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Multi-axis motion control system
Drive Sizing Tool User Manual

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1 Introduction

1.1 What is in this manual

The "NYCe 4000 Drive Sizing Tool User Manual" provides information how you can create a drive sizing report using the drive sizing tool. The drive sizing tool is included in the NYCe 4000 installation folder in the directory "`toys`". (default path "`C:\Program Files\Rexroth\NYCe4000`"). This manual describes the process steps how to create a drive sizing report for the model types "Flexible Transport System", "Direct Linear", "Rotary", and "Rotary with screw".

- chapter 2 "Drive sizing overview" on page 5 describes the overall layout and the prerequisites.
- chapter 3 "Drive Sizing Tool description" on page 9 describes the functionality of the drive sizing tool.
- chapter 4 "Drive sizing for an FTS" on page 15 describes the drive sizing process for an FTS.
- chapter 5 "Drive sizing for a linear actuator" on page 23 describes the drive sizing process for a linear actuator.
- chapter 6 "Drive sizing for a rotary motor" on page 31 describes the drive sizing process for a rotary motor.
- chapter 7 "Drive sizing for a rotary motor with screw" on page 41 describes the drive sizing process for a rotary motor with a spindle or a belt.
- chapter 8 "Appendix A - Drive sizing report for an FTS" on page 53 shows the generated drive sizing report of an FTS.

1.2 Intended audience

This manual is intended for users who have a certain level of background knowledge and understanding regarding the physics of the machine hardware that they are designing. This includes mechanical background knowledge, for example knowledge about friction in guiding systems, and knowledge about motors and drives.

1.3 Documentation

After you installed the NYCe 4000 LMS software on the PC you can find a folder "Rexroth" in the Start menu. You can find all NYCe 4000 documentation in that folder. The following documention is referenced in this manual.

Document name and order number	Document title and description
DOK-NY4000-HOUSING*ACC-PRRS-EN-E (R911337672)	NYCe 4000 Standard Housings & Accessories Manual, describes the NYCe 4000 system housings and accessories
DOK-INDRV*-HCS01******-PRRS-EN-P (R911322210)	Rexroth IndraDrive Cs Drive Systems with HCS01 Project Planning Manual, describes the IndraDrive Cs modules and accessories
DOK-INDRV*-HMV-S-D+HCS-PR (R911318790)	Rexroth IndraDrive Supply Units, Power Sections HMV, HMS, HMD, HCS02 and HCS03 Project Planning Manual, describes the IndraDrive C and M modules and accessories
ML3 Self-Cooled Linear Motors Project Planning manual (R911289760)	contains detailed information about the ML3 motors, including datasheets and drawings
MLF Synchronous Linear Motors Project Planning manual (R911293635)	contains detailed information about the MLF motors, including datasheets and drawings
IronLess Linear Motors MCL Project Planning Manual (R911330592)	contains detailed information about the MCL motors, including datasheets and drawings
Synchronous Servomotors MSM Data Sheet (R911329338)	contains the data sheets with technical data of all MSM motors
MS2N Synchronous Servomotors Project Planning manual (R911347583)	contains detailed information about the MS2N motors, including datasheets and drawings
Synchronous Servomotors MSK Project planning manual (R911296289)	contains detailed information about the MSK motors, including datasheets and drawings
MBT Synchronous Torque Motors Project Planning Manual (R911298798)	contains detailed information about the MBT motors, including datasheets and drawings

Tab. 1-1: Relevant documentation for drive sizing calculations

1.4 Abbreviations

The following table gives a summary of abbreviations used in this manual.

Abbreviation	Description
BLAC	Brushless Alternating Current motor
BLDC	Brushless Direct Current motor
DriveLink	SERCOS III connection based drives (IndraDrive and ctrlX DRIVE)
FTS	Flexible Transport system (formerly called LMS)

Abbreviation	Description
LMS	Linear Motion System
XML	Extensible Markup Language

Tab. 1-2: Summary of used abbreviations in this manual

2 Drive sizing overview

2.1 Introduction

The process of creating drive sizing calculations with the drive sizing tool is used for optimal selection of the motors and drives in the design phase of new machines or machine upgrades with Bosch Rexroth motors and drives.

2.2 Drive sizing model types

After you start a new project in the drive sizing tool you must choose the desired model type when you add an axis. The following model types are available.

- "Direct Linear" for linear actuators
- "Flexible Transport System" for FTS applications
- "Rotary" for applications with rotary motors like BLAC, BLDC and stepper
- "Rotary with screw" for applications with translating movement of the payload, by rotary motors with a spindle

The choice depends on the type of application. See fig. 2-1 "Model for type "Direct Linear" " on page 5, fig. 2-2 "Model type for "Flexible Transport System" " on page 6, fig. 2-3 "Model type for "Rotary" " on page 6 and fig. 2-4 "Model for type "Rotary with screw" " on page 6, for the schematic model representations used for these model types.

Direct Linear

Model type "Direct Linear" is for applications with a linear actuator. For linear actuators the motor coil is attached to the moving part or "carrier" and the permanent magnet plate is fixed to the track. There is no transmission between motor and load.

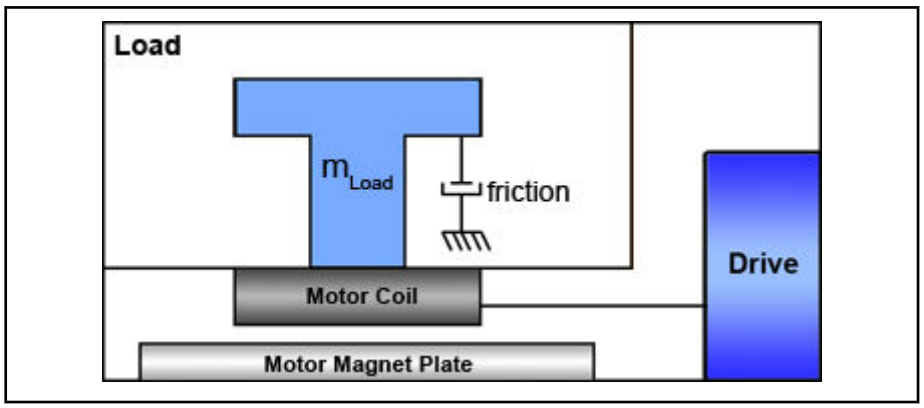


Fig. 2-1: Model for type "Direct Linear"

Flexible Transport System

Flexible transport systems are in principle inverted linear actuators. Therefore, the motor coils are on the fixed track and the permanent magnet plate is attached to the "carrier". There is no transmission between motor and load.

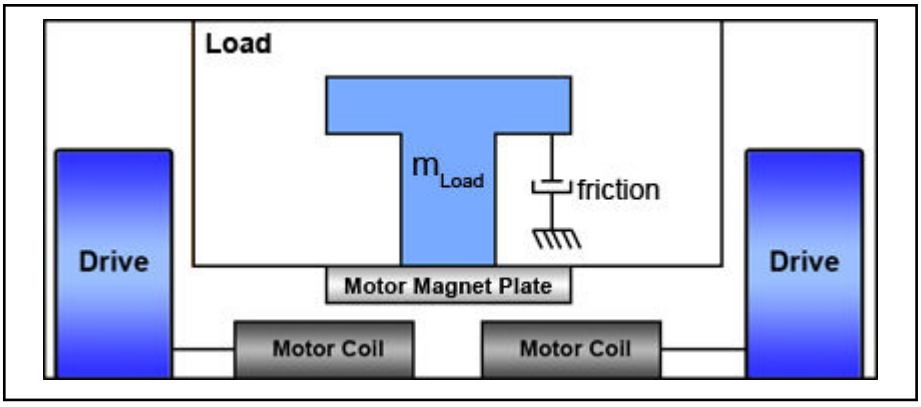


Fig. 2-2: Model type for "Flexible Transport System"

Rotary For applications with rotary motors and rotary loads, a transmission is often used to obtain a velocity and force ratio between motor and load.

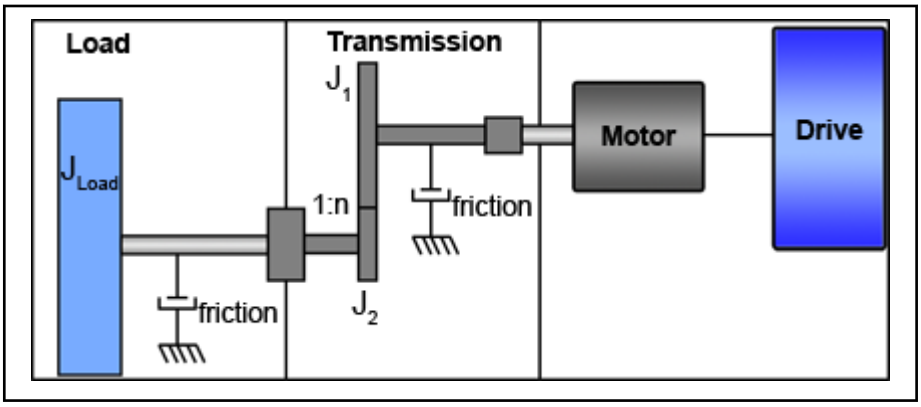


Fig. 2-3: Model type for "Rotary"

Rotary with screw For applications with rotary motor and spindle or belt, the rotary motor drives a spindle or belt, optionally with a transmission in between. The load makes a translating motion imposed by the spindle or belt. The schematic representation shows a spindle.

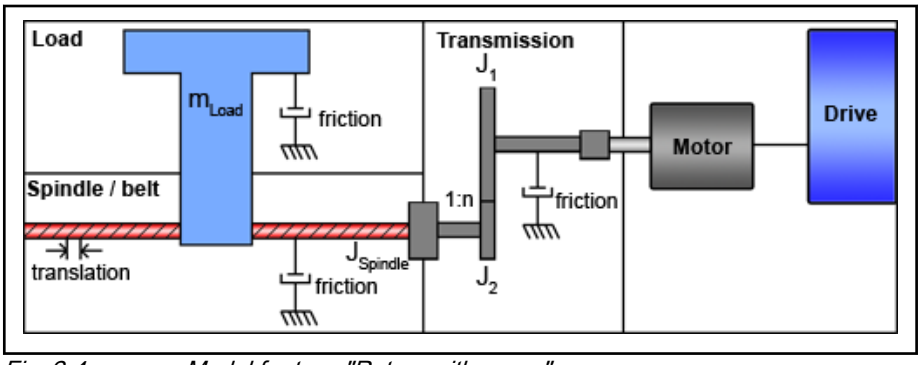


Fig. 2-4: Model for type "Rotary with screw"

2.3 Drive sizing workflow

The drive sizing process consists of 5 separate sequential steps, also called the "drive sizing workflow". The workflow to create a drive sizing report consists of the following steps.

- Mechanical parameterization
- Specifying the motion profiles
- Applying parameters for thermal utilization calculations
- Motor and drive selection
- Check of the results

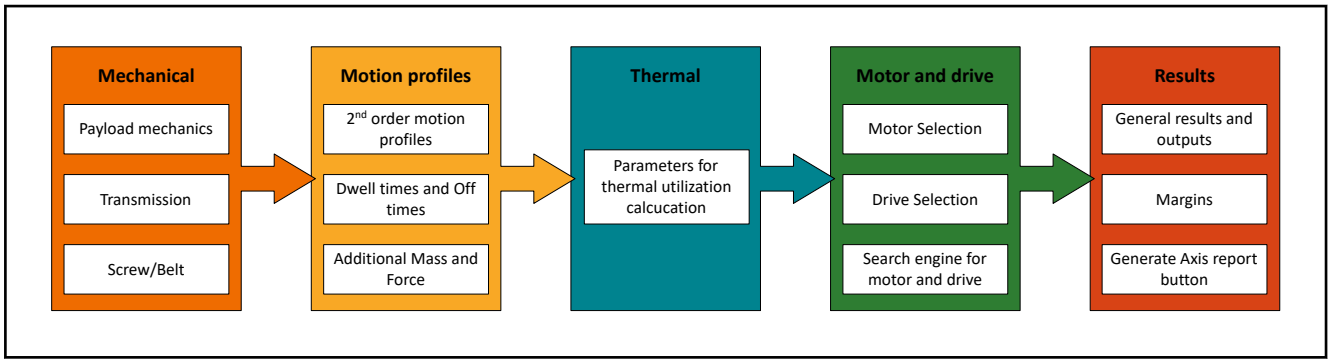


Fig. 2-5: Drive sizing workflow activities

Mechanical

The content of the "Mechanical" step depends on the model type. For "Flexible Transport System" and "Direct Linear" there is no transmission, because the payload is directly coupled to the translator of the motor. Therefore, the mechanical step contains only one tab where you define the payload mechanics "load mass", "friction force" and optionally the "inclination" if the orientation is not horizontal and a gravity component is involved.

For model type "Rotary", the payload mechanics are "inertia" and "friction torque". There is no inclination parameter, because there is no additional gravity component depending on the orientation. Furthermore, a transmission may exist between the motor and the load. Therefore, in case of a transmission, the inertias and angular velocity ratio must be defined. In the drive sizing tool, the payload mechanics and transmission, are separate tabs. The currently selected tab is shown in the schematic model with the specific part colored orange, see fig. 2-3 "Model type for "Rotary" " on page 6.

For model type "Rotary with screw", the payload mechanics are similar as for "Direct Linear" and "Flexible Transport System". The transmission parameters are the same as for model type "Rotary". Additionally, the spindle or belt mechanics must be defined. In the drive sizing tool the payload mechanics, transmission and spindle/screw are separate tabs. The currently selected tab is shown in the schematic model with the specific part colored orange, see fig. 2-4 "Model for type "Rotary with screw" " on page 6.

Motion profiles

The motion profiles that you define in the drive sizing tool are second order profiles, containing time and distance, velocity, and acceleration. These motion profiles apply to the payload. Additionally, profile segment types ‘Dwell’ and ‘Off’ can be added. "Dwell time" means that the payload is not moving, but current can still be sent through the coil when an additional force or mass is applied or in case of an inclination angle. "Off time" means that the drive power is switched off. In the "Motion Profiles" tab the required parameters are entered.

For model type "Rotary" the units are for rotary motion, for example angular velocity. For model types "Flexible Transport System", "Direct Linear" and "Rotary with screw" the units are for translating motion.

Thermal Thermal utilization calculations for both the motor and the drive are taken into account in the drive sizing tool. In the "Thermal" step, the required parameters are entered. In the background, the maximum I^2t values are calculated, similar to the I^2t check used the firmware on the node.

Motor and drive In this step the motor and the drive are selected. Selecting the motor and drive is an iterative process. After selection, you must validate the result in the next step, the "Results" step. If the selected motor and drive do not meet the application requirements or if the selected motor and drive are not optimal, you must select an other combination. A "Motor & drive search engine" is available to assist you in the selection of the right combination of motor and drive. When you click the "Search motor & Drive" button, all motor and drive combinations that meet the requirements are listed and you can select the desired combination.

Results In the results step, general results are shown, such as whether the drive and motor meet the requirements, whether an additional electronic capacitance is required, and for each output parameter how much margin is available with the hardware limitations. There is also a button "Show Axis Report" that generates the drive sizing report or "axis report"'. The "axis report" can be sent to the customer and is used as a final solution for the motor and drive selection.

2.4 Drive sizing report and file saving

The following data is stored in the "axis report".

- Project name, author and description
- Axis name, model type and description
- Mechanical requirements of the application such as load, friction, etc.
- The motor and drive selection
- Motion data containing the motion setpoint profiles of the payload and the corresponding current and power profiles
- Output data with the validation results which are also shown in the "Results" tab of the drive sizing tool.

The drive sizing report can be saved in a file in Word format,, Excel format, or PDF format. The project can also be saved in the drive sizing tool format. The project file is a PDF file, which is formatted as an XML file.

3 Drive Sizing Tool description

3.1 Introduction

When the drive sizing tool is started, the Drive Sizing Tool window appears, see fig. 3-1 "Bosch Rexroth Drive Sizing Tool window" on page 9. Below the menu bar are buttons to create a new project, open an existing project, save a project and save the project "as". These buttons are identical to the options in the "File" menu. This chapter describes the menu bar options.

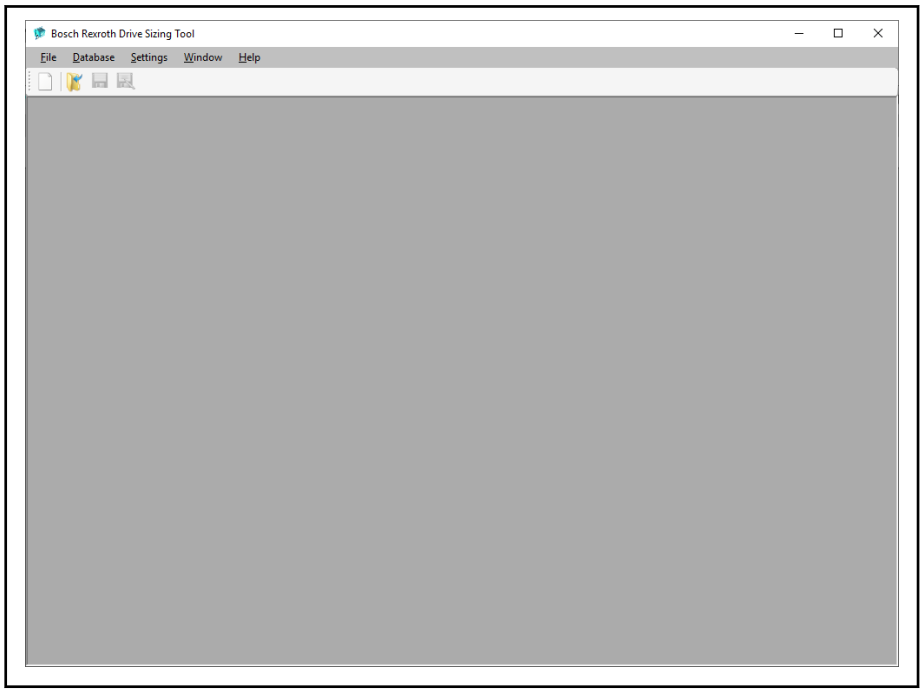


Fig. 3-1: Bosch Rexroth Drive Sizing Tool window

3.2 File menu

The "New project" option in the "File" menu is identical to the first button below the menu bar. After you select "New project" the "Standard Project - New Project" window appears, see fig. 3-2 "Drive Sizing Tool - Standard Project - New Project window" on page 10. You can enter a project name, for example, the company name or the company and application name, the name of the author, and a description of the project.

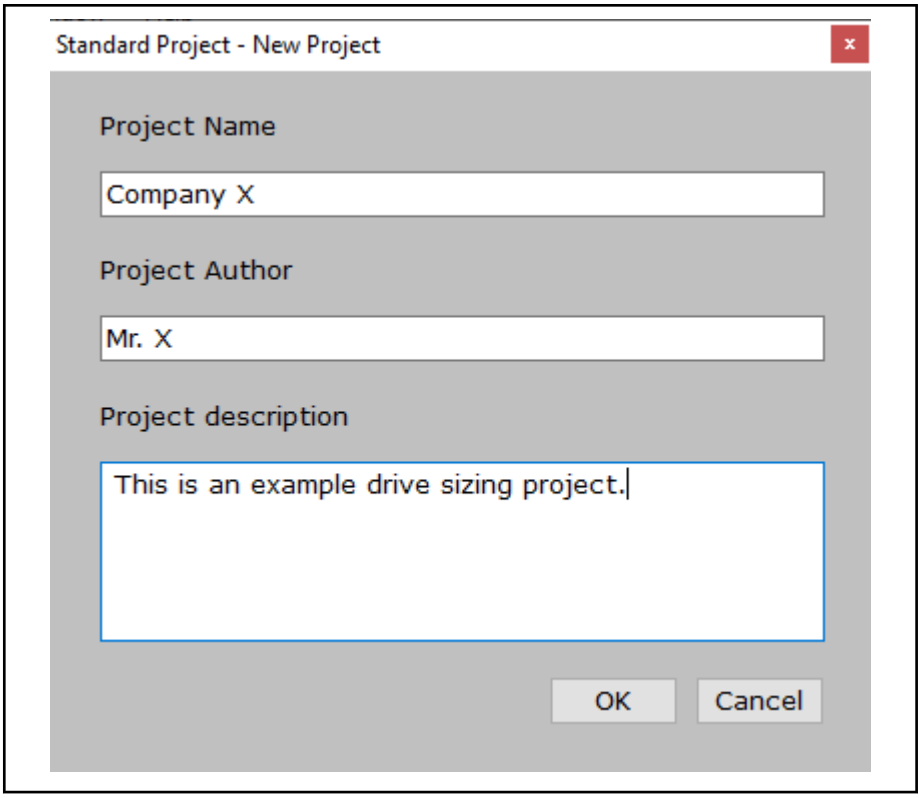


Fig. 3-2: Drive Sizing Tool - Standard Project - New Project window

After you click the "OK" button in the "Standard Project - New Project" the Project window appears, see fig. 3-3 "Drive Sizing Tool - Project window" on page 10. In the Project window you can click the "+ Add an axis" button to add an axis to the project.

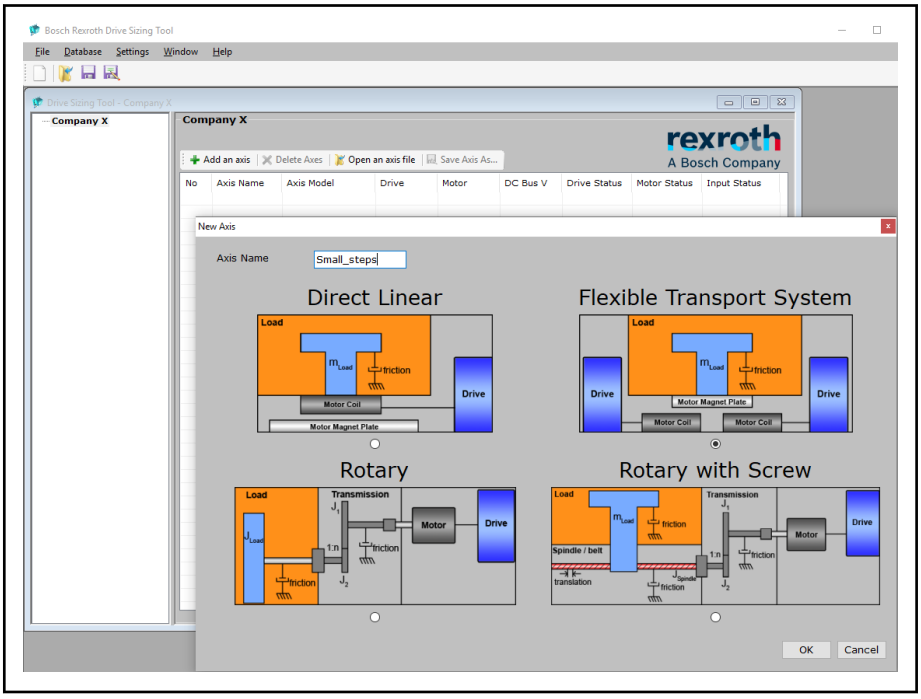


Fig. 3-3: Drive Sizing Tool - Project window

After you click the "+ Add an axis" button the "New Axis" window appears. In the "New Axis" window you enter a name for the axis and select a model type based on the application.

After you click the "OK" button in the "New Axis" window, the first tab for each model type is always the "Description" tab. In the "Descripton" tab you can enter an axis description.

The "Save Project" option is identical to the third button below the menu bar With this option you can save a project, for example, as "Company X.dpf", or save an existing project after you made changes.

The "Save As Project" option is identical to the fourth button below the menu bar. With this option you can save an existing project with a new name.

The "Open Project" option is identical to the second button below the menu bar. With this option you can open an existing project.

3.3 Database menu

In the ‘Database’ menu, the user has the option to add motors.

The database included in the drive sizing tool contains all the motors supported by Bosch Rexroth. However, in the "Database" menu you can add other motors.

Please contact Bosch Rexroth Eindhoven for support if you want to use a motor that is not available in the database.

3.4 Settings menu

In the "Unit Settings" menu you can modify all default dimensions and units, if needed. Each parameter has a drop-down menu from which you can select the dimension and unit, see fig. 3-4 "Drive Sizing Tool - Unit Settings window" on page 12.

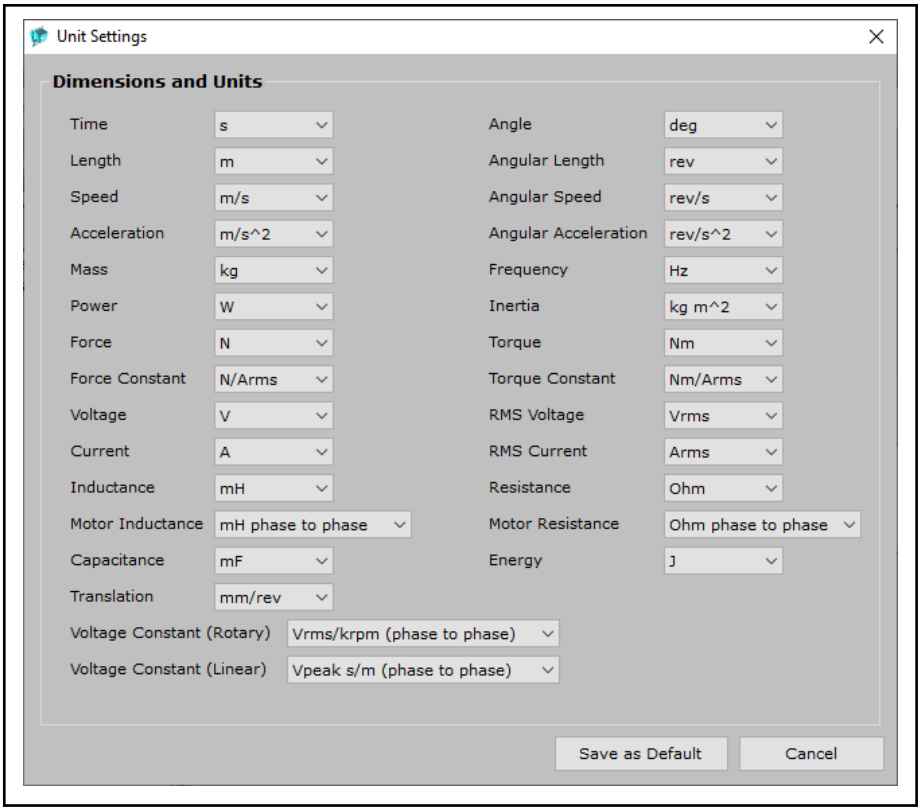


Fig. 3-4: Drive Sizing Tool - Unit Settings window

Click the "Save as Default" button after you changed the dimension and unit of parameters for your project.

☞ You must close and open the project, or terminate and start the drive sizing tool, to apply the changes to your project.

3.5 Window menu

Some options are available for the size and arrangement of the windows in the "Window" menu.

3.6 Help menu

When you select the "'About drive sizing tool" entry in the "Help" menu, the "About Bosch Rexroth Drive Sizing Tool" window appears. In that window you can read the Software version, Database version, and a disclaimer, see fig. 3-5 "Drive Sizing Tool - About Bosch Rexroth Drive Sizing Tool window" on page 13.

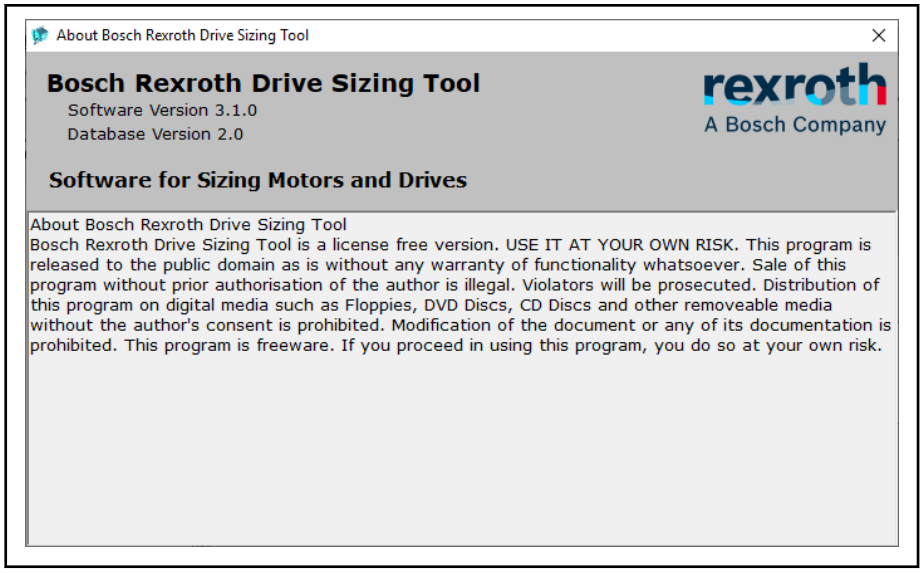


Fig. 3-5: Drive Sizing Tool - About Bosch Rexroth Drive Sizing Tool window

When you select the "View help" entry in the "Help" menu, the "Drive sizing help" window appears, see fig. 3-6 "Drive Sizing Tool - Drive sizing help window" on page 13. This window contains information about all topics of the drive sizing tool.

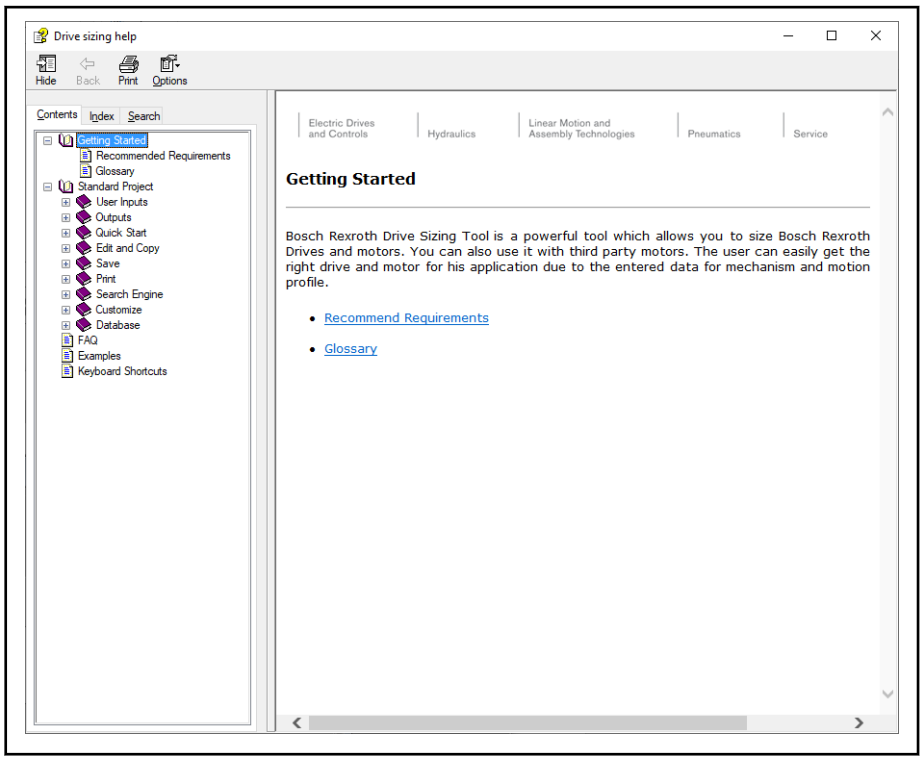


Fig. 3-6: Drive Sizing Tool - Drive sizing help window

4 Drive sizing for an FTS

4.1 Introduction

This chapter describes the process of a drive sizing calculation for an FTS application. As described in chapter 2.3 "Drive sizing workflow" on page 6, the drive sizing process follows a strict workflow order. Each step of the drive sizing workflow for an FTS is described in the following chapters.

Start the drive sizing tool, create a new project and add an axis, as described in chapter 3.1 "Introduction" on page 9 and chapter 3.2 "File menu" on page 9. After you click the "+ Add an axis" button, the "New Axis" window appears, see fig. 3-3 "Drive Sizing Tool - Project window" on page 10. In this window you enter the axis name and select the model type "Flexible Transport System". When you click the "OK" button in the "New Axis" window, the workflow tabs appear in the "Project" window, see fig. 4-1 "Drive Sizing Tool - Project window, Description tab" on page 15. In the "Description" tab you can enter any description information of the project. This description is also shown in the axis report.

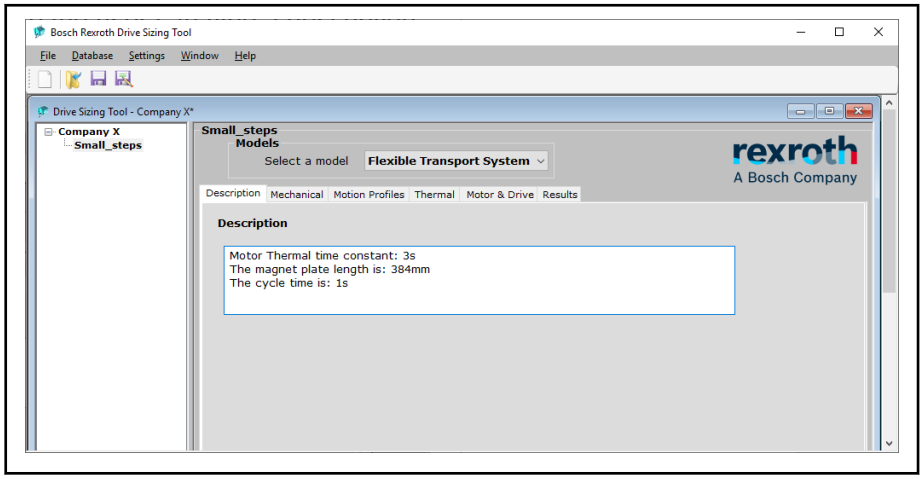


Fig. 4-1: Drive Sizing Tool - Project window, Description tab

For FTS projects, it is good practise to enter in the "Description" text field at least the motor thermal time constant, the magnet plate length and the cycle time, because these parameters are by default not shown in the drive sizing report. These parameters are required for the thermal utilization calculations.

4.2 Workflow step - Mechanical

After you entered a description in the "Description" tab, you click the "Mechanical" tab for the first step in the workflow process, see fig. 4-2 "Drive Sizing Tool - Project window, Mechanical tab" on page 16.

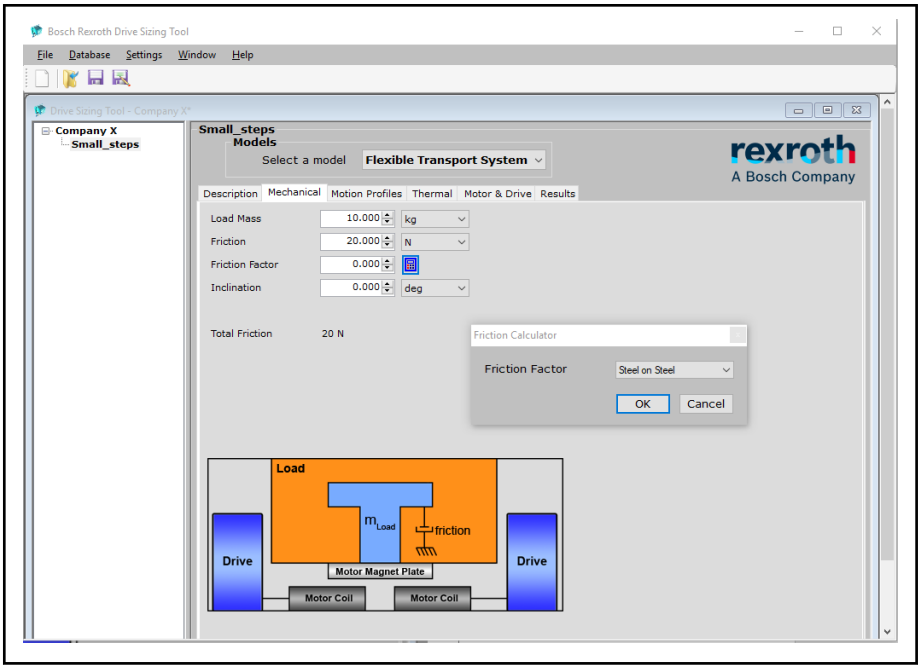


Fig. 4-2: Drive Sizing Tool - Project window, Mechanical tab

The model shown in this tab is the fig. 2-2 "Model type for "Flexible Transport System" " on page 6, where the orange colored plane indicates that the parameters related to the load are specified in this part of the workflow.

The "Load Mass" is the total carrier mass, including the magnet plate and the product to be transported.

Two options are available to specify the friction of the guiding system.

- "Friction" : here you specify the total friction force of a carrier moving at constant velocity.
- "Friction factor" : here you select a friction factor from the drop-down menu.

Obviously, you need to know the total friction force to specify the friction force. Keep in mind when you select a friction factor, this friction factor only applies to the total carrier mass or "Load Mass", while in reality there is also an attraction force between magnet plate and coil.

Typically for FTS applications, multiple guiding blocks are mounted underneath a carrier, often four. Practically, the mechanical alignment between the guiding blocks is never perfect. For that reason, the specified friction factors in data sheets of guiding system suppliers are typically not representative for the total friction subjected to the FTS carrier.

Practically, the friction or friction factor is a number based on experience. Often the friction force is between 10% and 20% of the carrier weight.

"Inclination" depends on the actual inclination angle of the FTS track. The default value is 0, which means that the FTS track is oriented horizontal. A gravity component is added to the required force and current calculations when the inclination angle is increased.

4.3 Workflow step - Motion Profiles

You can specify the movement setpoint profiles in the "Motion Profiles" tab, see fig. 4-3 "Drive Sizing Tool - Project window, Motion Profiles tab" on page 17.

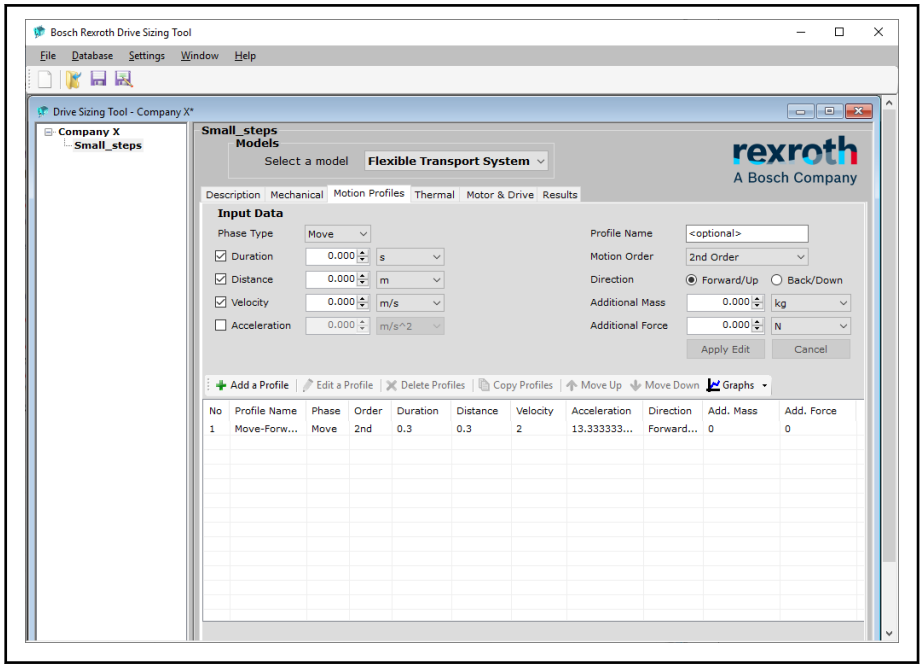


Fig. 4-3: Drive Sizing Tool - Project window, Motion Profiles tab

You can choose the profile segment type from the "Phase Type" drop-down menu. The following options are available.

- "Move"
- "Dwell"
- "Off"

Usually, "Move" is selected first. The required input parameters for "Move" are "Duration", "Distance", "Velocity" and "Acceleration". You must specify 3 of the 4 parameters, the fourth parameter is calculated automatically. Optionally, you can specify a profile name in the "Profile Name" text entry field. The "Motion Order" is in this case always "2nd Order", and cannot be changed. You can add an "Additional Mass" for a motion profile, for example, if at some location in the production line some mass is added to the carrier. You can also add an "Additional Force", for example, if at some process station in the production line a robot puts an external force onto the carrier. The applied "Additional Force" is a force in the direction of movement. When all parameters for one profile segment are specified, you can click the "+ Add a Profile". The specified profile step appears in the table below the "Input Data" section. This table is hereafter called "spread sheet".

The required input parameter for the phase type "Dwell" is only "Duration", because dwell is the standstill time of the carrier. At standstill time an external force could be excerted on the carrier and in that case a current is sent through the coils. For that reason you can also specify a value in the "Additional Force" field besides the dwell time.

The required input parameter for the phase type "Off" is only "Duration". "Off" means that the drive power is off, thus there is no sense to specify an additional force.

Next to the "+ Add a Profile" button, is the "Edit a Profile" button. When a profile step is selected from the spread sheet and you click the "Edit a Profile" button, you can change the profile parameters. Click the "Apply Edit" button to confirm the changes.

You can also delete defined profile steps. When a profile step is selected from the spread sheet and you click the "Delete Profiles" button, the selected profile step is deleted.

Profile steps can be duplicated. When a profile step or steps is selected from the spread sheet and you click the "Copy Profiles" button, the selected profile step(s) is copied.

With the buttons "Move Up" and "Move Down" you can change the order of the selected profile step(s).

When you click the "Graphs" button the total profile with all profile steps is displayed.

4.4 Workflow step - Thermal

You can specify the required parameters for drive and motor thermal utilization calculations in the "Thermal" tab, see fig. 4-4 "Drive Sizing Tool - Project window, Thermal tab" on page 18.

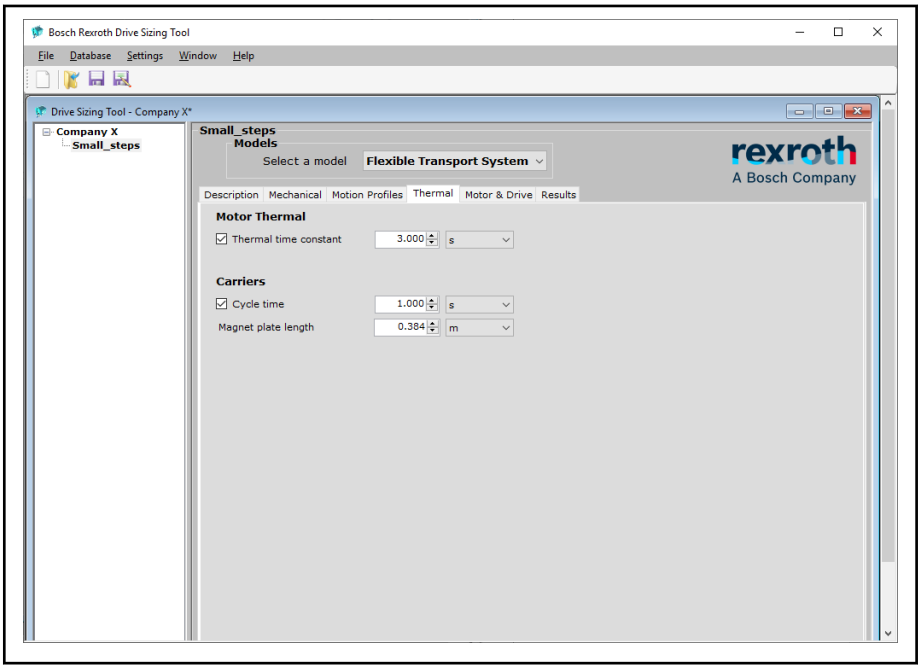


Fig. 4-4: Drive Sizing Tool - Project window, Thermal tab

In "Motor Thermal" you can specify the "Thermal time constant". This "Thermal time constant" is the time constant that is used for the motor I^2t calculation. The thermal utilization calculation for the drive is also an I^2t calculation. The algorithms used in the drive sizing tool for motor I^2t and drive I^2t are the same algorithms used in the NYCe 4000 firmware to control the FTS.

In "Carriers" the parameters "Cycle Time" and "Magnet plate length" are needed for an accurate calculation of the I^2t values, because carriers move from coil to coil and the drive sizing tool calculates the maximum I^2t values for

the worst case coil in the profile. In this context the worst case coil is the coil with the highest average current. The cycle time is the time from start movement of one carrier until start movement of the next carrier. If the cycle time is longer than the required time, current is sent through the worst case coil during one movement and then there is a rest time between the consecutive carriers. If the cycle time is shorter, then the profile over the worst case coil is continuously repeated and the cycle time might as well be switched off (remove the checkmark of the "Cycle time" checkbox). The exact time that the carrier moves over the worst case coil depends on the motion profile, the magnet plate length and coil type (number of coil triplets, which is not yet known).

4.5 Workflow step - Motor & Drive

You select the motor and drive in the "Motor & Drive" tab, see fig. 4-5 "Drive Sizing Tool - Project window, Motor & Drive tab" on page 19.

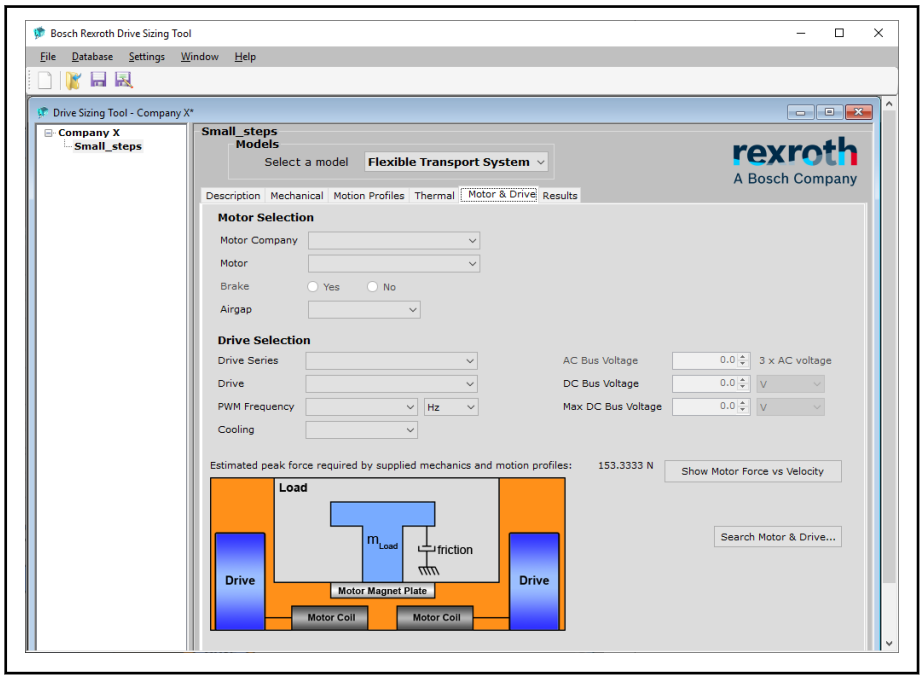


Fig. 4-5: Drive Sizing Tool - Project window, Motor & Drive tab

The selection of a motor and drive is in principle an iterative process. You select a motor and drive combination and then check whether the selection is optimal. A "Motor-Drive Search Engine" is included in the drive sizing tool to make this selection process more efficient. Click the "Search Motor & Drive..." button to open the search engine. The "Motor-Drive Search Engine" window appears, see fig. 4-6 "Drive sizing tool - Motor-Drive Search Engine window" on page 20.

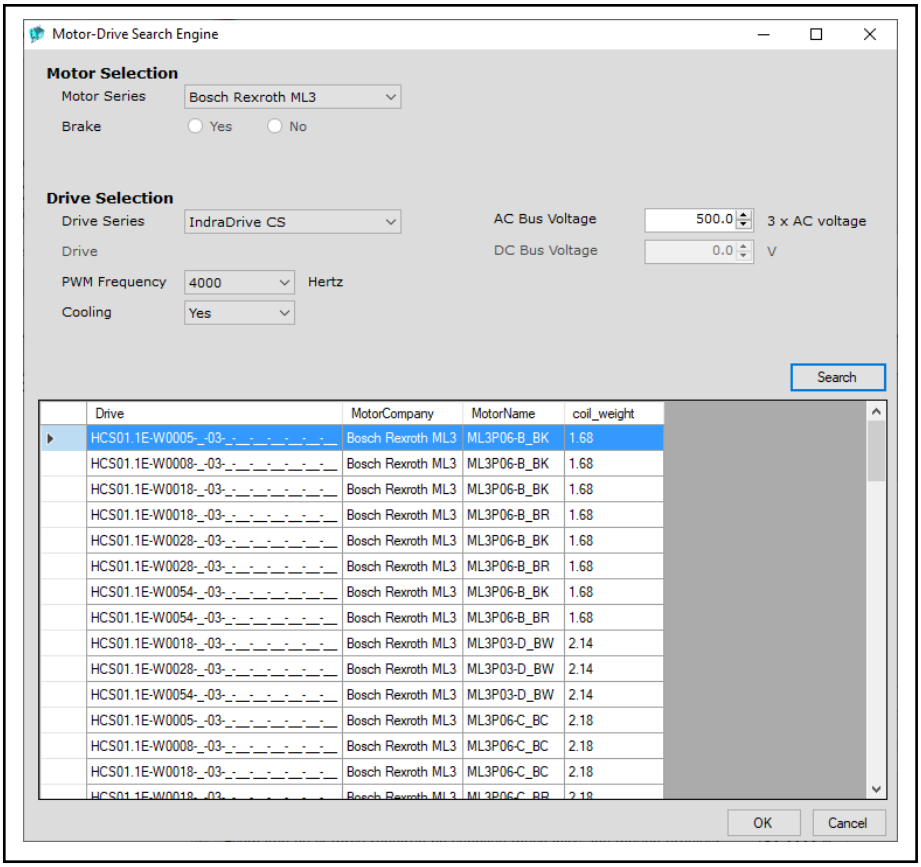


Fig. 4-6: Drive sizing tool - Motor-Drive Search Engine window

Motor Selection

In the "Motor Selection" you must select the "Motor Series". For FTS projects the only option is "Bosch Rexroth".

You specify the distance between the magnet plate of the carrier and coils with the "Airgap" drop-down box. The distance is specified in millimeters

Drive Selection

In the "Drive Selection" you must select the "Drive Series". For FTS projects the following options are available.

- NYCe 4000
- IndraDrive Cs
- IndraDrive C

With the "PWM Frequency" drop-down list you select the PWM frequency. For NYCe 4000 drives you can choose between 16000 Hz and 32000 Hz. The default value in the FTS control software is 32000 Hz. For DriveLink drives you must always select 4000 Hz.

You must always specify the bus voltage to the drives. You specify the DC Bus Voltage for NYCe 4000 drives. The DC Bus Voltage minimum value is 12V and the maximum value is 75V. Standard available power supplies are 24V, 48V and 72V. You specify the AC Bus Voltage for DriveLink drives. For single phase IndraDrive Cs (HCS01.1E-W00xx-02), the maximum value 230V can be selected. For three-phase IndraDrive Cs (HCS01.1E-W00xx-03), the maximum value 500V can be selected. For IndraDrive C, the maximum 500V can be selected.

The selection for the "Cooling" is always "Yes" and cannot be changed, because drive cooling with NYCe 4000 fan units is mandatory.

Click the "Search" button after you specified all fields in the "Motor Selection" and "Drive Selection". The first option in the list is the smallest combination, with the smallest drive that meets the requirements. You can select this combination, or the combination with the smallest motor and a larger drive, and click the "OK" button. The selected motor and drive combination is displayed in the "Motor & Drive" tab.

4.6 Workflow step - Results

The results, whether the chosen motor and drive meet the application requirements and whether the choice is optimal, are shown in the "Results" tab, see fig. 4-7 "Drive Sizing Tool - Project window, Results tab" on page 21.

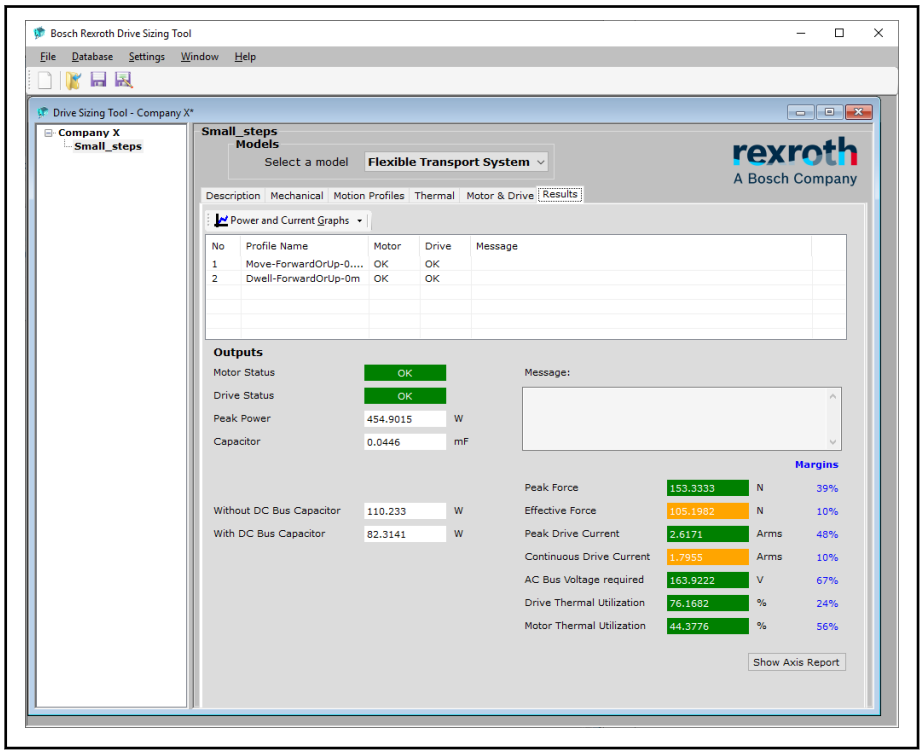


Fig. 4-7: Drive Sizing Tool - Project window, Results tab

The final results are shown in the "Outputs'" section. You can immediately see whether the "Motor Status" and "Drive Status" are "OK". Below the status results, the "Peak Power" required from the drive, the additional "Capacitor" required for the drive (to guarantee that no energy will be returned to the power supply, or mains in case of DriveLink drives, when decelerating the carrier), and average required power with and without capacitor are shown. Two standard capacitor kits for NYCe 4000 drives (NY4120/10) are available.

- NYA04.1-CAP-100V-NY4921, working voltage 100V and capacitance 6.8mF
- NYA04.1-CAP-200V-NY4921/10, working voltage 200V and capacitance 2.2mF

These capacitor kits can be installed on the NY4074 standard housing. You need a capacitor kit for each installed drive module.

DriveLink drives have internal capacitors. The capacitance indicated in the "Results" tab must be lower than the internal capacitance in the DriveLink

drives. This internal capacitance can be checked in the Project Planning manuals of the HCS01 (DOK-INDRV*-HCS01******-PRRS-EN-P), and HCS02 and HCS03 (DOK-INDRV*-HMV-S-D+HCS-PR).

If the "Motor Status" or "Drive Status" is "Not OK", you can read the reason in the "Message" box.

Below the "Message" box you can read the main check parameters and their margins. The "Motor Status" and "Drive Status" can only be "OK" if all margins are 10% or higher. If a margin is larger than 10% the value of the check parameter is green. If a margin is equal to 10% or lower than 10%, but larger than or equal to 0% the value of the check parameter is yellow. If the margin is below zero the value of the check parameter is red.

You must take into account an extra margin of 25% for curved tracks. Thus, the indicated margin for a curved track must be at least 35%. The extra margin is needed, because when a carrier is above a coil under an angle (in a curve), the same amount of current generates less force. This 35% margin applies for the max peak force, max continuous force, and thermal utilisation parameters.

You must take into account an extra margin of 10% if the magnet plates are vacuum plates for environmental temperatures up to 150 °C (SmCo magnets). The extra margin is needed, because SmCo permanent magnets are weaker than the magnets of standard magnet plates (NdFeB magnets). This 10% extra margin applies for the max peak force, max continuous force, and thermal utilisation parameters.

If the results are OK, click the "Show Axis Report" button to generate the Axis Report. See chapter 8 "Appendix A - Drive sizing report for an FTS" on page 53 for an example of an Axis Report of an FTS application. Click the "Save" icon in the icon bar to save the Axis Report to a file in Word format, Excel format or PDF format.

5 Drive sizing for a linear actuator

5.1 Introduction

This chapter describes the process of a drive sizing calculation for an application with a linear actuator. As described in chapter 2.3 "Drive sizing workflow" on page 6, the drive sizing process follows a strict workflow order. Each step of the drive sizing workflow for a linear actuator is described in the following chapters.

Start the drive sizing tool, create a new project and add an axis, as described in chapter 3.1 "Introduction" on page 9 and chapter 3.2 "File menu" on page 9. After you click the "+ Add an axis" button, the "New Axis" window appears, see fig. 3-3 "Drive Sizing Tool - Project window" on page 10. In this window you enter the axis name and select the model type "Direct Linear". When you click the "OK" button in the "New Axis" window, the workflow tabs appear in the "Project" window, see fig. 5-1 "Drive Sizing Tool - Project window, Description tab" on page 23. In the "Description" tab you can enter any description information of the project. This description is also shown in the axis report.

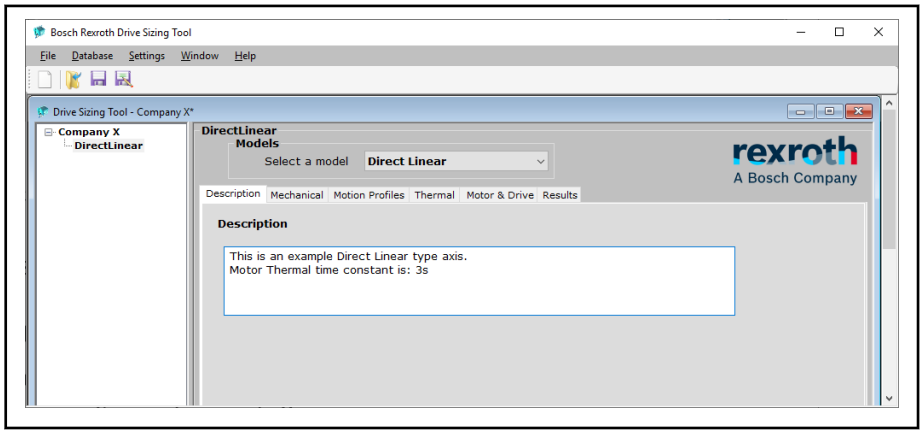


Fig. 5-1: Drive Sizing Tool - Project window, Description tab

For linear actuator projects, it is good practise to enter in the "Description" text field at least the motor thermal time constant, because this parameter is by default not shown in the drive sizing report. This parameter is required for the thermal utilization calculations.

5.2 Workflow step - Mechanical

After you entered a description in the "Description" tab, you click the "Mechanical" tab for the first step in the workflow process, see fig. 5-2 "Drive Sizing Tool - Project window, Mechanical tab" on page 24.

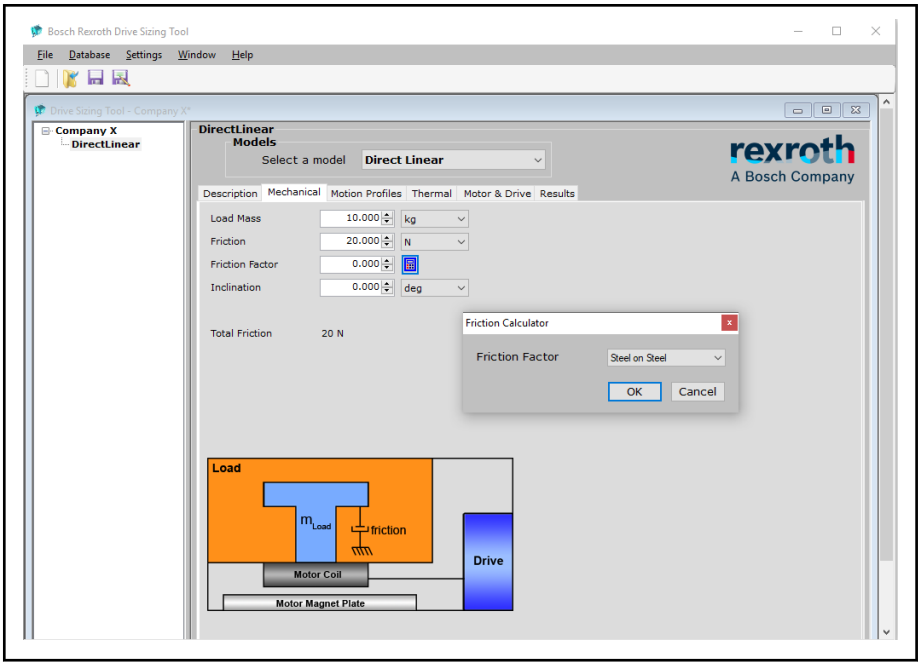


Fig. 5-2: Drive Sizing Tool - Project window, Mechanical tab

The model shown in this tab is the fig. 2-1 "Model for type "Direct Linear" " on page 5, where the orange colored plane indicates that the parameters related to the load are specified in this part of the workflow.

The "Load Mass" is the total carrier mass, including the coil and the product to be transported.

Two options are available to specify the friction of the guiding system.

- "Friction" : here you specify the total friction force of a carrier moving at constant velocity.
- "Friction factor" : here you select a friction factor from the drop-down menu.

Obviously, you need to know the total friction force to specify the friction force. Keep in mind when you select a friction factor, this friction factor only applies to the total carrier mass or "Load Mass", while in reality there is also an attraction force between magnet plate and coil.

Typically for Direct Linear applications, multiple guiding blocks are mounted underneath a carrier. Practically, the mechanical alignment between the guiding blocks is never perfect. For that reason, the specified friction factors in data sheets of guiding system suppliers are typically not representative for the total friction subjected to the carrier.

☞ Practically, the friction or friction factor is a number based on experience. Often the friction force is between 10% and 20% of the carrier weight.

"Inclination" depends on the actual inclination angle of the linear actuator track. The default value is 0, which means that the track is oriented horizontal. A gravity component is added to the required force and current calculations when the inclination angle is increased.

5.3 Workflow step - Motion Profiles

You can specify the movement setpoint profiles in the "Motion Profiles" tab, see fig. 5-3 "Drive Sizing Tool - Project window, Motion Profiles tab" on page 25.

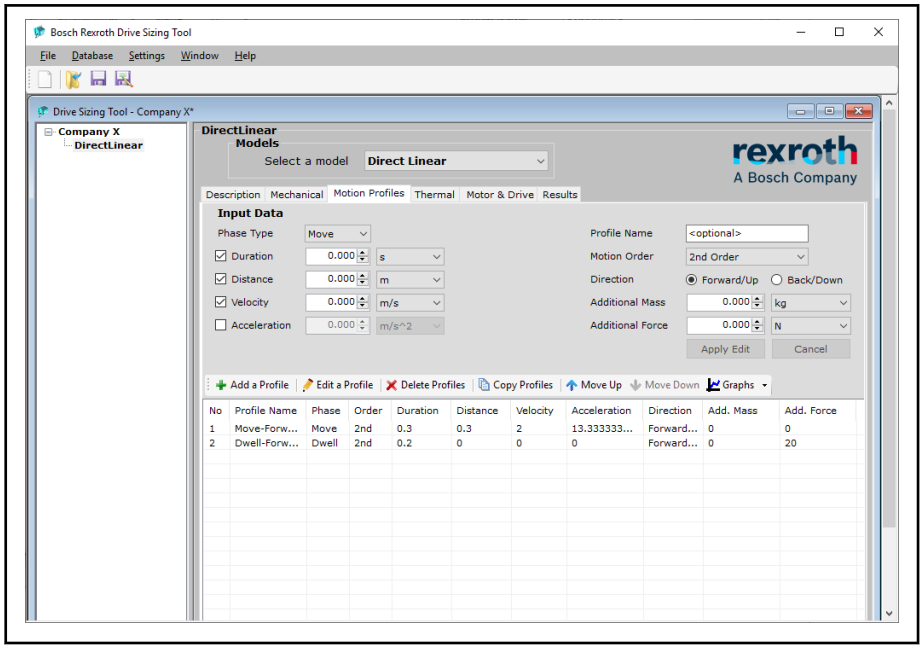


Fig. 5-3: Drive Sizing Tool - Project window, Motion Profiles tab

You can choose the profile segment type from the "Phase Type" drop-down menu. The following options are available.

- "Move"
- "Dwell"
- "Off"

Usually, "Move" is selected first. The required input parameters for "Move" are "Duration", "Distance", "Velocity" and "Acceleration". You must specify 3 of the 4 parameters, the fourth parameter is calculated automatically. Optionally, you can specify a profile name in the "Profile Name" text entry field. The "Motion Order" is in this case always "2nd Order", and cannot be changed. You can add an "Additional Mass" for a motion profile, for example, if at some location in the production line some mass is added to the carrier. You can also add an "Additional Force", for example, if at some process station in the production line a robot puts an external force onto the carrier. The applied "Additional Force" is a force in the direction of movement. When all parameters for one profile segment are specified, you can click the "+ Add a Profile". The specified profile step appears in the table below the "Input Data" section. This table is hereafter called "spread sheet".

The required input parameter for the phase type "Dwell" is only "Duration", because dwell is the standstill time of the carrier. At standstill time an external force could be excerted on the carrier and in that case a current is sent through the coils. For that reason you can also specify a value in the "Additional Force" field besides the dwell time.

The required input parameter for the phase type "Off" is only "Duration". "Off" means that the drive power is off, thus there is no sense to specify an additional force.

Next to the "+ Add a Profile" button, is the "Edit a Profile" button. When a profile step is selected from the spread sheet and you click the "Edit a Profile" button, you can change the profile parameters. Click the "Apply Edit" button to confirm the changes.

You can also delete defined profile steps. When a profile step is selected from the spread sheet and you click the "Delete Profiles" button, the selected profile step is deleted.

Profile steps can be duplicated. When a profile step or steps is selected from the spread sheet and you click the "Copy Profiles" button, the selected profile step(s) is copied.

With the buttons "Move Up" and "Move Down" you can change the order of the selected profile step(s).

When you click the "Graphs" button the total profile with all profile steps is displayed.

5.4 Workflow step - Thermal

You can specify the required parameters for drive and motor thermal utilization calculations in the "Thermal" tab, see fig. 5-4 "Drive Sizing Tool - Project window, Thermal tab" on page 26.

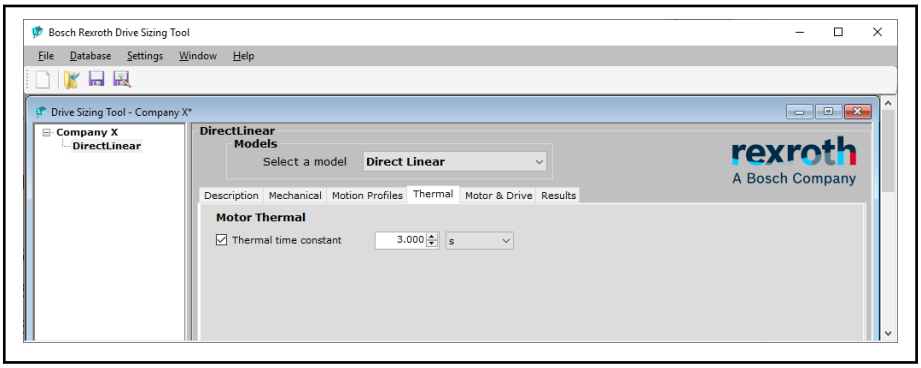


Fig. 5-4: Drive Sizing Tool - Project window, Thermal tab

In "Motor Thermal" you can specify the "Thermal time constant". This "Thermal time constant" is the time constant that is used for the motor I^2t calculation. The thermal utilization calculation for the drive is also an I^2t calculation. The algorithms used in the drive sizing tool for motor I^2t and drive I^2t are the same algorithms used in the NYCe 4000 firmware to control the linear actuator. The thermal time constant used for the drive thermal utilisation is fixed and cannot be changed.

5.5 Workflow step - Motor & Drive

You select the motor and drive in the "Motor & Drive" tab, see fig. 5-5 "Drive Sizing Tool - Project window, Motor & Drive tab" on page 27.

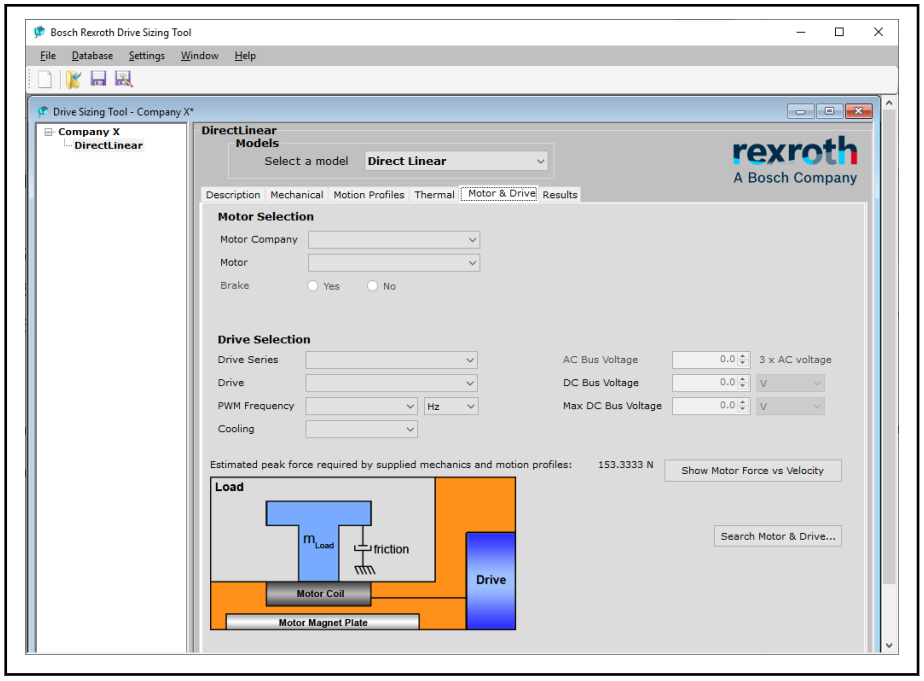


Fig. 5-5: Drive Sizing Tool - Project window, Motor & Drive tab

The selection of a motor and drive is in principle an iterative process. You select a motor and drive combination and then check whether the selection is optimal. A "Motor-Drive Search Engine" is included in the drive sizing tool to make this selection process more efficient. Click the "Search Motor & Drive..." button to open the search engine. The "Motor-Drive Search Engine" window appears, see fig. 5-6 "Drive sizing tool - Motor-Drive Search Engine window" on page 28.

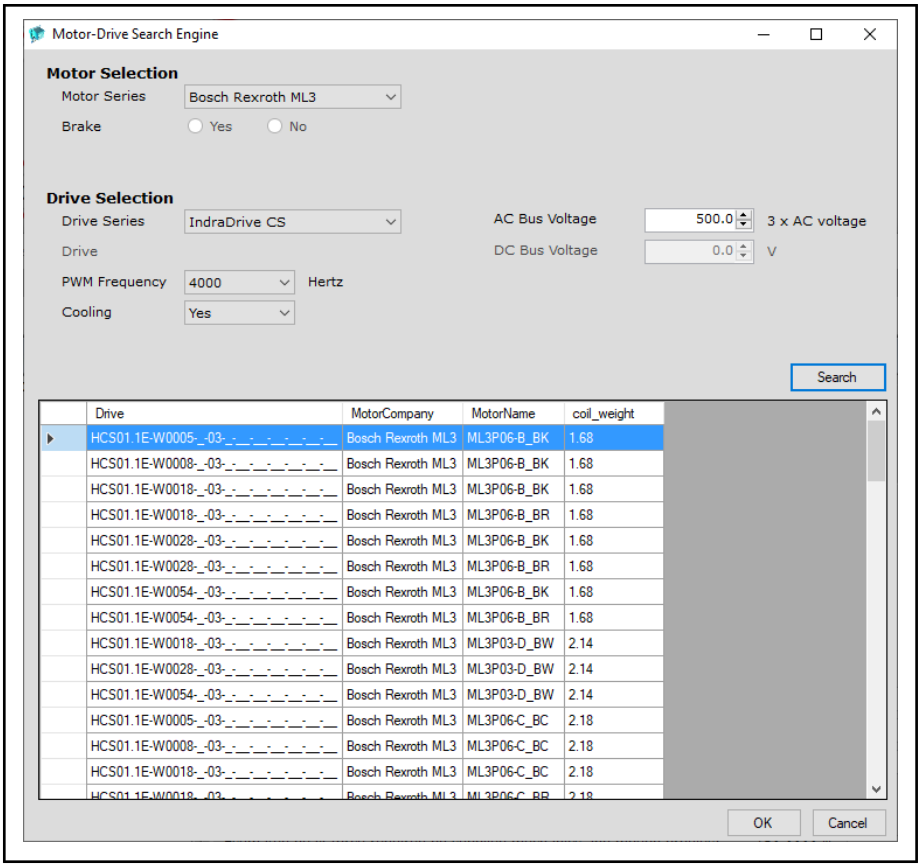


Fig. 5-6: Drive sizing tool - Motor-Drive Search Engine window

Motor Selection

In the "Motor Selection" you must select the "Motor Series". For Direct Linear projects the options are "Bosch Rexroth ML3", "Bosch Rexroth MCL" and "Bosch Rexroth MLF". The ML3 motors are the same iron core linear actuators as the Bosch Rexroth series for FTS projects, but with different names. The MLF motors are larger size iron core synchronous linear motors and the MCL series are ironless linear motors. See "ML3 Self-Cooled Linear Motors Project Planning manual", "MLF Synchronous Linear Motors Project Planning manual" and "IronLess Linear Motors MCL Project Planning Manual", order number R9113305, for detailed information.

Drive Selection

In the "Drive Selection" you must select the "Drive Series". For Direct Linear projects the following options are available.

- NYCe 4000
- IndraDrive Cs
- IndraDrive C

With the "PWM Frequency" drop-down list you select the PWM frequency. For NYCe 4000 drives you can choose between 16000 Hz and 32000 Hz. The default value in the control software is 32000 Hz. For Direct Linear projects using DriveLink drives you must always select 4000 Hz.

You must always specify the bus voltage to the drives. The NYCe 4000 drive modules you can use for Direct Linear projects are "NY4120" and "NY4140". You specify the DC Bus Voltage for NYCe 4000 drives. The DC Bus Voltage minimum value is 12V for both drive modules. The DC Bus Voltage maximum value is 75V for the NY4120. The DC Bus Voltage maximum value is 150V for the NY4140. Standard available power supplies are 24V, 48V and 72V. If

a higher bus voltage is needed, you can connect multiple DC power supplies in series.

Not all DC power supplies are suited to connect in series. Check the data sheet of the power supply manufacturer.

You specify the AC Bus Voltage for DriveLink drives. For single phase IndraDrive Cs (HCS01.1E-W00xx-02), the maximum value 230V can be selected. For three-phase IndraDrive Cs (HCS01.1E-W00xx-03), the maximum value 500V can be selected. For IndraDrive C, the maximum 500V can be selected.

Click the "Search" button after you specified all fields in the "Motor Selection" and "Drive Selection". The first option in the list is the smallest combination, with the smallest drive that meets the requirements. You can select this combination, or the combination with the smallest motor and a larger drive, and click the "OK" button. The selected motor and drive combination is displayed in the "Motor & Drive" tab.

The selection for the "Cooling" is always "Yes" and cannot be changed, because drive cooling with NYCe 4000 fan units is mandatory.

5.6 Workflow step - Results

The results, whether the chosen motor and drive meet the application requirements and whether the choice is optimal, are shown in the "Results" tab, see fig. 5-7 "Drive Sizing Tool - Project window, Results tab" on page 29.

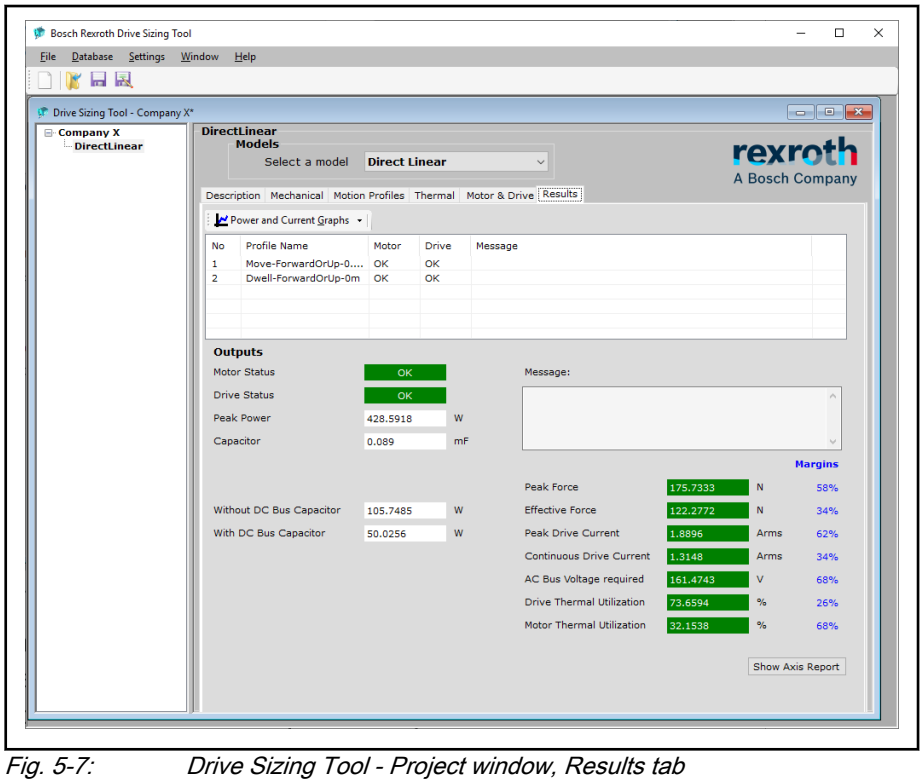


Fig. 5-7: Drive Sizing Tool - Project window, Results tab

The final results are shown in the "Outputs'" section. You can immediately see whether the "Motor Status" and "Drive Status" are "OK". Below the status

results, the "Peak Power" required from the drive, the additional "Capacitor" required for the drive (to guarantee that no energy will be returned to the power supply, or mains in case of DriveLink drives, when decelerating the carrier), and average required power with and without capacitor are shown. Two standard capacitor kits for NYCe 4000 drives (NY4120 and NY4140) are available.

- NYA04.1-CAP-100V-NY4921, working voltage 100V and capacitance 6.8mF
- NYA04.1-CAP-200V-NY4921/10, working voltage 200V and capacitance 2.2mF

These capacitor kits can be installed on the NY4074 standard housing. You need a capacitor kit for each installed drive module.

DriveLink drives have internal capacitors. The capacitance indicated in the "Results" tab must be lower than the internal capacitance in the DriveLink drives. This internal capacitance can be checked in the Project Planning manuals of the HCS01 (DOK-INDRV*-HCS01******-PRRS-EN-P), and HCS02 and HCS03 (DOK-INDRV*-HMV-S-D+HCS-PR).

If the "Motor Status" or "Drive Status" is "Not OK", you can read the reason in the "Message" box.

Below the "Message" box you can read the main check parameters and their margins. The "Motor Status" and "Drive Status" can only be "OK" if all margins are 10% or higher. If a margin is larger than 10% the value of the check parameter is green. If a margin is equal to 10% or lower than 10%, but larger than or equal to 0% the value of the check parameter is yellow. If the margin is below zero the value of the check parameter is red.

If the results are OK, click the "Show Axis Report" button to generate the Axis Report. Click the "Save" icon in the icon bar to save the Axis Report to a file in Word format, Excel format or PDF format.

6 Drive sizing for a rotary motor

6.1 Introduction

This chapter describes the process of a drive sizing calculation for an application with a rotary motor. As described in chapter 2.3 "Drive sizing workflow" on page 6, the drive sizing process follows a strict workflow order. Each step of the drive sizing workflow for a rotary motor is described in the following chapters.

Start the drive sizing tool, create a new project and add an axis, as described in chapter 3.1 "Introduction" on page 9 and chapter 3.2 "File menu" on page 9. After you click the "+ Add an axis" button, the "New Axis" window appears, see fig. 3-3 "Drive Sizing Tool - Project window" on page 10. In this window you enter the axis name and select the model type "Rotary". When you click the "OK" button in the "New Axis" window, the workflow tabs appear in the "Project" window, see fig. 6-1 "Drive Sizing Tool - Project window, Description tab" on page 31. In the "Description" tab you can enter any description information of the project. This description is also shown in the axis report.

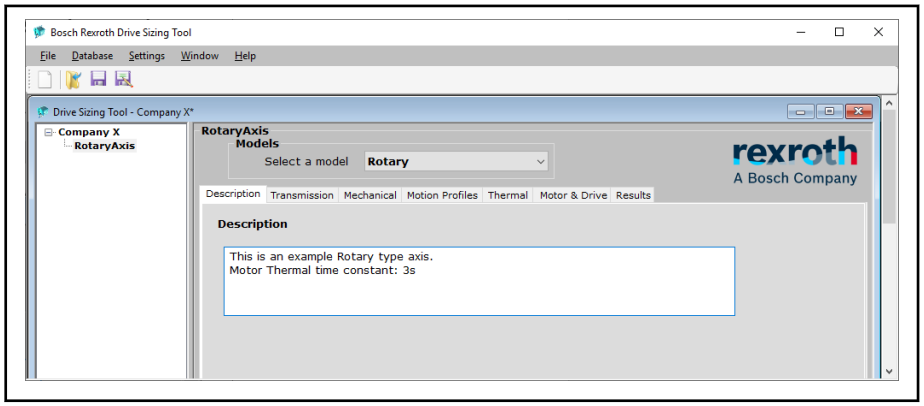


Fig. 6-1: Drive Sizing Tool - Project window, Description tab

For rotary motor projects, it is good practise to enter in the "Description" text field at least the motor thermal time constant, because this parameter is by default not shown in the drive sizing report. This parameter is required for the thermal utilization calculations.

6.2 Workflow step - Mechanical

After you entered a description in the "Description" tab, you can start the first step in the workflow process. The first step in the workflow process for a rotary motor consists of two tabs in the drive sizing tool, "Transmission" and "Mechanical". In the "Transmission" tab the mechanics of an optional transmission between the motor and the load are described. In the "Mechanical" tab the mechanics of the load are described.

Transmission

The "Transmission" tab is shown in fig. 6-2 "Drive Sizing Tool - Project window, Transmission tab" on page 32. The model shown in this tab is the fig. 2-3 "Model type for "Rotary" " on page 6, where the orange colored part marks the transmission and the parameters related to the transmission specified in this part of the workflow.

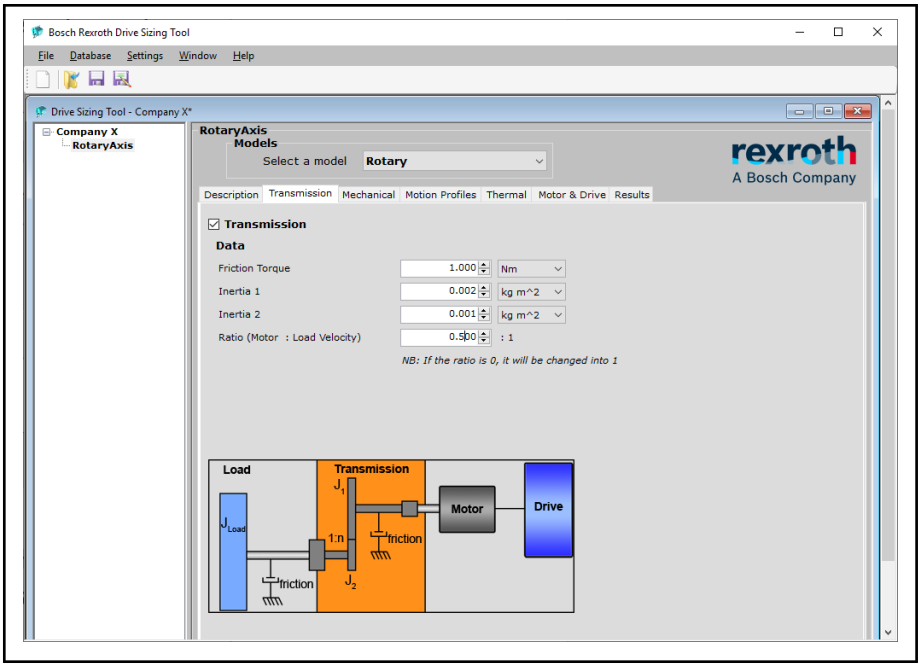


Fig. 6-2: Drive Sizing Tool - Project window, Transmission tab

You can specify whether the rotary axis application includes a transmission with the "Transmission" checkbox on the "Transmission" tab. If you specify a transmission, you must specify the parameters "Friction Torque" of the transmission, the inertias of the gear wheels, "‘Inertia 1" on the motor side and "Inertia 2" on the load side, and the velocity "Ratio" between motor and load.

Mechanical

After you entered a description and optionally specified a transmission, you can click the "Mechanical" tab to specify the mechanical parameters of the load, see fig. 6-3 "Drive Sizing Tool - Project window, Mechanical tab" on page 33.

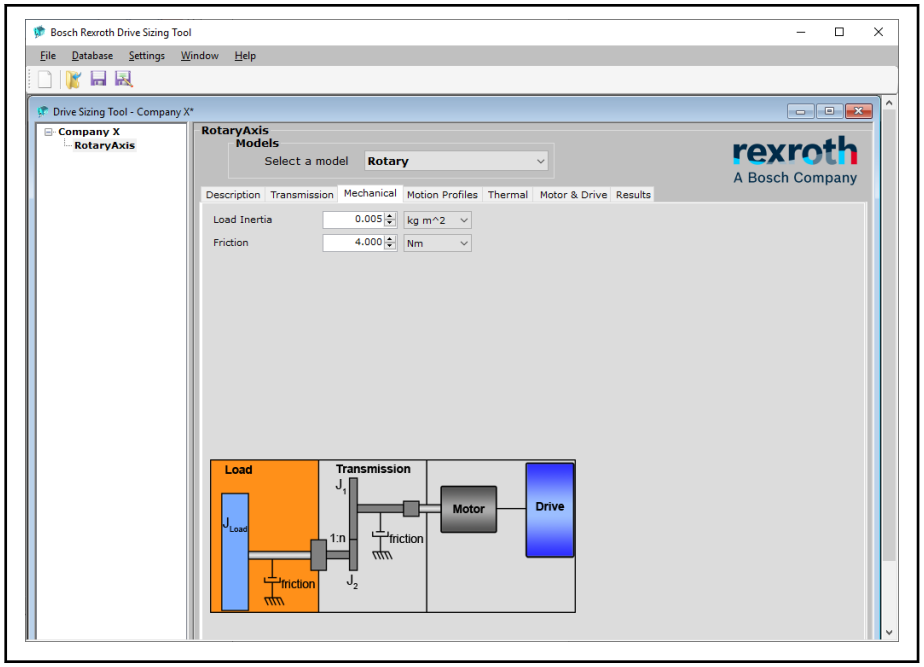


Fig. 6-3: Drive Sizing Tool - Project window, Mechanical tab

The model shown in this tab is the fig. 2-3 "Model type for "Rotary" " on page 6, where the orange colored part marks the load and the parameters related to the load specified in this part of the workflow.

"Load Inertia" is the total inertia directly coupled on the transmission output axis (load side), or in case no transmission is involved, the total inertia directly coupled on the motor output axis.

"Friction" is the total friction torque at the load axis. In case of a transmission, the transmission output axis must overcome this torque to rotate the load axis. In case transmission is involved, the motor output axis must overcome this torque to rotate the load axis.

6.3 Workflow step - Motion Profiles

You can specify the movement setpoint profiles in the "Motion Profiles" tab, see fig. 6-4 "Drive Sizing Tool - Project window, Motion Profiles tab" on page 34. The specified setpoint profiles refer to the movement of the load axis.

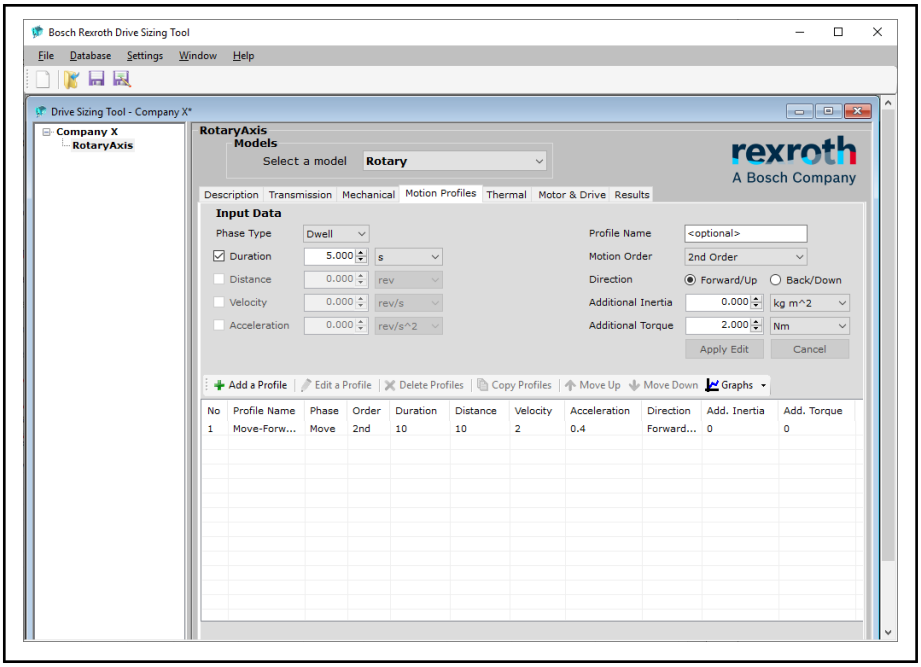


Fig. 6-4: Drive Sizing Tool - Project window, Motion Profiles tab

You can choose the profile segment type from the "Phase Type" drop-down menu. The following options are available.

- "Move"
- "Dwell"
- "Off"

Usually, "Move" is selected first. The required input parameters for "Move" are "Duration", "Distance", "Velocity" and "Acceleration". You must specify 3 of the 4 parameters, the fourth parameter is calculated automatically. Optionally, you can specify a profile name in the "Profile Name" text entry field. The "Motion Order" is in this case always "2nd Order", and cannot be changed. You can add an "Additional Inertia" for a motion profile, for example, if at some moment in the application production line some inertia is added to the load axis. You can also add an "Additional Torque", for example, if at some moment in the application production line an external torque is added to the load axis. When all parameters for one profile segment are specified, you can click the "+ Add a Profile". The specified profile step appears in the table below the "Input Data" section. This table is hereafter called "spread sheet".

The required input parameter for the phase type "Dwell" is only "Duration", because dwell is the standstill time of the load axis. At standstill time an external force could be excerted on the load axis and in that case a current is sent through the motor. For that reason you can also specify a value in the "Additional Torque" field besides the dwell time.

The required input parameter for the phase type "Off" is only "Duration". "Off" means that the drive power is off, thus there is no sense to specify an additional torque.

Next to the "+ Add a Profile" button, is the "Edit a Profile" button. When a profile step is selected from the spread sheet and you click the "Edit a Profile" button, you can change the profile parameters. Click the "Apply Edit" button to confirm the changes.

You can also delete defined profile steps. When a profile step is selected from the spread sheet and you click the "Delete Profiles" button, the selected profile step is deleted.

Profile steps can be duplicated. When a profile step or steps is selected from the spread sheet and you click the "Copy Profiles" button, the selected profile step(s) is copied.

With the buttons "Move Up" and "Move Down" you can change the order of the selected profile step(s).

When you click the "Graphs" button the total profile with all profile steps is displayed.

6.4 Workflow step - Thermal

You can specify the required parameter for the motor thermal utilization calculations in the "Thermal" tab, see fig. 6-5 "Drive Sizing Tool - Project window, Thermal tab" on page 35.

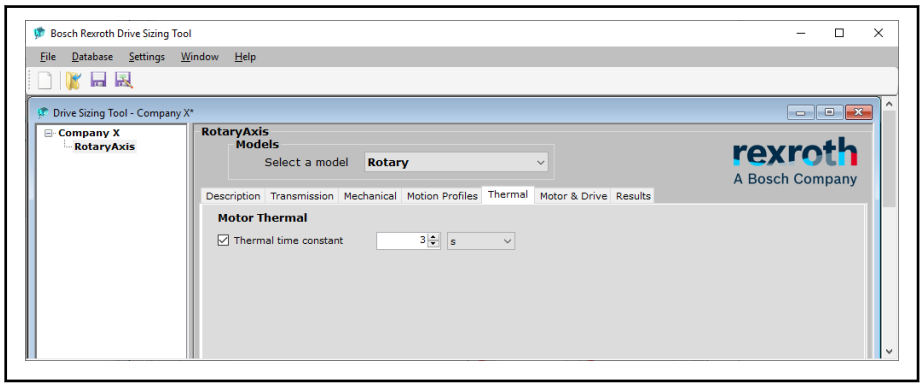


Fig. 6-5: Drive Sizing Tool - Project window, Thermal tab

In "Motor Thermal" you can specify the "Thermal time constant". This "Thermal time constant" is the time constant that is used for the motor I^2t calculation. The thermal utilization calculation for the drive is also an I^2t calculation. The algorithms used in the drive sizing tool for motor I^2t and drive I^2t are the same algorithms used in the NYCe 4000 firmware to control the rotary motor. The thermal time constant used for the drive thermal utilisation is fixed and cannot be changed.

6.5 Workflow step - Motor & Drive

You select the motor and drive in the "Motor & Drive" tab, see fig. 6-6 "Drive Sizing Tool - Project window, Motor & Drive tab" on page 36.

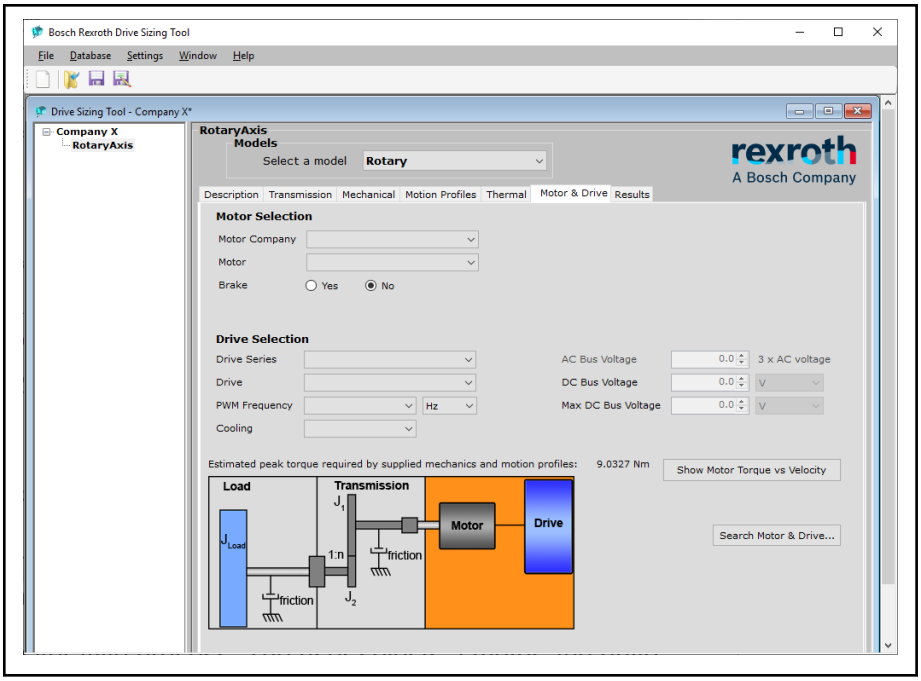


Fig. 6-6: Drive Sizing Tool - Project window, Motor & Drive tab

The selection of a motor and drive is in principle an iterative process. You select a motor and drive combination and then check whether the selection is optimal. A "Motor-Drive Search Engine" is included in the drive sizing tool to make this selection process more efficient. Click the "Search Motor & Drive..." button to open the search engine. The "Motor-Drive Search Engine" window appears, see fig. 6-7 "Drive sizing tool - Motor-Drive Search Engine window" on page 37.

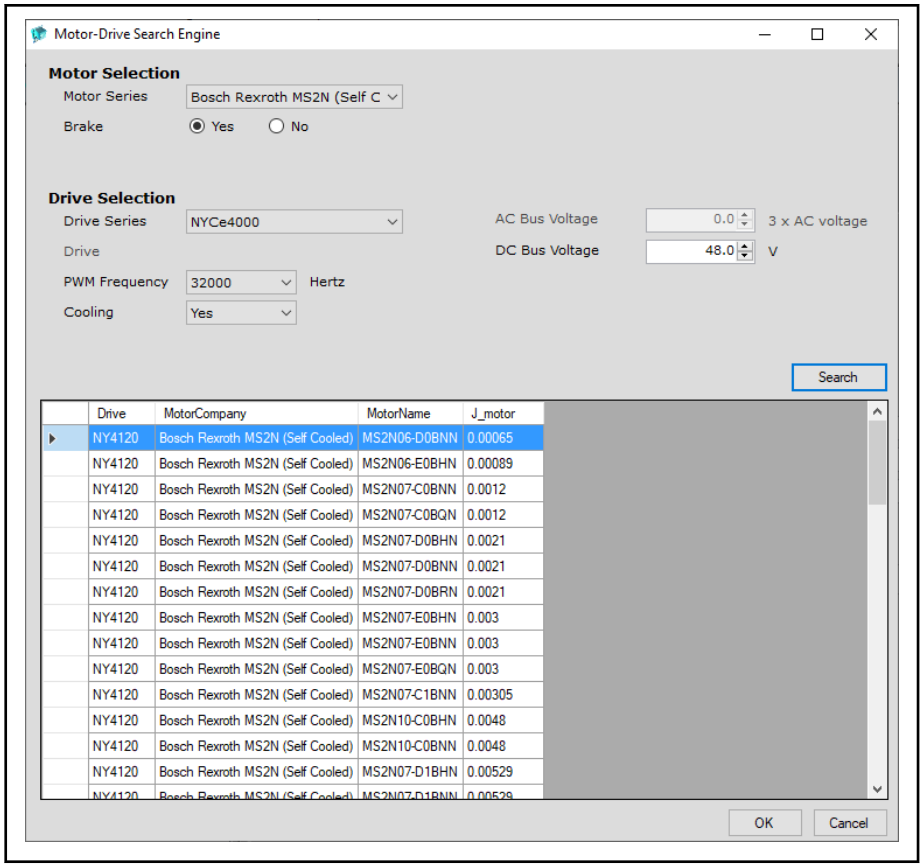


Fig. 6-7: Drive sizing tool - Motor-Drive Search Engine window

Motor Selection

In the "Motor Selection" you must select the "Motor Series". For Rotary Axis projects the options are "Bosch Rexroth MSM", "Bosch Rexroth MS2N" (Self Cooled), "Bosch Rexroth MS2N" (Forced Ventilation), "Bosch Rexroth MS2N" (Water Cooled), and "Bosch Rexroth MSK". These motors are all synchronous servo motors. You can find detailed information about these motors in the following manuals.

- Synchronous Servomotors MSM Data Sheet R911329338.
- MS2N Synchronous Servomotors Project Planning Manual R911347583.
- Synchronous Servomotors MSK Project planning manual R911296289.

The rotary motor type "Bosch Rexroth MBT" is rarely used and for that reason not included in the standard database. You can find detailed information about this motor type in the following manual.

- MBT Synchronous Torque Motors Project Planning Manual R911298798.

If a motor of this type is desired, the motor can be added to the custom database, see chapter 3.3 "Database menu" on page 11. Contact Bosch Rexroth for the implementation.

Drive Selection

In the "Drive Selection" you must select the "Drive Series". For Rotary projects the following options are available.

- NYCe 4000
- IndraDrive Cs
- IndraDrive C

With the "PWM Frequency" drop-down list you select the PWM frequency. For NYCe 4000 drives you can choose between 16000 Hz and 32000 Hz. The default value in the control software is 32000 Hz. For Rotary projects using DriveLink drives you must always select 4000 Hz.

You must always specify the bus voltage to the drives. The NYCe 4000 drive modules you can use for Rotary projects are "NY4120" and "NY4140". You specify the DC Bus Voltage for NYCe 4000 drives. The DC Bus Voltage minimum value is 12V for both drive modules. The DC Bus Voltage maximum value is 75V for the NY4120. The DC Bus Voltage maximum value is 150V fort he NY4140. Standard available power supplies are 24V, 48V and 72V. If a higher bus voltage is needed, you can connect multiple DC power supplies in series.

☞ Not all DC power supplies are suited to connect in series. Check the data sheet of the power supply manufacturer.

You specify the AC Bus Voltage for DriveLink drives. For single phase IndraDrive Cs (HCS01.1E-W00xx-02), the maximum value 230V can be selected. For three-phase IndraDrive Cs (HCS01.1E-W00xx-03), the maximum value 500V can be selected. For IndraDrive C, the maximum 500V can be selected.

Click the "Search" button after you specified all fields in the "Motor Selection" and "Drive Selection". The first option in the list is the smallest combination, with the smallest drive that meets the requirements. You can select this combination, or the combination with the smallest motor and a larger drive, and click the "OK" button. The selected motor and drive combination is displayed in the "Motor & Drive" tab.

NYCe 4000 fan units for cooling of the drive modules is optional. If you select "No" for "Cooling", the allowed continuous current is decreased.

6.6 Workflow step - Results

The results, whether the chosen motor and drive meet the application requirements and whether the choice is optimal, are shown in the "Results" tab, see fig. 6-8 "Drive Sizing Tool - Project window, Results tab" on page 39.

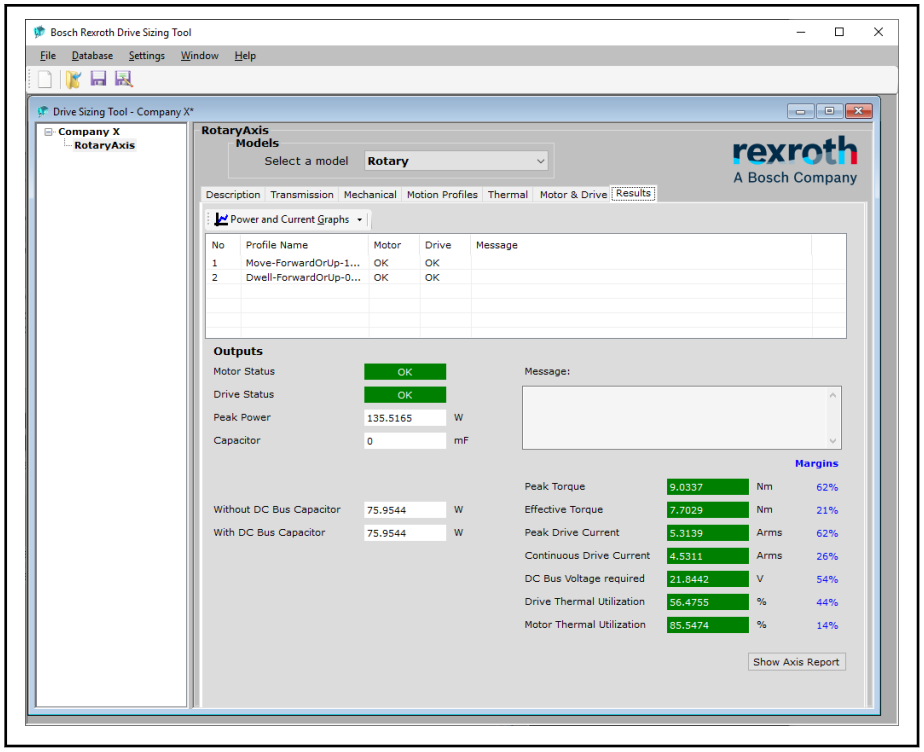


Fig. 6-8: Drive Sizing Tool - Project window, Results tab

The final results are shown in the "Outputs'" section. You can immediately see whether the "Motor Status" and "Drive Status" are "OK". Below the status results, the "Peak Power" required from the drive, the additional "Capacitor" required for the drive (to guarantee that no energy will be returned to the power supply, or mains in case of DriveLink drives, when decelerating), and average required power with and without capacitor are shown. Two standard capacitor kits for NYCe 4000 drives (NY4120 and NY4140) are available.

- NYA04.1-CAP-100V-NY4921, working voltage 100V and capacitance 6.8mF
- NYA04.1-CAP-200V-NY4921/10, working voltage 200V and capacitance 2.2mF

These capacitor kits can be installed on the NYCe 4000 standard housing. You need a capacitor kit for each installed drive module.

DriveLink drives have internal capacitors. The capacitance indicated in the "Results" tab must be lower than the internal capacitance in the DriveLink drives. This internal capacitance can be checked in the Project Planning manuals of the HCS01 (DOK-INDRV*-HCS01******-PRRS-EN-P), and HCS02 and HCS03 (DOK-INDRV*-HMV-S-D+HCS-PR).

If the "Motor Status" or "Drive Status" is "Not OK", you can read the reason in the "Message" box.

Below the "Message" box you can read the main check parameters and their margins. The "Motor Status" and "Drive Status" can only be "OK" if all margins are 10% or higher. If a margin is larger than 10% the value of the check parameter is green. If a margin is equal to 10% or lower than 10%, but larger than or equal to 0% the value of the check parameter is yellow. If the margin is below zero the value of the check parameter is red.

If the results are OK, click the "Show Axis Report" button to generate the Axis Report. Click the "Save" icon in the icon bar to save the Axis Report to a file in Word format, Excel format or PDF format.

7 Drive sizing for a rotary motor with screw

7.1 Introduction

This chapter describes the process of a drive sizing calculation for an application with a rotary motor with a spindle or belt to transfer the rotary motion of the motor to linear motion of the load mass. As described in chapter 2.3 "Drive sizing workflow" on page 6, the drive sizing process follows a strict workflow order. Each step of the drive sizing workflow for a rotary motor with a spindle or belt is described in the following chapters.

Start the drive sizing tool, create a new project and add an axis, as described in chapter 3.1 "Introduction" on page 9 and chapter 3.2 "File menu" on page 9. After you click the "+ Add an axis" button, the "New Axis" window appears, see fig. 3-3 "Drive Sizing Tool - Project window" on page 10. In this window you enter the axis name and select the model type "Rotary with screw". When you click the "OK" button in the "New Axis" window, the workflow tabs appear in the "Project" window, see fig. 7-1 "Drive Sizing Tool - Project window, Description tab" on page 41. In the "Description" tab you can enter any description information of the project. This description is also shown in the axis report.

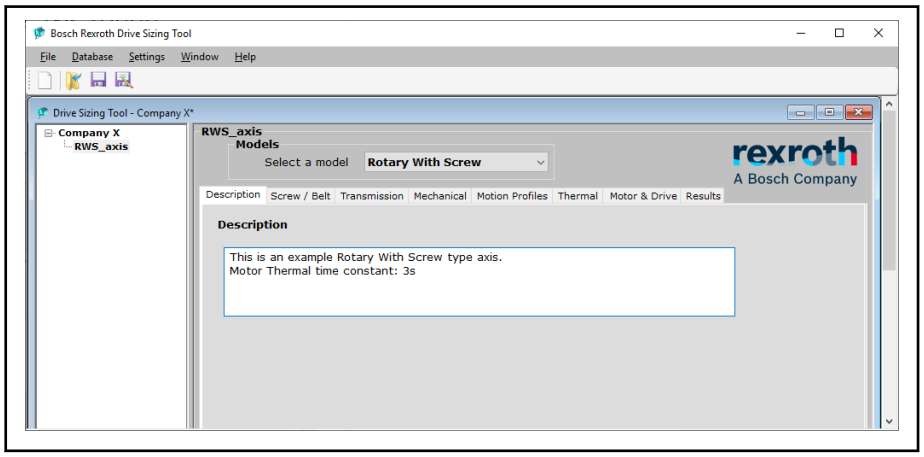


Fig. 7-1: Drive Sizing Tool - Project window, Description tab

For rotary motor with a spindle or belt projects, it is good practise to enter in the "Description" text field at least the motor thermal time constant, because this parameter is by default not shown in the drive sizing report. This parameter is required for the thermal utilization calculations.

7.2 Workflow step - Mechanical

After you entered a description in the "Description" tab, you can start the first step in the workflow process. The first step in the workflow process for a rotary motor with screw consists of three tabs in the drive sizing tool, "Screw / Belt", "Transmission" and "Mechanical". In the "Screw / Belt" tab, the mechanics of the spindle or belt are described. In the "Transmission" tab the mechanics of an optional transmission between the motor and the load are described. In the "Mechanical" tab the mechanics of the load are described.

Screw / Belt

The "Screw / Belt" tab is shown in fig. 7-2 "Drive Sizing Tool - Project window, Screw / Belt tab" on page 42. The model shown in this tab is the fig. 2-4 "Model for type "Rotary with screw" " on page 6, where the orange

colored part marks the spindle or belt and the parameters related to the spindle or belt specified in this part of the workflow.

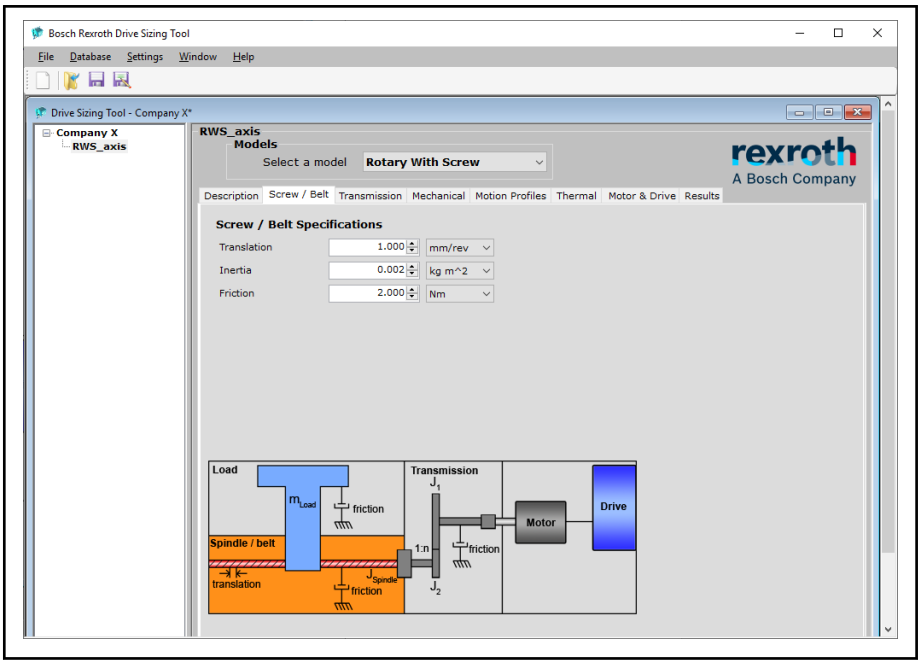


Fig. 7-2: Drive Sizing Tool - Project window, Screw / Belt tab

The parameters in this tab are "Translation", "Inertia", and "Friction". The "Translation" defines the travel distance of the load mass per revolution of the spindle. "Inertia" and "Friction" are the inertia and the friction torque of the spindle.

Transmission

The "Transmission" tab is shown in fig. 7-3 "Drive Sizing Tool - Project window, Transmission tab" on page 43. The model shown in this tab is the fig. 2-4 "Model for type "Rotary with screw" " on page 6, where the orange colored part marks the transmission and the parameters related to the transmission specified in this part of the workflow.

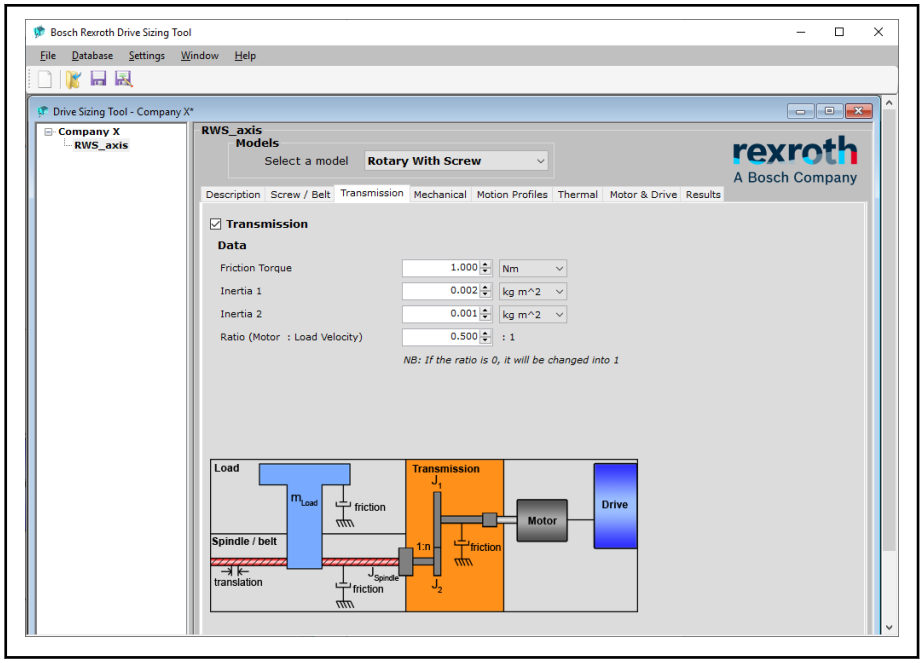


Fig. 7-3: Drive Sizing Tool - Project window, Transmission tab

You can specify whether the rotary axis with screw application includes a transmission with the "Transmission" checkbox on the "Transmission" tab. If you specify a transmission, you must specify the parameters "Friction Torque" of the transmission, the inertias of the gear wheels, "'Inertia 1" on the motor side and "Inertia 2" on the load side, and the velocity "Ratio" between motor and load.

Mechanical

After you entered a description, defined the spindle or belt, and optionally specified a transmission, you can click the "Mechanical" tab to specify the mechanical parameters of the load, see fig. 7-4 "Drive Sizing Tool - Project window, Mechanical tab" on page 44.

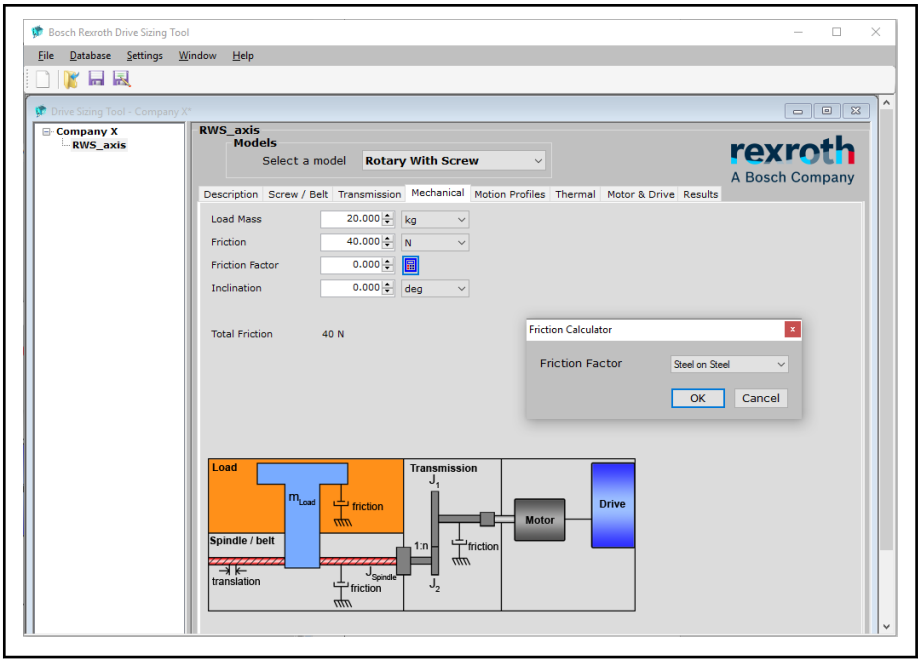


Fig. 7-4: Drive Sizing Tool - Project window, Mechanical tab

The model shown in this tab is the fig. 2-4 "Model for type "Rotary with screw" " on page 6, where the orange colored part marks the load and the parameters related to the load specified in this part of the workflow.

The "Load Mass" is the total linear moving mass, including the product to be transported.

Two options are available to specify the friction of the guiding system.

- "Friction" : here you specify the total friction force of a load mass at constant velocity.
- "Friction factor" : here you select a friction factor from the drop-down menu.

Obviously, you need to know the total friction force to specify the friction force.

"Inclination" depends on the actual inclination angle of the load mass and the spindle or belt. The default value is 0, which means that the linear movement is oriented horizontal. A gravity component is added to the required force and current calculations when the inclination angle is increased.

7.3 Workflow step - Motion Profiles

You can specify the movement setpoint profiles in the "Motion Profiles" tab, see fig. 7-5 "Drive Sizing Tool - Project window, Motion Profiles tab" on page 45. The specified setpoint profiles refer to the movement of the load axis.

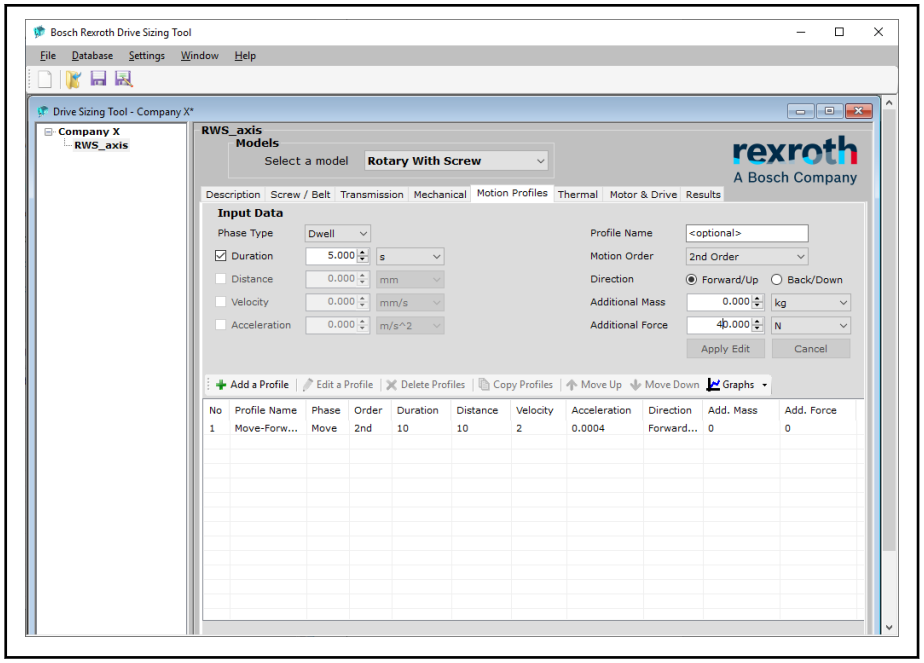


Fig. 7-5: Drive Sizing Tool - Project window, Motion Profiles tab

You can choose the profile segment type from the "Phase Type" drop-down menu. The following options are available.

- "Move"
- "Dwell"
- "Off"

Usually, "Move" is selected first. The required input parameters for "Move" are "Duration", "Distance", "Velocity" and "Acceleration". You must specify 3 of the 4 parameters, the fourth parameter is calculated automatically. Optionally, you can specify a profile name in the "Profile Name" text entry field. The "Motion Order" is in this case always "2nd Order", and cannot be changed. You can add an "Additional Mass" for a motion profile, for example, if at some location in the spindle or belt trajectory some mass is added to the translating load mass. You can also add an "Additional Force", for example, if at some process station in the production line a robot puts an external force onto the translating load mass. The applied "Additional Force" is a force in the direction of movement. When all parameters for one profile segment are specified, you can click the "+ Add a Profile". The specified profile step appears in the table below the "Input Data" section. This table is hereafter called "spread sheet".

The required input parameter for the phase type "Dwell" is only "Duration", because dwell is the standstill time of the load mass. At standstill time an external force could be excerted on the load mass and in that case a current is sent through the motor. For that reason you can also specify a value in the "Additional Force" field besides the dwell time.

The required input parameter for the phase type "Off" is only "Duration". "Off" means that the drive power is off, thus there is no sense to specify an additional force.

Next to the "+ Add a Profile" button, is the "Edit a Profile" button. When a profile step is selected from the spread sheet and you click the "Edit a Profile" button, you can change the profile parameters. Click the "Apply Edit" button to confirm the changes.

You can also delete defined profile steps. When a profile step is selected from the spread sheet and you click the "Delete Profiles" button, the selected profile step is deleted.

Profile steps can be duplicated. When a profile step or steps is selected from the spread sheet and you click the "Copy Profiles" button, the selected profile step(s) is copied.

With the buttons "Move Up" and "Move Down" you can change the order of the selected profile step(s).

When you click the "Graphs" button the total profile with all profile steps is displayed.

7.4 Workflow step - Thermal

You can specify the required parameter for the motor thermal utilization calculations in the "Thermal" tab, see fig. 7-6 "Drive Sizing Tool - Project window, Thermal tab" on page 46.

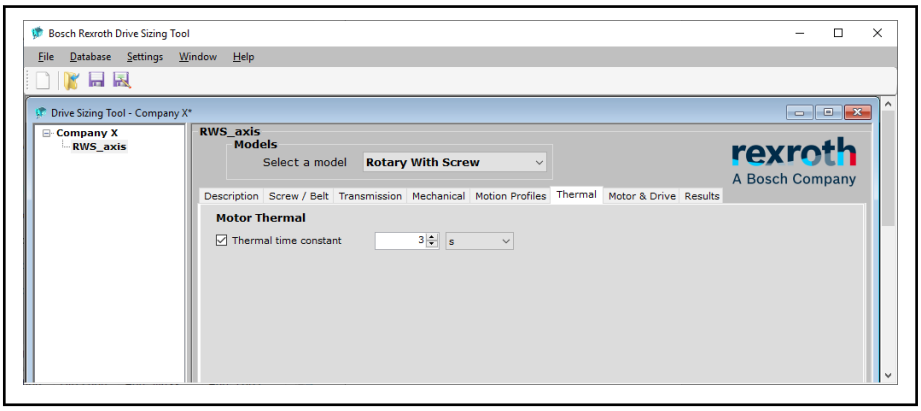


Fig. 7-6: Drive Sizing Tool - Project window, Thermal tab

In "Motor Thermal" you can specify the "Thermal time constant". This "Thermal time constant" is the time constant that is used for the motor I^2t calculation. The thermal utilization calculation for the drive is also an I^2t calculation. The algorithms used in the drive sizing tool for motor I^2t and drive I^2t are the same algorithms used in the NYCe 4000 firmware to control the rotary motor. The thermal time constant used for the drive thermal utilisation is fixed and cannot be changed.

7.5 Workflow step - Motor & Drive

You select the motor and drive in the "Motor & Drive" tab, see fig. 7-7 "Drive Sizing Tool - Project window, Motor & Drive tab" on page 47.

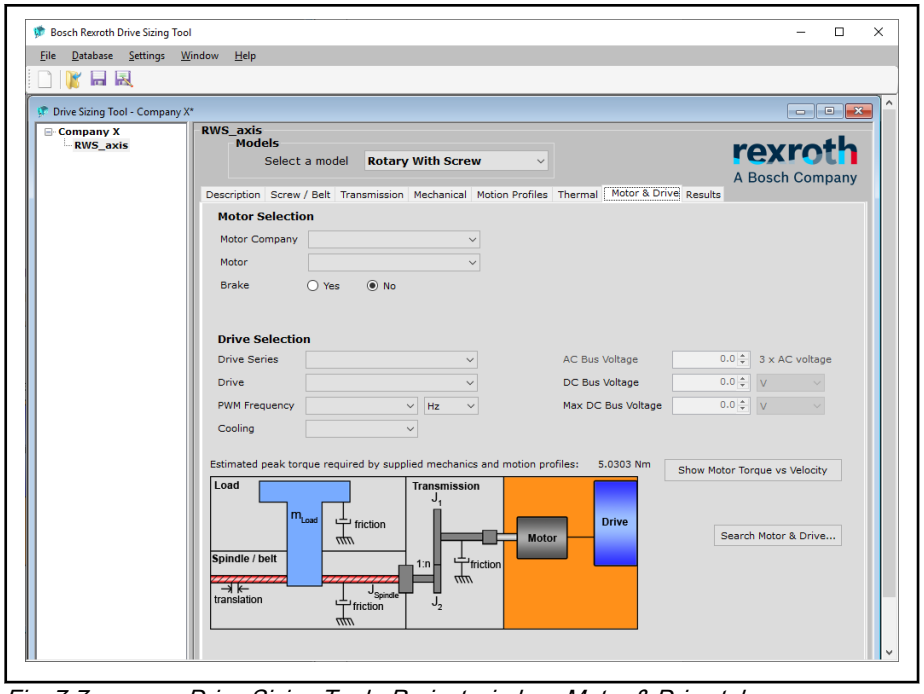


Fig. 7-7: Drive Sizing Tool - Project window, Motor & Drive tab

The selection of a motor and drive is in principle an iterative process. You select a motor and drive combination and then check whether the selection is optimal. A "Motor-Drive Search Engine" is included in the drive sizing tool to make this selection process more efficient. Click the "Search Motor & Drive..." button to open the search engine. The "Motor-Drive Search Engine" window appears, see fig. 7-8 "Drive sizing tool - Motor-Drive Search Engine window" on page 48.

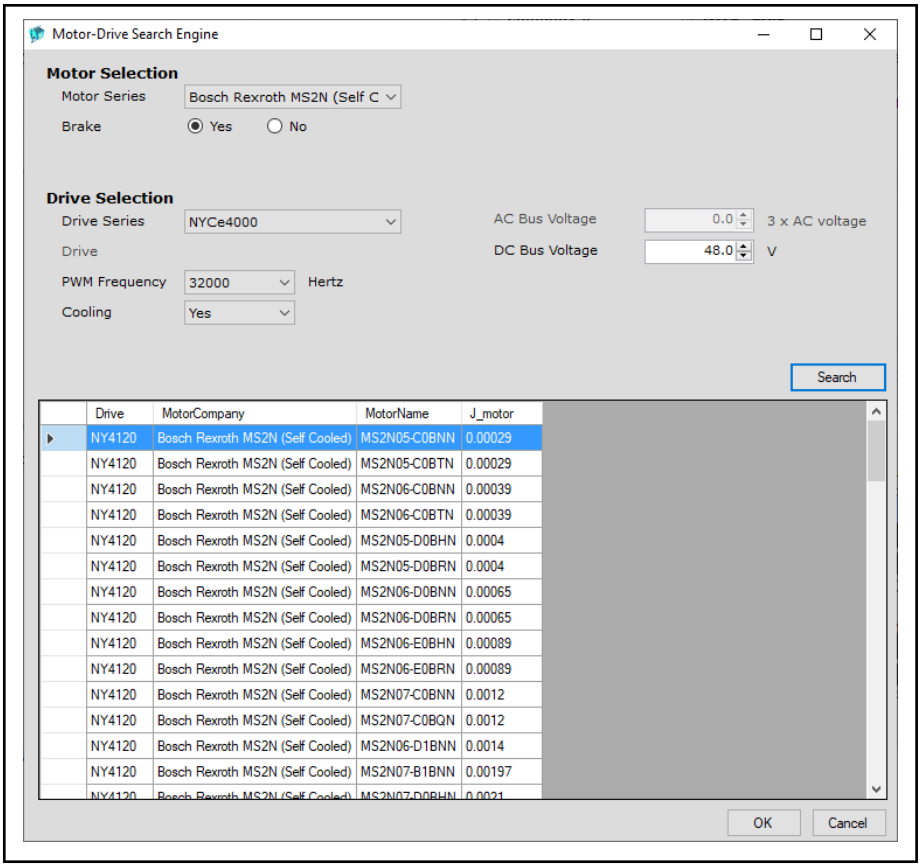


Fig. 7-8: Drive sizing tool - Motor-Drive Search Engine window

Motor Selection

In the "Motor Selection" you must select the "Motor Series". For Rotary Axis with Screw projects the options are "Bosch Rexroth MSM", "Bosch Rexroth MS2N" (Self Cooled), "Bosch Rexroth MS2N" (Forced Ventilation), "Bosch Rexroth MS2N" (Water Cooled), and "Bosch Rexroth MSK". These motors are all synchronous servo motors. You can find detailed information about these motors in the following manuals.

- Synchronous Servomotors MSM Data Sheet R911329338.
- MS2N Synchronous Servomotors Project Planning Manual R911347583.
- Synchronous Servomotors MSK Project planning manual R911296289.

The rotary motor type "Bosch Rexroth MBT" is rarely used and for that reason not included in the standard database. You can find detailed information about this motor type in the following manual.

- MBT Synchronous Torque Motors Project Planning Manual R911298798.

If a motor of this type is desired, the motor can be added to the custom database, see chapter 3.3 "Database menu" on page 11. Contact Bosch Rexroth for the implementation.

Drive Selection

In the "Drive Selection" you must select the "Drive Series". For Rotary with Screw projects the following options are available.

- NYCe 4000
- IndraDrive Cs
- IndraDrive C

With the "PWM Frequency" drop-down list you select the PWM frequency. For NYCe 4000 drives you can choose between 16000 Hz and 32000 Hz. The default value in the control software is 32000 Hz. For Rotary with Screw projects using DriveLink drives you must always select 4000 Hz.

You must always specify the bus voltage to the drives. The NYCe 4000 drive modules you can use for Rotary with Screw projects are "NY4120" and "NY4140". You specify the DC Bus Voltage for NYCe 4000 drives. The DC Bus Voltage minimum value is 12V for both drive modules. The DC Bus Voltage maximum value is 75V for the NY4120. The DC Bus Voltage maximum value is 150V for the NY4140. Standard available power supplies are 24V, 48V and 72V. If a higher bus voltage is needed, you can connect multiple DC power supplies in series.

☞ Not all DC power supplies are suited to connect in series. Check the data sheet of the power supply manufacturer.

You specify the AC Bus Voltage for DriveLink drives. For single phase IndraDrive Cs (HCS01.1E-W00xx-02), the maximum value 230V can be selected. For three-phase IndraDrive Cs (HCS01.1E-W00xx-03), the maximum value 500V can be selected. For IndraDrive C, the maximum 500V can be selected.

Click the "Search" button after you specified all fields in the "Motor Selection" and "Drive Selection". The first option in the list is the smallest combination, with the smallest drive that meets the requirements. You can select this combination, or the combination with the smallest motor and a larger drive, and click the "OK" button. The selected motor and drive combination is displayed in the "Motor & Drive" tab.

NYCe 4000 fan units for cooling of the drive modules is optional. If you select "No" for "Cooling", the allowed continuous current is decreased.

7.6 Workflow step - Results

The results, whether the chosen motor and drive meet the application requirements and whether the choice is optimal, are shown in the "Results" tab, see fig. 7-9 "Drive Sizing Tool - Project window, Results tab" on page 50.

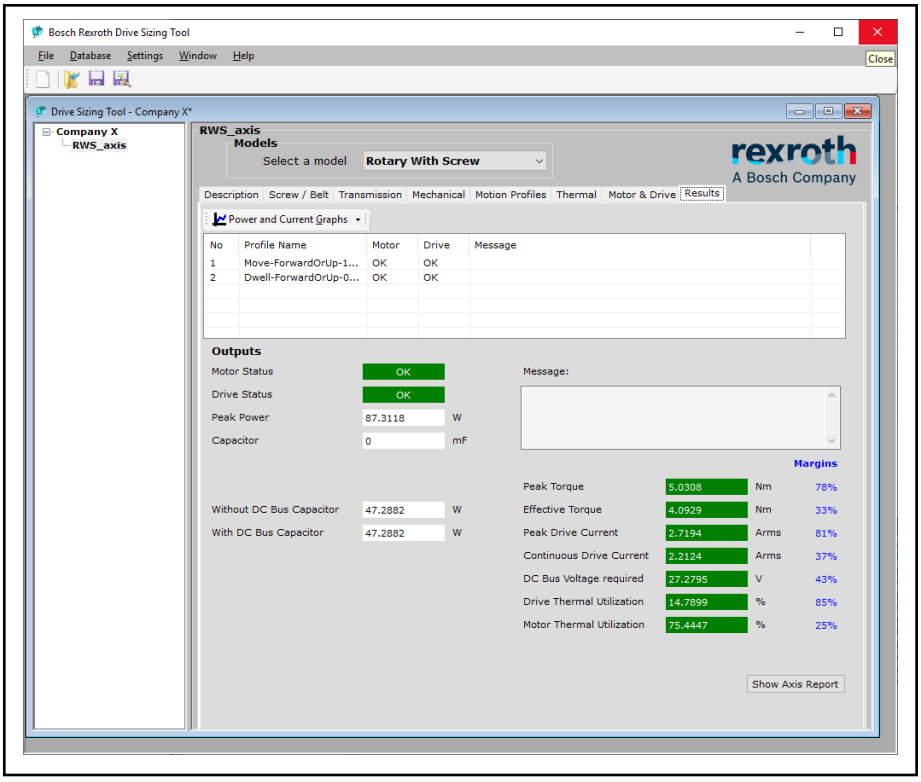


Fig. 7-9: Drive Sizing Tool - Project window, Results tab

The final results are shown in the "Outputs'" section. You can immediately see whether the "Motor Status" and "Drive Status" are "OK". Below the status results, the "Peak Power" required from the drive, the additional "Capacitor" required for the drive (to guarantee that no energy will be returned to the power supply, or mains in case of DriveLink drives, when decelerating the load mass), and average required power with and without capacitor are shown. Two standard capacitor kits for NYCe 4000 drives (NY4120 and NY4140) are available.

- NYA04.1-CAP-100V-NY4921, working voltage 100V and capacitance 6.8mF
- NYA04.1-CAP-200V-NY4921/10, working voltage 200V and capacitance 2.2mF

These capacitor kits can be installed on the NYCe 4000 standard housing. You need a capacitor kit for each installed drive module.

DriveLink drives have internal capacitors. The capacitance indicated in the "Results" tab must be lower than the internal capacitance in the DriveLink drives. This internal capacitance can be checked in the Project Planning manuals of the HCS01 (DOK-INDRV*-HCS01******-PRRS-EN-P), and HCS02 and HCS03 (DOK-INDRV*-HMV-S-D+HCS-PR).

If the "Motor Status" or "Drive Status" is "Not OK", you can read the reason in the "Message" box.

Below the "Message" box you can read the main check parameters and their margins. The "Motor Status" and "Drive Status" can only be "OK" if all margins are 10% or higher. If a margin is larger than 10% the value of the check parameter is green. If a margin is equal to 10% or lower than 10%, but larger than or equal to 0% the value of the check parameter is yellow. If the margin is below zero the value of the check parameter is red.

If the results are OK, click the "Show Axis Report" button to generate the Axis Report. Click the "Save" icon in the icon bar to save the Axis Report to a file in Word format, Excel format or PDF format.

8 Appendix A - Drive sizing report for an FTS

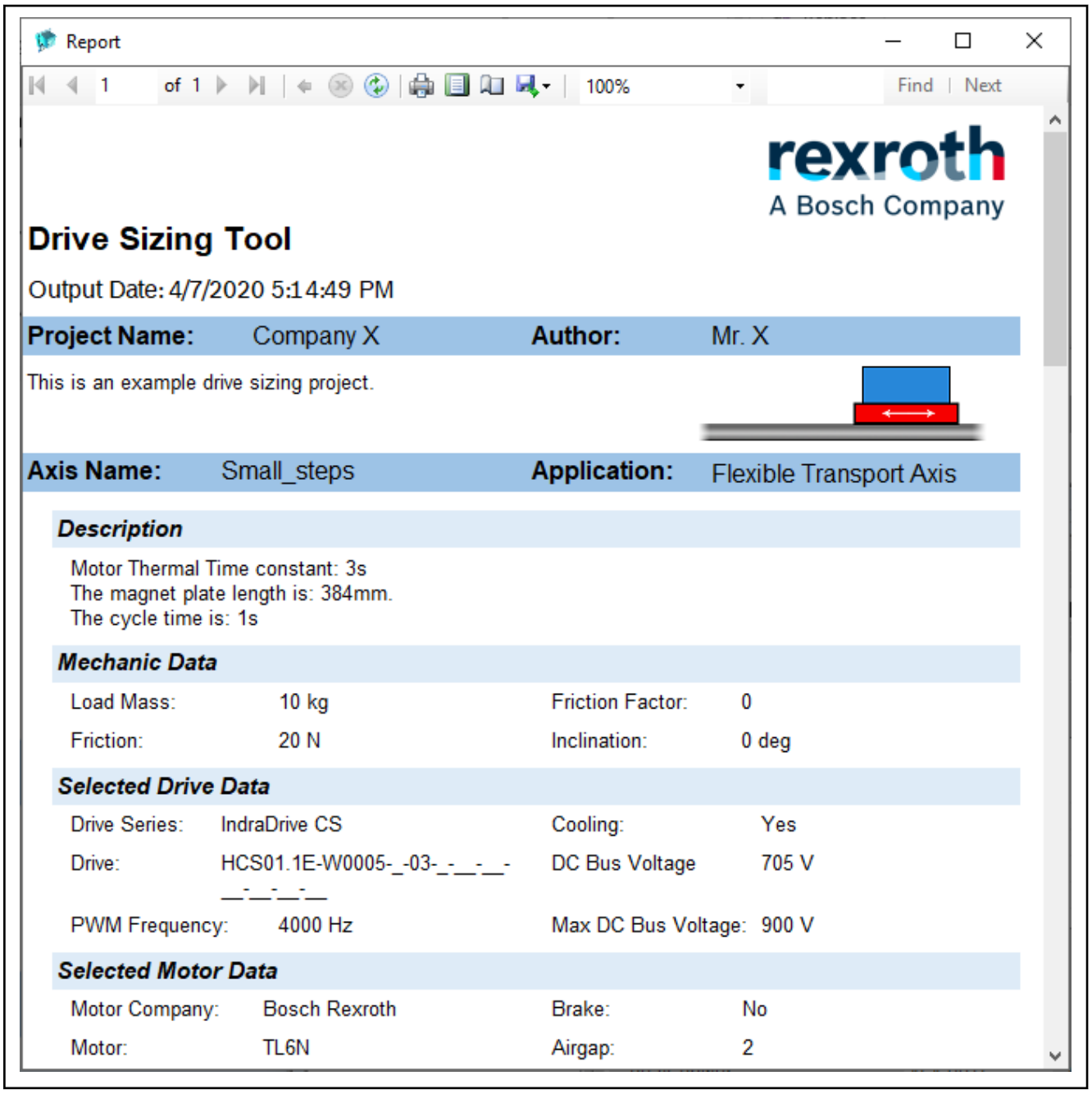
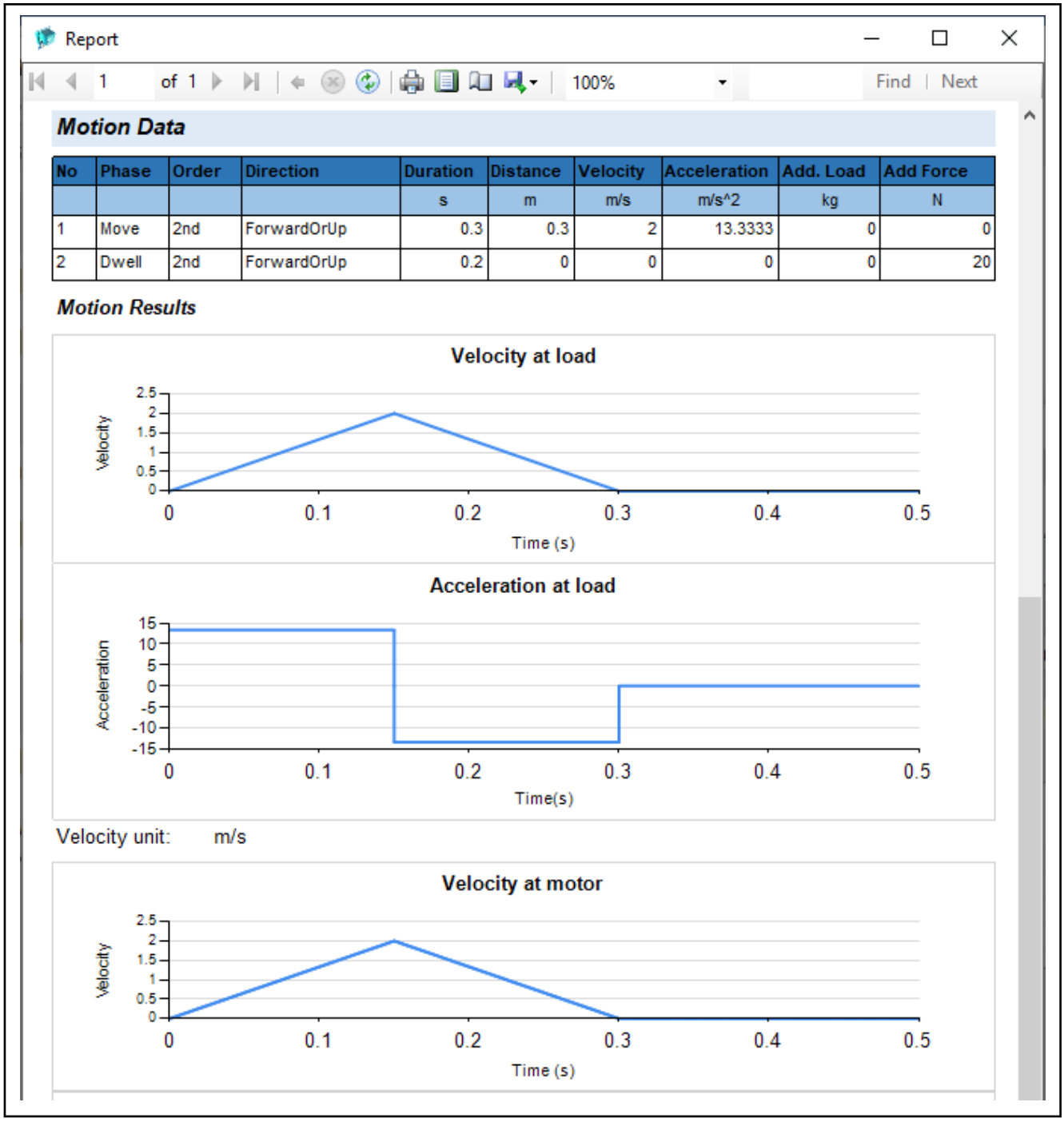


Fig. 8-1: Drive Sizing Tool - Drive sizing report - Axis



No	Phase	Order	Direction	Duration	Distance	Velocity	Acceleration	Add. Load	Add Force
				s	m	m/s	m/s^2	kg	N
1	Move	2nd	ForwardOrUp	0.3	0.3	2	13.3333	0	0
2	Dwell	2nd	ForwardOrUp	0.2	0	0	0	0	20

Fig. 8-2: Drive Sizing Tool - Drive sizing report - Motion (part 1)

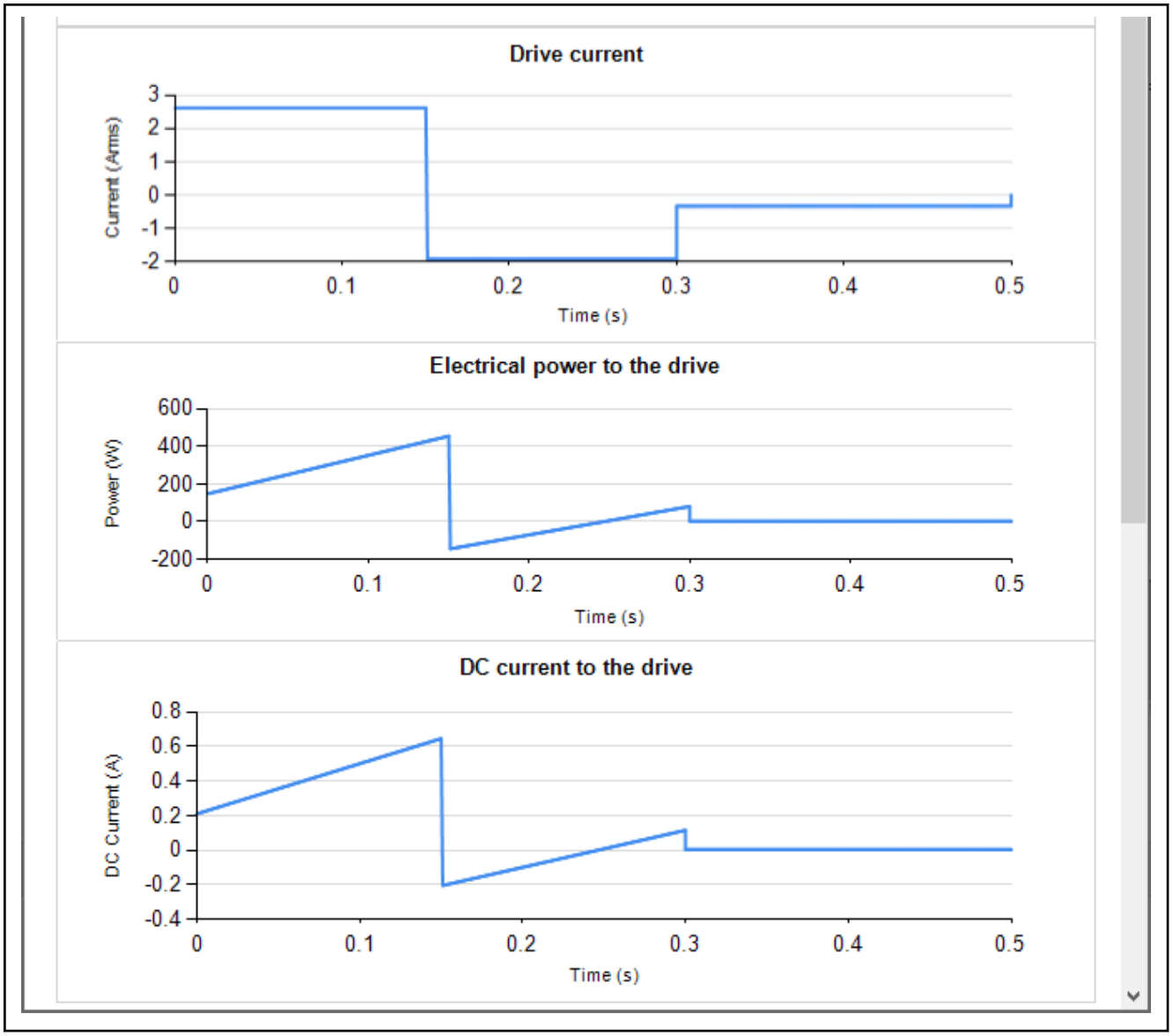


Fig. 8-3: Drive Sizing Tool - Drive sizing report - Motion (part 2)

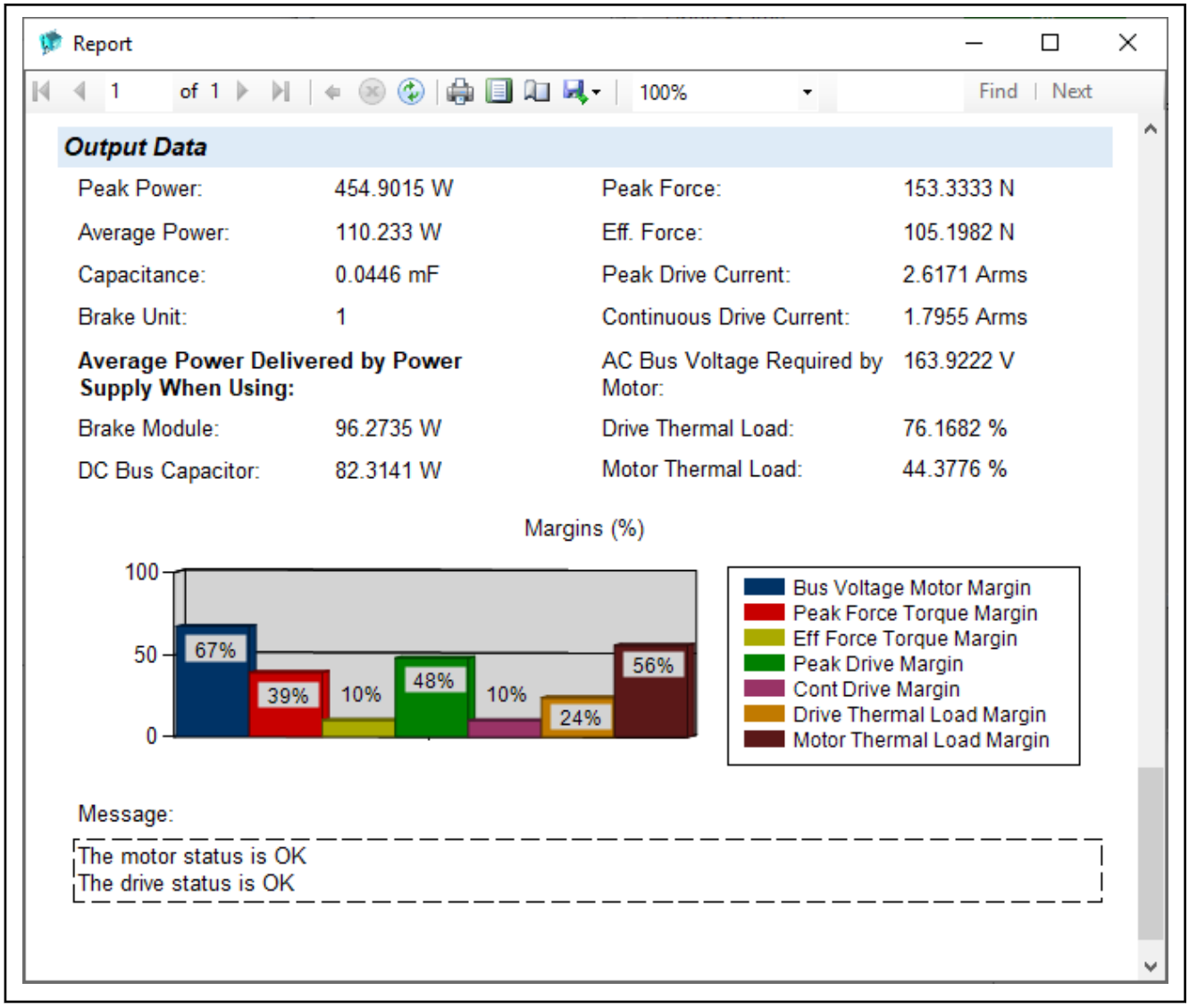


Fig. 8-4: Drive Sizing Tool - Drive sizing report - Output

Notes

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