceed further.

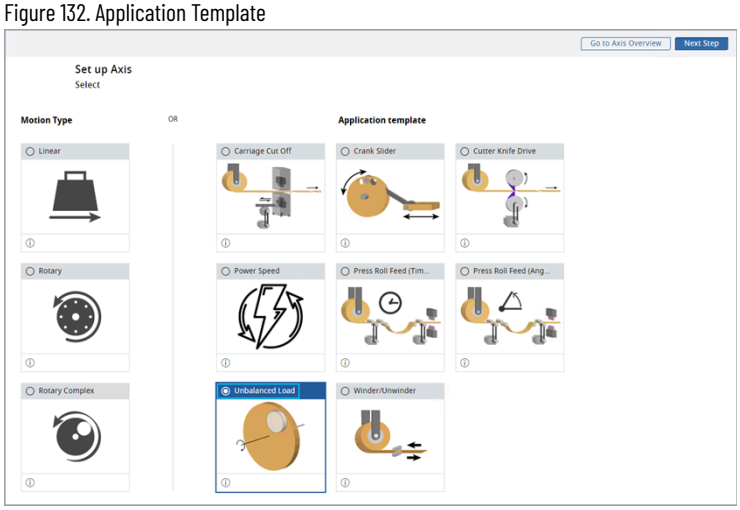
Unbalanced Load Template

The Unbalanced Load template allows the user to enter parameters for an unbalanced load application. Motion Analyzer assumes that the axis of rotation is parallel to the ground if no axis angle is entered and that unbalanced masses create a gravity-related torque. Secondary Inertia, Secondary Mass, and Axis Separation parameters are required to consider gravity-induced torque values.

Perform the following steps to add the Unbalanced Load template to the Motion Profile:

1. Under the Motion Definition menu, click [Set up Axis].
2. Under the Application Template, select the Unbalanced Load Template and click [Next Step].

Figure 132. Application Template

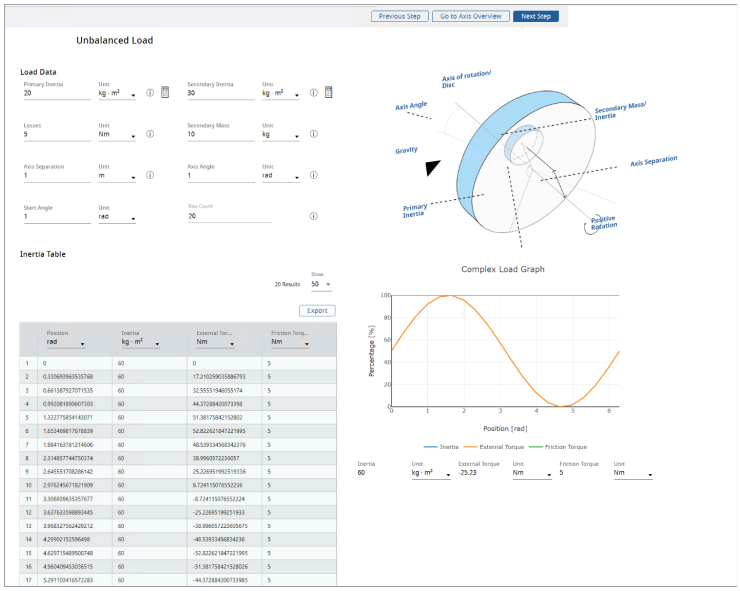


3. The 'Confirm changes' dialog displays. Click [Confirm].

Figure 133. Confirm Changes

The Unbalanced Load template page displays.

Figure 134. Unbalanced Load Template



4. Provide the load data details:

Table 30. Load Data

Field	Description
Primary Inertia	The inertia of any balanced load about its own axis of rotation. For example, if the main mass is a circular table that is driven about its own axis of symmetry, then Primary Inertia is equal to the table inertia. Or If the user has the measurements and other details of the balanced load, click the [ ] icon to calculate the inertia of the balanced load. Refer to Inertia Calculator section.
Losses	The losses consist of the torque lost in the system due to friction.
Axis Separation	The distance between the secondary mass' center of gravity and the axis of rotation.
Start Angle	The starting angle for the Unbalanced Load profile.

Secondary Inertia	The moment of inertia of the unbalanced mass about its own center of gravity. Or If the user has the measurements and other details of the unbalanced load, click the [ ] icon to calculate the inertia of the unbalanced load. Refer to Inertia Calculator section.
Secondary Mass	The unbalanced mass.
Axis Angle	The starting angle of rotation. Zero indicates that at the start of the motion profile, the center of gravity lies vertically below the center of rotation. This is the position of the load if it is allowed to swing freely. Positive rotation is clockwise. **NOTE:** Based on the angle selected, the unbalanced diagram changes its axis.
Row Count	Number of rows

Based on the provided parameters, the Motion Analyzer application calculates the inertia table and complex load graph automatically.

NOTE: Ensure to provide valid parameters to calculate.

The Inertia table displays.

Figure 135. Inertia Table

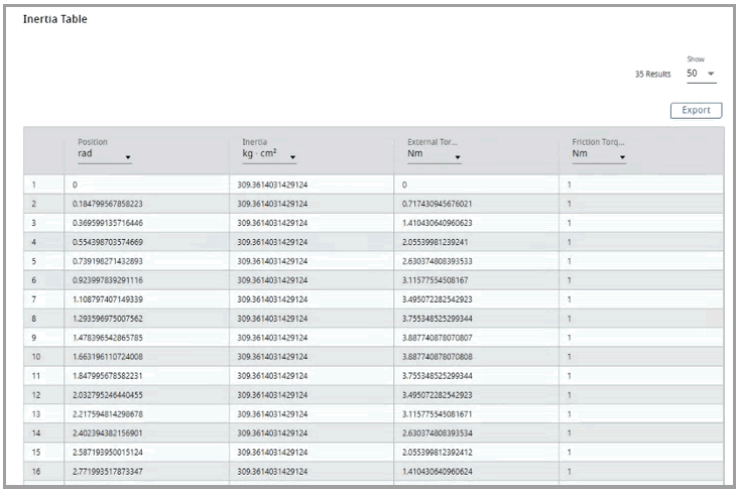


Table 31. Inertia Table

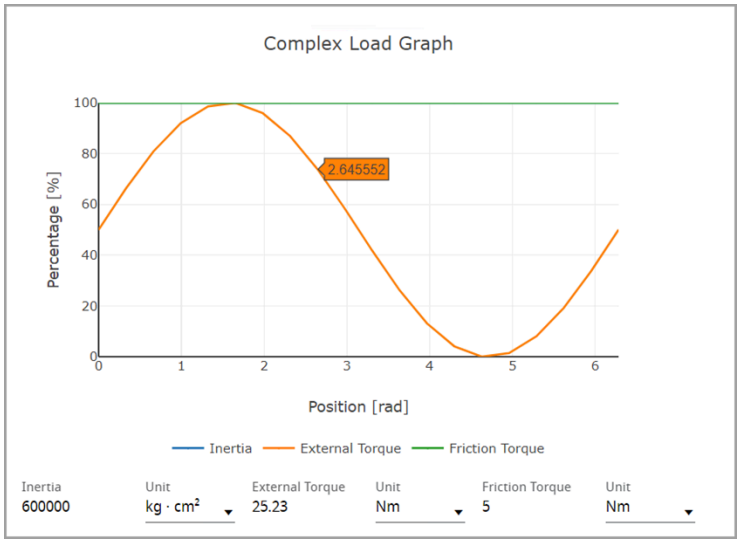
Field	Description
Position	Driving shaft angle with reference to the starting angle.
Inertia	Load inertia for the given shaft angle.
External Torque	Torque applied at the given position.

Friction Torque	Torque loss due to friction.
Export	To export load data as an external file in .csv format from the Complex Load Data table.

NOTE: User cannot edit the labels and rows in the Inertia Table.

5. The Complex Load Graph displays the data on the graph. Hover the mouse pointer on the graph line to view the values.

Figure 136. Complex Load Graph

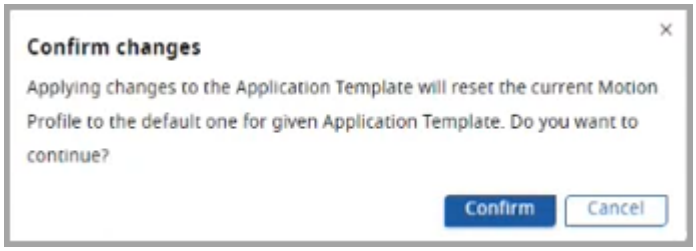


6. Click [Next Step]. The Confirm Changes dialog displays.

NOTE: This dialog displays even if the user clicks [Previous Step] on the top right corner or wants to leave the application template page.

7. Click [Confirm].

Figure 137. Confirm Changes



8. Based on the given parameters, the Motion Profile is defined on the Profile Editor page. Refer to "Define Your Profile on page 59" section to proceed further.

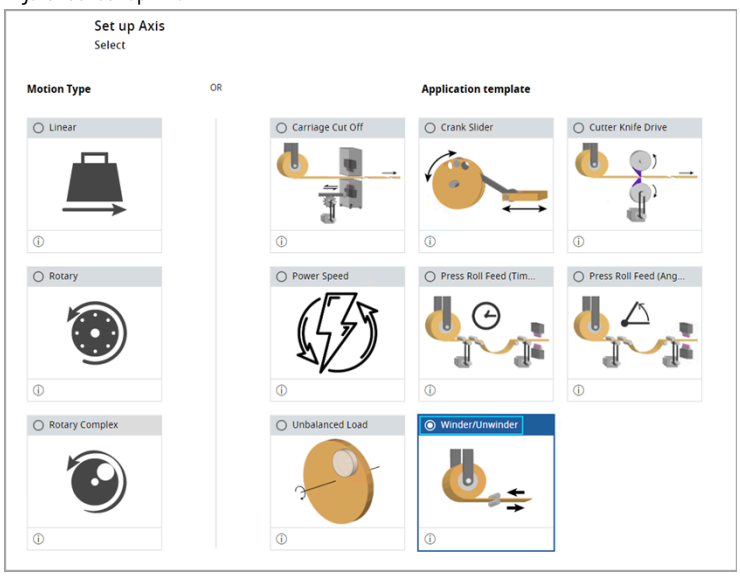
Winder/Unwinder

The Winder/Unwinder template provides the required inputs to calculate the Motion Profile for Winder or Unwinder applications.

Perform the following steps to add the Winder/Unwinder template to the Motion Profile:

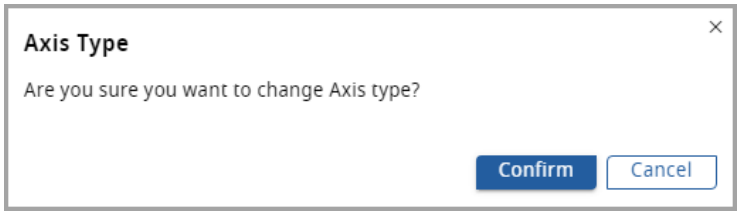
1. Under the Motion Definition menu, click [Set up Axis].

Figure 138. Set up Axis



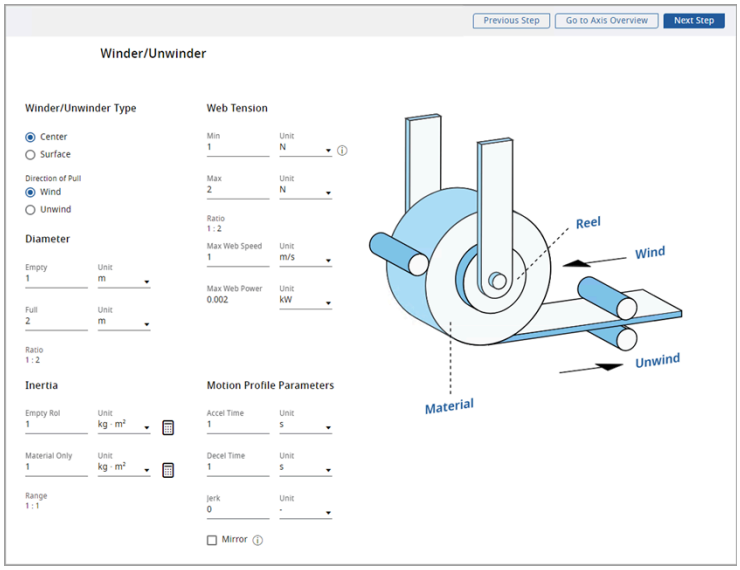
2. Under the Application Template, select the Winder/Unwinder template and click [Next Step].
3. The 'Axis Type' dialog displays. Click [Confirm].

Figure 139. Confirmation



4. The Winder/Unwinder template displays.

Figure 140. Winder/Unwinder Template



5. Provide the following details:

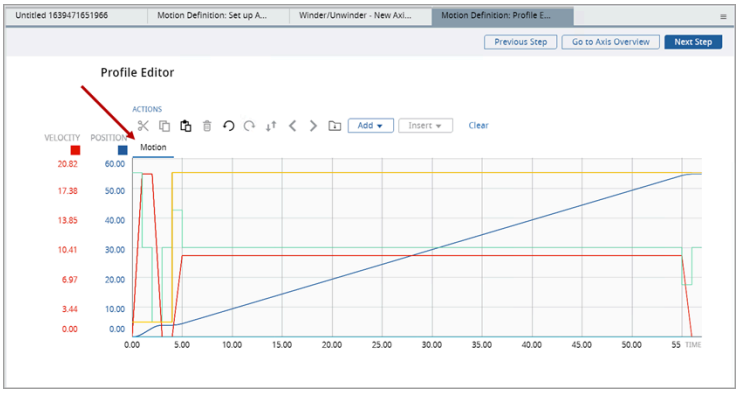
Table 32. Bus Context Menu

Options	Description
Winder/Unwinder Type	The type of the Winder/Unwinder: Center Driven or Surface Driven. ◦ Center Driven: The roll is driven directly via a shaft at its center of rotation. For a center-driven application, the Rotary Load is selected, and the roll is modeled as Inertia and Torque in a Multi-segment profile. No further load information needs to be added. ◦ Surface Driven: The roll is driven by the friction of rollers pressing onto the circumference of the web. For a Surface Driven application, Linear Load and Belt Drive are selected and the roll is modeled as Mass and Force in a Multi-segment profile. **Important**: The driving roll/rolls data should be added as Drive Roll and Idler Roll.
Motion Type	Select either Wind or Unwind for the application. This setting determines the direction of pull from the web tension.
Diameter	
Empty Diameter	Minimum reel diameter when the roll is completely unwound.
Full Diameter	Maximum reel diameter when the roll is completely wound.
Ratio	Ratio of the Maximum/Minimum diameter of the roll.
Inertia	
Empty Roll	Inertia of the reel when it is completely unwound.
Material Only	Inertia of the reel when it is at full diameter or completely wound.
Range	Ratio of Maximum/Minimum inertia values. A large inertia range value is more difficult to control.
Web Tension	
Min	Minimum web tension for the application. It is used to calculate the Tension Ratio.
Max	Maximum allowable web tension for the material. The value is used for sizing purposes.
Ratio	Ratio of the Maximum/Minimum tension values
Max Web Speed	Design speed of the material running through the machine.
Max Web Power	Maximum web tension multiplied by the maximum web speed. This power is regenerated continuously during unwind and should be catered for by suitably rated dump

	resistors or a regenerative power supply. Motion Analyzer software underestimates this rating by approximately 10%.
Motion Profile Parameter	
Acceleration Time	Shortest required acceleration time from zero to maximum web speed.
Deceleration Time	Shortest required deceleration time from maximum web speed to zero.
Jerk	This is the jerk for the acceleration/Deceleration of the profile segment.
Mirror	This option is used only when a Wind and Unwind axis share a DC power rail. The two axes are first sized as normal (for example, Profile Mirror is set to Off). The Winder is then set to Profile Mirror. This matches the two axis motion profiles as if they were connected by the web. This is necessary only to check the system sizing. In this mode, the motor winding temperature of the Winder axis will be underestimated.

6. Click [Next Step] on the top right corner. Based on the provided parameters, the Motion Profile is defined on the Profile Editor page.

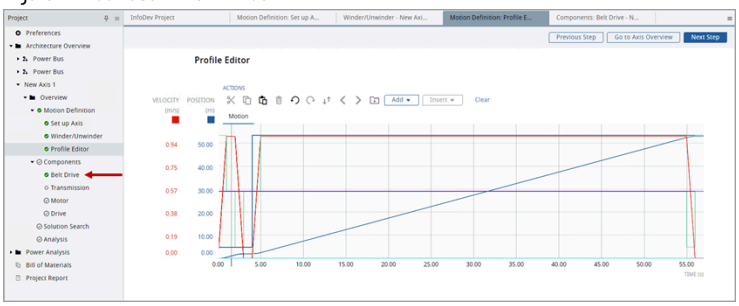
Figure 141. Motion Profile



7. If the user selects Surface Driven winder type, by default the Belt Drive is selected under the components.

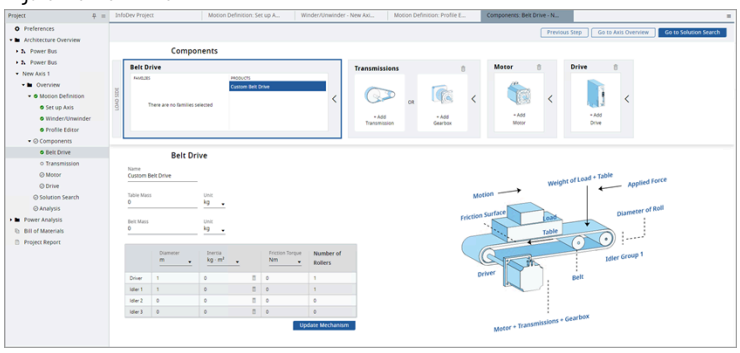
NOTE: In this case, the user cannot delete the Belt Drive.

Figure 142. Surface Driven Winder



8. Click [Belt Drive], the components page displays.

Figure 143. Belt Drive



9. User can update the parameters and click [Update Mechanism].

NOTE: Ensure to provide valid parameters.

10. The updated values are reflected in the components section of the profile tree.
Refer to the "Define Your Profile on page 59" section to proceed further.

Profile Editor Toolbar

The Profile toolbar contains buttons and pull-down menus to add, move, and remove the profile segments or an entire motion profile.

Figure 144. Profile Toolbar Features

Action Toolbar

The Profile Editor Action Toolbar allows you to add, insert, and modify plot profiles for Motion, Inertia, Torque, and Friction. Modifications include cutting, copying, pasting, and deleting segments. You may also undo and redo recent actions, invert segments, and navigate forward and back through segments, and download your plot profile. Adding a segment to your plot profile will append the new segment to the end of your plot profile while inserting a segment allows you to place a new segment in between existing segments.

Figure 145. Action Toolbar

Table 33. Action Toolbar

Icon	Name	Description
	Cut	Cut the selected segment from the plot profile.
	Copy	Copy the selected segment to the clipboard.

Table 33. Action Toolbar (continued)

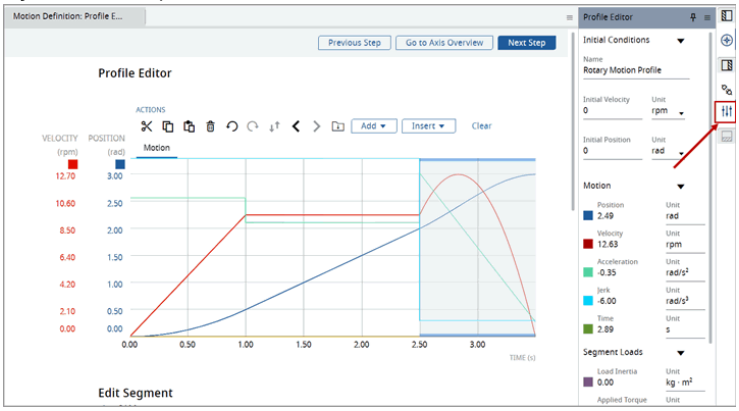
	Paste	Paste a cut or copied segment into the plot profile.
	Delete	Delete the selected segment.
	Undo	Undo last action.
	Redo	Redo last undone action
	Invert	Invert the plot profile.
	Back	Navigate back one segment.
	Forward	Navigate forward one segment.
	Import Profile	To import a profile. Refer to Import Motion Profile on page 105 section to import a Motion Profile.
	Add	Add a new segment to the end of the plot profile. The following types of segments can be added: Acceleration/Deceleration Index Cruise/Dwell Cam Index Advance Inertia Torque Friction
	Insert	Inserts a new segment between two existing segments. The segment types available in the 'Add' drop-down are also available in the 'Insert' drop-down.
	Clear	Clear data from the plot profile.

NOTE: Use the mouse wheel to scroll up/down and zoom in/out within the Profile Editor.

Edit Graph

1. On the right pane, click the [ ] icon. The Profile Editor panel displays.

Figure 146. Edit Graph



2. Using the following options, the User can change units, and toggle on/off the plots and the axes:
   a. **Initial Conditions**: To edit the Profile name, initial velocity, and initial position along with their units.
   b. **Motion**: To view the change in velocity, position, acceleration, jerk, and time while moving the cursor on the graph at a given time. The Profile Editor panel allows the User to change the units, and hide/show a parameter, and the Y-axis toggle button allows the User to toggle the Y-axis on/off on the plot and may also be used to gain space.
   c. **Segment Loads**: To view the Load Inertia and Applied torque values. The Profile Editor panel allows the User to change the units, hide/show the parameter, and the Y-axis toggle button allows the User to toggle the Y-axis on/off on the plot and may also be used to gain space.
   d. **Additional Loads**: To view the Inertia, torque, and friction values. The Profile Editor panel allows the User to change the units, and hide/show the parameter, and the Y-axis toggle button allows the User to toggle the Y-axis on/off on the plot and may also be used to gain space.

NOTE: Only the initial condition can be edited. The other options are used to change the display options (hide/show, change UoM) and does not affect the profile. User can change the units, toggle on/off the plots and the axes, but cannot support swapping of axes.

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3. Each colored line indicates a unique parameter in the motion profile.
4. Use the View option [ ] to hide/show the graph of a particular parameter.

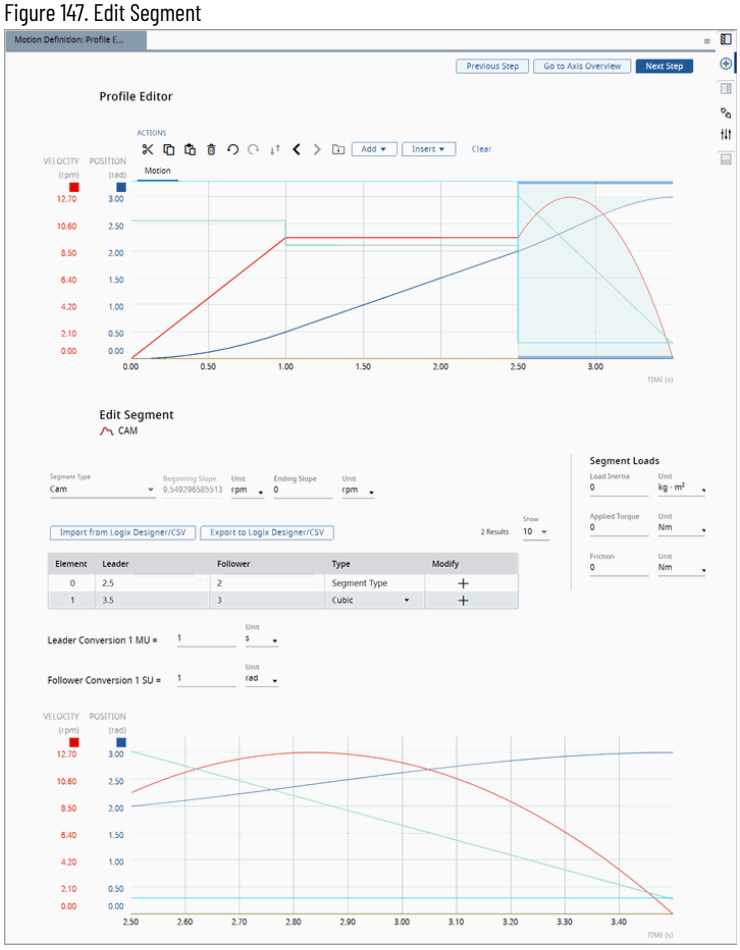
Tip: Use the mouse wheel to scroll up/down and zoom in/out within the Profile Editor.

Edit Segment

Perform the following steps to edit a segment:

1. Select the type of a segment, the selected segment gets highlighted, and the respective edit panel and the graph displays in the second plot as shown in the following image:

Figure 147. Edit Segment



2. Each Profile Segment Type has a different associated Segment Edit window:

Table 34. Edit Segment

Parameter	Description
Accel/Decel	Provides parameters for an Acceleration or Deceleration profile segment.
Index	Provides parameters for an Index profile segment. An Index profile segment consists of an Acceleration, a Cruise, and a Deceleration.
Cruise/Dwell	Provides parameters for a Cruise or Dwell profile segment. The profile segment is considered a Cruise if the velocity at the end of the previous profile segment is non-zero and is considered a Dwell if that velocity is zero.
Cam	Provides parameters for a Cam profile segment.

Parameter	Description
Index Advance	To select more advanced velocity, acceleration, and jerk profiles for an Index profile segment.
Segment Loads	
Load Inertia	Load inertia for a given segment.
Applied Torque	Torque applied at the given position.
Friction	Torque loss due to friction.

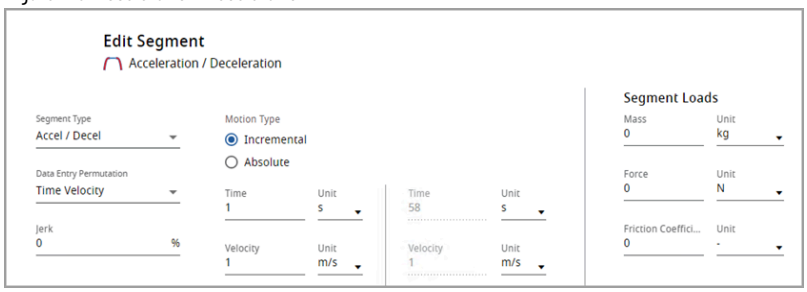
Acceleration/Deceleration

Provide the following parameters for Acceleration/Deceleration:

Table 35. Accel/Decel

Parameter	Description
Data Entry Permutation	Select an option to provide the profile segment parameters: • Time Distance • Time Velocity • Time Acceleration • Distance Velocity • Distance Acceleration • Velocity Acceleration
Jerk	Provide a value to set the amount of S-curve of the Acceleration/Deceleration profile segment. Increasing the percent jerk increases the amount of S-curve.
Motion Type	Select whether to input Incremental or Absolute parameter values. • Incremental values represent the change either in the distance or time that occurs during the profile segment. • Absolute values represent the total distance or time elapsed throughout the entire motion profile.
Distance/Time/Velocity/Acceleration	Provide the parameter for any one of the Distance/Time/Velocity/Acceleration based on the Data Entry Permutation selection to define the profile segment.

Figure 148. Acceleration/Deceleration



Index

Provide the following parameters for Index:

Table 36. Index

Parameter	Description
Index Type	**Triangle:** 1/2 acceleration and 1/2 deceleration motion profile. **Trapezoidal:** This index type allows the User to use sliders to provide the velocity and time axes of the motion profile. **Vertical Bar:** Adjusts the height/velocity component of the motion profile. As the value of the slider is increased, more time is spent accelerating and decelerating the load, and less time is spent dwelling at a constant velocity. **Horizontal Bar:** Adjusts the ratio of the time spent accelerating to the time spent decelerating for the profile segment. A negative value on the slider indicates that more time is spent decelerating the load than accelerating it. A positive value on the slider indicates that more time is spent accelerating the load than decelerating it.
Smoothness	**Custom:** 0% Jerk (Trapezoidal) **Standard/Automatic:** 40% Jerk (Partial S-curve) **Maximum:** 100% Jerk (Full S-curve)
Acceleration Jerk/Deceleration Jerk	The percent of time for Acceleration/Deceleration Jerk increases the peak acceleration (and therefore current) above that of a trapezoidal motion profile. The acceleration of a trapezoidal motion profile is taken to be 100%.
Motion Type	Select whether to input Incremental or Absolute parameter values. Incremental values represent the change in either the distance or time that occurs during the profile segment Absolute values represent the total distance or time elapsed throughout the entire motion profile.
Distance/Time	Select and enter either the Distance or Time parameter to define the profile segment.
Positive/Negative Velocity Limit	When the user provides the Positive or Negative Velocity Limit for the profile, the Motion Analyzer adjusts the acceleration and deceleration times required to reach the desired velocity limits.

Figure 149. Index

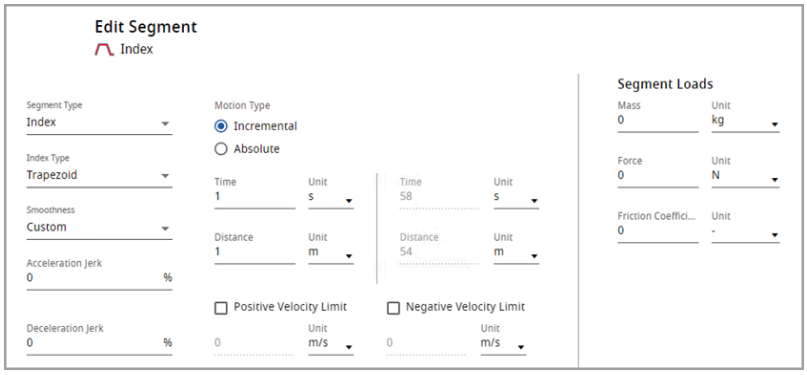


Table 37. Segment Loads

Parameter	Description
Load Inertia	Load inertia for the given segment.
Applied Torque	Torque applied at the given position.
Friction	Toque loss due to friction.

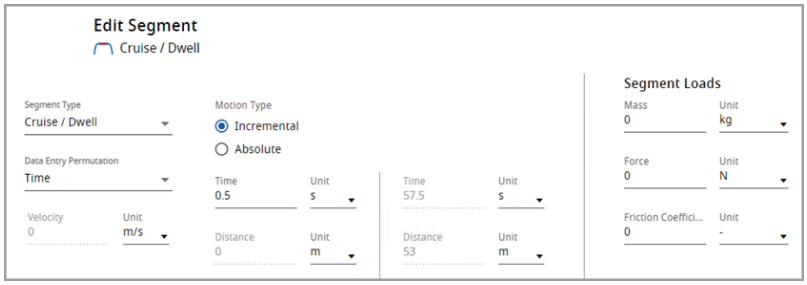
Cruise/Dwell

Provide the following parameters for Cruise/Dwell:

Table 38. Cruise/Dwell

Parameter	Description
Data Entry Permutation	Select an option to provide the profile segment parameters: • Time • Distance
Motion Type	Select whether to input Incremental or Absolute parameter values: • Incremental values represent the change either in the distance or time that occurs during the profile segment. • Absolute values represent the total distance or time elapsed throughout the entire motion profile.
Segment Loads	Provide the parameter for any one of the following: • Load Inertia • Applied Torque • Friction

Figure 150. Cruise/Dwell



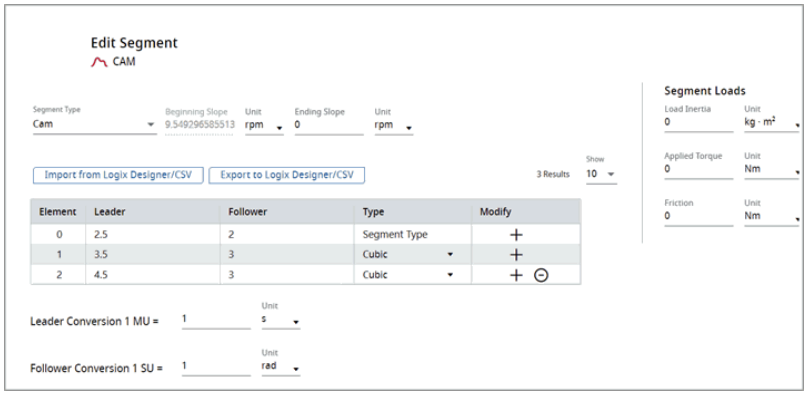
CAM

Provide the following parameters for CAM:

Table 39. CAM Segment

Parameter	Description
Beginning Slope	Provide the slope value for the beginning of the segment.
Ending Slope	Provide the slope value for the end of the segment.
Import from Logix Explorer	Import data from Logix.
Export to Logix Explorer	Export data to a clipboard.
Leader/Follower Elements	Use the [+] and [-] icons under the Modify column to add or remove Leader and Follower elements or modify the segment type. The following segment types are available: • Linear • Cubic
Show	View the desired number of elements.
Leader Conversion 1 MU	Specify the conversion factor and unit to be used in Leader Conversion.
Follower Conversion 1 SU	Specify the conversion factor and unit to be used in Follower Conversion.
Segment Loads	Provide the parameter for any one of the following: • Load Inertia • Applied Torque • Friction

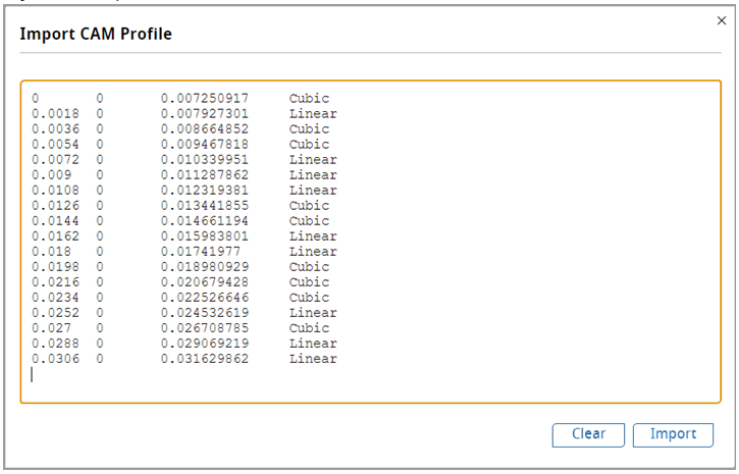
Figure 151. CAM



To import data from Logix:

1. Click [Import from Logix Explorer]. The Import CAM Profile dialog displays.

Figure 152. Import CAM Profile



2. Copy the data from a clipboard. The User has the privilege to edit the data on this editor.

NOTE: Ensure that the data provided is valid and is in ascending order. The maximum number of elements allowed is 300 and the minimum is 2. The segment name must be either cubic or linear.

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3. Click [Clear] to clear the input data in the editor.
4. Click [Import]. The data is displayed in the table and the relevant changes are reflected in the graph.

Figure 153. Import

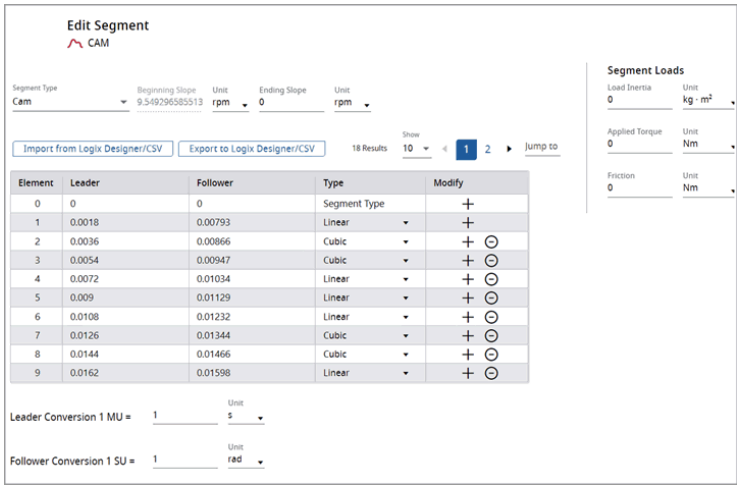
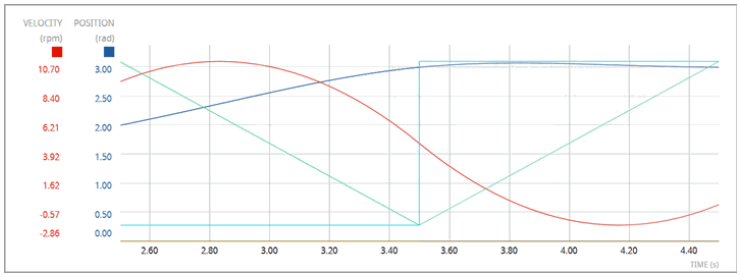
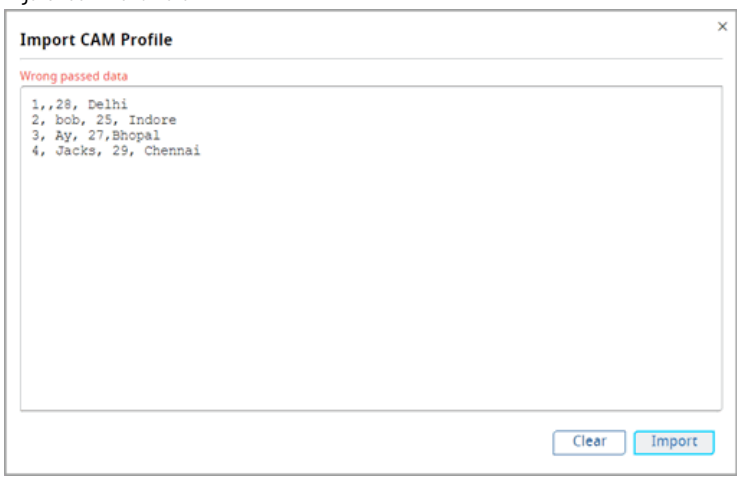


Figure 154. Import Graph



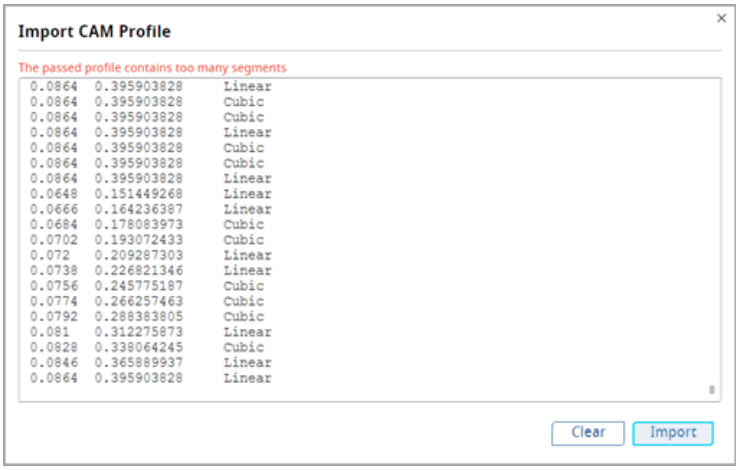
5. If the data being imported through the editor is invalid, a validation message is displayed.

Figure 155. Invalid Data



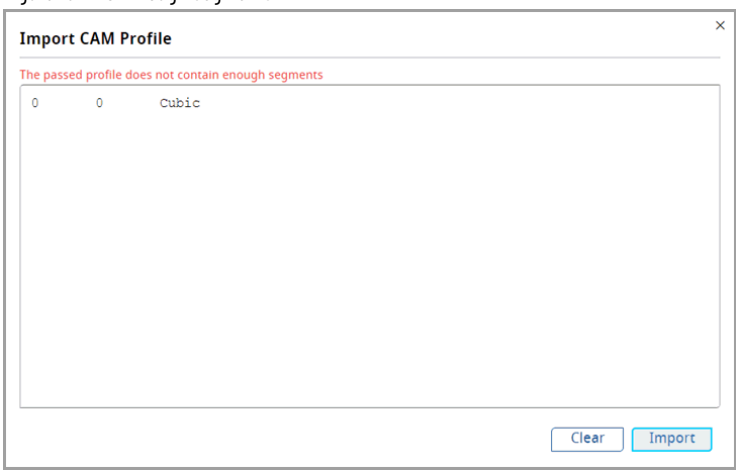
6. If the data being imported contains more than 300 segments, "*The pasted profile contains too any many segments*" message is displayed.

Figure 156. Too Many Segments



7. If the data being imported contains less than 2 segments, "*The pasted profile does not contain enough segments*" message is displayed.

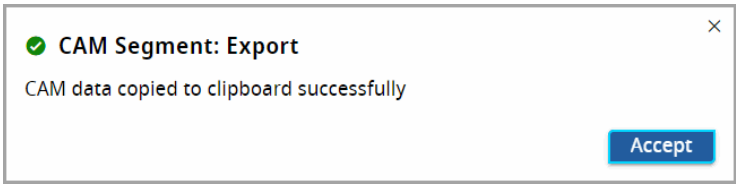
Figure 157. Not Enough Segments



To export the data to a clipboard:

1. Click [Export to Logix Explorer]. The Cam Segment Export dialog displays.

Figure 158. Export



2. Click [Accept]. The data will be copied to a clipboard. The exported data matches the data in the table.

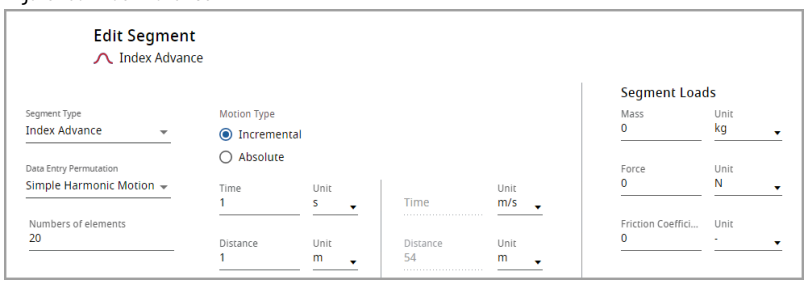
Index Advance

Provide the following parameters for Index Advance:

Table 40. Index Advance

Parameter	Description
Data Entry Permutation	Select the Data Entry Permutation. • Simple Harmonic Motion • 2-3 Polynomial • 3-4-5 Polynomial • 4-5-6-7 Polynomial • Modified Sine • Adjusted Sine • Modified Trapezoid
Number of Elements	Provide the desired number of elements.
Motion Type	Select whether to input Incremental or Absolute parameter values. • Incremental values represent the change either in the distance or time that occurs during the profile segment. • Absolute values represent the total distance or time elapsed throughout the entire motion profile.
Segment Loads	Provide the parameter for any one of the following: • Load Inertia • Applied Torque • Friction

Figure 159. Index Advance



Additional Loads: Edit Segment provides the User with the option to select additional loads, which include Inertia, Torque, and Friction. To select a load, click the ADD or INSERT buttons and click the desired load. Once the load segment is added, the User may edit the load parameters in the Additional Loads input pane and view the changes on the Segment Graph.

Inertia

Provide the following parameters for Inertia:

Table 41. Inertia

Parameter	Description
Permutation (Variable)	The following parameters can be defined for Variable Permutation: • Start Time: Define the start time and the desired unit of measurement. • End Time: Define the end time and the desired unit of measurement. • Start Inertia: Define the start inertia and the desired unit of measurement. • End Inertia: Define the end inertia and the desired unit of measurement.
Permutation (Constant)	The following parameters can be defined for Constant Permutation: • Full Load: Define the full load value and the desired unit of measurement.

Click Apply Changes when you are finished.

Figure 160. Inertia - Variable Permutation

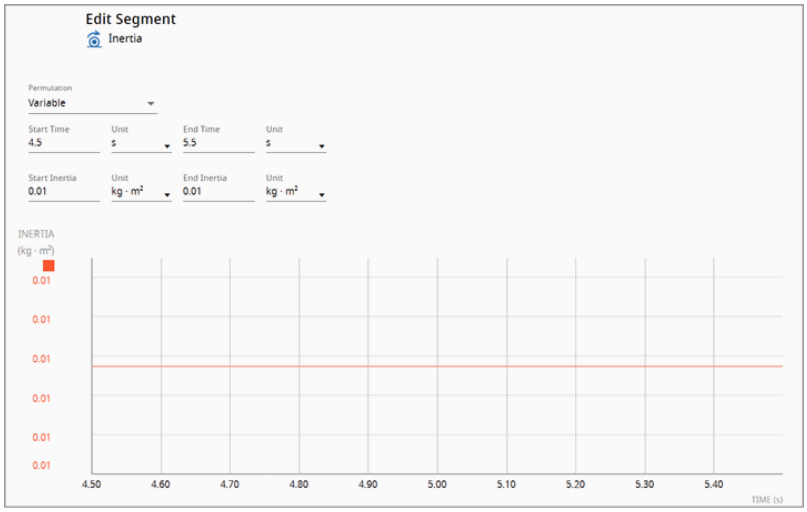
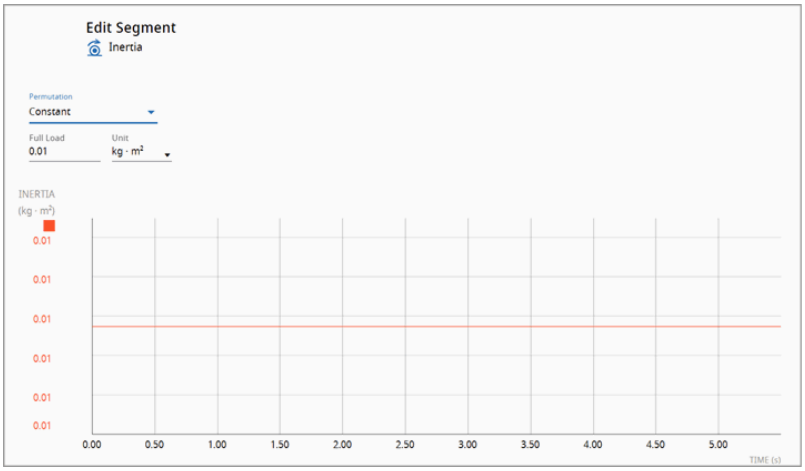


Figure 161. Inertia - Constant Permutation



Torque

Provide the following parameters for Torque:

Table 42. Torque

Parameter	Description
Permutation (Variable)	The following parameters can be defined for Variable Permutation: • Start Time: Define the start time and the desired unit of measurement. • End Time: Define the end time and the desired unit of measurement. • Start Torque: Define the start torque and the desired unit of measurement. • End Torque: Define the end torque and the desired unit of measurement.
Permutation (Constant)	The following parameters can be defined for Constant Permutation: • Full Load: Define the full load value and the desired unit of measurement.

Click Apply Changes when you are finished.

Figure 162. Figure: Torque - Variable Permutation

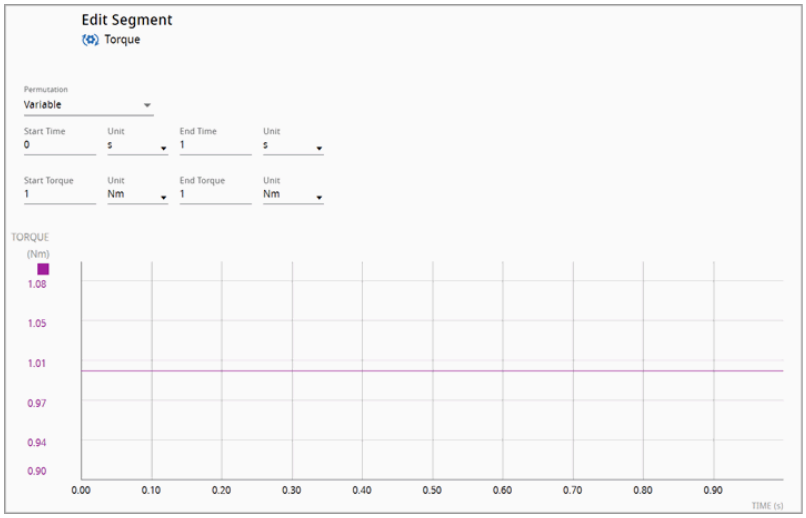
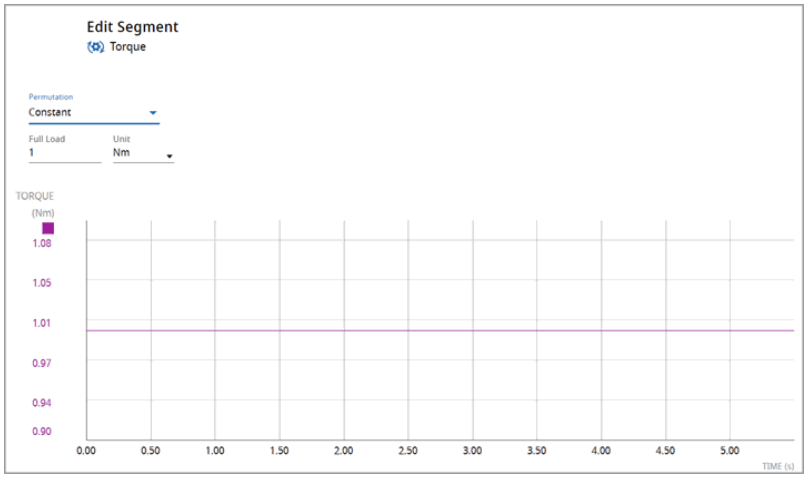


Figure 163. Torque - Constant Permutation



Friction

Provide the following parameters for Friction:

Table 43. Friction

Parameter	Description
Permutation (Variable)	The following parameters can be defined for Variable Permutation: • Start Time: Define the start time and the desired unit of measurement. • End Time: Define the end time and the desired unit of measurement. • Start Friction: Define the start friction and the desired unit of measurement. • End Friction: Define the end friction and the desired unit of measurement.

Table 43. Friction (continued)

Parameter	Description
Permutation (Constant)	The following parameters can be defined for Constant Permutation: • Full Load: Define the full load value and the desired unit of measurement.

Click [Apply Changes].

Figure 164. Friction - Variable Permutation

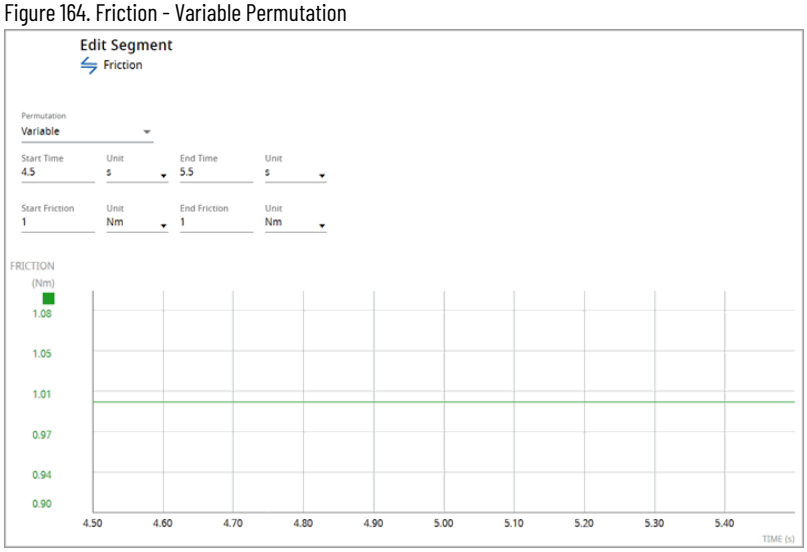
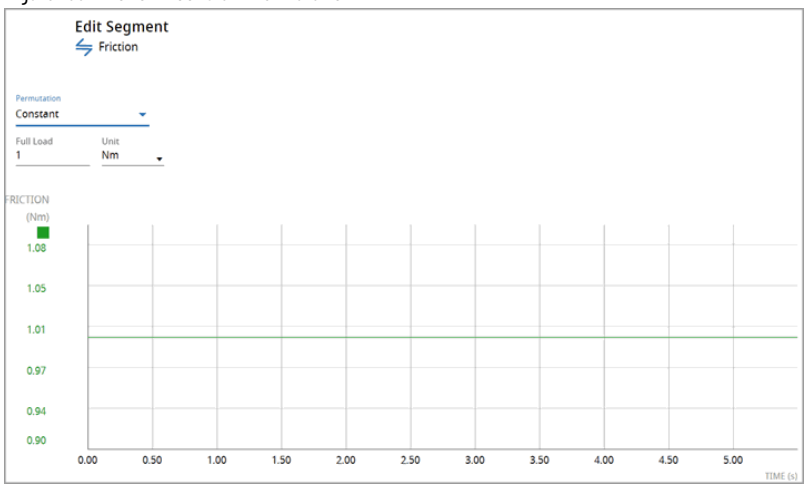


Figure 165. Friction - Constant Permutation



Troubleshooting

To refresh the content within the profile editor, utilize the View feature to toggle the display of a specific parameter's graph.

Import Motion Profile

This section describes the Excel format in which the imported Motion Profile shall be defined. It covers several mandatory points on how such a file should be implemented along with screenshot examples attached to the explanations.

The document is split into chapters describing separate Excel worksheets, responsible for defining the Motion Profile data, the motion itself, and loads.

Prerequisites

When importing a Motion Profile using the spreadsheet template, one must remember that a given profile can be imported only to the Axis with the same type, for example, Rotary profile can be imported only to the Rotary Axis. Profile imported to Axis with a different type will result in an error.

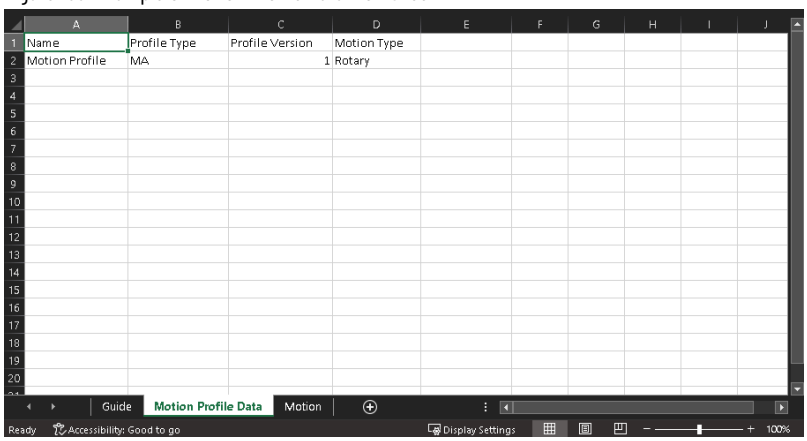
General Data

Under this term rely on such things as Name, Profile Type, Profile Version, and Motion Type.

This data must be defined in a separate worksheet named "**Motion Profile Data**".

Each of these values must be defined as a separate column, as shown in the example below.

Figure 166. Example of Motion Profile Data Worksheet

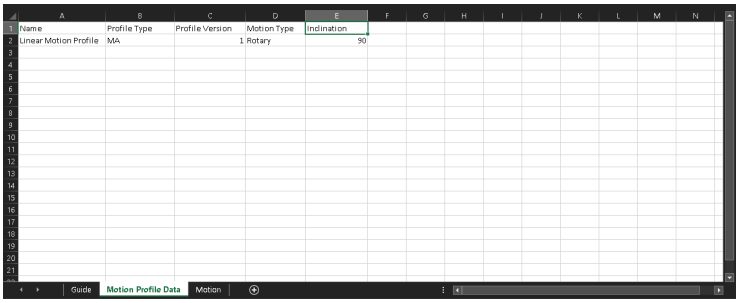


Columns Explanation

- Name should contain a single row with a value representing the name of the Motion Profile,
- Profile Type – should have a single row with MA value
- Profile Version - should have a single row with 1 value, which represents the Motion Profile format version
- Motion Type - describes the type of the Motion Profile; this accepts values such as Rotary or Linear

- Inclination - column should be added if the Motion Profile is Linear type; the value must be provided in degrees

Figure 167. Linear Motion Profile Data Worksheet Example



Columns Explanation

- Name should contain a single row with the value representing the name of the Motion Profile,
- Profile Type - should have a single row with MA value
- Profile Version - should have a single row with 1 value, which represents the Motion Profile format version
- Motion Type - describes the type of the Motion Profile; this accepts values such as Rotary or Linear
- Inclination - a column should be added if the Motion Profile is Linear type; the value must be provided in degrees

Loads

The Motion Profile can have loads defined. These should be defined as separate worksheets, named as following:

For Rotary Motion Profiles:

- **Inertia**: The name of the worksheet is **{Inertia}** in **[kg · m2]**
- **Torque**: The name of the worksheet is **{External Force or Torque}** in **[Nm]**
- **Friction**: The name of the worksheet is **{Friction}** in **[Nm]**

For Linear Motion Profiles:

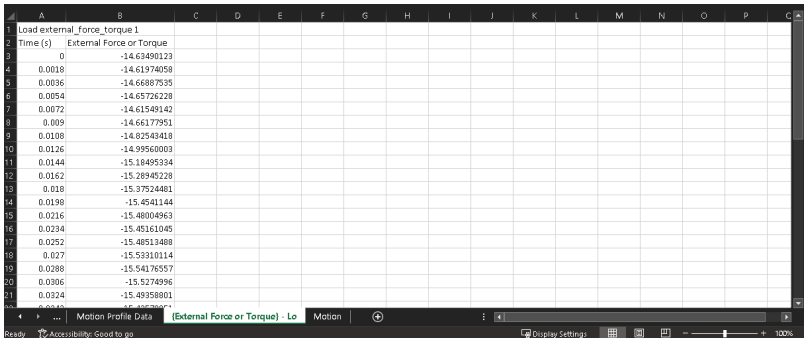
- **Weight (mass)**: The name of the worksheet is **{Weight}** in **[kg]**
- **Force**: The name of the worksheet is **{Force}** in **[N]**
- **Friction Coefficient**: The name of the worksheet is **{Friction Coefficient}**

Each of the worksheets representing the loads must be defined in the specific format.

The first cell within the worksheet represents the **Name** of the Load.

Next in the second row, there are Column Headers defined, where the first column represents the **Time (s)** and the second column the **Load name**. The headers for the second columns must be named correctly, according to the given load.

Figure 168. External Force or Torque Worksheet Example



	A	B
1	Load external_force_torque 1	
2	Time (s)	External Force or Torque
3	0	-14.63490123
4	0.0018	-14.61974058
5	0.0036	-14.66887535
6	0.0054	-14.65726228
7	0.0072	-14.61549142
8	0.009	-14.66177951
9	0.0108	-14.82543418
10	0.0126	-14.99560003
11	0.0144	-15.18495334
12	0.0162	-15.28945228
13	0.018	-15.37524481
14	0.0198	-15.4541144
15	0.0216	-15.48004963
16	0.0234	-15.45161045
17	0.0252	-15.48513488
18	0.027	-15.53310114
19	0.0288	-15.54176557
20	0.0306	-15.5274996
21	0.0324	-15.49358801

Keep in mind that for the given Motion Profile type, only selected Loads are available, otherwise the import will fail.

Motion

The Motion Profile depends on the Motion data itself. The Basic Motion Segments include **Accel/Decel, Index, and Cruise Dwell**.

The individual segments data is defined based on **Time, Position, Velocity, Acceleration, Jerk**, and **Smoothness**.

All these variables are defined in the worksheet named **Motion** within separate columns, named accordingly to the Profile Type. The difference in headers between Linear and Rotary Profile Types comes down to the hardcoded units.

The column headers for the **Linear Profile** are as follows:

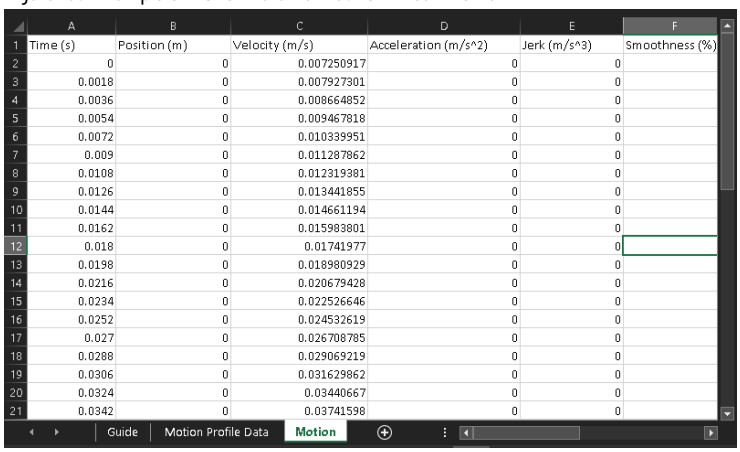
- **Time (s)** – the time
- **Position (m)** – position at the given time
- **Velocity (m/s)** – velocity at the given time
- **Acceleration (m/s^2)** – acceleration at the given time
- **Smoothness (%)** – jerk percentage value, accepts values from the range 0 to 1

For the **Rotary Profile**, the columns are as follows:

- **Time (s)** – the time
- **Position (rad)** – position at the given time
- **Velocity (rad/s)** – velocity at the given time
- **Acceleration (rad /s^2)** – acceleration at the given time

- **Smoothness (%)** – jerk percentage value, accepts values from the range 0 to 1

Figure 169. Example of Motion Data Defined for Linear Profile



	A	B	C	D	E	F
1	Time (s)	Position (m)	Velocity (m/s)	Acceleration (m/s^2)	Jerk (m/s^3)	Smoothness (%)
2	0	0	0.007250917	0	0	
3	0.0018	0	0.007927301	0	0	
4	0.0036	0	0.008664852	0	0	
5	0.0054	0	0.009467818	0	0	
6	0.0072	0	0.010339951	0	0	
7	0.009	0	0.011287862	0	0	
8	0.0108	0	0.012319381	0	0	
9	0.0126	0	0.013441855	0	0	
10	0.0144	0	0.014661194	0	0	
11	0.0162	0	0.015983801	0	0	
12	0.018	0	0.01741977	0	0	
13	0.0198	0	0.018980929	0	0	
14	0.0216	0	0.020679428	0	0	
15	0.0234	0	0.022526646	0	0	
16	0.0252	0	0.024532619	0	0	
17	0.027	0	0.026708785	0	0	
18	0.0288	0	0.029069219	0	0	
19	0.0306	0	0.031629862	0	0	
20	0.0324	0	0.03440667	0	0	
21	0.0342	0	0.03741598	0	0	

Guide | Motion Profile Data | Motion

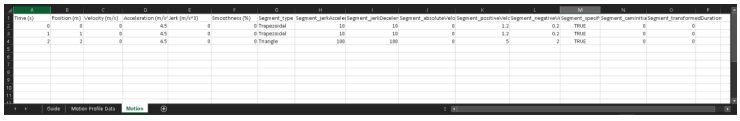
Index segments

The **Index** segments are defined in a unique way compared to others, meaning additional columns and data must be included so that the segments are correctly recreated.

The additional data is included in the following columns:

- **Segment_type** - the type of Index segment, accepts values **Trapezoidal** or **Triangle**
- **Segment_jerkAccelerationPercent** - this impacts the smoothness of acceleration in percentage (accepts values **0 – 100**)
- **Segment_jerkDecelerationPercent** - this impacts the smoothness of deceleration in percentage (accepts values **0 – 100**)
- **Segment_positiveVelocityLimit** - positive velocity limit (maximum) in **[m/s]** or **[rad/s]**
- **Segment_negativeVelocityLimit** - negative velocity limit (minimum) in **[m/s]** or **[rad/s]**
- **Segment_specifyVelocityLimit** - accepts values **TRUE** or **FALSE**, **IT MUST BE SET!**

Figure 170. Sample Index Segments With All Necessary Data



Requirements

When defining segments, the following conditions must be met:

1. Time must be positive.
2. The Positive velocity limit for Index segments must be larger than the segment velocity.

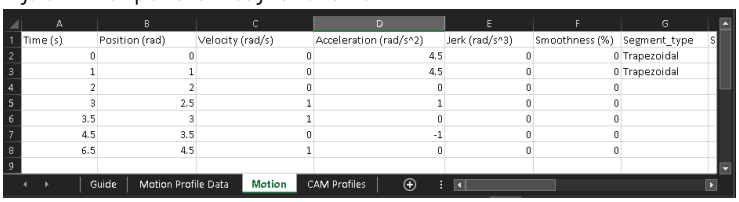
CAM Segments

CAM Segments belong to Advanced Segments and require additional configuration. Because of that, they are defined in the separate worksheet called **CAM Profiles**.

The CAM table values are defined in the following columns:

- **Key** – this refers to the row number of the Segment defined in the Motion worksheet, which will be replaced by the **CAM** segment itself
- **MasterMU** - time when the subsegment ends in **[s]**
- **SlaveSU** – the final position achieved when the subsegment ends in **[rad]**
- **SlopeSUMU** – the ending slope provided in **[rad/s]**
- **Type** – the type of CAM segment, accepts values **Cubic** and **Linear**

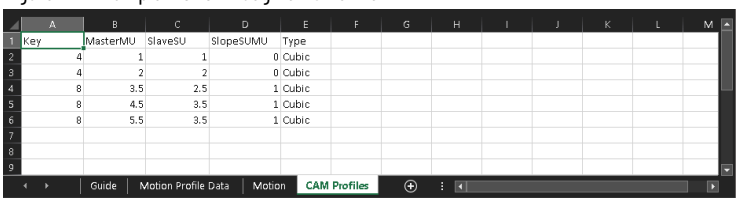
Figure 171. Example 1 of CAM Segments Define



	A	B	C	D	E	F	G
1	Time (s)	Position (rad)	Velocity (rad/s)	Acceleration (rad/s^2)	Jerk (rad/s^3)	Smoothness (%)	Segment_type
2	0	0	0	4.5	0	0	Trapezoidal
3	1	1	0	4.5	0	0	Trapezoidal
4	2	2	0	0	0	0	
5	3	2.5	1	1	0	0	
6	3.5	3	1	0	0	0	
7	4.5	3.5	0	-1	0	0	
8	6.5	4.5	1	0	0	0	
9							

Guide | Motion Profile Data | Motion | CAM Profiles

Figure 172. Example 2 of CAM Segments Define



	A	B	C	D	E
1	Key	MasterMU	SlaveSU	SlopeSUMU	Type
2	4	1	1	0	Cubic
3	4	2	2	0	Cubic
4	8	3.5	2.5	1	Cubic
5	8	4.5	3.5	1	Cubic
6	8	5.5	3.5	1	Cubic
7					
8					
9					

Guide | Motion Profile Data | Motion | CAM Profiles

The CAM segments do not act as a standalone segment but rather replace the provided one in **Motion**, based on **Key** property.

In the above example, you can see two **CAM** segments defined, one defined in between different segments and the other one at the end of the Profile.

As you can see in **Motion**, the **Cruise Dwell** segment that starts at 2s is in the end being replaced by the **CAM** segment from the **CAM Profiles** worksheet.

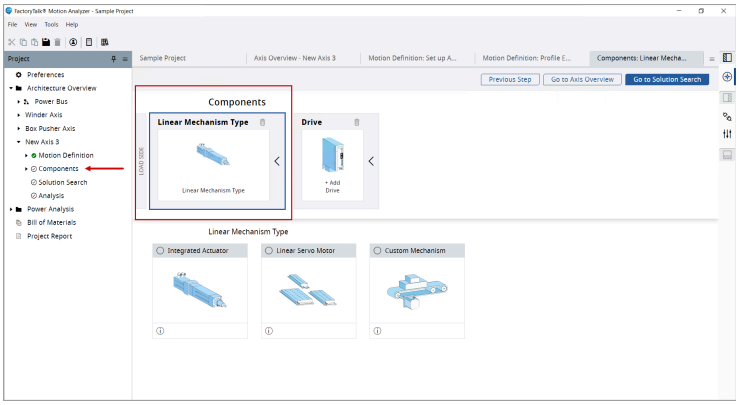
Components

The Components section allows the user to select different types of Mechanisms, transmissions, drives, and motors for an axis.

Mechanism

1. On the profile editor page, select a Linear axis type and click [Next].
2. Under components, the Linear Mechanism Component displays.

Figure 173. Linear Mechanism Types



3. Choose the following Linear Mechanism types:
   - Integrated Actuators
   - Linear servo Motors
   - Custom Mechanisms

Change Motion Type

If the user defines a motion in the Rotary motion type and configures the motor, transmission, and drive and wants to change the motion type to linear:

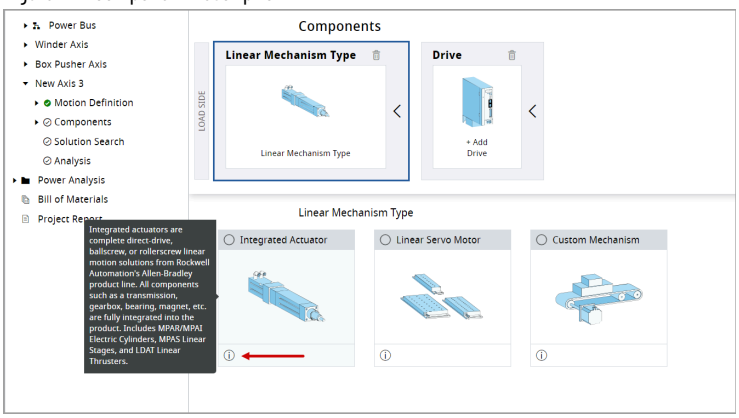
1. Go to the Set-up Axis page, click [Linear] under motion type, and click [Next].
2. The Confirm changes dialog displays.
3. Click [Confirm] to change the motion type.

NOTE: Ensure that the defined motor, transmission, and drive may get affected, if the motion type is changed in the defined profile and the warning signs are displayed across the defined motion tree in the left panel.

---

4. To view the component's description, click the [ⓘ] icon. The Component's description is displayed.

Figure 174. Component Description



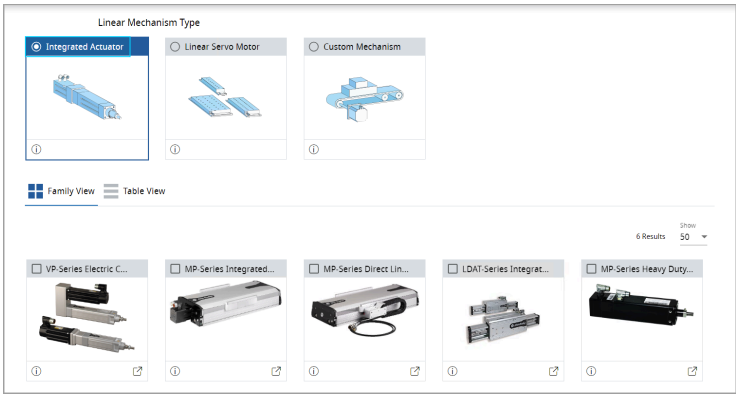
Integrated Actuators

Integrated actuators are complete direct-drive, ballscrew, or rollerscrew linear motion solutions from Rockwell Automation's Allen-Bradley product line. All components such as a transmission, gearbox, bearing, magnet, etc. are fully integrated into the product. Includes MPAR/MPAI Electric Cylinders, MPAS Linear Stages, and LDAT Linear Thrusters.

Perform the following steps to add a component from the Integrated Actuator:

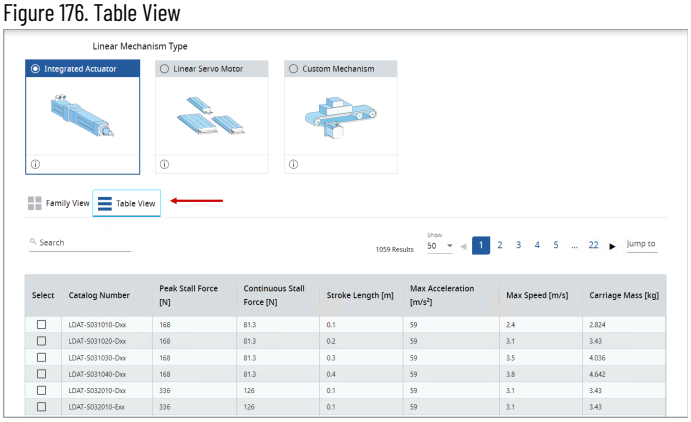
1. Under the Linear Mechanism, select the Integrated Actuator and the list of available Actuators display.

Figure 175. Integrated Actuator



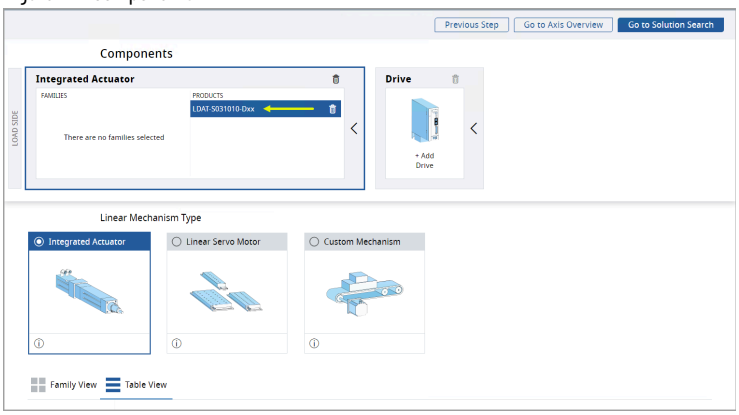
2. User can select the Actuator from Family View or Table View:
   - The Family View tab displays a list of Actuator families that can be selected.
   - The Table View tab displays a list of available Actuator. User can scroll down or use the Search option for a desired Actuator.

Figure 176. Table View



3. Select the required component and the respective Actuator displays under the Components section as shown in the following image:

Figure 177. Components



4. Click [Next Step].

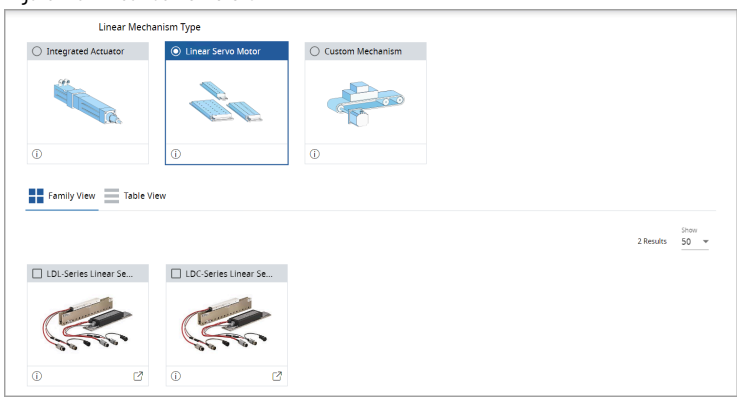
Linear servo Motors

High-speed linear servo motors are direct-drive coil and magnet packages that allow the user to fully customize their own linear solution. LDC iron core servo motors have high force density while LDL ironless servo motors provide smooth, zero-cog motion.

Perform the following steps to add a Linear Servo Motor:

1. Under the Linear Mechanism, select the Linear Servo Motor and the list of available motors display.

Figure 178. Linear Servo Motors



2. User can select the Motors from Family View or Table View:
   - The Family View tab displays a list of Linear Servo Motor families which can be selected.
   - The Table View tab displays a list of available Linear Servo Motors. User can scroll down or use the Search option for a desired Linear Servo Motor.
3. Select the required motor and the respective motor displays under the Components section as shown in the following image:

Figure 179. Components - Family

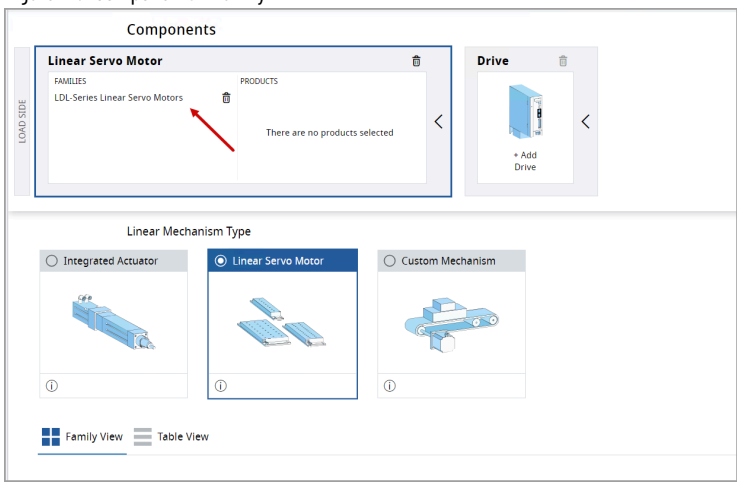
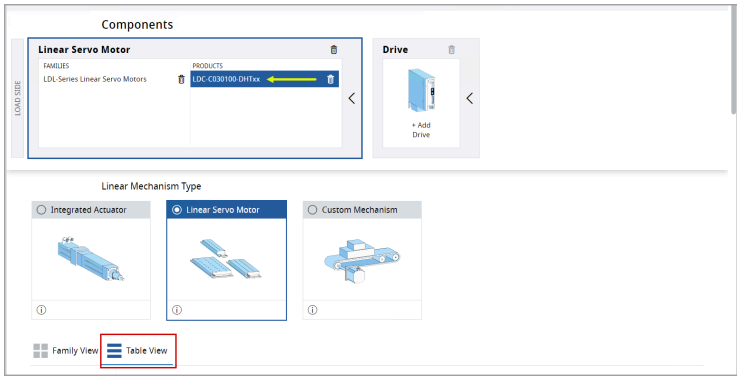


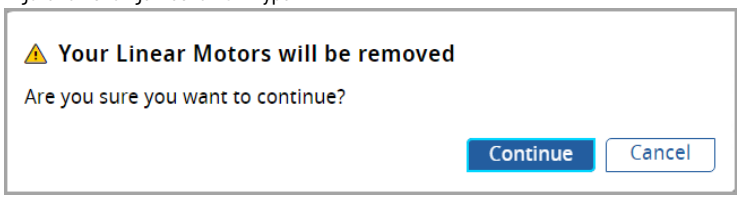
Figure 180. Components - Table



4. Click [Next Step].

NOTE: If user switches between the Linear Mechanism types, a warning dialog displays. To proceed, click [Continue] and add the desired component.

Figure 181. Change Mechanism Type

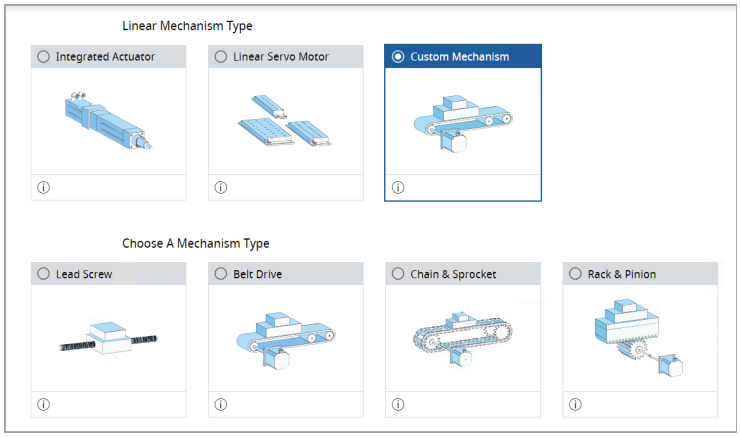


Custom Mechanisms

Select the Custom Mechanism and the following Linear Mechanism types display:

- Lead Screw
- Belt Drive
- Chain & Sprocket
- Rack & Pinion

Figure 182. Custom Mechanism



Lead Screw

A lead screw is coupled to a rotary motor and causes relative linear motion between a rotating screw and its non-rotating nut.

1. Select [Lead Screw] and provide the following parameters:

Table 44. Lead Screw

Field	Description
Name	Name for the Lead Screw type.
Lead	The distance that the slide moves per one full rotation of the screw shaft.

Inertia	The inertia of the lead screw if the lead screw rotates, and the nut is stationary. Provide the inertia of the nut when the Lead screw is stationary, and the nut rotates. Or If the user has the measurements and other details of the Lead screw, click the [ ] icon to calculate the inertia of the Lead screw. Refer to Inertia Calculator on page 16 section.
Pre-Load	The friction torque is produced by pre-loading the two nuts of a ball screw against each other. This is done to reduce backlash and increase stiffness in the system. Seal friction should be included in this value. This value can be obtained from the manufacturer's data and is normally quoted in datasheets.
Efficiency	The efficiency of the lead screw. The efficiency value depends on the unit of measure, which can be % or none. If there is no unit selected, it is written as a decimal (between 0 and 1). If the % is selected, this value is multiplied by 100
Slide Mass	The mass of the slide travels along the lead screw. This mass is affected by gravity if the inclination in the Load Type Tab is non-zero.

Rack & Pinion

A Rack and Pinion is a rotary motor coupled to a toothed pinion wheel that engages a toothed rack to create relative motion between the two elements.

1. Select [Chain & Sprocket] and provide the following parameters:

Table 45. Rack & Pinion

Field	Description
Name	Provide a name for the Lead Screw type.
Pinion PCD	Pinion Pitch Circle Diameter. The pitch circle diameter value can be obtained from standard catalog data. The value can also be calculated by multiplying the tooth pitch by the number of teeth on the sprocket and dividing by pi.
Pinion Inertia	The inertia of the Pinion. Or If the user has the measurements and other details of the pinion, click the [ ] icon to calculate the inertia of the pinion. Refer to Inertia Calculator on page 16 section.
Friction Torque	The torque loss due to friction at the pinion shaft. This value can be obtained from the supplier or Engineering tables.
Table Mass	The mass of the linear load table.

Belt Drive

A Belt drive is a rotary motor coupled to a sprocket wheel that drives a belt, with its coupled load, back and forth between the idler sprocket guides.

1. Select [Belt Drive] and provide the following parameters:

Table 46. Belt Drive

Field	Description
Name	Provide a name for the Belt Drive type.
Table Mass	The mass of the linear load table.
Belt Mass	The mass of the Belt. This mass is not affected by gravity.
Diameter	The diameter of the Driver and the Idler(s)
Inertia	The inertia of the Driver and the Idler(s). Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator on page 16 section.
Friction Torque	The torque loss due to friction at the driver or idler shaft. This value can be obtained from the supplier or Engineering tables.
Number of Rollers	The number of rollers for each Idler group. Provide the number in Integers.

Chain & Sprocket

A Chain and Sprocket is a rotary motor coupled to a sprocket wheel that drives a linked chain, with its coupled load, back and forth between idler sprocket guides.

1. Select [Chain & Sprocket] and provide the following parameters:

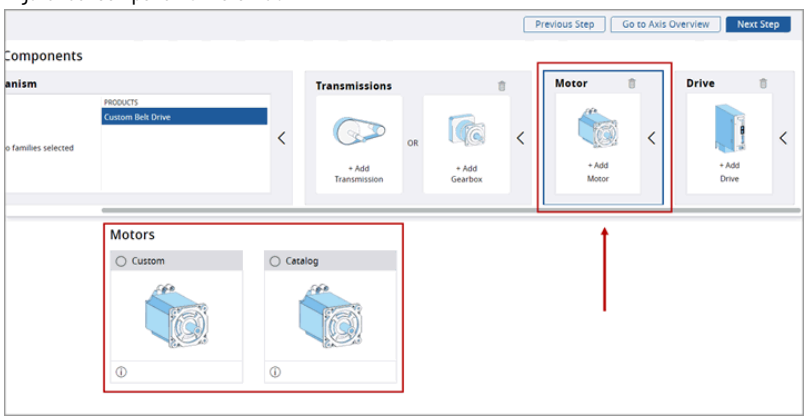
Table 47. Chain & Sprocket

Field	Description
Name	Provide a name for the Chain & Sprocket type.
Table Mass	The mass of the linear load table.
Chain Mass	The mass of the Chain. This mass is not affected by gravity.
Diameter	The diameter of the Driver and the Idler(s)
Inertia	The inertia of the Driver and the Idler(s). Or the user can calculate the inertia using the [ ] icon. Refer to Inertia Calculator on page 16 section.
Friction Torque	The torque loss due to friction at the driver or idler shaft. This value can be obtained from the supplier or Engineering tables.
Number of Sprockets	The numbers of sprockets for each Idler group. Provide the number in Integers.

Choose Your Motor

User can either select the motors from the catalog or user can define the custom motor parameters.

Figure 183. Components: Motor tab



Custom Motor

1. Select the Custom Motor and provide the following details:

Table 48. Inertia Table

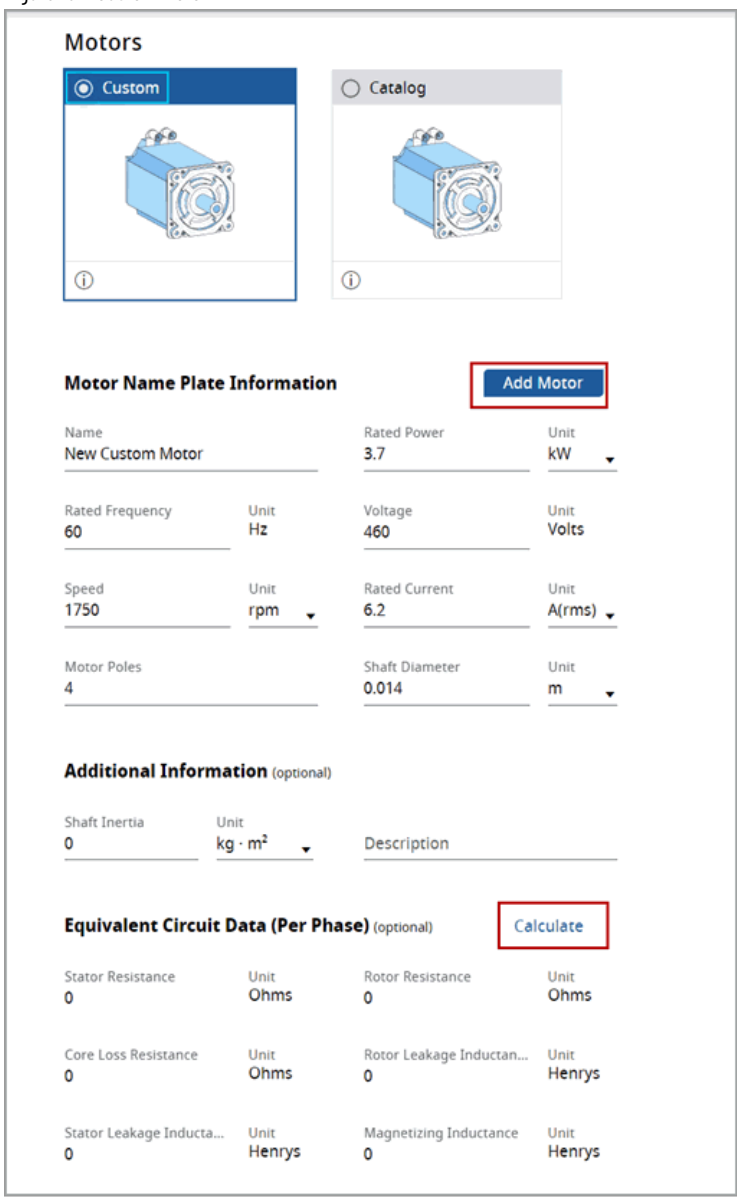
Field	Description
Motor Name Plate Information	
Name	Name of the custom motor
Rated Power	The motor power output under full load conditions of rated current, speed, and voltage
Rated Frequency	The motor rated frequency at synchronous speed.
Voltage	The phase-to-phase voltage applied to the motor required to reach rated speed at full load
Speed	The Motor rotary rated speed, rated speed (rpm), or Linear Motor-Rated Speed (m/s)
Rated Current	The current applied to the motor under full-load conditions at rated speed and voltage
Motor Poles	Number of Motor poles
Shaft Diameter	The diameter of the shaft
Additional Information (Optional)	
Shaft Inertia	The Inertia of the shaft
Description	To add any additional information on the shaft.
Equivalent Circuit Data (per Phase)	
Stator Resistance	The winding resistance of the stator in the motor
Rotor Resistance	The winding resistance of the rotor in the motor
Core Loss Resistance	The resistance of the energy loss
Rotor Leakage Inductance	The leakage inductance of the rotor winding in the motor

Stator Leakage Inductance	The leakage reactance of the stator winding in the motor
Magnetizing Inductance	The self-inductance of an induction motor with a magnetic core

2. Click [Calculate] to manually calculate the equivalent circuit data.

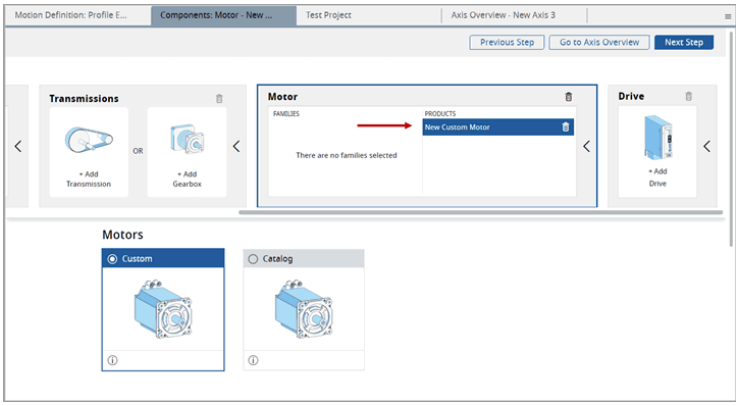
NOTE: Ensure to provide valid parameters to calculate.

Figure 184. Custom Motor



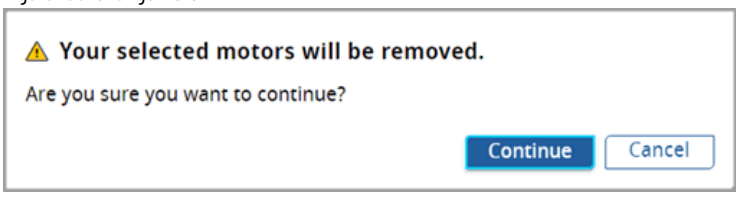
3. Click [Add Motor] and the custom motor is added to the profile.

Figure 185. New Custom Motor



4. User can update the custom motor and click [Update Motor] to update the changes.
5. If the user changes from catalog to custom or from Custom motor to a Catalog motor, the following warning dialog displays.

Figure 186. Change Motor



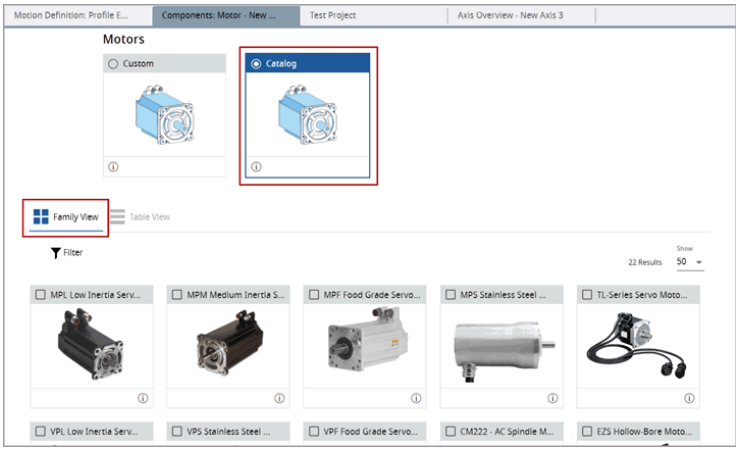
6. If user chose to continue, the custom motor will be deleted, and user can select the Catalog Motors.

Catalog Motors

Perform the following steps to add a motor from the from the list of available catalog:

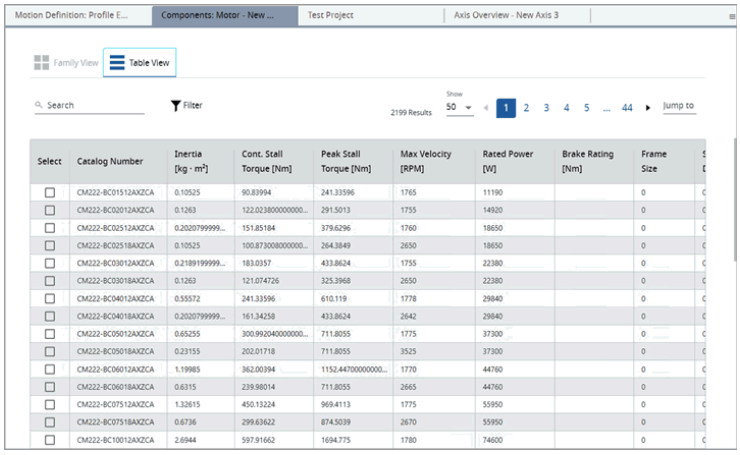
1. Select the motor from Family View or Table View:
   - The Family View tab in the Motors section displays a list of available Motor families which can be selected.
   - Click [Table View] to open the Table View tab.

Figure 187. Catalog Motors



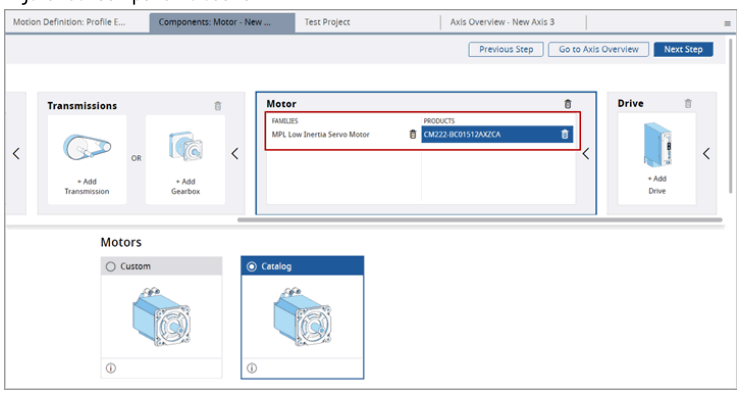
2. The Table View tab in the Motors section displays a list of available Motor products. When user selects a motor, Motion Analyzer validates the power requirements of axis.

Figure 188. Table View in Motor section



3. Use the Search option to find a specific Motor product or to filter Motor products with partial text. Click [Family View] to open Family View back.
4. All selected Motor families and products will be displayed in the Motor tile in the Components section.

Figure 189. Components section



5. When the user tries to calculate Solution Search without selecting Drive family or product, warning icons will be displayed on the page as well a proper message will show up.

Figure 190. Missing Drive

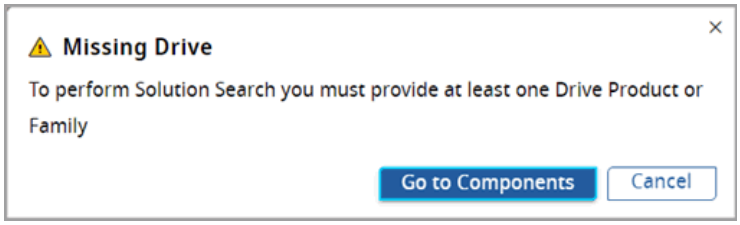
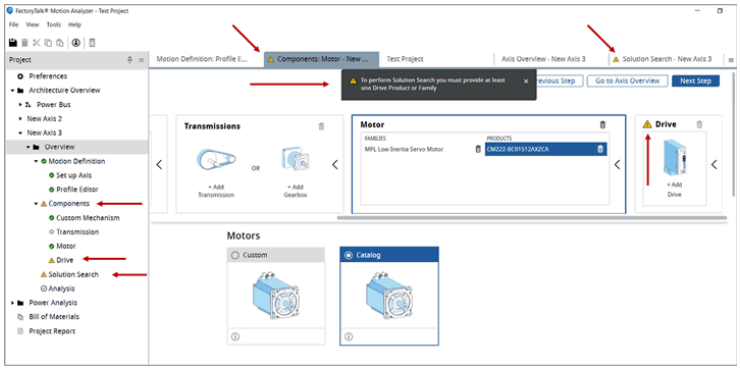


Figure 191. Warning



DSM Motor

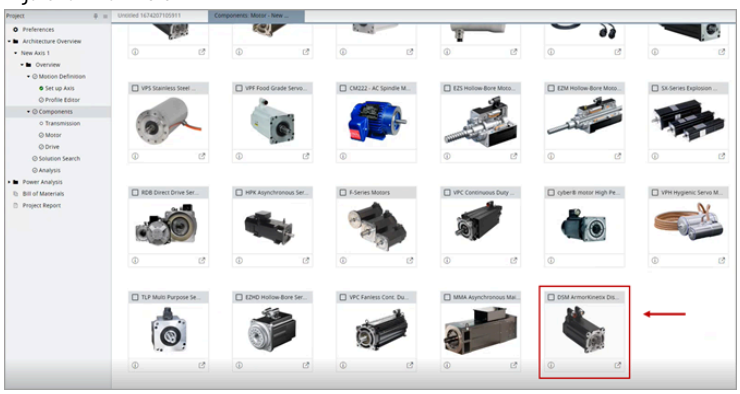
ArmorKinetix® Distributed Servo Motors (DSM) integrate the proven technologies of Kinetix® 5700 Servo Drives and VP Low Inertia Servo Motors into an On Machine™ decentralized motion solution supporting Integrated Motion on EtherNet/IP. This Kinetix® 5700/VPL combo is designed to be mounted out on the application rather than in an electrical enclosure. This decentralized approach simplifies design architectures by minimizing cabling requirements, reducing electrical enclosure requirements, decreasing enclosure climate control requirements, and enabling a modular/expandable solution. The simplified approach helps reduce overall installation and commissioning time while simplifying the architecture and potentially reducing overall machine size.

Add DSM Motor

Perform the following steps to add DSM Motors:

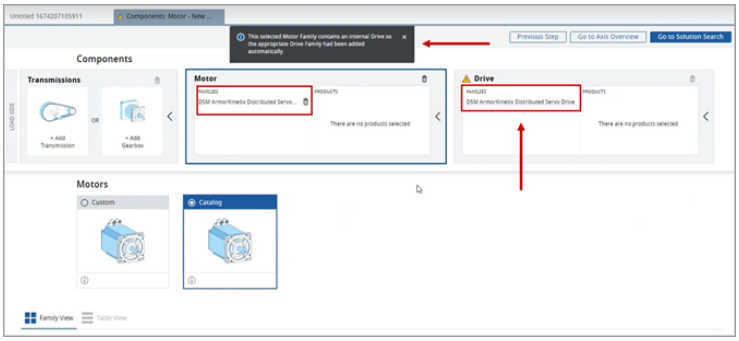
1. Under the Family view, select the DSM Motor family.

Figure 192. DSM Motor



2. The DSM motors is added to the axis workflow. By default, the DSM motors contain a drive inside and the drive is automatically added as shown in the following image:

Figure 193. Internal Drive



3. User can select the specific DSM Motors under the Product view. The respective drive is automatically added and the user cannot delete the drive, hence the delete icon is disabled.
   If multiple DSM motors are added, then the respective drive(s) are automatically added as shown in the following images:

Figure 194. Drive Delete Icon

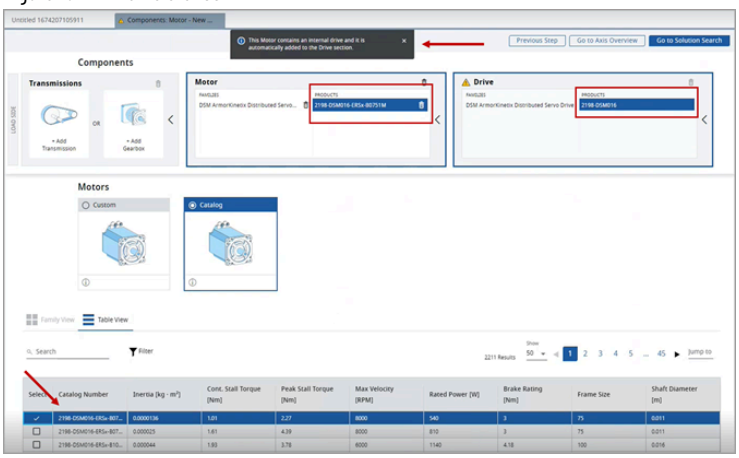
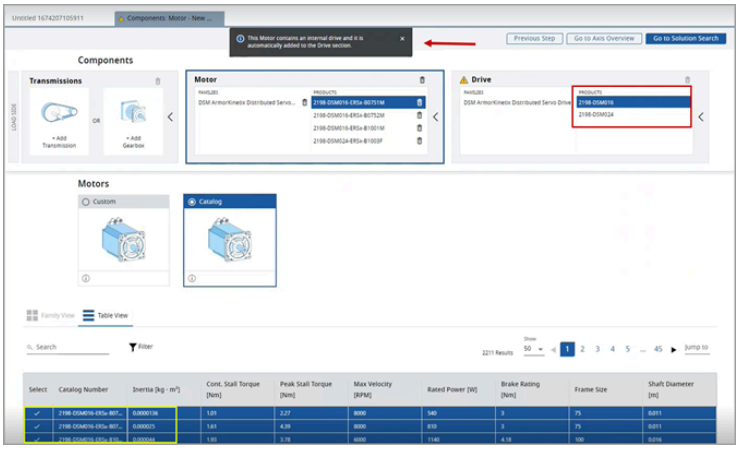
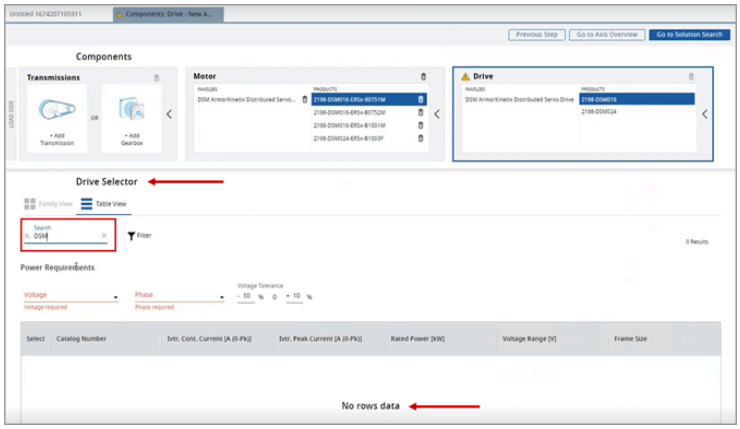


Figure 195. Multiple Motors



Hence a user cannot add any other DSM drives to these DSM motors manually. If required, user can add drives other than the DSM.

Figure 196. Drive Selector

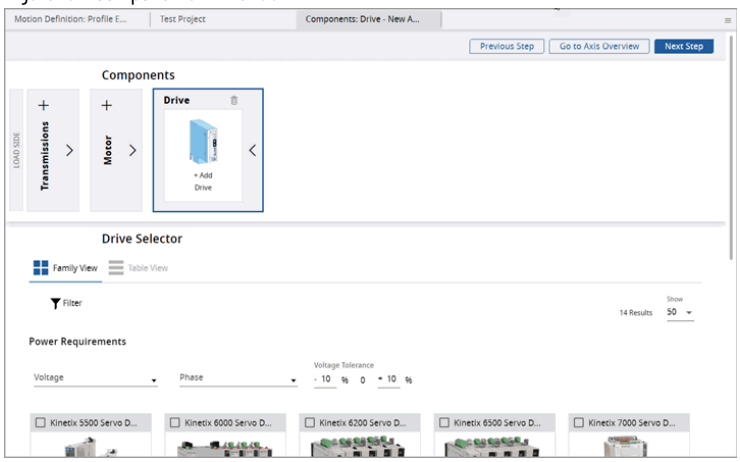


Choose Your Drive

Perform the following steps to select a Drive:

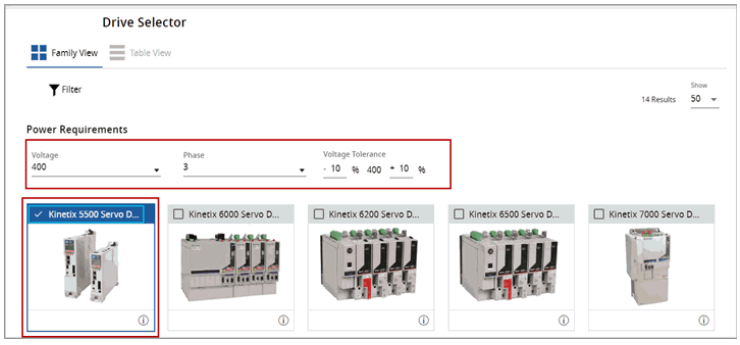
1. Under the Components, click the Drive tab. This list of available drives are displayed.

Figure 197. Components: Drive tab



2. The Family View tab in the Drive Selector section displays the list of available Drive families which can be selected.

Figure 198. Family View in Drive section



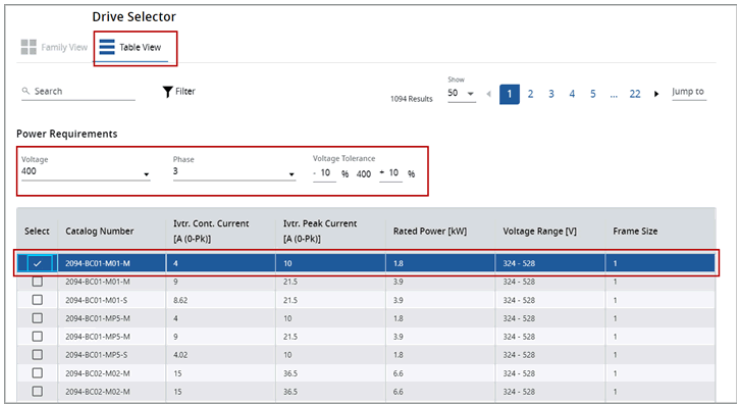
3. Enter the following parameters to further narrow the drive family options and help the user to decide which drive is best for the application.

Table 49. Additional parameters for Drives

Parameter	Description	
Power Requirements	Voltage	Select Voltage from the drop-down menu
	Phase	Select Phase from the drop-down menu, available phases depend on the chosen voltage
	Voltage Tolerance	Insert the high and low tolerance for the voltage using input fields

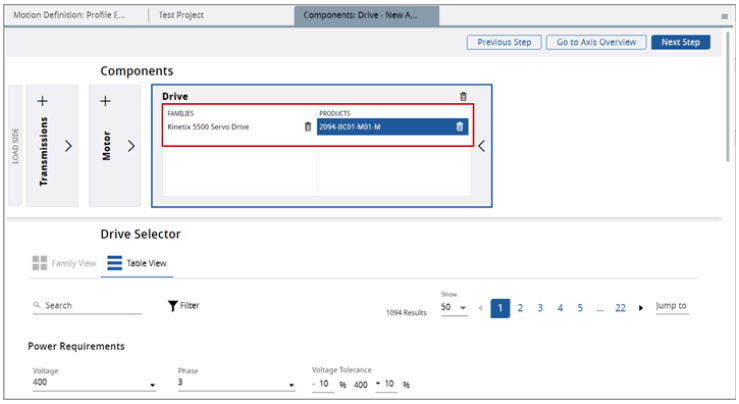
4. Click [Table View] to open the Table View tab. The Table View tab in the Drive Selector section displays a list of available Drive products which can be selected.

Figure 199. Table View in Drive Selector section



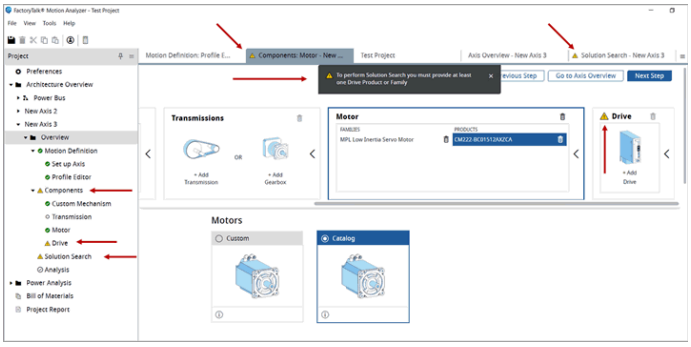
5. Use the Search option to find specific Drive products or to filter Drive products with partial text. Click [Family View] to open Family View back.
6. All selected Drive families and products will be displayed in the Drive tile in the Components section.

Figure 200. Components section



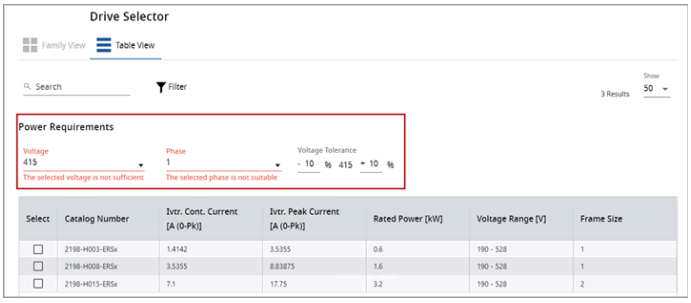
- When the user tries to calculate Solution Search without selecting Drive family or product, warning icons will be displayed on the page as well a proper message will show up.

Figure 201. Warning icons for Drive



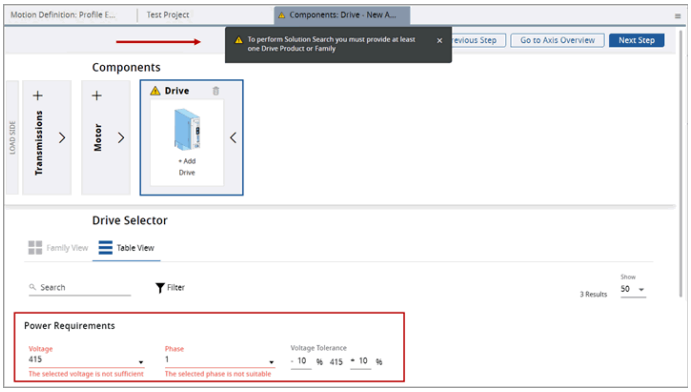
- If the power requirements of the bus are not valid, a warning icon displays on the respective component(s) as shown in the following image:

Figure 202. Warning Icons - Components



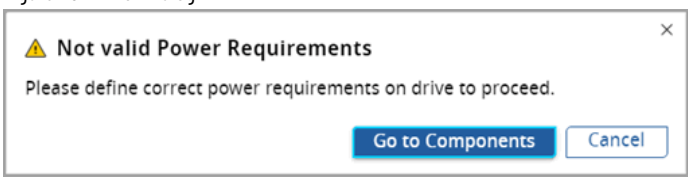
- If the power requirements are not valid, an error message displays as shown in the following image:

Figure 203. Error Message – Power Requirements



- If the user tries to move to next step (Solution search), an error dialog displays to define the correct power requirements.

Figure 204. Error Dialog



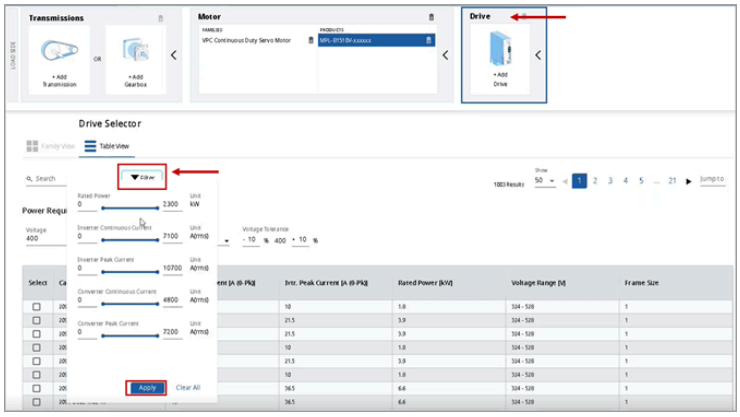
NOTE: Ensure to provide valid power requirements to proceed further.

Pre-filter Drives

By default, during a workflow, if a motor(s) is selected either from the families or from the products, then the Motion Analyzer application automatically filters and displays the drives that are compatible with that motor(s).

1. Under the drive selector, user can use the [Filter] option to filter the drives as shown in the following image:

Figure 205. Drive Selection

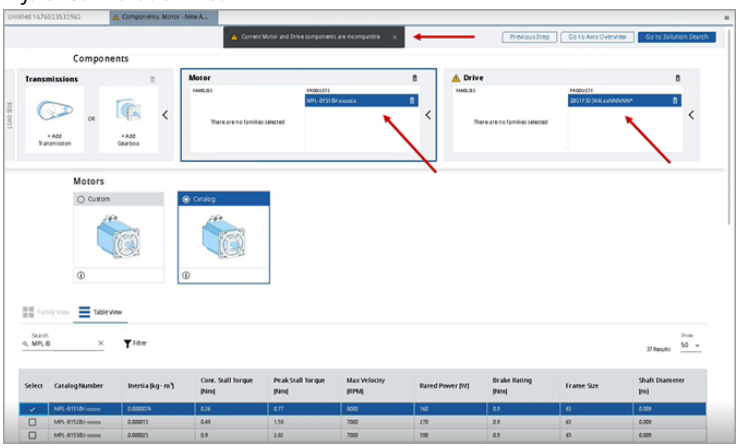


2. Based on the requirements, user can give the minimum and the maximum power values, and the application displays the compatible drives.

NOTE: In a workflow, if a user tries to select a drive first, even then the application displays all the available motors. In this case, if the user selects a motor that is not compatible with

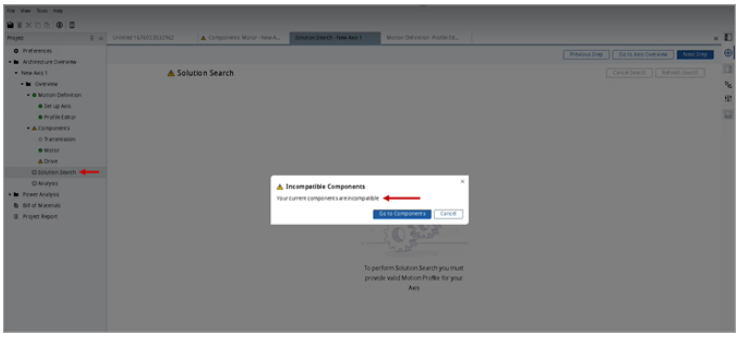
the selected drive, then the “Current Motor and Drive components are incompatible” error message is displayed:

Figure 206. Available Drives



3. It also displays warning icons on the project tree. If the user proceeds to Solution Search, a warning dialog displays to return back to the Component section to fix the component configuration as shown in the following image:

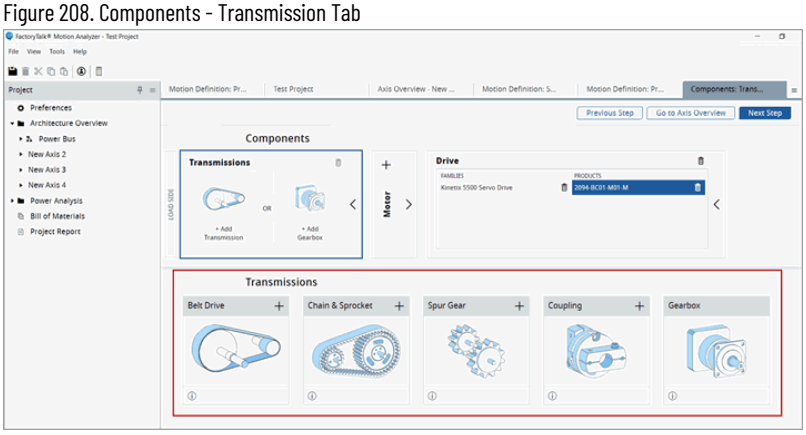
Figure 207. Incompatible Components



Transmission

A transmission helps to provide a speed-torque conversion, such as a gear reduction or speed reduction, from a higher speed to a slower, more forceful output.

Figure 208. Components - Transmission Tab



The user may add up to four transmission components. Perform the following steps to a transmission:

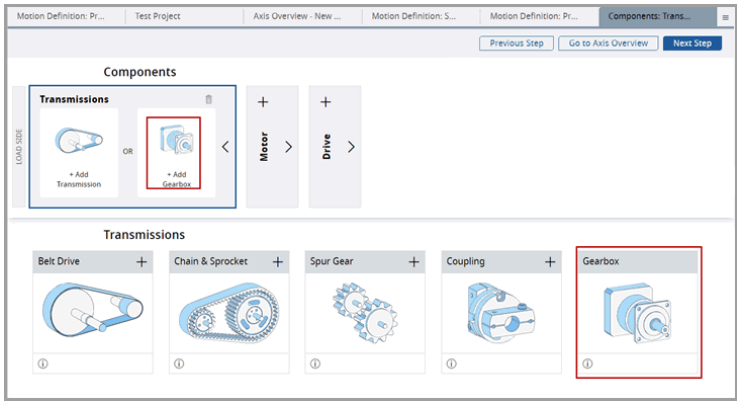
1. Under the Components, click Transmissions.
2. The list of Transmission types is displayed. click the [+] icon for the appropriate component.

Table 50. Transmission Types

Transmission type	Description
Belt Drive	A belt drive consists of a loop of flexible material that is used to mechanically link two or more rotating shafts with pulleys.
Chain & Sprocket	A sprocket is a profiled wheel with teeth that mesh with a chain.
Spur Gear	A spur gear consists of a rod or disk with the teeth extruding radially. These gears can mesh together correctly only if they are fitted to parallel shafts.
Coupling	A coupling is a device used to connect two shafts together at their ends to transmit power. The inertia, stiffness, and backlash of couplings can be found in Manufacturers Data Sheets.
Gearbox	A gearbox is a device which uses gears to change the speed or direction of rotation in a machine. Some transmissions have multiple gear ratios and some may also have single fixed gear ratio.

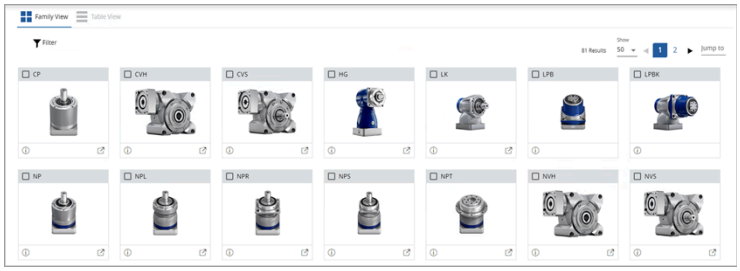
3. The user may also add gearbox families or products. Click [Add Gearbox] or Gearbox tile to open the Family View tab.

Figure 209. Family View tab for Gearboxes



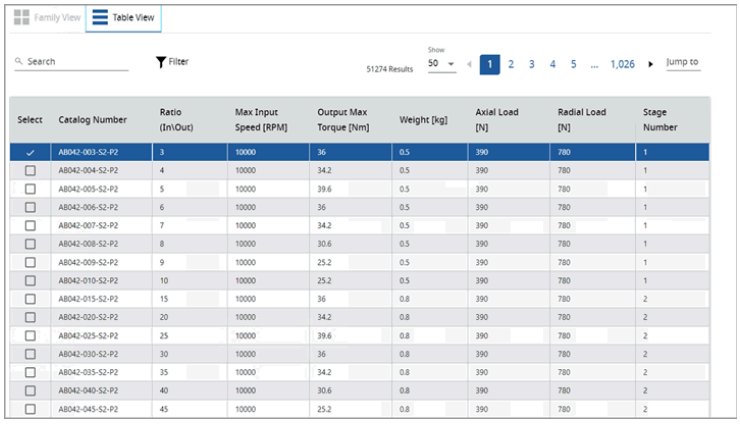
The Family View tab displays a list of available Gearbox families which can be selected.

Figure 210. Family View for Gearboxes



4. Click [Table View] to open the Table View tab which displays a list of available Drive products which can be selected.

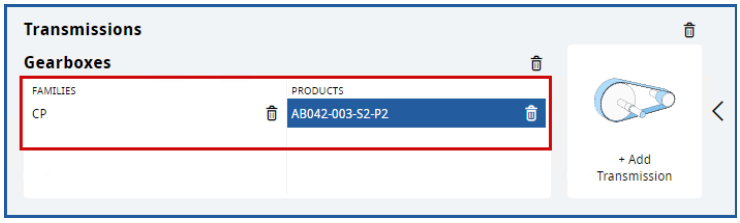
Figure 211. Table View for Gearboxes



5. Use the Search option to find specific Gearbox products or to filter Gearbox products with partial text. Click [Family View] to open Family View back.

   All added Transmissions and Gearbox families and products will be displayed in the Transmission tile in the Components section.

Figure 212. Components Section



6. The user can modify the parameters of every added transmission on its respective tile.

Table 51. Transmission Parameters

Parameter	Description
Ratio	Transmission component ratio. If a straight-through coupling is being modeled, set Ratio = 1
Inertia	Inertia on the motor side (the rotor inertia and if a gearbox is present, the inertia of the pinion attached to the rotor).
Efficiency	Efficiency is widely misused. It refers to the ratio of output power to input power for a single operating condition, but a servo system typically operates over a wide range of operating conditions. A gearbox supplier normally specifies the efficiency at an optimum point such as full load and full speed. For example, a gearbox that has an output rating of 100 Nm (885 lb. in.) and an efficiency of 98%. This means that the losses at full load are 2 Nm (18 lb. in). But because most of the losses in a gearbox are due to shaft seal friction and churning of the lubricant, this would not reduce significantly at a lower load torque. In using this gearbox, a well-matched servo motor only has a continuous rating of around one-third of the peak torque, and it is quite likely that the average torque over the motion cycle would be even lower, for example about 20 Nm (177 lb in) at the gearbox output. The losses of 2 Nm (18 lb in) amount to 10% of the load on the motor, which can have a significant effect on the temperature rise of the motor. Motion Analyzer software overcomes this problem by dynamically computing the real losses throughout the motion cycle, and thereby avoids underestimating the effect of losses on the motor.
Friction	This is the torque caused by friction on the motor side between the rotor and the transmission component. This

	value can be obtained from the supplier or Engineering tables.

7. Use the Inertia Calculator to calculate the Inertia for a transmission. Each Transmission has its own Inertia Calculator, and it can store the definitions for each transmission.
   Click the [ ] icon and define the parameters. Refer to Inertia Calculator on page 16 section.

Solution

To organize the solutions, click on the table header. The column data is now sorted in descending order. Click on the table header again and column data is sorted in the ascending order. Click column heading for a third time restores the default sorting.

By default, 50 results are displayed on each page. To navigate to each page use the pagination control available above the table. Click the page number link or directly typing the page number in the “Jump to” input box. Usercan also use chevrons navigating to previous or next page. The number of displayed results can be changed to one of (10, 20, 50) by using the drop-down menu.

Solution Search Results

The results can be adjusted by using the checkbox filter. A checkbox filter is a filter trigger that enables users to add and remove filters by checking and unchecking boxes next to following filter criteria.

1. Full Matches
2. Partial Matches
3. Not Recommended

The Refresh Search button allows to re-calculate solution search results. The Cancel Search allows to terminate ongoing calculation.

Figure 213. Solution Search Tab

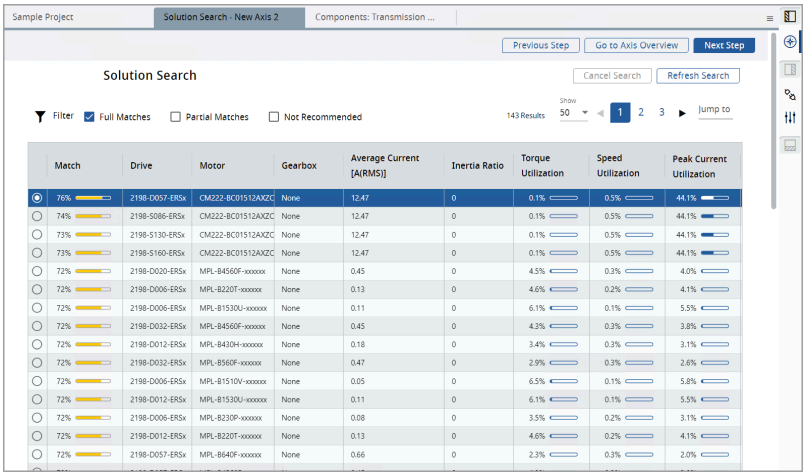


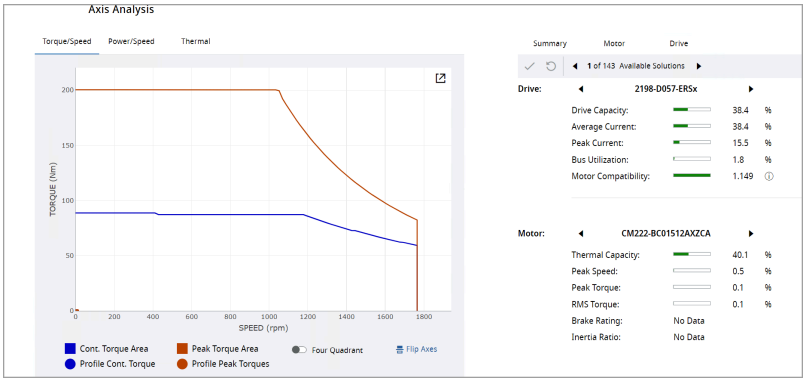
Table 52. Solution Search Tab Properties

Property	Action
Previous Step	Click to open the Components selection tab
Go to Axis Overview	Click to open the Axis Overview tab
Next Step	Click to open the View Solution tab

Axis Analysis

The Axis Analysis tab contains information and tools that you can use to evaluate system performance and efficiency.

Figure 214. Axis Analysis Tab



NOTE: If the selected motor and the drive are incompatible, then the warning icon will be displayed in front of the Analysis menu and also under the Torque/Speed Summary page.

NOTE: In case of any incomplete configuration of Motion Profile, if the user proceeds to Axis Analysis, then the application displays a warning icon(s) in front of the respective menu and also an empty Axis Analysis page along with an instruction to complete the previous steps with compatible components to proceed further.

View the following parameters for your solution. The Summary portion of the Axis Analysis view provides an overall summary of the performance characteristics for the various components of the system.

When a solution includes a gearbox, the inertia ratio is not simply the Reported Application Inertia divided by the Reported Motor Inertia (rotor inertia), as with systems that do not include a gearbox.

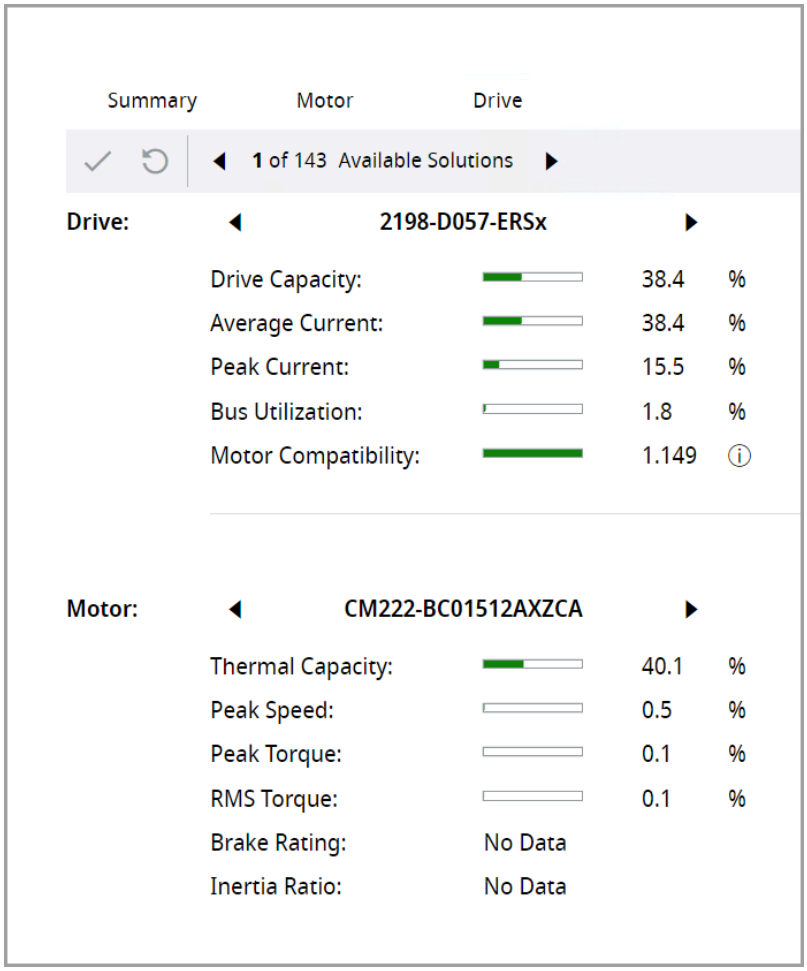
When a system includes a gearbox, the Input Pinion of the gearbox is rigidly attached to the rotor, while the rest of the gears in the gearbox remain connected to the application. Most of the backlash in the system occurs between the input pinion and the rest of the system.

To correctly calculate the inertia ratio, the Input Pinion Inertia must be removed from the Reported Application Inertia and added to the Reported Motor Inertia.

$$(Reported\ Application\ Inertia - Input\ Pinion\ Inertia) \div (Reported\ Motor\ Inertia + Input\ Pinion\ Inertia) = Inertia\ Ratio$$

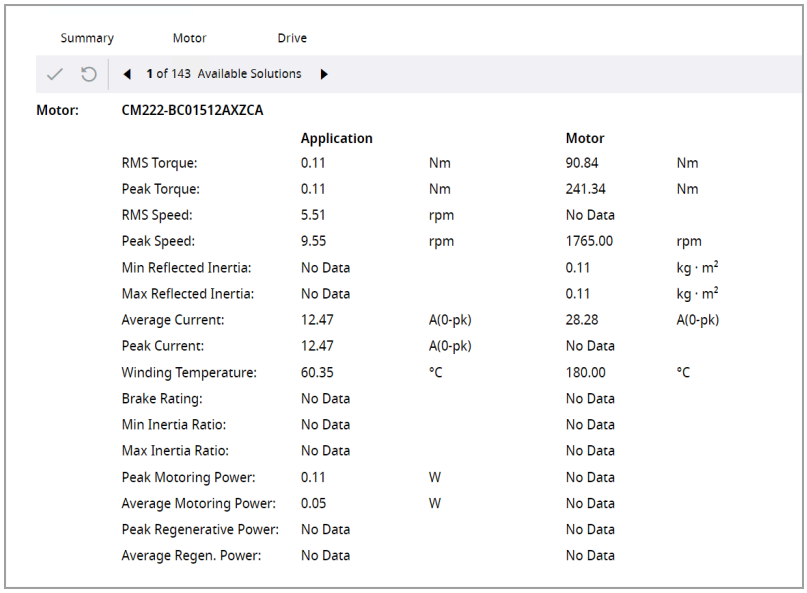
For example, the system in the following image with an VPL-B1001M motor and a VRT-200C-28-F3-28 gearbox has a 1.19:1 inertia ratio.

Figure 215. Summary Tab



Click the Motor tab to view the Reported Application Inertia and the Reported Motor Inertia.

Figure 216. Motor Tab



	Application		Motor	
RMS Torque:	0.11	Nm	90.84	Nm
Peak Torque:	0.11	Nm	241.34	Nm
RMS Speed:	5.51	rpm	No Data	
Peak Speed:	9.55	rpm	1765.00	rpm
Min Reflected Inertia:	No Data		0.11	kg · m²
Max Reflected Inertia:	No Data		0.11	kg · m²
Average Current:	12.47	A(0-pk)	28.28	A(0-pk)
Peak Current:	12.47	A(0-pk)	No Data	
Winding Temperature:	60.35	°C	180.00	°C
Brake Rating:	No Data		No Data	
Min Inertia Ratio:	No Data		No Data	
Max Inertia Ratio:	No Data		No Data	
Peak Motoring Power:	0.11	W	No Data	
Average Motoring Power:	0.05	W	No Data	
Peak Regenerative Power:	No Data		No Data	
Average Regen. Power:	No Data		No Data	

The Motion Analyzer database contains the Input Pinion Inertia for every available gearbox. To obtain a correct inertia ratio, Motion Analyzer software adds the Input Pinion Inertia to the Reported Motor Inertia, which decreases the application inertia and increases the motor inertia.

$$(Reported\ Application\ Inertia - Input\ Pinion\ Inertia) \div (Reported\ Motor\ Inertia + Input\ Pinion\ Inertia) = Inertia\ Ratio$$

In this example, a division produces the correct inertia ratio of 1:19:1.

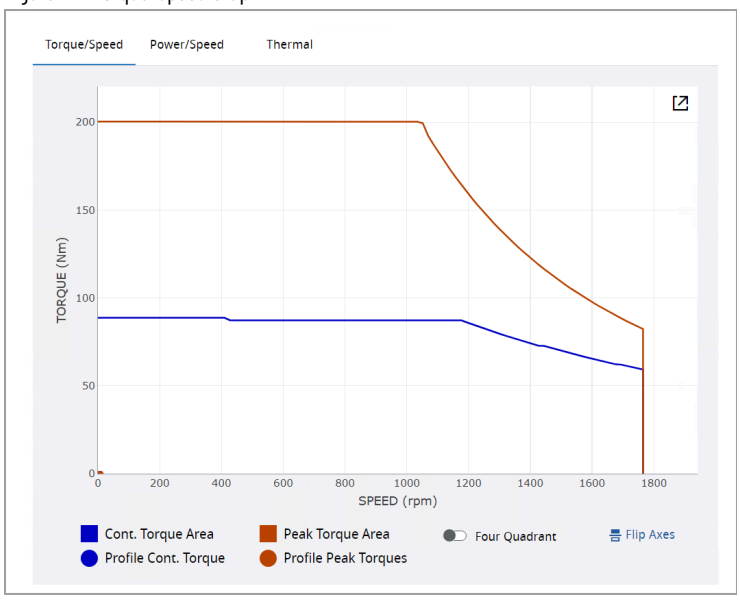
The individual component tabs (for example, Motor, Drive, Gearbox, and Transmission) provide detailed performance information.

In the Motor tab, the brake rating compares the maximum static torque that can be applied to the brake with the quoted holding torque of the brake. This normally occurs when the drive is disabled with the motor/load stationary. This static torque arises from any applied load torques or forces, including gravitational effects. It does not consider friction. If a high proportion of the brake torque (or force) is used for static loads, then little may be left in case the brake is required to stop motion suddenly. Brakes reduce performance if operated during motion. The motor brake is intended as a holding brake applied when motion is stopped and cannot be relied upon to stop a moving load when the drive fails or loses power. An independent method of stopping is recommended for all emergency, where there is a gravitational load or applied force/torque. A resistive brake module provides some braking but will never stop a mechanism with a gravitational load or applied force/torque.

The Axis Analysis tab provides graphical representations of the performance characteristics of the system.

- The Torque-Speed tab contains the torque/speed graph for the selected motor/drive combination. This graph is created dynamically, which means that if the supply voltage changes in the Motor or Drive tab, the graph will change accordingly.

Figure 217. Torque-Speed Graph



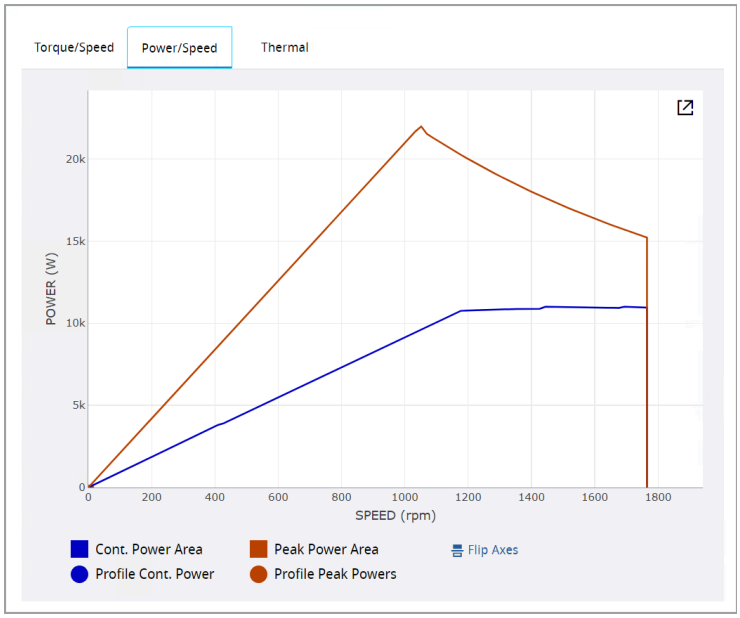
Enable the four-quadrant toggle to view the graph in the four-quadrant view.

Figure 218. Four Quadrant

To flip the graph, click [ ] icon.

- The Power-Speed tab contains the power/speed graph for the selected motor and drive combination. This graph is typically used for Variable Frequency Drive (VFD) applications where power is more appropriate than torque as a measure of performance.

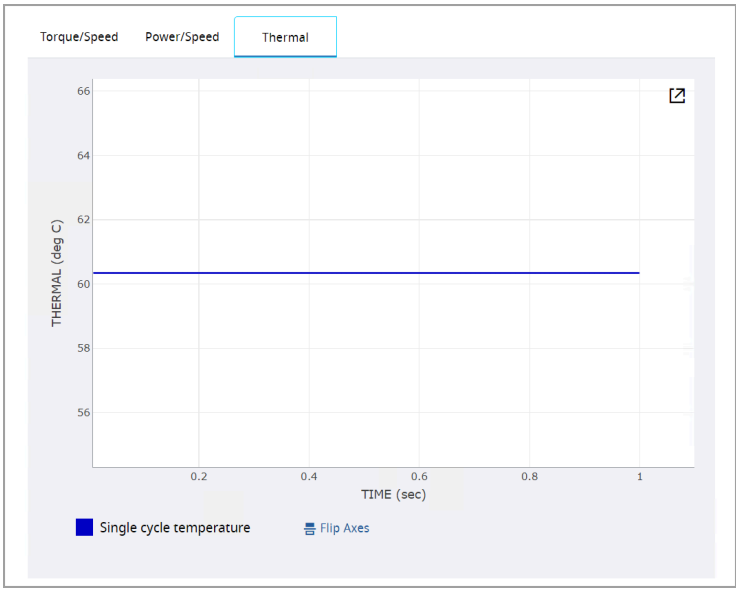
Figure 219. Power-Speed Graph



To flip the graph, click [ ] icon.

- The Thermal tab displays the output of drive and motor thermal models that reside in the drive firmware.

Figure 220. Thermal Graph



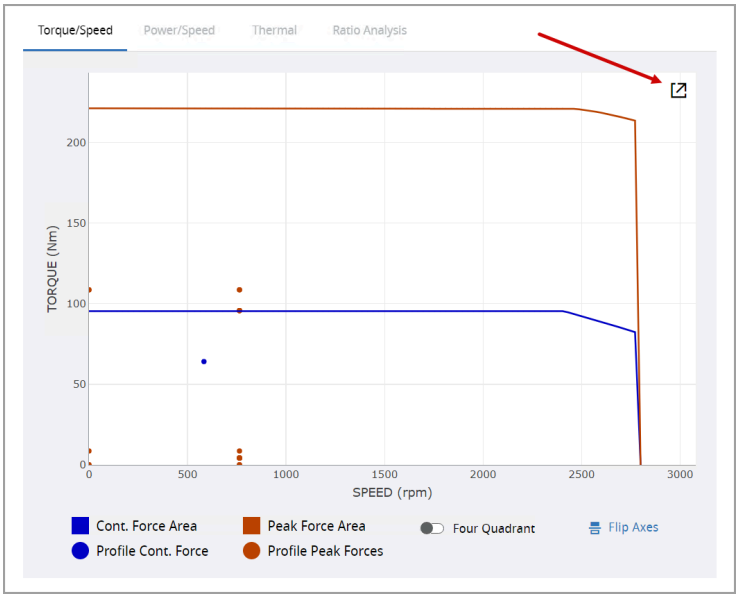
To flip the graph, click [ ] icon.

Expand Graph

This feature enables users to open an expanded graph in a separate pop-up window.

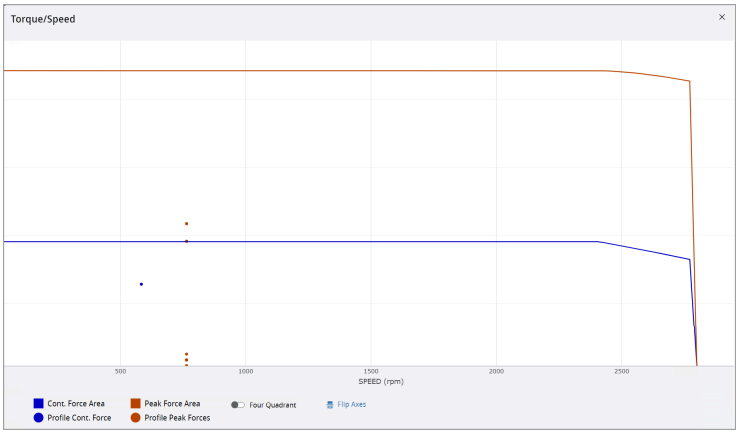
1. On the graph, click the [ ] icon.

Figure 221. Graph



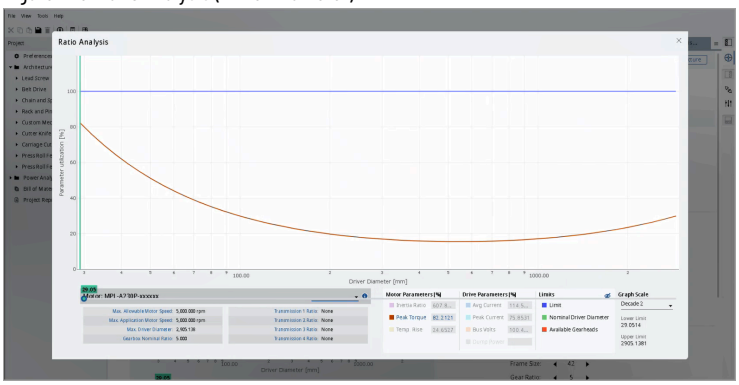
2. The graph opens up in a pop-up window. Users can also view the graph in the Four Quadrant view and Flip Axes view in the window.

Figure 222. Expand Graph



This feature is also applicable to the graphs in the Power/Speed, Thermal, and Ratio Analysis tabs. The following image is the enlarged version of a graph from the Ratio Analysis tab along with their parameters.

Figure 223. Ratio Analysis (Driver Diameter)



Ratio Analysis

Ratio Analysis allows the user to evaluate the different parameters for selected Motor and Drive combinations based on different transmission ratios. The Ratio Analysis can be performed on all Rotary templates and the Linear Custom Mechanism templates that use any of these: Belt drive, Lead screw, Rack pinion, and Chain & sprocket.

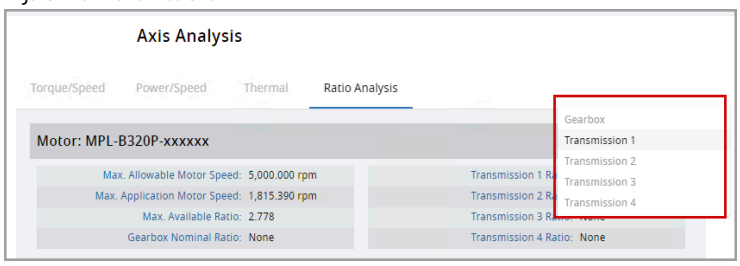
1. Go to the Ratio Analysis tab.
2. Depending on the system configuration, the following Ratio Analysis options display along with the Motor family:
    - Gearbox
    - Transmission 1
    - Transmission 2
    - Transmission 3
    - Transmission 4
    - Lead
    - Sprocket PCD (sprocket pitch circle diameter)
    - Pinion PCD (pinion pitch circle diameter)
    - Drive Diameter

NOTE: For the templates that use Belt drive (Cutter Knife Drive, Carriage Cut Off, Press Roll Feed Time, and Press Roll Feed Angle) the Drive Diameter option is used.

Figure 224. Motor Family

3. Select any one of the Ratio Analysis options from the available drop-down list that you are optimizing.

Figure 225. Transmissions



4. Based on the selected Transmission type, the Motor Speed and ratio values are displayed.

   Example: The following image displays the parameters from a Custom Rack and Pinion component.

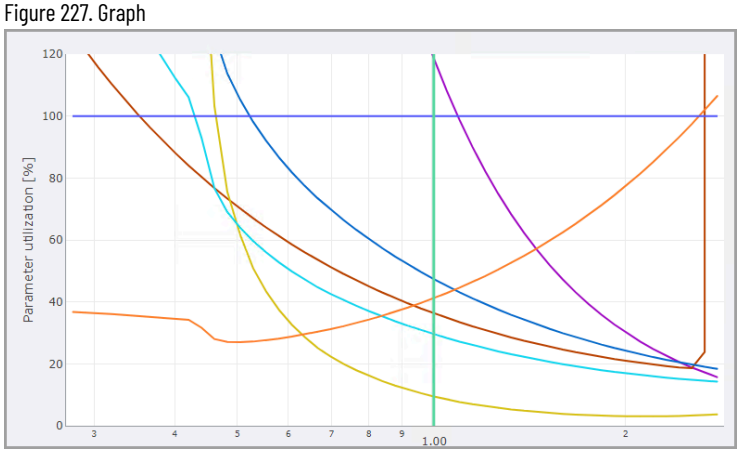
Figure 226. Select Transmission Type

NOTE: The Max Ratio is calculated based on the Nominal Ratio and Peak Speed from the application requirements.

5. The chart displays the graphs of all Motor and Drive Parameters (on the Y-axis) against the ratio (on the X-axis).

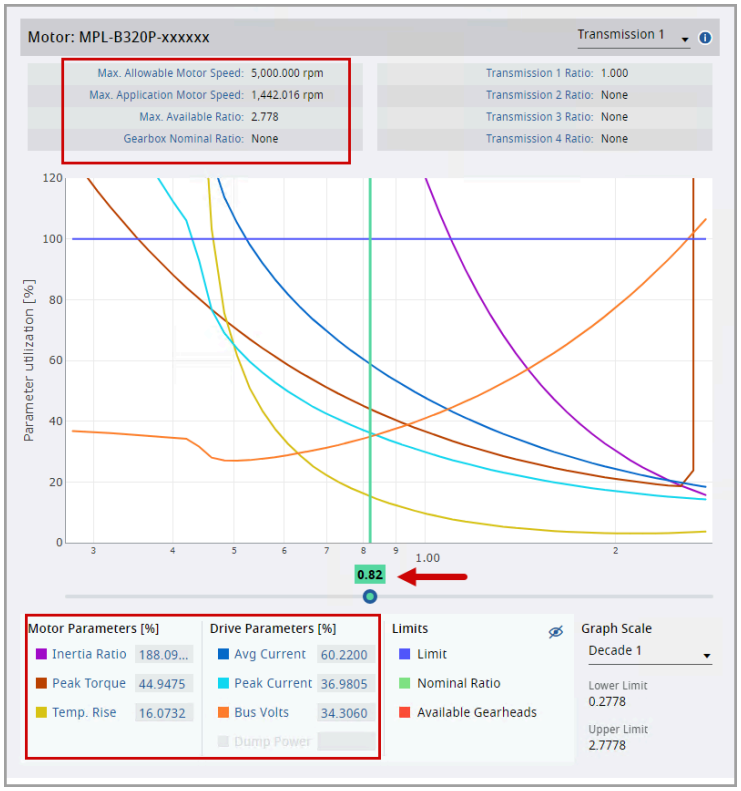
NOTE: For each Transmission type, the graphs may vary.

Figure 227. Graph



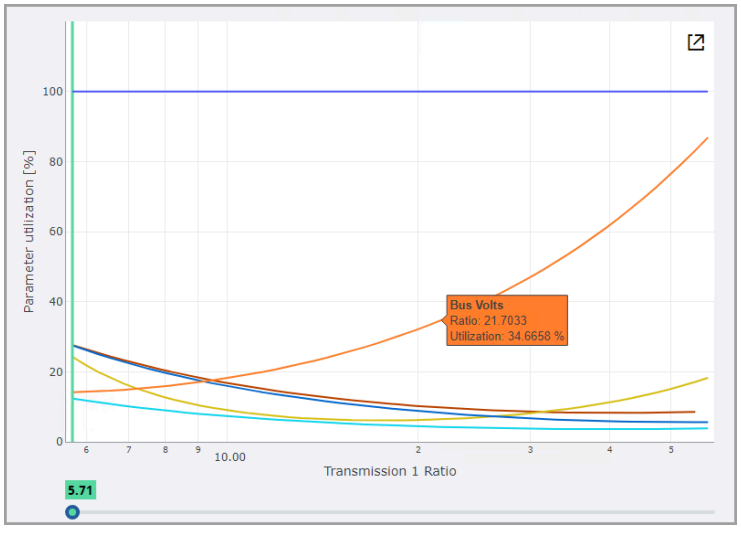
6. The slider below the chart is available to adjust the ratio you are optimizing. Move the slider and the Motor and Drive parameters change as per the given ratio and the user can read these parameters.

Figure 228. Slider



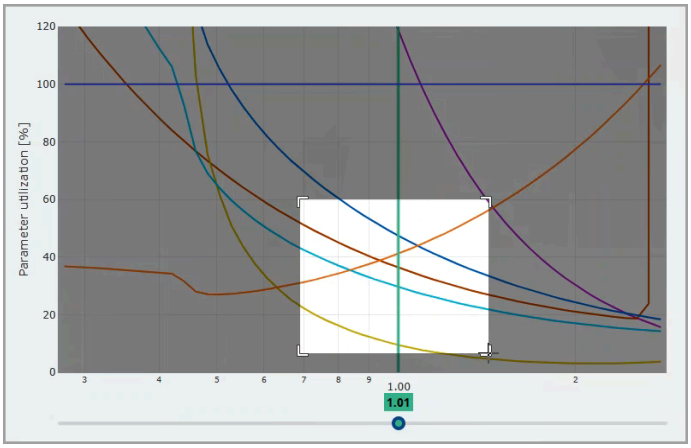
7. User can also hover the cursor on a graph to view the Ratio and the Parameter Utilization.

Figure 229. Mouse Hover - Value



8. User can zoom in and zoom out the graphs:
   - Zoom In: Click and drag the cursor on the selected area to zoom in.

Figure 230. Zoom In

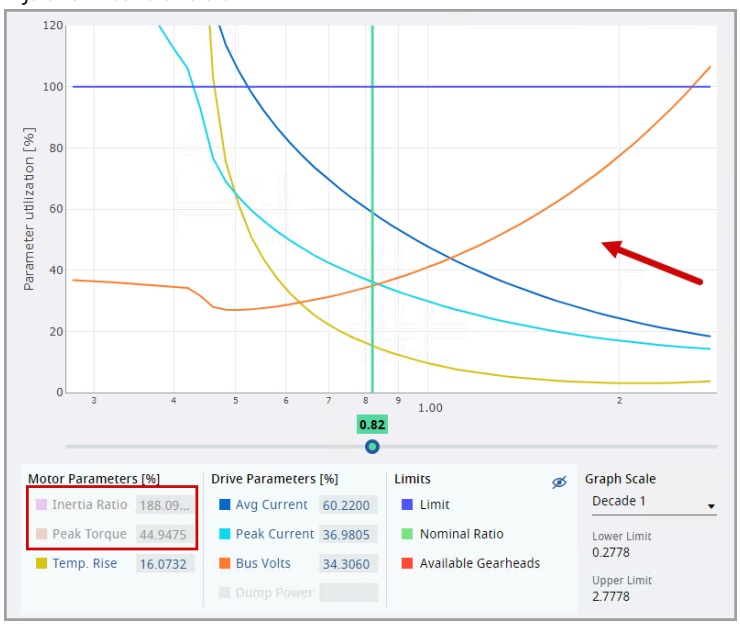


   - Zoom Out: Double-click on the chart to zoom out.

9. Motor/Drive Parameters: User can check which motor and drive parameters are displayed when the user clicks on selected Curves. The value for each parameter is listed for the particular gearbox or transmission component ratio indicated by the slider.
10. To enable or disable the graph from the chart, user can click the Motor/Drive parameters given below the chart based on the color code.

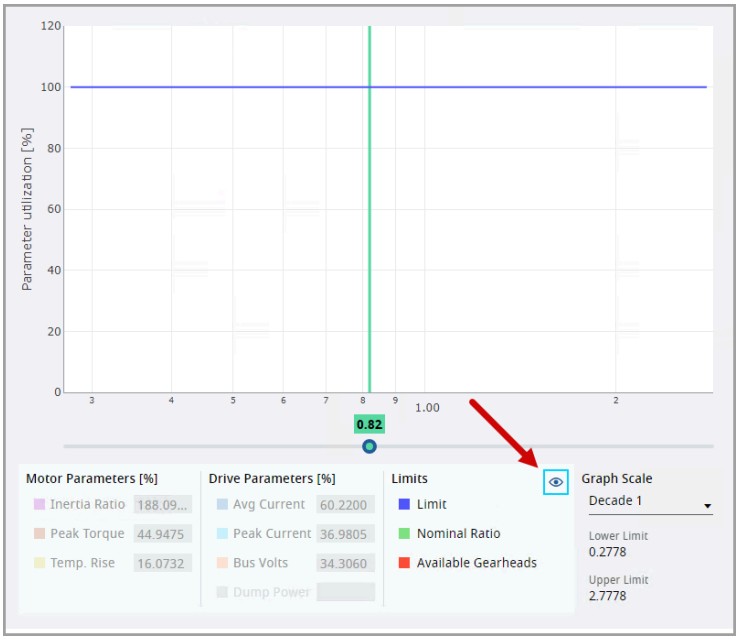
    For example, in the following image, the Inertia Ratio and Peak Torque are disabled, hence the respective graphs disappear from the chart.

Figure 231. Hide Parameters



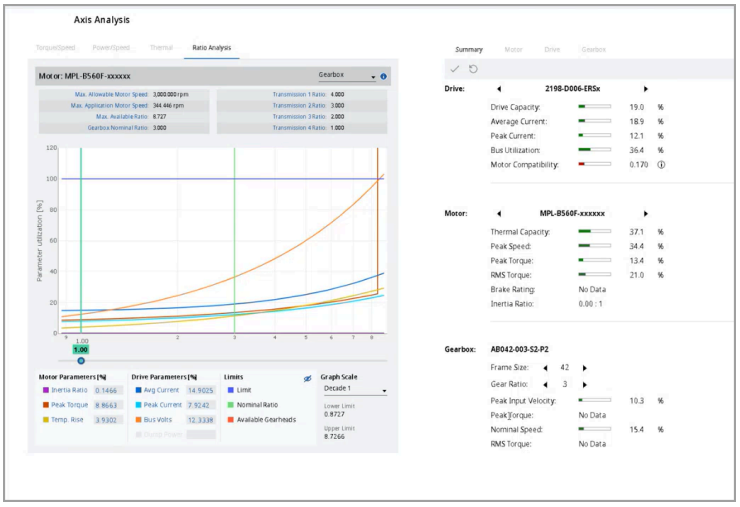
11. User can also use the [ ] icon to hide or show all the graphs from the chart.

Figure 232. View



12. From the Graph Scale drop-down menu, User can set the predefined Graph Scale to 1, 2, 3 decades, or Custom.
    - Custom: Provide the lower and upper limits of the Ratio (on the X-axis) of the graph.
13. Once the axis limit values are entered, the application automatically refreshes the chart.

Figure 233. Updated Chart



Size Up and Size Down

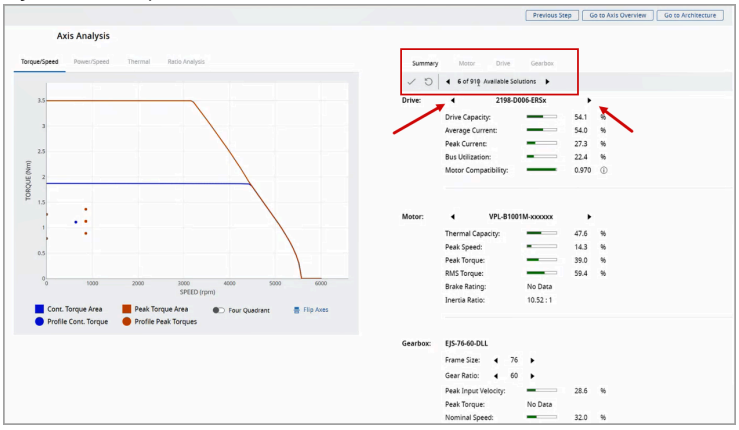
User can size up or size down the components from the given family based on the requirement. The backward arrow fetches the component from the lower level in descending order and the forward arrow fetches the component from the higher level in ascending order. It also displays the list of available solutions along with the sequence number from the entire list.

NOTE: The list that is shown here is the same list of available solutions from the Solution search page without any filters. Though the filters are applied on the solution search page, all the available

solutions are displayed for sizing on the Axis Analysis page. If the solution search is not performed, then the top panel displays only 1 available solution.

1. Click the forward or backward arrow to scroll through the various available components in the given family.

Figure 234. Size Up and Size Down

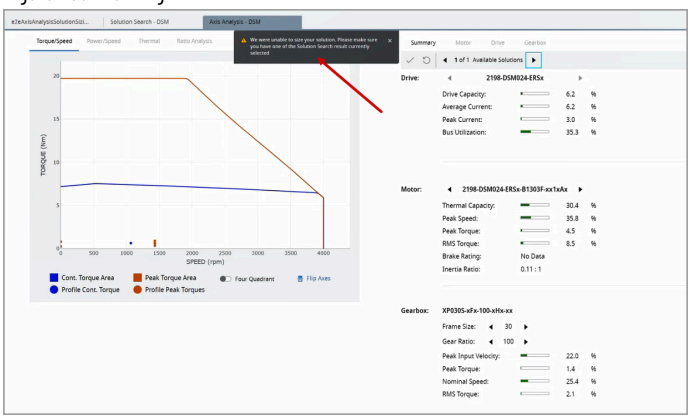


2. The list of available solutions may vary based on the following scenarios:
   - It should be the same number as the list refined in the solution search.
   - It may be 1 of 1 only when after modifications (using product size up/down) the solution is not within the results returned by the solution search.

     For example: In the above image, under the Gearbox section, if the Frame Size/ Gear ratio is sized, then the list of available solutions changes.

> **NOTE:** If the user tries to size beyond the available solutions, then the following warning message displays.

Figure 235. Warning



3. Upon changing the component, the chart and the other details automatically are refreshed and display the updated graph and values.
4. To save the changes, the User can click the [✓] icon or the [💾] icon in the toolbar.

IMPORTANT: This action will update the components across the project.

- Click the [ ] icon to revert the changes before sizing. After saving user can no longer revert the changes.

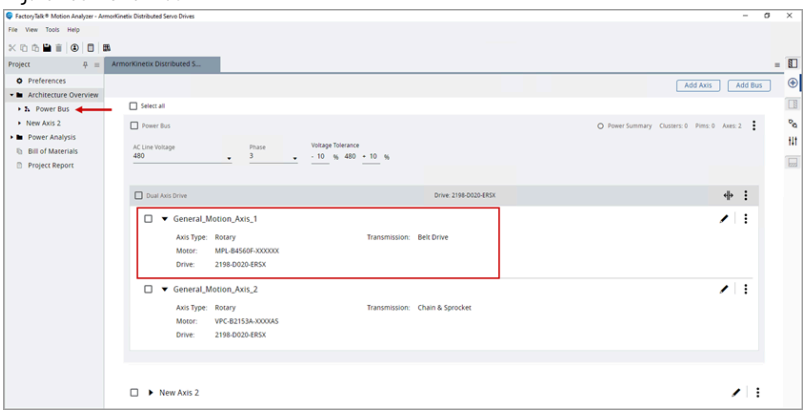
5. If the lower/higher level components are not available, then a warning message is displayed.
6. Limitation:
   - The sizing for ArmorKinetix DSM products is exclusively accessible for motors. As the drive and motors are integrated, there's no separate sizing available for the drive itself.
   - The sizing for the custom motor is not available.
   - In case of a Dual-Axis that shares the same drive, sizing the one drive in an axis will automatically change the drive in the second axis.
   - If two drives have Power sharing using shunts, by sizing the one drive, the power-sharing configurations are reset to default on the Power Analysis page and the Power supply solutions (if any) are lost. User has to manually set up the Power Analysis.
   - The gearbox sizing is done by changing frame size and gear ratio parameters.

Power Analysis

Motion Analyzer allows the user to calculate the detailed power analysis for a power bus based on the axes, bus configuration (selected Motion Profile and other components), and selection of power accessories (selected manually or automatically by the program).

User can calculate the Power Analysis for any Power bus that contains valid axes with a drive, motor, valid phase information, valid voltage, valid Motion Profile, and the solution search selected; otherwise an error message displays while calculating the Power Analysis.

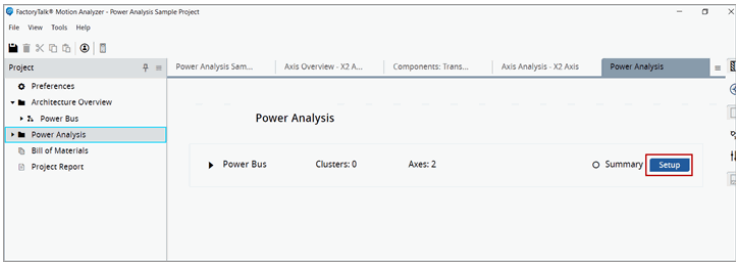
Figure 236. Power Bus



Perform the following steps to setup Power Analysis:

1. On the left panel, click the Power Analysis menu. The list of available Power buses display.
2. Choose your Power Bus and click [Setup]. The Power Analysis Setup page displays.

Figure 237. Power Analysis



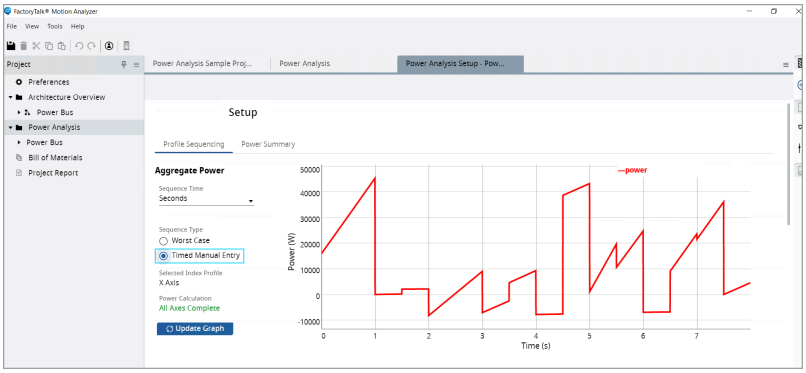
NOTE: This may a take few seconds to fetch the Power aggregation data.

Power Analysis Setup

This section allows the user to update the Power-Time graph by performing the sequencing and choosing a Power Supply, multiple Capacitors, and multiple Shunts for the selected power bus (or the default selections using the Auto mode) and perform the calculation for power analysis. This connects the power analysis accessories with calculations and displays the power analysis results.

NOTE: In the Auto mode, after the calculation, the application selects the power accessories such as power supply, Capacitors, and shunts.

Figure 238. Power Analysis Setup



The setup section contains two tabs:

- Profile Sequencing
- Power Summary

Profile Sequencing

Allows the user to update the graph by performing the sequencing. Under the Profile Sequencing tab, the Power-Time graph displays along with the axes available in the power bus.

1. Under the Aggregate Power section, provide the following details:
   a. Sequence Time: Time in Milliseconds or Seconds or Minutes.
   b. Sequence Type: Type of the Sequence
      - Timed Manual Entry: By default, this option is selected. This option allows the user to define the time offset for the power consumption of each axis separately.
      - Worst Case: Used if the User predicts that the power reaches its peak stage.
   c. Selected Index Profile: Displays the Index profile selected.
      - Scroll down the Aggregate Power section and select the desired axis as the Index Profile. By default, the offsets will be zero, if all the axis profiles have the same length and start at their correct respective positions. User can define new offsets to align the profiles correctly.
   d. Power Calculation: Displays the status of the Power calculation for the axes that are available in the power bus.
2. Click [Update Graph] to update the graph based on the sequencing.

Project Summary

Allows the user to calculate the Power Analysis results based on the selected components and Motion Profile. If the Auto mode is selected, the Power accessories such as the power supply, capacitors, and shunts are selected after the calculation.

The Power Summary tab contains two sections:

- Calculate
- Power Analysis Result

Calculate

Allows the user to define the following parameters and calculate the power analysis for a power bus:

- Power Supply
- Power Supply Options
- Shunts
- Capacitors

NOTE: User can select one Power Supply and multiple Shunts and Capacitors for calculation.

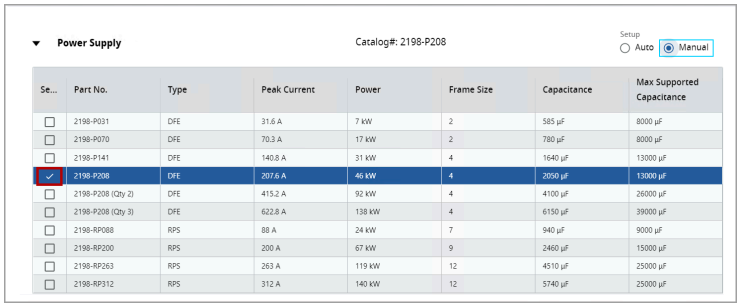
NOTE: Not all the Power buses have these options to select. The availability of these power components (accessories) depends upon the axis configurations and available bus features.

Perform the following steps to calculate the Power Analysis:

1. Click the [ ] icon to expand the Power Supply and the list of available Power supplies display. User can switch between the power supplies to calculate as required.
   - By default, the Power Supply setup is set to Manual mode. User can choose the Auto mode to define the Power Supply automatically.

     NOTE: Some of the drives has the power supply built-in, so re-selection of the power supply can affect to selection of drive component.

     Figure 239. Power Supply Setup

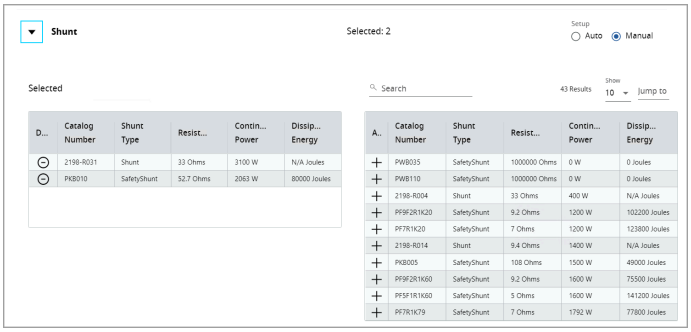
     

2. Under the Power Supply Options section, user can select the converter Type and select the [Power Supply In Standalone Cluster] option.
   - Converter Type: Select the type of Converter used. This option is only available if the Power Supply is set to Auto mode. By default, the DFE type is selected. If the RPS converter type is selected, the user can define the VDC Setpoint and enable the regulation.
   - Power Supply In Standalone Cluster: Check this box 'Yes' if you plan to run cables from the power supply to your drive clusters. This means that no driver modules are connected directly to the power supply. This standalone cluster will also require an additional capacitor module.

     Figure 240. Power Supply Options

3. Under the Shunt section, user can select the required shunts to be calculated. for which power analysis will be calculated or select the Auto option to select shunts automatically.
   - The left pane displays the selected shunts. Click the [⊖] icon to delete the shunts.
   - The Right pane displays the list of available shunts. Click the [+] icon to add the shunts.

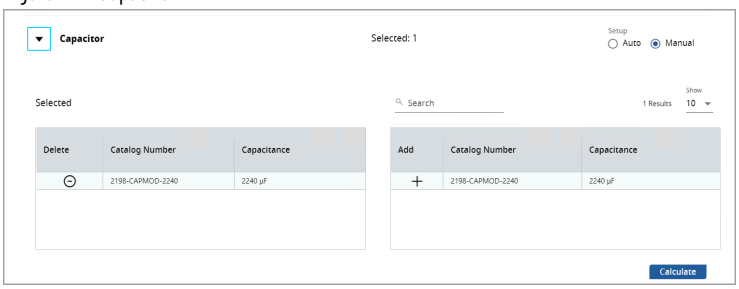
Figure 241. Shunt



By default, the Shunt selection is set to Manual mode. User can choose the Auto mode to select the Shunts automatically.

4. Under the Capacitor section, user can select the required capacitors for which power analysis will be calculated or select the Auto option to select the Capacitors automatically.

Figure 242. Capacitor

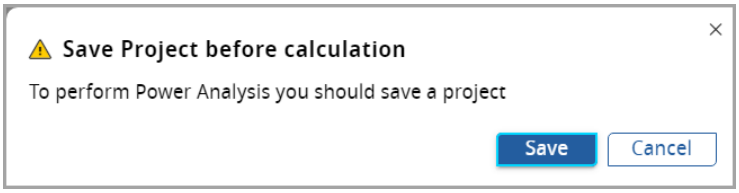


By default, the Capacitor selection is set to Manual mode. User can choose the Auto mode to select the Capacitor automatically.

5. Click the [💾] icon on the Quick Access Toolbar to save the project.
6. Click [Calculate], the results display under the Power Analysis Result section.

NOTE: If user does not save the project and proceeds to calculate, then the 'Save Project before Calculation' dialog displays. Click [Save] and the calculation begins.

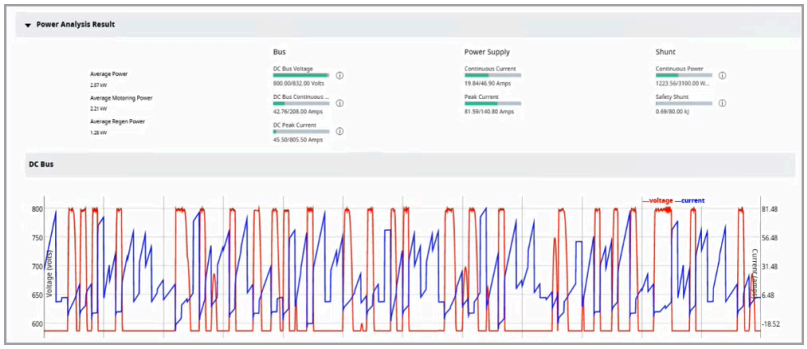
Figure 243. Save Project



Power Analysis Result

The calculated Power Analysis Result displays in values along with the Voltage-Current graph.

Figure 244. Voltage Current Graph



These results are displayed based on the selected accessories and the type of parameters are displayed based on the response dynamically. Hover the mouse on the labels for more details.

Figure 245. Power Analysis Result

After the calculation, if the user changes any of the above parameters, a warning pop-up displays to re-calculate.

Power Sharing

This feature is available only for families that support AC and DC power sharing (Kinetix 5500 drives). If the drivers are selected from the Kinetix 5500 family, then the user must define a valid power-sharing configuration during the Power Analysis.

- **DC Sharing**: To support common DC bus configuration supplied by one or more shared AC inputs. Use the DC Sharing configuration to group axes to share a common DC bus and input AC supply (optional).
- **AC Sharing Only**: To support one or more shared AC inputs. 3-phase AC input power can be shared among drives with the same power rating. No DC bus connections are allowed in this configuration. Use the AC Sharing Only configuration to group axes to share input AC supply only, with no DC bus sharing.
- **Clear All**: To clear the power-sharing selection.
- **Power Sharing Table**: This table displays the list of Axes from a given bus along with their drive Catalog Numbers, Frame Size, Power in Kilowatts, and power-sharing from DC or AC line. User can manually enable or disable the sharing options.

NOTE: If neither DC Sharing nor AC Sharing Only is selected, then [Shares DC] and [Shares AC] checkboxes will be disabled.

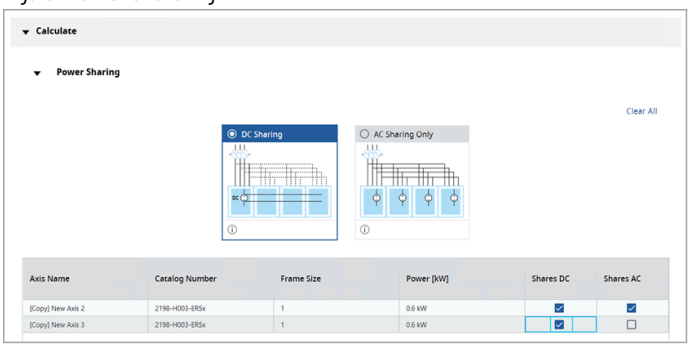
Limitations

The following restrictions are imposed on the number of drives allowed in common bus or shared AC/DC configurations:

1. **Common AC/DC Sharing**:
   a. The most powerful driver acts as a leader and should share the power with other drives in the DC line.

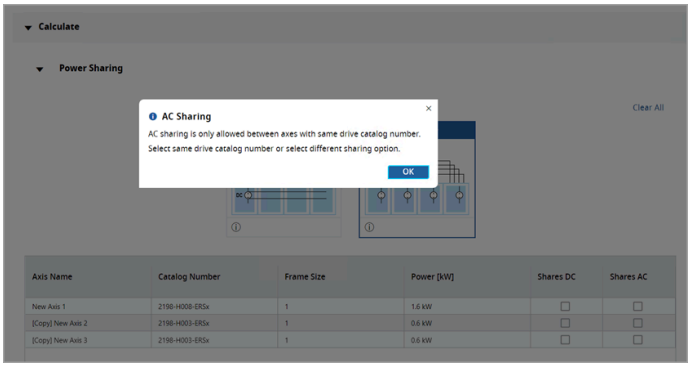
NOTE: Ensure that the powerful drive is created at the top of the list.

Figure 246. Power Sharing



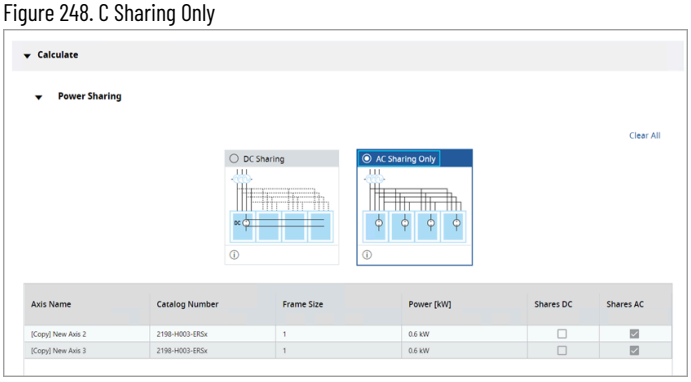
   b. AC sharing is only allowed between axes with the same drive catalog number. If user tries to enable the [AC Sharing Only] option with different drivers, then a warning message displays as shown in the following image:

Figure 247. AC Sharing



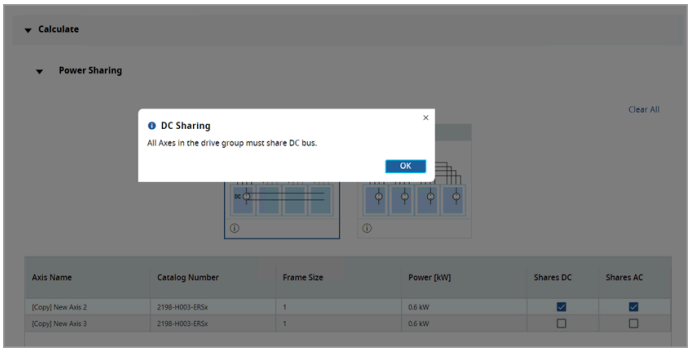
NOTE: Ensure to select the same drive catalog number in the given bus or select a different sharing option.

Figure 248. C Sharing Only



c. If the [Shares DC] checkbox is disabled manually for any axis from the same bus, then a warning message displays as shown in the following image:

Figure 249. DC Sharing



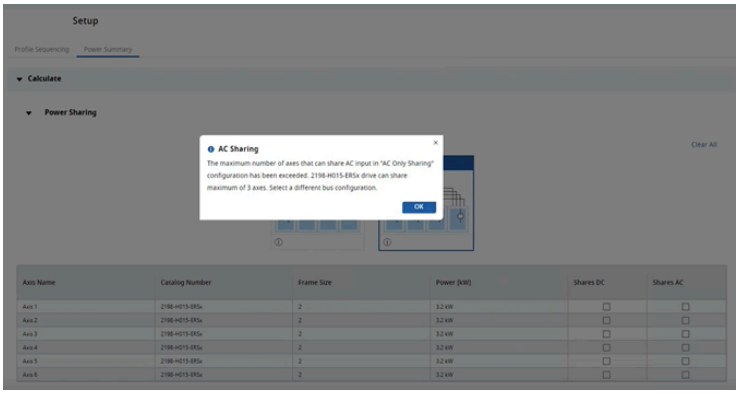
NOTE: Ensure that all Axes in the drive group must share the DC line.

2. **None K5500 family**: If the drive selection is not from the Kinetic 5500 family, then the Power Sharing section is not available in the Power Analysis.
3. **Single Axis Bus**: The Power sharing is only available for multiple axes sharing single bus.
4. **None Sorted Axis**: The Power Sharing is sorted from the most powerful driver to the least powerful driver irrespective of the axis created.

Figure 250. None Sorting Axis

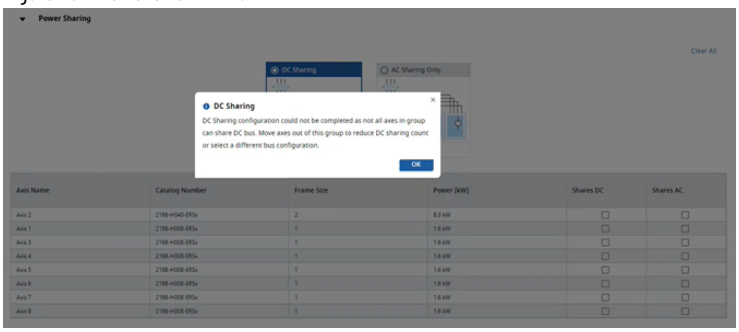
5. **AC Sharing Limitations**: The maximum number of axes that can share AC Inputs is based on the driver configurations. If the driver is shared across multiple axes beyond its configuration limits then a warning message displays as shown in the following image:

Figure 251. AC Sharing Limitations



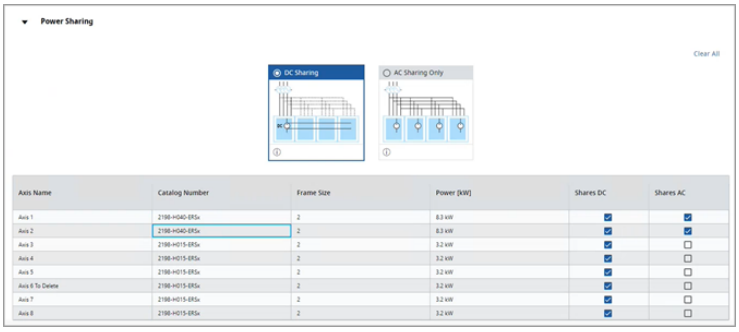
6. **DC Follower Limits**: In a given group of axes with a powerful axis acting as the leader with other axes acting as followers and they share different DC bus or it exceeds DC power sharing, a warning message displays as shown in the following image:

Figure 252. DC Follower Limits



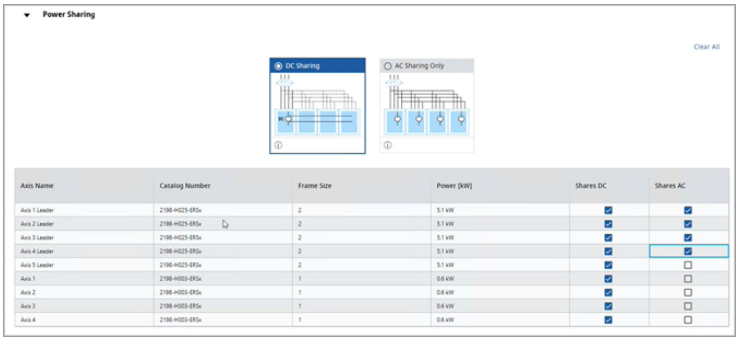
7. **DC Limits**: If a group contains 2 powerful drivers and more than 6 follower drivers, then the 1st driver acts as a leader for the second drive and the second driver will act as the leader for the other follower drivers.

Figure 253. DC Limits



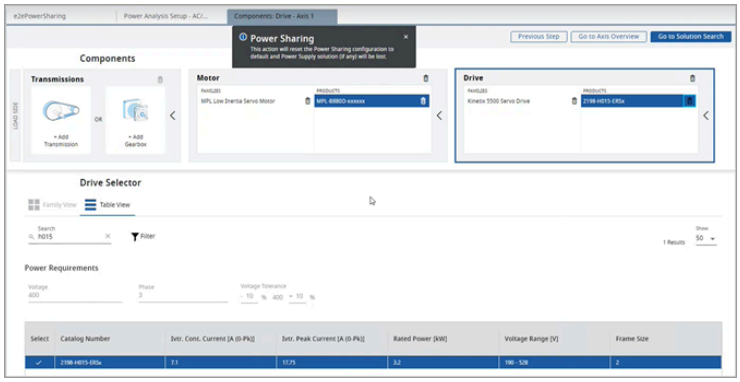
8. **AC Limit in DC Sharing Manual (Hybrid sharing)**: If a group of axes contains shares same Driver, then both DC and AC sharing can be enabled beyond its configuration limits as shown in the following image:

Figure 254. Hybrid Sharing



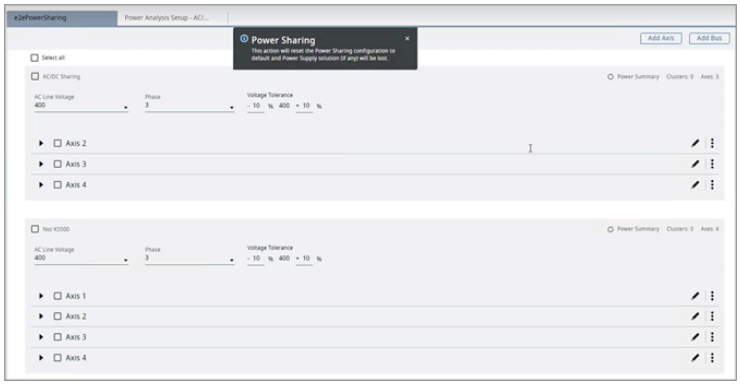
9. If the Power sharing is configured and the user deletes the drive from the components list, then a warning message displays, and the power-sharing is reset to none and the user must configure the Power sharing.

Figure 255. Power Sharing Warning



10. If the axis is deleted from the power bus, then a warning message displays, and the power-sharing is reset to none and the user must configure the Power sharing.

Figure 256. Power Sharing



PIM Summary

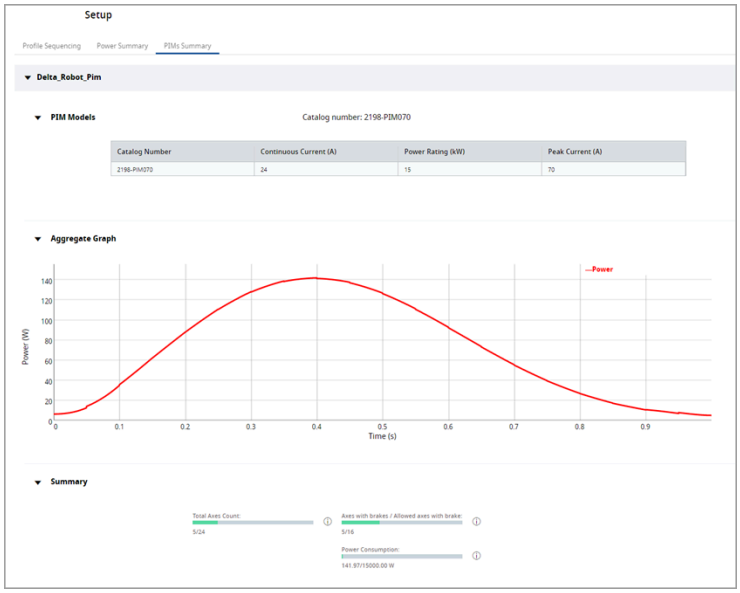
The section provides information about the list of PIM Modules and their summary. Each PIM summary contains the PIM details along with the number of axes with brakes, and the details about the power consumption. This tab is only available for the bus containing PIM modules. Users can expand/collapse the section view.

The PIM Summary consists of 3 sections:

- PIM Name: Displays the information about the details of the PIM Module. List of PIM used along with the Catalog Number, Power Rating, and Continues Current and Peak Current details.
- Aggregation Graph: Displays the Aggregation Graph of the axes inside the PIM module. Users can hover the mouse on the graph line to view the Power values against the time.

- Summary: Display the total number of axes inside the PIM, the number of brakes used, and the Power consumption.

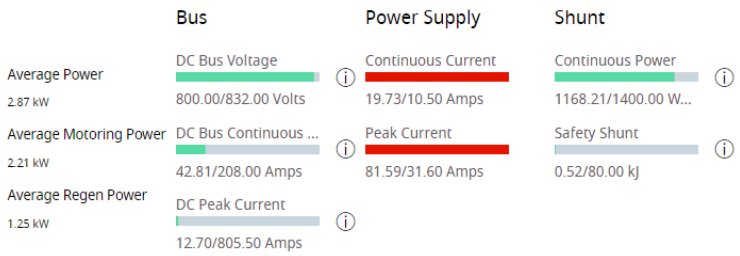
Figure 257. PIMs Summary



Operation Range Error

If the Power Analysis parameters exceed their normal operating range, it will be marked as red progress-bar as shown in the following image (for Continuous Current and Peak Current):

Figure 258. Invalid Results



To view these invalid or excess results, perform the following steps:

1. Open your Power Analysis Sample Project, select the power supply manually to first option.
   For example: In this case 2198-p031 (or second 2198-p070)
2. Change the Setup option of Shunts and Capacitor to 'Auto' mode and click [Calculate] to calculate the Power Analysis.

Bill of Materials

The Bill of Materials menu displays the total list of Axes, and components that configured in the Project. User can view them in two tabs:

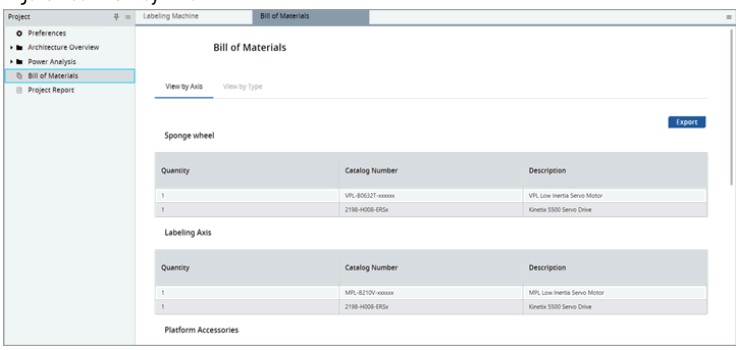
- View by Axis
- View by Type

View by Axis

Displays the list of components that are divided by:

- Axes configured in the project.
- Platforms (if some bus is in a project, or drive needs some special components assigned to platform).
- Power Components and accessories which displays power components (based on selection in Power Analysis of buses)

Figure 259. View by Axis



View by Type

Displays the list of components in the project grouped by each type such as Drives, Motors, Gearboxes, Linear mechanisms, Actuators, Platform Accessories, and Power Buses.

Figure 260. View by Type

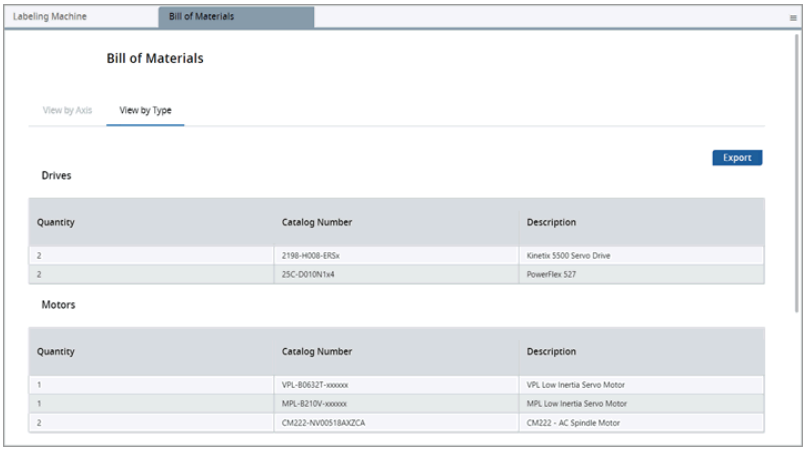


Table 53. View by Type

Column	Description

Table 53. View by Type (continued)

Quantity	Number of components.
Catalog Number	The component's catalog number.
Description	The Family name of the component.

Export Bill of Materials

User can export the Bill of Materials in both tabs: View by Axis and View by Type.

1. Click [Export] and provide the path to save the exported file.
   The file format is .csv. After exporting, a success message displays.

Figure 261. Successfully Exported

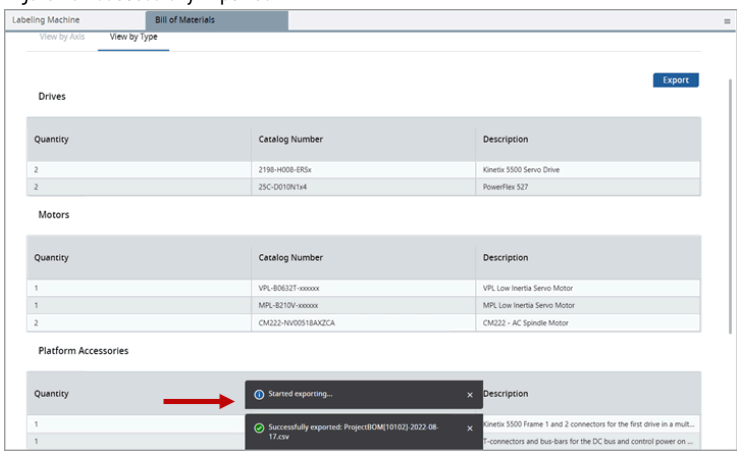
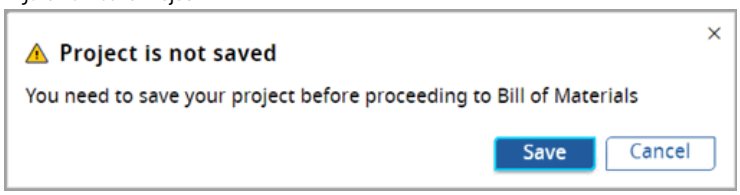


Figure 262. Save Project



Project Report

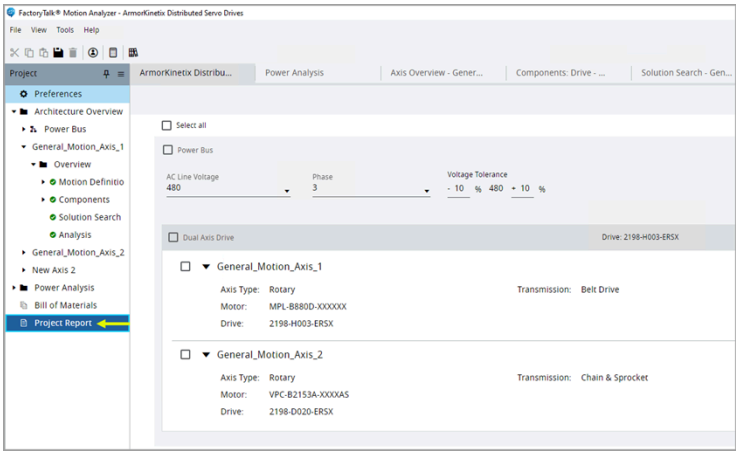
The Project report allows the user to generate the information related to the project in one place including all axes, motion profiles, components, solution search results, BOM, power analysis results, and other information. This report is updated based on the changes that the user makes in the development process. This feature also allows user to save the report in PDF.

Generate Project Report

Perform the following steps to generate the Project Report:

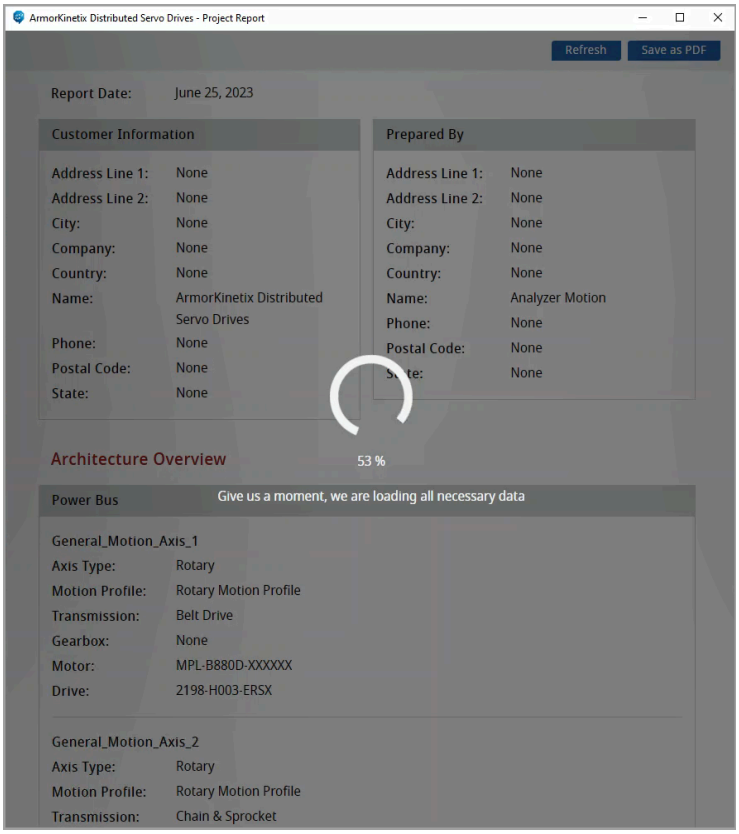
1. On the left pane, double-click the Project Report menu.

Figure 263. Project Report Menu



2. A new window displays the Project details. This may take a while to load the necessary data.

Figure 264. Generating Project Report



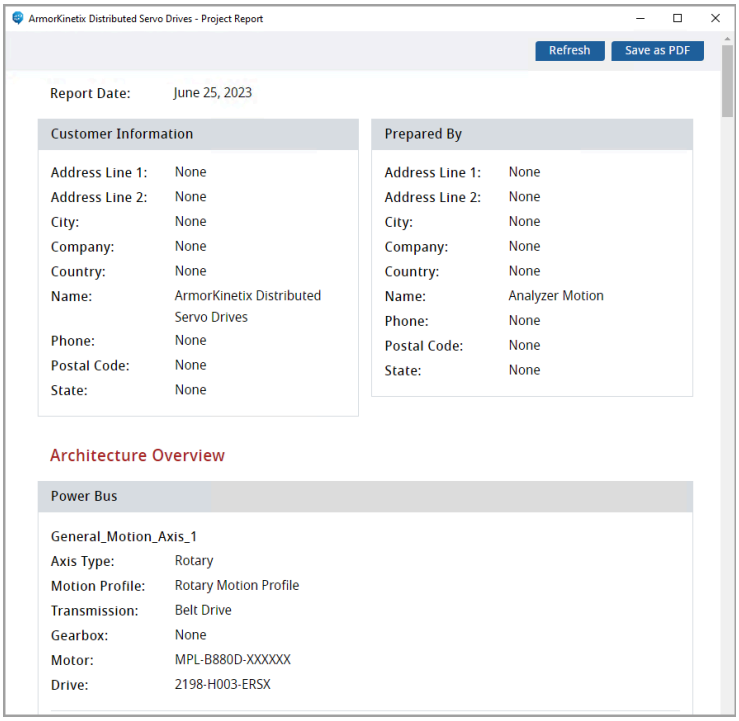
The Project Report displays the following project details:

Table 54. Project Report

Label	Description
Report Date	The Date when this report is generated.
Customer Information	The customer information is mentioned in the Preferences menu.
Prepared By	The information about the report publisher.
Architectural Overview	The information about the list of available power buses, List of Axes / Dual-axis along with their components (Motor, Driver, Transmissions), and the Cluster details, if available.

Details | <Axis Name>	The information about the Axis/Dual-Axis/Bus such as Axis Type, Motion Profile, and detailed information about the components along with the graphs.

Figure 265. Project Report



Refresh

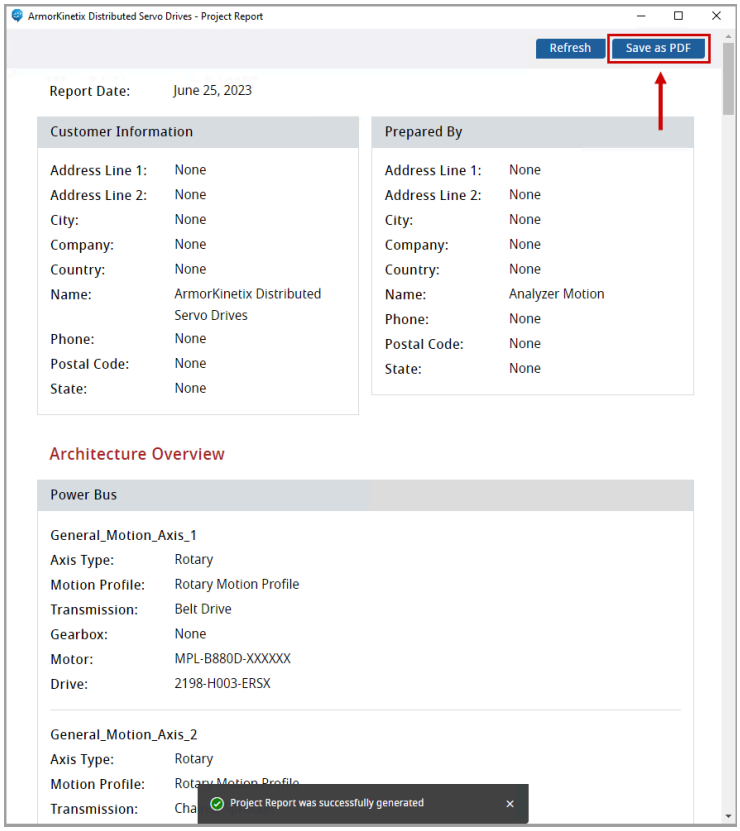
To refresh the Project report for the changes to take effect.

Save the report

To save the Project Report as PDF output:

1. Click [Save as PDF] the Save As dialog displays.
2. Select the desired location and provide the file name.
3. Click [Save]. A success message displays as shown below.

Figure 266. Save as PDF



Open the published PDF and the Project Report displays along with the Publisher name in the page footer as shown in the following image:

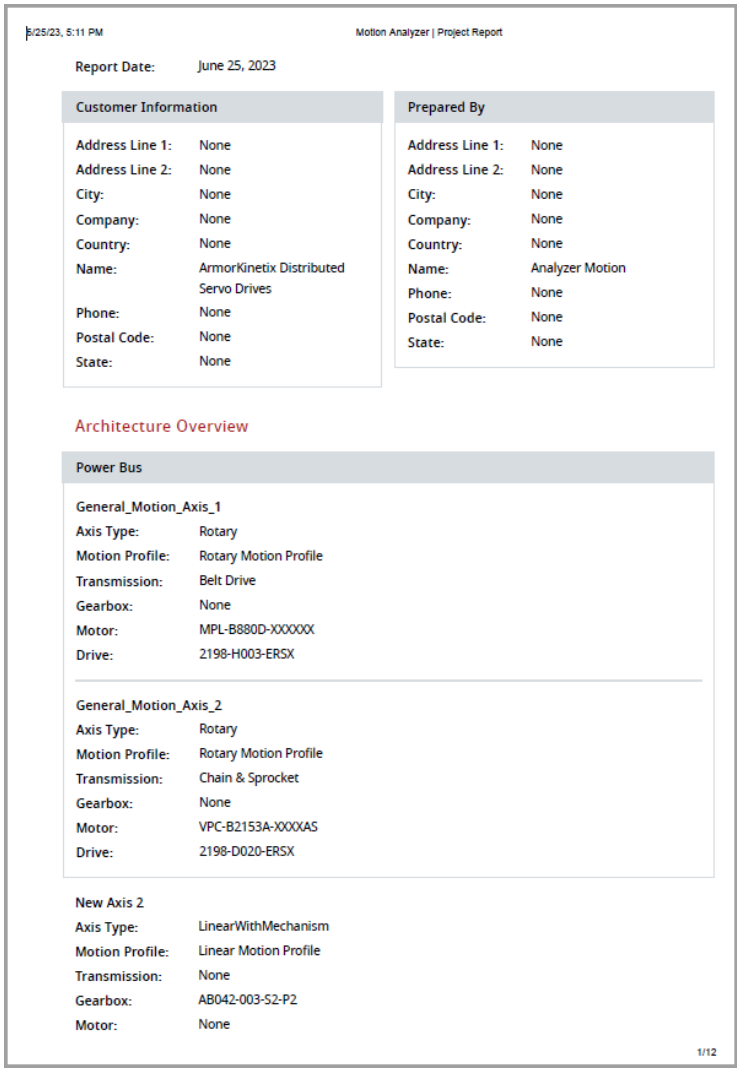



Figure 267. PDF