

Drive Solution Designer



Manual

EN



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Lenze

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1 Notes on usage

1.1 Licencing and contractual conditions

The use of the »Drive Solution Designer« is only permitted if the user accepts the licencing and contractual conditions in the currently valid version.

- The valid version of the licencing and contractual conditions can be found under <http://www.Lenze.com>

1.2 Terms and conditions

For deliveries and counselling services the respective valid terms and conditions of the Lenze group apply.

- The valid terms and conditions can be found under <http://www.Lenze.com>

1.3 Important information on the program

The »Drive Solution Designer« supports you on the basis of Lenze products, in order to find a correct and feasible solution for a drive task.

- For this purpose, a knowledge base with inverters, motors, gearboxes, electrical brake units, mechanical brakes, and feedback systems is stored in the »Drive Solution Designer«, which is used for the calculation of the drive solution.
- The »Drive Solution Designer« not only calculates the physical connections by means of formulas, but filters suggested solutions from the knowledge base according to different criteria.



Note!

The product-specific data integrated into the »Drive Solution Designer« with regard to drive components are not subject to a cyclic revision service.

In case of doubt, the information in the currently valid product documentation (catalogues, operating instructions, system manuals, etc.) available in printed form and via the internet applies!

Why have we developed the DSD?

Drive systems become more and more powerful and have to be optimally adapted to mechatronic requirements. The cost pressure in the field of engineering increases permanently. At the same time, however, less time is available for planning, dimensioning, and selecting the drive system. These high market requirements have motivated us to develop an efficient software which can carry out complex calculations of drive physics. The program is based on complex product knowledge and can be easily used by every engineer. With the DSD you can solve your drive task professionally in a few minutes and document it consistently. Like this, others are able to follow your calculations anytime, too. Moreover, the DSD serves to optimise the application and the drive system regarding energy efficiency.

Who has developed the DSD?

The program was developed by drive specialists and computer scientists in cooperation with experienced Lenze sales staff. The cooperation of this interdisciplinary development team makes it possible to carry out practically relevant dimensioning processes with the DSD.

Who has worked with the DSD so far?

Lenze sales staff, Lenze customers, and universities work with the DSD worldwide today. Already since 2002 we have gained experience with this design program for drives. On the basis of this experience, the DSD is continuously perfected and adapted to current needs.

What is dimensioned with the DSD and what isn't?

A dimensioning includes the drive components: gearbox, motor, inverter, encoder on the motor side, electrical brake units, regenerative power supply modules, and electromechanical brakes.

Further accessories such as mains filters, automation modules, drive software, etc., currently cannot be configured in the DSD yet, however, they can be determined via the »EASY Product Finder«.

- The »EASY Product Finder« can be found on the Internet:
<http://www.Lenze.com> → "Product Finder" area

Who is responsible for the dimensioning result?

In the past years the DSD has stood the test of time during countless drive dimensioning processes. In the context of our quality management the program is maintained continuously.

- In the "Downloads" area at <http://www.Lenze.com>, free-of-charge service packs and updates are provided.
- The Application Knowledge Base (AKB) is an important means of support for your work with the DSD.
In the AKB you'll find:
 - **Release notes (notes for restrictions)**
 - Frequently Asked Questions (FAQ)
 - Tips and tricks
- The AKB can be found in the internet:
<http://AKB.Lenze.de>

All drive dimensionings with the DSD primarily are based on your default settings and the data that you have entered. When the program-based calculations are carried out, we therefore depend on correct and complete information by the customer. If our counselling services or program calculations are incorrect, unfeasible, or incomplete, and if this is due to incorrect and incomplete information by the respective user, liability by Lenze is excluded.

If error messages of the program cannot be eliminated by other entries, or if there are other doubts during the use of the program, please consult your responsible Lenze sales representative at any rate.

The dimensioning calculated by the DSD is based on general physical laws. If products of other manufacturers are used, of course Lenze does not give a warranty for their function. After all: The DSD carries out physical drive dimensioning. Characteristics of the operational performance of a drive solution therefore cannot be taken into consideration necessarily.

2 About this documentation

Target group

This documentation is directed at all persons who want to dimension drive systems with the »Drive Solution Designer«Engineering software.

Information regarding the validity

This documentation applies to the Lenze "Drive Solution Designer" from version 4.9 onwards.

Document history

Version			Description
4.9.1	03/2020	TD23	Revision of DSD version 4.9
4.9	10/2019	TD23	Revision for DSD version 4.8 • Added: "eccentric lift table" application, i550 frequency inverter. • Deleted: GST, MPG, MPR gearboxes; MCS, MDxKS motors.
4.8	04/2019	TD23	Revision for DSD version 4.7 • Added: "slider-crank mechanism" application • Expanded: energy efficiency.
4.7	11/2018	TD23	Revision for DSD version 4.6
4.6	11/2017	TD23	Revision for DSD version 4.5
4.5	12/2016	TD23	Revision for DSD version 4.4
4.4	05/2015	TD23	Revision for DSD version 4.3
4.3	11/2014	TD23	Revision for DSD version 4.2
4.2	12/2013	TD23	Revision for DSD version 4.1
4.1	07/2013	TD23	Revision for DSD version 4.0
4.0	02/2013	TD23	Partly revised for DSD version 4.0
3.1	01/2012	TD23	Descriptions for multi-axis application, structure of the drive axis, DC bus, energy efficiency, warning signals extended; errors corrected.
3.0	02/2011	TD23	Revision for DSD version 3.0

2.1 Conventions used

This documentation uses the following conventions to distinguish the following types of information:

Type of information	Marking	Examples/notes
Spelling of numbers		
Decimal separator	Point	The decimal point is generally used. For example: 1234.56
Text		
Version info	Blue text colour	Information that is only valid for or as from a certain software version of the inverter is marked accordingly in this documentation. Example: The function extension is available from software version V3.0 or higher!
Program name	» «	The Lenze PC software »PLC Designer«...
Window area	<i>Italics</i>	The <i>Message window</i> ... / The <i>Options</i> dialog box...
Variable identifiers		By setting <i>bEnable</i> to TRUE...
Control element	Bold	The OK button... / The Copy command ... / The Properties tab... / The Name input field ...
Sequence of menu commands		If several commands in succession are required to carry out a function, the individual commands are separated by an arrow: select the command File→Open to...
Keyboard command	< Bold >	By < F1 >, you call up the online help.
		If a keyboard combination is required for a command, a "+" is placed between the keyboard identifiers: by < Shift >+< ESC >...
Program code	Courier	IF var1 < var2 THEN a = a + 1 END IF
Keyword	Courier bold	
Hyperlink	<u>Underlined</u>	Optically highlighted reference to another topic which is activated via mouse-click in this online documentation.
Icons		
Page reference	 17	Optically highlighted reference to another page which is activated via mouse-click in this online documentation.
Step-by-step instruction		Step-by-step instructions are indicated by a pictograph.

2.2 Definition of the notes used

In order to indicate dangers and important information, the following signal words and symbols are used:

Safety information

Layout of the safety instructions:



Pictograph and signal word!

(indicate the type and the degree of the danger)

Note

(describes the danger and provides information on its prevention)

Pictograph	Signal word	Meaning
	Danger!	Danger of injuries to persons by hazardous electrical voltage Note with regard to an imminent danger, which may result in death or severe injuries if the appropriate measures are not taken.
	Danger!	Danger of personal injury by a general source of danger Note with regard to an imminent danger, which may result in death or severe injuries if the appropriate measures are not taken.
	Stop!	Danger of damage to material assets Note with regard to a possible danger which may result in damage to material assets if the appropriate measures are not taken.

Application notes

Pictograph	Signal word	Meaning
	Note!	Important note for the trouble-free function
	Tip!	Useful tip for simple handling

Specific safety instructions and application notes for UL and UR

Pictograph	Signal word	Meaning
	Warnings!	Safety instruction or application note for the operation of a UL approved drive in UL approved systems Possibly the drive system is not operated in a UL approved manner, if the appropriate measures are not taken.
	Warnings!	Safety instruction or application note for the operation of a UR approved drive in UL approved systems Possibly the drive system is not operated in a UL approved manner, if the appropriate measures are not taken.

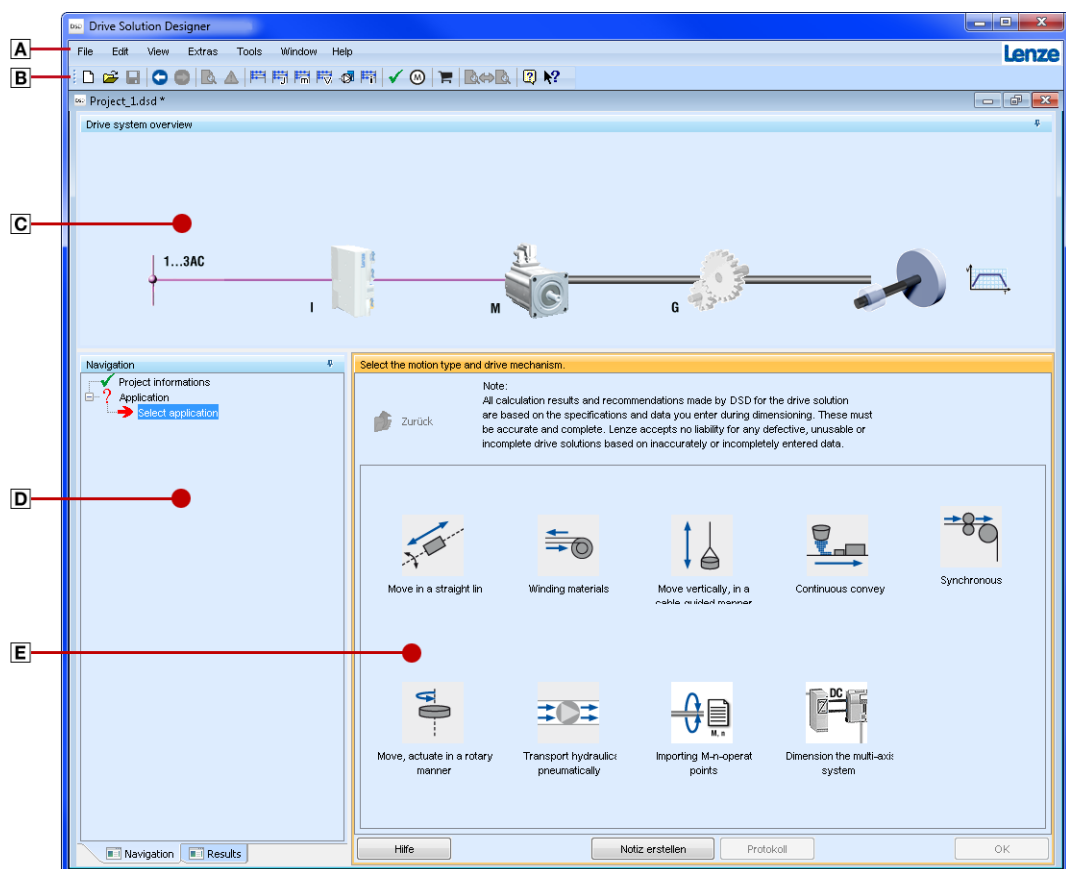
3 User interface

This chapter introduces different control and function elements of the user interface to you and explains how you can close the program again.

- ▶ [Control and function elements](#) (19)
- ▶ [Shortcuts](#) (39)
- ▶ [Closing the program](#) (40)

3.1 Control and function elements

The user interface has the following control and function elements:



- A [Menu bar](#) (20)
- B [Toolbar](#) (25)
- C [Drawing](#) (28)
- D [Navigation tree and result tree](#) (33)
- E [Input area](#) (34)

3.1.1 Menu bar

Via the *Menu bar* you have access to all menu commands.

- Click a menu to show the contained menu commands.
- Click a menu command to execute the connected function.
 - Grey menu commands are inactive during the current program state.

3.1.1.1 File

Menu command	Function
New	▶ Create new project (📖 48)
Open	▶ Open project (📖 50)
Recently opened projects	A list of the last five projects edited is provided
Close	Close the open project.
Save	▶ Saving the project (📖 52) • The current dimensioning state is saved in a project file. • If the project file is already existing, it is overwritten by the current dimensioning status.
Save as...	Save the current dimensioning status as a project with the specified name. • If the project name is different from the project that may currently be edited, it is renamed. • The project name is displayed in the window headline.
Exit	▶ Closing the program (📖 40)

3.1.1.2 Edit

Menu command	Function
Move one step back	Move one entry back in the navigation tree.
Move one step forward	Move one entry forward in the navigation tree.

3.1.1.3 View

Menu command	Function
Notes	- Note recording current dimensioning step - Display or write a comment on the current dimensioning step. - All notes - Display, print or deletion of all comments that were created for the project. ► Notes (437)
Messages	Shows all warnings, notes and tips for the current drive dimensioning. ► Drive sizing messages (506)
Sizing report	Create and display Log. - The dimensioning protocol that is generated can be printed or opened in Microsoft Word. - The completeness of the report depends on the progress of the dimensioning. If the dimensioning report is opened early, some components possibly are not displayed. - At the end of the drive dimensioning the DSD offers different possibilities of presenting the results. ► Reports (438)
Project comparison	Compare projects among each other. If several projects are open at the same time, they can be compared with respect to the application and the utilisation of the components. ► Reports (438)
Product options for the EASY Product Finder / SAP	Shows product options of the components which are required for the purchase order with the »EASY Product Finder«. The »EASY Product Finder« is the electronic catalogue on the Lenze web page.

3.1.1.4 Extras

Menu command	Function
Select language	Change the language of the user interface. German, English (British), Czech, Danish, English (American), Spanish, French, Italian, Dutch, Russian, Swedish, Chinese (simplified) and Chinese (traditional) are provided.
Settings	► Settings (42)

3.1.1.5 Tools

Menu command	Function
Application check list	Select and open the checklist for an application. • Every application provides a check list including requests for the respective application. • Parameters indicated with * have to be known for the dimensioning. • The calculability at least requires the *parameters of the process and of the motion; all further requests concerning components are optional.
Manage user motors	
Storing all DSD projects in the shopping cart	
Calculator	► Calculator (Microsoft® calculator) (□ 469)
Inertial calculator	Calculation of moments of inertia on the basis of geometric quantities and the material-specific density. ► Inertial calculator (□ 472)
Mass calculator	Calculation of masses on the basis of geometric quantities and the material-specific density. ► Mass calculator (□ 470)
MotionDesigner	Irrespective of the dimensioning of a project, motion profiles can be created, loaded, edited, and saved graphically or manually. ► MotionDesigner (□ 243)
Gearbox calculator	Conversion of gearbox sizes. ► Gearbox calculator (□ 475)
Energy efficiency, fan/pump	Host computer to detect energy savings for applications with pumps or fans. • Comparison of an electronic control (frequency inverter) with a lossy mechanical control. The system parameters and the frequency distribution of the load are defined.
Special host computers	Determination of specific parameters of an application. The following auxiliary calculators are included in the DSD: • Travelling resistance • Pinion diameter • Spindle efficiency • Mass of belt • Mass of delivery volume (materials handling technology) • Uniform load mass (materials handling technology) • Backing force • Mass of counterweight (hoist drive) • Mass of rope/cable (hoist drive) ► Special host computers (□ 468)
Physical coefficients	Value tables with physical coefficients. The tables can also be called in auxiliary calculators and input templates. Like this the coefficients can be accepted directly in the input field. The following value tables are included in the DSD: • Density of solids • Density of winding material • Density of liquids • Static friction coefficient • Coefficient of sliding friction • Coefficient of friction for rolls • Bearing and leadscrew friction • Wheel flange and lateral friction • Lever arm of the rolling friction • Shunt-force factor for belt conveyors • Filling factor for belt conveyors • Efficiency of drive elements ► Physical coefficients (□ 488)

Menu command	Function
Collection of formulae	"Drive solutions – formulae, tables and dimensioning" Manual in the PDF format. • The reference book, formulary and tables provide the physical-mathematical basics in drive technology. • The Manual can be read e.g. with the free-of-charge Adobe Reader.
Other tools (web links)	Useful references to the Lenze web page. For using it, an internet connection is required. • »EASY Product Finder« • Electronic catalogue to configure and/or order drive components and accessories. • Sales documents, technical documentation, software • Generation of CAD data • CAD data of Lenze motors • EPLAN macros for Lenze products

3.1.1.6 Window

In the **Window** menu, all open DSD projects are listed. By selecting the corresponding menu item the project window is shown in the front. Project windows can be arranged using the following menu commands:

Menu command	Function
Cascading window	If several windows are open, they are arranged one behind the other in a slightly staggered manner; by this other windows can be quickly selected.
Split window horizontally	The display window is split horizontally into several areas. The projects are arranged one below the other.

3.1.1.7 Help

Menu command	Function
About DSD	Open the information dialog showing the version number, registration information, and important information about DSD.
Help	Open online help.
Sizing examples	Examples of different drive dimensionings. The DSD files can be used as a template for individual drive dimensionings.
Check for updates	Search for available updates for the DSD. For using it, an internet connection is required.
Acquisition of application data	Send log file with application information to the Lenze DSD server. - The log file contains important information on the Lenze development for optimising the Drive Solution Designer. - For using it, an internet connection is required. ► Recording usage data (📖 563)
Support on the intranet (AKB)	Weblink to the Lenze Application Knowledge Base. - The Application Knowledge Base contains various information on the Drive Solution Designer. - For using it, an internet connection is required.
Information on drive sizing	
Support in the web	Search the Lenze Application Knowledge Base for information and solutions. For using it, an internet connection is required.
Software downloads	The download area of the Lenze Application Knowledge Base contains the current DSD version and the published service packages. - Always use the most current service package! - For using it, an internet connection is required.
Lenze on the Internet	The Lenze webpage contains current information on the company and its products. For using it, an internet connection is required. http://www.Lenze.com

3.1.2 Toolbar

Via the icons in the *toolbar* you can directly carry out the most frequently used functions.

- Click on an icon to carry out the respective function.

Symbol	Menu command	Keyboard command	Function
	File→New	<Ctrl>+<N>	► Create new project (□ 48)
	File→Open...	<Ctrl>+<O>	► Open project (□ 50)
	File→Save	<Ctrl>+<S>	► Saving the project (□ 52)
	Edit→Undo	–	Undo last action
	Edit→Redo	–	Redo last undone action
	View→Dimensioning report...	–	► Reports (□ 438)
	View→Warning signals...	–	Shows all warning signals, notes and tips for the current drive dimensioning. ► Drive sizing messages (□ 506)
	Tools→Calculator...	–	► Calculator (Microsoft® calculator) (□ 469)
	Tools→Inertial calculator...	<Alt>+T>	► Inertial calculator (□ 472)
	Tools→Mass calculator...	<Alt>+M>	► Mass calculator (□ 470)
	Tools→MotionDesigner...	–	Creating, changing and saving motion profiles ► MotionDesigner (□ 243)
	Tools→Energy-efficient fan/pump...	–	Detecting energy efficiency for applications with fans or pumps
	Tools→Gearbox calculator...	<Alt>+G>	► Gearbox calculator (□ 475)
	Tools→Application checklist...	–	► Data collection via checklists (□ 53)
	Tools→Store all DSD projects in the shopping cart...	–	► Shopping cart for »EASY Product Finder« (□ 444)
	View→Project comparison...	–	► Project comparison (□ 59)
	Help→Help	<F1>	Call up help
	–	–	Call up context-sensitive help

The [MotionDesigner](#) serves to carry out the most frequently required functions via the icons in the toolbar. Many functions can also be carried out via shortcuts. There are no menu commands. ([📖 243](#))

- Click on an icon to carry out the respective function.

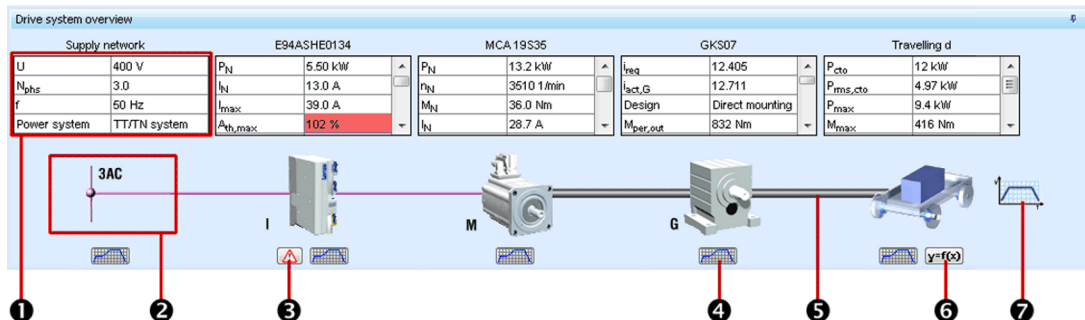
Symbol	Keyboard command	Function
	<Ctrl>+<N>	Create new motion profile.
	<Ctrl>+<O>	Load motion profile. ▶ Load the motion profile (📖 252)
	<Ctrl>+<S>	Save motion profile. • When a newly created motion profile is saved, you are asked for the destination of the Imp file. • When the motion profile is newly saved, the Imp file is updated. ▶ Save motion profile (📖 253)
	–	Save motion profile as... • During the saving process, you are asked for the destination of the Imp file. ▶ Save motion profile (📖 253)
	–	Import the motion profile with parameter profiles from an ASCII file. ▶ Importing profile data (📖 254)
	–	Create note for motion profile • The note is attached to the "Motion" dimensioning step. • The function is only available with the application-dependent <i>MotionDesigner</i> . ▶ Notes (📖 37)
	<Del>	Delete highlighted element. • The element is deleted permanently.
	–	Application analysis. • Shows diagrams and table of values via the entered and calculated values with regard to a cycle of the motion profile. • The function is only available with the application-dependent <i>MotionDesigner</i> .
	<Ctrl>+<Z>	Undo last action.
	<Ctrl>+<Y>	Redo last undone action.
	–	Default settings for the dialog box. • Identical to the "Motion" register in the DSD menu Extras→Settings . ▶ Settings (📖 42) ▶ "Motion" register (📖 43)
	–	Zoom x-axis and y-axis • Draw up a rectangle across the area to be zoomed in by keeping the left mouse button pressed.
	–	Return to standard view.
	<Ctrl>+<X>	Cut the highlighted element and drag to the clipboard.
	<Ctrl>+<C>	Copy the highlighted element into the clipboard.
	<Ctrl>+<V>	Paste the element from the clipboard.
	–	Select the element or deactivate an active symbol.

Symbol	Keyboard command	Function
	–	Draw trapezoidal element. • The "Profile" register contains a selection of trapezoidal elements. ▶ Creating and editing elements (📖 260) ▶ Parameter area: Description (📖 265)
	–	Draw line. ▶ Creating and editing elements (📖 260)
	–	Draw S-shaped element. ▶ Creating and editing elements (📖 260)
	–	Import an individual motion profile or parameter profile. ▶ Importing profile data (📖 254)
	–	Move elements to the left. • Moves separated elements on the drawing area to the left and connects them to its preceding element. ▶ Shift elements automatically to the left (📖 262)
	–	Combines the elements that form a trapezium so that an element is generated. • Only connected elements can be combined. • The elements to be combined must be highlighted. ▶ Combining elements (📖 263)
	–	Undo combination. • Deactivate the combination of a trapezoidal element so that the elements can be processed separately.
	–	Reflect highlighted element on the time axis. • This function can only be accessed via the context menu (click the right mouse button).
–	<Ctrl>+<Click>	Duplicates an element in the drawing area when the element is right-clicked while the Ctrl key is pressed.
–	<Ctrl>+<G>	Shows or hides the grid of the drawing area.
–	<Ctrl>+<A>	Highlights all elements on the drawing area.
–	<Shift>+<Click>	In order to highlight several elements keep the <Shift> button pressed and right-click the elements.

3.1.3

Drawing

The drawing visualises the current state of the drive dimensioning.



Legend	Information
❶	Short overview of the drive system with the data entered, rated data of the selected drive components and their utilisation, and display of warning parameters.
❷	Illustration of the component (at the same time button). By clicking on the illustration you directly reach the selection table for the corresponding component where a variety of data is provided.
❸	Button for calling messages and notes for the corresponding component. Disregarding warning signals may result in damage or malfunctions of the application, as far as this is not monitored by the system. ▶ Drive sizing messages (□ 506)
❹	Button for calling the diagrams for the corresponding component. - Graphical representation of the speed, torque and utilisation behaviour. ▶ Diagrams for the components (□ 434)
❺	Representation of the drive train used.
❻	Button for calling the description of the application in the online help.
❼	Button for calling the motion profile. ▶ Motion design (□ 242)

Notes

- At the beginning of the configuration a general drive train is displayed, consisting of the following components:
 - Mains/environment
 - Inverter
 - Motor
 - Gearbox
 - Application
 - Motion
- The components inverter and gearbox (with or without an additional drive component) are optional, i. e. their presence depends on the application or the dimensioning procedure.
 - Therefore these components are displayed in an inactive manner at the beginning of the dimensioning. Depending on the further procedure the inverter or gearbox is displayed or removed from the drawing.
- Additionally, with regard to multi-axis applications, the drawing can be extended by a power supply module (Master project) or by a place holder (Slave project).
- If an "Additional drive element" is used, this is symbolised by a toothed belt in the drawing, irrespective of the type selected.

- The drawing shows additional information required for a dimensioning process.
 - Above the images of the components, important parameters and their values are shown in tables.
 - Below the images of the components, depending on the dimensioning a button is displayed, via which you can call the diagrams for the component.

3.1.3.1 "Application" image

Symbol	Description
$a_{\max}$	Max. acceleration of the application
$d_{\dim}$	Sizing diameter • Diameter which is reached after termination of the acceleration phase.
HW	Winding characteristic (hard/soft), describes the tensile force drop for rewinders as a function of the reel diameter
$J_{\max}$	Max. load moment of inertia • Max. load moment of inertia for the slider-crank mechanism • The load moment of inertia considers the masses of all bodies moved (slider, payload, crank, connecting rod) and the additional moment of inertia J_{add}. • The max. load moment of inertia serves to determine the load-matching factor. • The calculation is performed using an approximation formula.
k_f	Tensile force setting range, $K_F = F_{\max}(d_{\max})/F_{\min}(d_{\min})$
k_M	Torque setting range, $k_M = M_{\max}/M_{\min}$
$l_{\max}$	Length of the winding material for a max. reel diameter $d_{\max}$ and a min. material thickness $s_{\min}$
$m_{\max,L}$	Max. mass of the winding material
$m_{\text{sum,max}}$	Max. mass in motion in case of the slider-crank mechanism • The maximum mass in motion at the slider consists of the fixed mass m_{Slid} of the slider and the variable mass m_L of the payload. • The masses of the crank and the connecting rod are not added here. However, they are considered when the torque requirement is determined.
	Max. mass in motion in case of the hoist drive without counterweight • The maximum mass in motion consists of the mass of the cage and the payload.
$M_{\max}$	Required max. torque of the application • Is determined from the diagram for the torque.
Mode	Winder control mode
$N(*.dsd)$	Number of DSD projects
n_{av}	Average speed of the application
N_D	Number of drive axes with multi-axis system.
	Movement of drive axes • Axes coordinated • Axes uncoordinated
$n_{\max}$	Max. speed of the application • Is determined from the diagram for the speed.
P_{cto}	Base process power of the application used for motor dimensioning • The base process power is a theoretical value resulting from the max. speed and the max. torque of the application. • The base process power often equals the max. required power, since the max. speed and the max. torque are often required at the same time.
$P_{\text{gen,av}}$	Required average power of the brake resistor, taking into account the thermal time constant.
$P_{\text{gen,max}}$	Max. occurring regenerative power
$P_{\max}$	Required max. power of the application • Is determined from the diagram for the power.
$P_{\text{mot,max}}$	Max. occurring motor power

Symbol	Description
$P_{\text{mot,av}}$	Average power (mean value)
$P_{\text{rms,cto}}$	Required thermal power of the motor
q_{dim}	Dimensioning winding ratio, $q_{\text{dim}} = d_{\text{max}}/d_{\text{min}}$
q_{max}	Max. winding ratio, $q_{\text{max}} = d_{\text{max}}/d_{\text{min}}$
s	Path/distance of the slider with the slider-crank mechanism The distance covered by the slider and the payload starts from zero at the beginning of the motion cycle.
t_{Crd}	Coordinated cycle time

3.1.3.2 "Gearbox" image

Symbol	Description
$A(M_{\text{eq}})$	Ratio of the equivalent torque to the max. permissible torque: $M_{\text{eq}} / M_{\text{max,per,G}}$
$A(M_{\text{in,max}})$	Clutch utilisation with reference to the max. drive torque For flange mounting only
$A(M_{\text{max}})$	Ratio of the max. torque of the application to the max. permissible torque of the gearbox: $M_{\text{max}} / M_{\text{max,per,G}}$
$A(n_{\text{max}})$	Max. occurring speed relative to the max. speed of the gearbox: $n_{\text{max}} / n_{\text{max,G}}$
$A_{\text{th,1,G}}(n_{\text{th}})$	Utilisation of the gearbox relative to the thermal output speed
$A(T)$	Utilisation of the gearbox relative to the fatigue strength If the value is > 100 %, an exact check is required.
Type	Direct or standard mounting of the motor on the Lenze gearbox
i_{req}	Required ratio (Lenze gearbox and additional drive element if required) - Is calculated from the intended input speed of the gearbox, relative to the max. speed of the application: $n_{\text{in}} / n_{\text{max}}$ - Ratio i_{req} is required to operate the motor with the field weakening factor specified by DSD.
$i_{2,\text{req}}$	Required ratio of the additional drive element under consideration of a Lenze gearbox, if any - Is calculated from the intended input speed, relative to the max. speed of the application: $n_{\text{in}} / n_{\text{max}}$ - Ratio i_{req} is required to operate the motor with the field weakening factor specified by DSD.
$i_{\text{act,G}}$	Actual ratio of the Lenze gearbox
$i_{\text{act,K}}$	Actual ratio of the additional drive element
$J_{\text{out,K}}$	Moment of inertia at the output end of the additional drive element
k_{G}	Correction factor for the torque of the gearbox
$M_{\text{per,out}}$	Permissible output torque without speed evaluation.
M_{eq}	Equivalent output torque of the Lenze gearbox Is calculated from the diagram for the torque of the application.
η_{K}	Efficiency of the additional drive element at the rated point
$n_{\text{in,max}}$	Max. input speed of the Lenze gearbox Is determined from the M-n diagram of the Lenze gearbox
$n_{\text{out,max}}$	Max. speed at the output shaft
$n_{\text{per,in,max}}$	Max. permissible input speed of the Lenze gearbox
$n_{\text{per,th,out}}$	Permissible thermal output speed of the gearbox

3.1.3.3 "Motor" image

Symbol	Description
P_N	Rated power of the motor
n_{rated}	Rated speed of the motor
M_{rated}	Rated torque of the motor
$M_{dyn,M}$	Maximum torque in air gap
I_N	Rated motor current
$A_{th,max}$	Max. thermal utilisation of the motor
$A(M_{max})$	Utilisation of the motor relative to the torque Ratio of the max. required torque to the max. possible torque of the motor during operation on the selected inverter and with the selected control mode: $M_{max,req} / M_{max,M}$
$A(M_{rms})$	Utilisation of the motor with reference to the effective torque and taking into account the thermal time constant
$A(M_{dyn,M})$	Dynamic utilisation of the motor Ratio of the max. occurring motor torque to the rated motor torque: (M_{max} / M_N)
$A(M_0')$	Utilisation of the synchronous motor, taking an unfavourable rotor position with a load at a standstill into consideration (thermal standstill utilisation)
k_f	Field weakening factor of the motor
$k_{J,max}$	Load-matching factor of the motor

3.1.3.4 "Inverter" image

Symbol	Description
$A(I_{max} / I_{rated,M})$	Utilisation of the inverter - Ratio of the max. output current of the inverter (I_{max}) to the rated motor current ($I_{N,M}$). - If the inverter is highly overdimensioned with regard to the motor, the control quality decreases.
$A(I_{imp,max})$	Thermal utilisation of the inverter relative to the power pulse current for 1 s or 60 s
$A(I_{red,max})$	Utilisation of the inverter relative to the reduced max. output current
$A_{th,Brm}$	Thermal utilisation of the internal brake transistor
$A_{Brm}(ED)$	Utilisation of the internal brake transistor, relative to the ixt monitoring
A_{max}	Max. utilisation of the brake resistor
A_{th}	Thermal utilisation of the brake resistor
$A_{th,max}$	Max. thermal utilisation of the inverter relative to the reduced output current
I_{max}	Max. output current of the inverter selected
I_N	Rated current of the inverter selected
P_N	Rated motor power of the inverter selected
Type	Type of brake resistor

3.1.3.5 Image "Power supply module" or "Regenerative power supply module"

Symbol	Description
$A_{Brm}(ED)$	Utilisation of the internal brake transistor, relative to the ixt monitoring
$A_{Brm}(P_{max})$	Utilisation of the brake transistor, relative to the max. power
$A_{max,Rb}$	Max. utilisation of the brake resistor
$A_{Sup}(P_{imp,DC})$	Utilisation of the power supply module, relative to the pulse power in the DC bus.
$A_{Sup}(P_{max})$	Utilisation of the power supply module, relative to the max. power.
$A_{Sup}(P_{gen,max})$	Utilisation of the regenerative power supply module without brake transistor, relative to the max. regenerative power
$A_{Sup,Brm}(P_{gen,max})$	Utilisation of the regenerative power supply module with brake transistor, relative to the max. regenerative power
$A_{th,Brm}$	Thermal utilisation of the brake transistor
$A_{th,Rb}$	Thermal utilisation of the brake resistor
$A_{th,Sup}$	Thermal utilisation of the power supply module
$P_{gen,cto}$	Regenerative power from which a brake resistor is used additionally
$P_{gen,max}$	Max. permissible regenerative power
$P_{gen,N}$	Rated power in generator mode
$P_{max}(\tau_1)$	Max. permissible power, relative to the 5-s cycle • 0.5 s overload / 4.5 s load removal with 75 % of the continuous rated quantity
$P_{max}(\tau_2)$	Max. permissible power, relative to the 3-s cycle • 60 s overload / 120 s load removal with 75 % of the continuous rated quantity
P_{rated}	Rated horsepower
Type	Type of brake resistor

3.1.3.6 "Supply network" image

The displayed quantities always refer to the supplying mains (AC mains or DC mains). In case of multi-axis controllers that are connected via a power supply module or a regenerative power supply module, the values of the power supply unit are indicated.

Symbol	Description
U	Rated mains voltage of the supplying electrical network
N_{phs}	Number of phases of the supplying electrical network
f	Mains frequency of the supplying electrical network
Power system	Power system of the supplying three-phase system

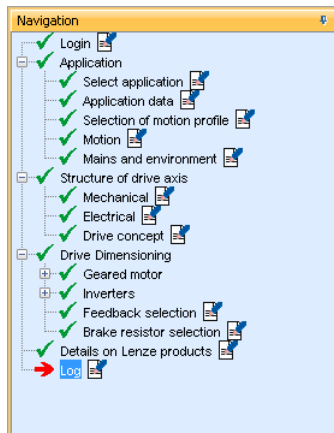
3.1.4 Navigation tree and result tree

Below the drawing on the left the *Navigation tree* or the *Result tree* is displayed.

- Via the two registers below the *Navigation tree* or *Result tree* you can switch between the two views anytime.

3.1.4.1 Navigation tree

The *Navigation tree* indicates your position within the dimensioning process:



- A green tick indicates all the dimensioning steps that have been edited.
- The steps still to be edited are indicated by a question mark.
- The current step is marked by a red arrow.
- The context menu (select dimensioning step and click the right mouse button) serves to execute the following commands:
 - [Creating an alternative](#) (□ 55)
 - Create note and delete note. ▶ [Notes](#) (□ 37)
- The dimensioning steps marked with □ contain notes.
 - A mouse-click on the icon opens the note.



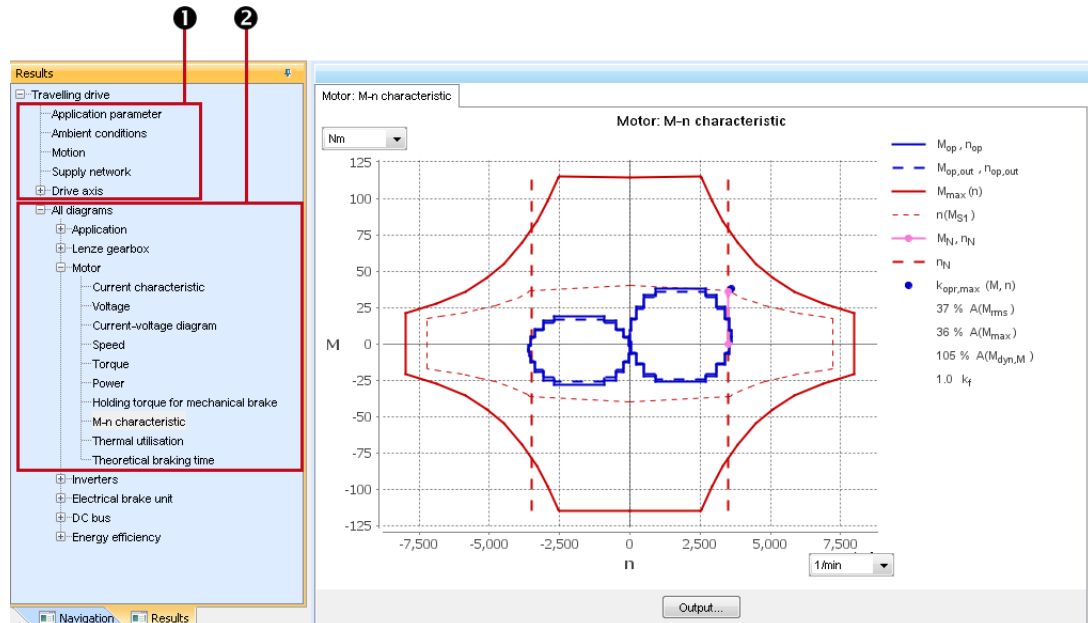
Tip!

In the *Navigation tree* you can also select dimensioning steps that have been previously edited and change to the corresponding input template.

3.1.4.2 Result tree

The *Result tree* shows the logic structure of the drive train.

- All components of a drive train are visualised with regard to their interconnection via the *Result tree*.
- If a component is not clearly selected yet, e.g. if three different motors are still possible, the value range of the parameter is displayed.



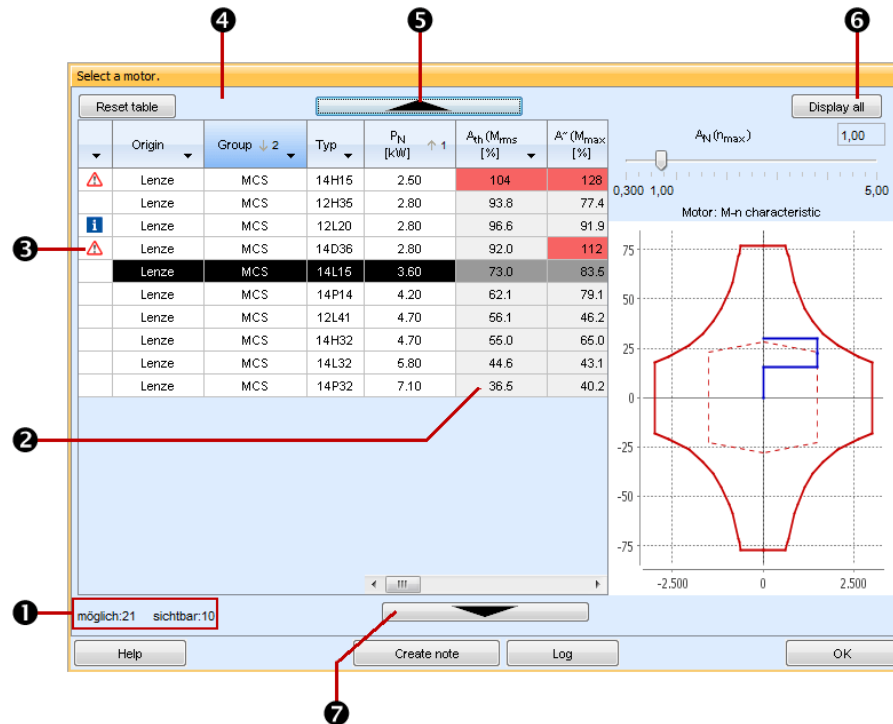
Legend	Information
①	Representation in table form of quantities of the application and of rated quantities and calculated values of the components.
②	Diagrams of entered and calculated values as well as rated quantities for evaluating the drive task (application), components and energy efficiency.

3.1.5 Input area

In the *input area*, you enter the parameters for drive dimensioning.

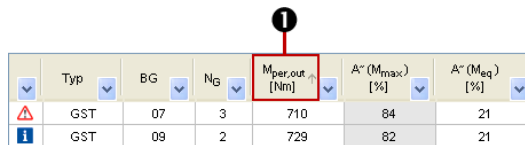
- A dimensioning process is dynamically: depending on the selection made in a dimensioning step, it may change.
- The representation of the *input area* depends on the dimensioning step.
 - Depending on the task, the input fields, selection fields, the *MotionDesigner*, selection tables appear with or without curve diagrams and decision fields.

3.1.5.1 Structure of the selection tables



Description	
❶	Number of results: • Possible: Total results detected by DSD. • Visible: Results proposed and displayed by DSD.
❷	Preview value • A cell with a grey background signals that the corresponding parameter is a preview value which can cause a warning signal.
❸	Drive dimensioning messages. • Several messages can be available for one component. • The left column always shows the symbol of the highest warning level.
	⚠ Warning • Important criteria (e.g. limit values) are not fulfilled. A red background indicates the corresponding value. • If an utilisation value 1000 is shown, the value is outside the calculable range. The component cannot be used.
	ℹ Note • Important information has to be observed for a correct function of the component. A blue background indicates the corresponding value.
	💡 Tip • Tips contain useful information on optimisation. A yellow background indicates the corresponding value.
❹	Button for resetting the extended representation of the selection table.
❺	Button to show more components with smaller performance values.
❻	Show all possible values detected by DSD.
❼	Button to show more components with higher performance values.

3.1.5.2 Sorting and filtering results in selection tables



	Typ	BG	Ng	M _{per,out} [Nm]	A ⁺ (M _{max}) [%]	A ⁺ (M _{eq}) [%]
⚠	GST	07	3	710	84	21
i	GST	09	2	729	82	21

Sorting results

Sorting by alphanumeric characters is possible. Up to three columns can be included. Table columns that contain symbols cannot be sorted.



How to sort the results:

- Click the desired column header ❶.
 - The result list is sorted according to the data in the selected table column.
 - ↑ Sorting of the data sets in ascending order.
 - ↓ Sorting of the data sets in descending order.
- Keep the <Ctrl> key pressed and click another column header with the mouse to include another column in the sorting.

Filtering results

- The available filters provide comfortable assistance in selecting specific data sets.



How to filter results:

- Click the desired button ▼ in the header.
 - A selection menu opens.
- Select filter or filter function.

Filter or filter function

Selection menu	Description	
Display all	Reset all filters of the table column.	
User-defined	When the user-defined filter is selected, a dialog box opens in which three specific filters can be set.	
	Identical value	• Select a value to indicate only the data sets with this value.
	Value range	• Select min. and max. value to indicate only the data sets within this value range.
	Several values	• Select several values to indicate only the data sets with these values.
Alphanumeric characters	The selection menu lists all alphanumeric values of the table column. • Select a value to indicate only the data sets with this value.	

3.1.5.3 Changing a value or a selection subsequently

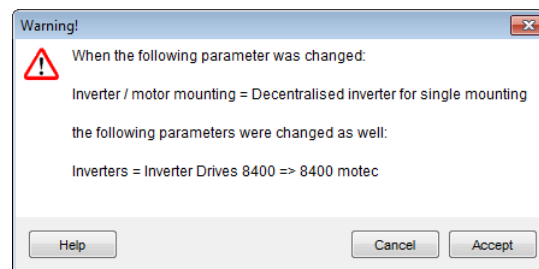


How to change a value or a selection subsequently:

1. Select the desired dimensioning step in the *navigation tree*.
2. Change the value or the selection in the *input area*.
3. Press **OK**.
 - You get a confirmation prompt whether the change is to be accepted.
4. Confirm with **Yes** to accept the change.
 - The following, already executed dimensioning steps are deleted.
 - The dimensioning process is continued after the changed dimensioning step.
5. Or press **No** to cancel the executed changes.

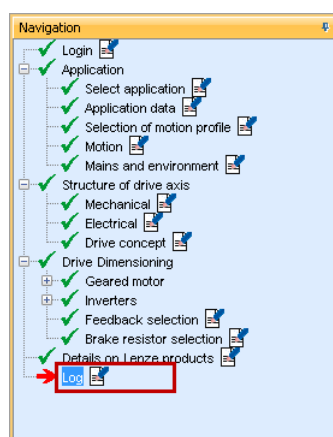
3.1.5.4 Changing interdependent values

Many dimension-specific parameters/components are interdependent. DSD takes these internal dependencies into consideration and waits for a decision in the case of any changes made.



3.1.6 Notes

Each dimensioning step can be provided with a notepad for comments and notes. The notes can be output in the protocol.





How to create a note for a dimensioning step:

1. Select the desired dimensioning step in the *navigation tree*.
2. Three options to open the *Notepad* dialog box:
 - Open the *Context menu* with the right mouse button and select **Create note**.
 - Execute the command **View→Notes→Note of current dimensioning step**.
 - Click the **Create note** button in the status bar.
3. Enter comments and notes.
 - A note is created when you at least enter one character.
4. Press the **Close** button.
 - The dimensioning step is marked with .



How to open created notes:

Three options to open a single note:

- Click the desired notepad  in the *Navigation tree*.
- Click the **Create note** button in the status bar.
- Select the desired dimensioning step in the *Navigation tree* and execute the command **View→Notes→Note of current dimensioning step**.

Open the *All notes* dialog box:

- Select the desired dimensioning step in the *Navigation tree* and execute the command **View→Notes→All notes**.



Note!

- You cannot change notes in the dialog box.
- Copying of texts is possible.
- You can print notes via the Print button.



How to delete notes:

A single note:

- Mark the desired dimensioning step in the *Navigation tree*, open the *Context menu* with the right mouse button and select **Delete note**.

All notes:

- Execute the command **View→Notes→All notes**.
- Go to the *All notes* dialog box and press the **Delete all** button.
- Press **OK** to close the dialog box.

3.2

Shortcuts

In order to use the DSD easier via keyboard, some functions can be accessed via shortcuts.

Keyboard command	Function
<Alt>+<F4>	Exit DSD.
<Alt>+<G>	Gearbox calculator (📖 475)
<Alt>+<M>	Mass calculator (📖 470)
<Alt>+<T>	Inertial calculator (📖 472)
<Esc>	Cancel current action.
<F1>	Call the "Help" menu.
<Ctrl>+<C>	Copy the highlighted element into the clipboard.
<Ctrl>+<N>	Create new project (📖 48)
<Ctrl>+<O>	Open project (📖 50)
<Ctrl>+<S>	Saving the project (📖 52)
<Ctrl>+<V>	Paste the element from the clipboard. • Only numerical values can be entered into input fields.
<Ctrl>+<X>	Exit DSD.
<Ctrl>+<Tab>	Change between multiple opened projects.
<Tab>	Skip to the next control element (input field, button, etc.) within the dialog box.

In order to use the [MotionDesigner](#) easier via keyboard, some functions can be accessed via shortcuts. (📖 243)

Keyboard command	Function
<Del>	Delete highlighted element. • The element is deleted permanently.
<Shift>+<Click>	In order to highlight several elements keep the <Shift> button pressed and left-click the elements.
<Ctrl>+<A>	Highlights all elements on the drawing area.
<Ctrl>+<C>	Copy the highlighted element into the clipboard. ▶ Processing functions (📖 247)
<Ctrl>+<G>	Shows or hides the grid of the drawing area.
<Ctrl>+<Click>	Duplicates an element in the drawing area when the element is left-clicked while the Ctrl key is pressed.
<Ctrl>+<N>	Create new motion profile.
<Ctrl>+<O>	Load the motion profile (📖 252)
<Ctrl>+<S>	Save motion profile (📖 253)
<Ctrl>+<V>	Paste the element from the clipboard. ▶ Processing functions (📖 247)
<Ctrl>+<X>	Cut the highlighted element and drag to the clipboard. ▶ Processing functions (📖 247)
<Ctrl>+<Y>	Redo last undone action.
<Ctrl>+<Z>	Undo last action.

3.3

Closing the program

Options to exit the »Drive Solution Designer«:

- Select the command **File→Exit**.
- Click the Window icon **✕** in the Title bar.
- Press the shortcut <CTRL>+<X>.
- Click the shortcut <ALT>+<F4>.

**Note!**

If the program is closed and projects with changes that are not saved yet are still open, you are asked via the *Save project* dialog box whether you want to save the projects.

► [Managing projects: Saving the project](#) (📖 52)

4 Setting up the DSD workplace

4.1 Settings during installation

4 Setting up the DSD workplace

Before starting the work with the »Drive Solution Designer«, please set up your DSD workplace first.

4.1 Settings during installation

During the installation of the DSD, country-specific settings can be changed already:

Select language

- Language of the user interface.

Language selection for the online help

Select the language in which a web link is to be called

- DSD menus *Tools* and *Help* contain web links which serve to directly access information provided on the Lenze web page or the Lenze Intranet.

Preferred unit system

- When values are entered, DSD offers the preferred unit system first.



Tip!

The settings can also be changed later in DSD in the menu **Extras→Settings**.

4.2 Language

With the command **Extras→Select language** you select the language of the user interface.

- The languages German, English (British), Czech, Danish, English (American), Spanish, French, Italian, Dutch, Russian, Swedish, Chinese (simplified) and Chinese (traditional) are provided.
- The change-over is effected immediately. The DSD does not have to be restarted.



Tip!

By means of the language switch you can create a project in your native language and then print the Log in another language.

4.3 Settings

By using the command **Extras→Settings**, you open the *Settings* dialog box.

- The *Settings* dialog box contains different tabs via which you can carry out the basic settings.
- Detailed information on the different tabs can be found in the following subchapters.
- With the buttons in the dialog box below you confirm or reject changes carried out:

Button	Function
OK	Confirm entries and close dialog box.
Cancel	Reject entries and close dialog box.
Accept	Confirm entries and keep dialog box open for further entries.

4.3.1 "General" register

Settings	Information
Working directory	Selection of the directory that is called by default for opening and saving projects. • Use last path • Defines whether the directory called last is used for opening and saving projects.
Script	Define the font used in the masks
Start-up window	• Display start-up window • Define whether the start-up window is to be displayed when starting the DSD.
Tips for drive sizing	• Display tips • Tips contain useful information about optimising settings.
Main memory	Reserve main memory (RAM) of the computer for DSD. • The change of the setting requires a restart of the DSD. • As long as DSD is open, the reserved main memory is not available for other applications. • Generally, the Lenze setting is sufficient. • Reserve more main memory if • many projects are open at the same time and are to be processed, • a motion profile with a lot of grid points is to be imported into the project.

4 Setting up the DSD workplace

4.3 Settings

4.3.2 "Network connections" register

Settings	Information
Test of the online connection at the start of DSD	In the Lenze setting, at every program start it is checked whether an Internet connection has been established.
Proxy server	Activate <i>Use proxy server for Internet connection</i> if an Internet connection is only possible via a proxy server in your local area network. A proxy acts as a switching centre between your computer and the rest of the Internet. • Ask your system administrator if you require the data (address, port, user name, password) for accessing the proxy server.
URL for product configuration	With an active Internet connection, product options and CAD data are directly provided by the »EASY Product Finder«. The »EASY Product Finder« can be reached at the following Internet address: • https://productfinder.lenze.com or • https://productfinder.lenze.cn Under URL for product configuration and URL for CAD data one of the two Internet addresses is preset depending on the installation of the DSD. Tip! If the »EASY Product Finder« is not available at one of the URLs, you can enter the other URL.
URL for CAD data	
Port MotionDesigner	This value must only be changed in consultation with the Lenze Support department.

4.3.3 "Help" tab

Settings	Information
Language	Language selection for the online help. Selection of the language on the Lenze web page if a weblink is called.

4.3.4 "Motion" register

Settings	Information
Digital resolution motion profile	The analog motion profile created in the <i>MotionDesigner</i> is decomposed into points for further processing in the DSD and for the export into an ASCII file (digitised). • Max. resolution [dots] • Max. number of values the motion profile is decomposed into. • Max. error rate [%] • Relative error frequency, with regard to the max. resolution.
Default values, units	Default settings for the graphical and numerical creation of motion profiles/subprofiles.
Flying restart functions	Drawing help for the graphical creation of motion profiles/subprofiles. For simple positioning of drawn elements.

4.3.5 "Units" tab

Settings	Information
Unit systems	Definition of unit systems that are to be available in the input masks. • You can both select the SI unit system or the Imperial unit system.
Preferred unit system	Application of the unit system: Imperial or Metric with regard to inputs and outputs.
Preferred units	Definition of the units for frequently used physical quantities.

4.3.6 "Protocol" tab

Settings	Information
Output format	Setting of the output format for the log file: • Word 97-2003 document (*.doc) • Microsoft Word 97 to Word 2003 • Word document (*.docx) • From Microsoft Word 2007 • Portable document format (*.pdf) • PDF (for reading the file, Adobe Reader is required).
Preferences for the detailed report Settings for the commissioning data	The two tabs can be used to make separate settings for the detailed protocol and the commissioning data. Output of Selection of additional information which is to contain the detailed Log and the commissioning data • Notes • Notes for single dimensioning steps written by the user. • Diagrams • Dependent on the settings under <i>Detailed selection diagrams/table of values</i>. • Tables of values • Dependent on the settings under <i>Detailed selection diagrams/table of values</i>. • Product options • Details on Lenze products like motor, brake, gearbox, inverter. Detailed selection diagrams/tables of values Selection of diagrams and tables of values which are to contain the detailed Log and the commissioning data. • Extensive selection of diagrams and tables of values regarding application, gearbox, motor, inverter, DC bus and energy efficiency on evaluating and analysing the dimensioning. Lenze setting The selection of diagrams and tables of values is reset to the Lenze setting.

4.3.7 "Customer data" tab

Customer data are managed in a customer database in the DSD. In the "Project information" dimensioning step you select customer data or create new customers. Via the Export and Import functions, you can transfer the customer data to other DSD installations.

Settings	Information
Export	Export of the complete customer data to an XML file.
Import	Import of the XML file with customer data.

4.3.8 "User data" tab

User data

Settings	Information
Salutation, title	Sex, title.
Name	Surname of the registered person.
First name	First name of the registered person.
Company	Company of the registered person.
Department	Area of work within the company
E-mail	E-Mail address of the registered person. • The automatically generated e-mails are sent to this address.
Function	Field of responsibility within the company
Street/house number or PO box Postcode, town	Postal address of the company.
Country	Site (country) of the company.
Phone	Telephone number under which the user can be reached.
Fax	Telefax number under which the user can be reached.
Language for communication	User's language for communication with Lenze for communication via e-mail, telephone, or telefax. • German • English
Detection of usage data	Regular statistical investigation on the use of the DSD for continuous and target-oriented development. Personal data will not be saved or transmitted. • Recording usage data (□ 563) • Read the data protection notice at http://www.lenze.com .

Licence information:

Information regarding the licence that has been entered in the »EASY Navigator«.

- Read only.

4 Setting up the DSD workplace

4.4 Communication with the Lenze DSD server

4.4 Communication with the Lenze DSD server

In the following situations data are generated, which the DSD wants to send to the Lenze DSD server automatically:

Reason	File type	Call
Acquisition of application data	*.zip	Every three months automatically or manually by the user.
Hard conflict	conflict_xxxxxxx.dsd	Hard conflict in the DSD. The conflict is definitely indicated automatically by means of a number combination.
Registration dialog	*.xml	Only once, during the registration, the information as to when a registration request has already been sent is stored.
Check for updates	–	Manually or automatically at regular intervals.

All data transmitted by the DSD are locally saved to your PC under "C:\Users\Benutzername\AppData\Roaming\Lenze\DSD\V4.x.x.x\user_data\mail" in the "sent" or "outbox" directory.

- If there is an Internet connection, copies of the data transmitted are stored in the "sent" directory.
 - Read the data protection notice at <http://www.Lenze.com>.
- If there is no Internet connection, the data to be transmitted are stored in the "outbox" directory.
 - At the next program start, the DSD will try to send these data again. Delete the files in the "outbox" directory if the DSD is not to send these data.
 - When the data have been transmitted successfully, copies of the data transmitted are stored in the "sent" directory.
 - Ask your responsible Lenze sales department if you want to send data from the "outbox" directory to Lenze via e-mail.

4.4.1 Messages

When the data is sent to the DSD server, the following messages are displayed which must be confirmed by pressing **OK**.

- If there is an Internet connection:

Message	Meaning
Your message has been sent successfully to the DSD server. A copy of your message is saved under "C:\Users\Benutzername\AppData\Roaming\Lenze\DSD\V4.x.x.x\user_data\mail\sent".	With the transmission two files were stored in the "sent" folder: *.mail: This file was sent. *.type: Original source file. This file was saved for manual use.
The outbox still contains unsent data.	The DSD has identified a connection to the Internet and is now sending the files from the "outbox" folder.

4 Setting up the DSD workplace

4.4 Communication with the Lenze DSD server

- If there is no Internet connection:

Message	Meaning
Connection to the DSD server could not be established. The data are saved under "C:\Users\Benutzername\AppData\Roaming\ Lenze\DSD\V4.0.0.4\user_data\mail\outbox". When the DSD is started for the next time with a faultless online connection, this data is sent.	The files could not be sent. They are saved in the "outbox" folder until they can be transmitted successfully. 1. *.mail: This file is transmitted when an online connection has been established. 2. *.type: Original source file. This file was saved for manual use.

4.4.2 Software updates

Message	Meaning
The DSD version is up-to-date.	There are no new software updates for the DSD on the DSD server.
An up-to-date version of DSD is available.	An update DSD version has been found. Follow the given download link and save the new version on the computer. Close all opened projects and close the DSD. Carry out the update.
No online connection available. It is not possible to search for an update version.	DSD has not detected any connection to the Internet.



Note!

Always keep the »Drive Solution Designer« updated.

- Regular software updates correct existing errors.

4.4.3 Assistance in dealing with problems

DSD cannot send any data to the DSD support although a connection to the Internet has been established:

- Check the setting of your firewall
- Specify a proxy server in DSD if a proxy server is used in your local area network.
 - ▶ [Settings](#) (□ 42)
 - ▶ ["Network connections" register](#) (□ 43)
- Consult your system administrator.

5 Managing projects

This chapter deals with the handling of DSD projects.

- When you start the »Drive Solution Designer«, initially no project is loaded and the *Start-up window* is displayed in the basic setting.
- In the *Start-up window* you can choose whether you want to create a new project or open a project that is already existing.

Options in the start-up window		
	Create new project	▶ Create new project
	Recently opened projects Re-open one of the last opened projects offered in the list field.	▶ Open project
	Open other projects Open an already existing project in the <i>Open project</i> dialog box.	

5.1 Create new project



How to create a new project:

Select the option **Create new project** in the *Start-up window*,
or

click on the  icon in the *Toolbar*, or select the command **File→New**.

First the login template for the project information opens, from which the dimensioning with the application selection is continued.

5.2 Project information

The first navigation step, "Project information", serves to record the user data, customer data, and project data. The data are archived with the project and shown in the log.

Customer data

Customer data contain the data of the recipient of the protocol.

- In order to avoid a repeated specification of the data with regard to a further project for the same customer, customer data is stored in an internal database in the DSD.
- The customer data are saved in a common data structure. They can only be created, altered, deleted, imported, exported, and selected together.
- After entering the data, the respective customer data set can be selected via a selection menu next to the identifier "Customer", "Customer no.", "Contact person".
 - If a selection from the list has been made, it can be rejected by the 'selection "All" '.



Tip!

The customer data and project data in the "Project information" navigation step can be changed anytime and their entry is carried out independently of the further configuration steps.

Edit the desired data and confirm your changes with OK.

Button	Function
Import / export customer data	Import or export of the customer data (database as a whole) • An export enables the transfer/backup of a user's complete customer database. This can make sense if the DSD has to be uninstalled or the data are to be provided to a third party. • An import adopts the data of an external customer database to the DSD, i. e. the existing customer database is completed by the imported customer data.
Remove	Delete a data record from the customer database
Change	Change a data record in the customer database • If a customer data record is to be changed this can only be effected in a cohesive manner. The changed data record afterwards is provided for selection.
New entry	Create a new data record in the customer database • Additional information can be added via the Change button.
All customers	Reset the customer data mask to the initial state.

5.3

Open project

The constant further development of the DSD and update of data may cause a deviation of the project created with an earlier DSD version from the knowledge and database of the current DSD version. Thus, when a project is opened, the DSD checks if the project is compatible. In case of an incompatibility, the *Compatibility check* dialog box opens that shows your the test results and provides possible processing steps.



How to open a project (*.dsd):

1. Select a procedure to open the project.
 - Select the corresponding project in the *Start dialog* in the list field under **Recently opened projects**, or select the option **Open other projects**.
 - Click the  icon in the *Toolbar*.
 - Execute the command **File→Open** or press the <Ctrl>+<O> keys.
 - Select the corresponding project using the command **File→Recently opened projects**.
2. When the *Compatibility check* dialog box is displayed, you have the following options depending on the test results:
 - [Import project](#) (□ 51)
 - [Open the project in the ProjectViewer](#) (□ 52)

Processing options of the project in the *Compatibility check* dialog box:

Project		Import project	Open the project in the ProjectViewer
Created with	DSD version 4.x	Possible	Possible
	DSD version 3.x	Possible to a limited extent ¹⁾	Possible
	DSD version 1.x or 2.x	Not possible	Not possible
With user motor		Not possible	Possible
Multi-axis application		Not possible	Possible

1) Due to product updates or optimised dimensioning algorithms, the DSD may not reconstruct the project.

5.3.1 Import project

The *Compatibility check* dialog box is displayed.



Note!

During the import, the DSD tries to reconstruct the project. Parameters and values that cannot be reconstructed have to be entered manually.

Comply with the following rules during the import:

- Open the original project in the *ProjectViewer* in order that the original parameters and values are readily available.
- Only select values and parameters that are identical with the original project.
 - Consider electrical and mechanical parameters.
 - In the *Import project* dialog box, unknown parameters are marked.
- Do not select any alternatives if original parameters or values cannot be set (e.g. a component is not available anymore).
 - Instead, abort the import process. DSD creates a project with the already imported dimensioning steps. Now complete the dimensioning of the drive with alternative parameters or values.

Check the imported project:

- Compare the protocols of the imported project and the original project with regard to deviations.
- Evaluate deviations to the original project with regard to their dimensioning relevance. If required, re-dimension the drive system.

Restrictions:

- Projects with user motors cannot be imported.
- Product options cannot be imported.



How to import a project:

1. Click **Import project**.
 - The import process starts and the *Import project* dialog box is displayed.
2. Follow the instructions in the dialog box.
 - The project is imported in the sequence of the dimensioning steps.
3. In order to simultaneously display the original project, click **Open project in the ProjectViewer**.
 - The *ProjectViewer* starts in a separate dialog box. You can move the dialog box to display the import process and the original project next to each other.
 - The display in the *ProjectViewer* is automatically synchronised with the progress of the import process. Thus, required changes of parameters and values can be immediately compared to the settings in the original project.
4. In order to abort the import process, click **Cancel**.
 - The *Import project* dialog box is closed.
 - The project with the already imported dimensioning steps has been created in the DSD and can be further processed.
5. After the project has been imported successfully, click **Close**.
 - The *Import project* dialog box is closed.
 - The project has been created in the DSD.

5.3.2 Open the project in the ProjectViewer

The *Compatibility check* dialog box is displayed.



How to open a project in the ProjectViewer:

1. Click **Open project in the ProjectViewer**.
 - All dimensioning details of the DSD project are displayed.
 - Navigation tree, result tree and logs are provided as usual.
 - The motion profile (created in the *MotionDesigner*) can be saved in a file.
 - The drive dimensioning cannot be changed.
2. In order to close the *ProjectViewer*, click on in the dialog box.

5.4 Saving the project

Save opened projects from time to time, in order to protect your work against power failures or system problems.

- In the Lenze setting, the **Automatic saving** is activated to save the project at regular intervals. The function is executed in the background and can be set. ▶ [Settings](#) (42)
- If you open the saved project in the DSD again later on, the dimensioning can be continued from the point of saving.
- You can also skip back to any position in the navigation tree, e.g. to adapt an already available solution for similar requirements.



How to save the current project:

Click the icon in the *Toolbar*, execute the command **File→Save** or press the <Ctrl>+<S> keys.

- All pieces of information concerning the configured drive solution are saved.
- The file receives the extension **.dsd* by default.

6 Drive dimensioning tools

6.1 Data collection via checklists

The parameters of the application are important data without which a dimensioning process cannot be carried out. These parameters are marked in the check list with "***".

- The relevant data (e.g. mass, speed and motion) must be fully available.
- If less important data are missing (e. g. travelling resistances), you can make assumptions. Additionally document this in the dimensioning protocol.

To support the data collection, the DSD contains a checklist for each application, by means of which you can collect the data of the application.

- The checklists can be printed.
- The checklists are accessed via the **Tools→Application checklist** menu.
 - A dialog box opens, by means of which you can select the appropriate application via option fields.
 - By clicking on **Open** the corresponding checklist is opened in Word.
- The checklist contains queries concerning the following topics:

Dimensioning part	Data
Customers and project data	Authorised user, customer, project.
Application data	General drive; general drive with an import function for application data; rotary table; travelling drive; belt conveyor for unit loads; belt conveyor for bulk material; hoists with and without counterweight; chain conveyor; line drive with single roll or squeegees; pump; fan; linear axes with a stationary belt drive or an omega belt drive that is moved along; roller conveyor; spindle drive; rack drive.
Motion	• Operation with predefined motion profile according to operating mode S1, S2, S3 or S6 • Operation with specific motion profile. The motion profile can be created graphically or be imported. • Collect the parameters in tabular form in the check list or make a sketch.
Electrical supply and ambient conditions	Optional
Miscellaneous	Optional (accuracies...)
Motor	Optional including third-party motor
Gearbox/ratio	Optionally also for " Additional drive element"
Mechanical brake	Optional
Inverter	Optional
Dissipation of generated power	Optional
Feedback	Optional

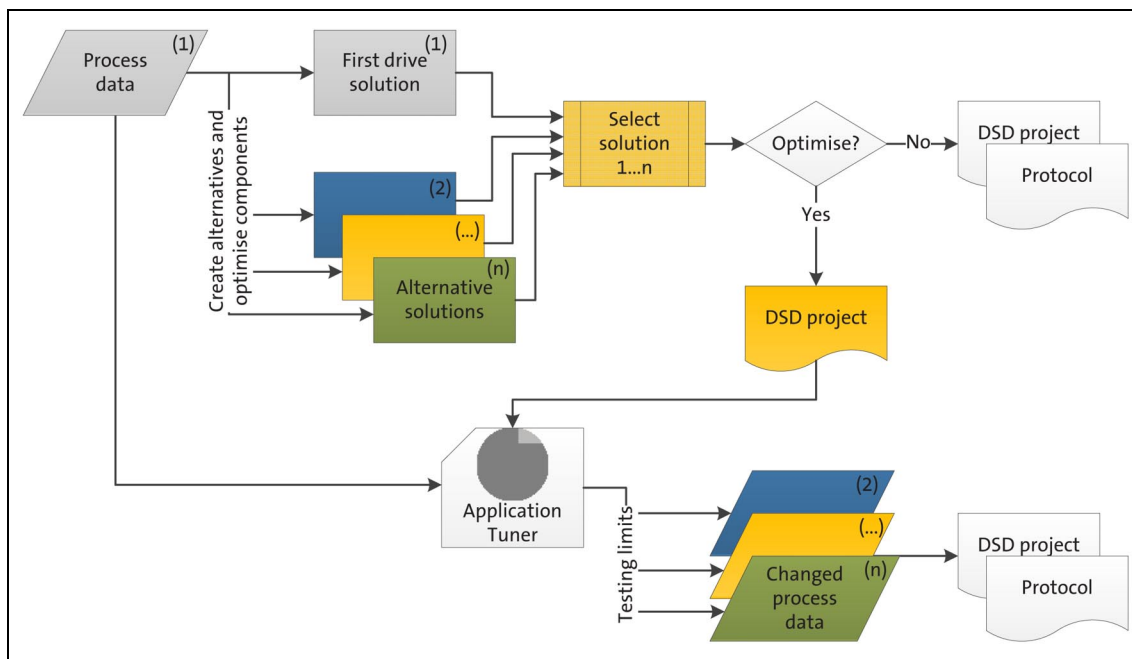


Tip!

The data marked with "Optional" are included in the checklist for the sake of completeness, however, they are not absolutely required for the dimensioning.

6.2 Optimising drive solutions

DSD provides different functions for optimising drive dimensionings and finding a demand-oriented drive solution.



[6-1] Functions for optimising drive dimensionings

Creating alternatives and project comparison

Recommended use

- The drive should be dimensioned with alternative components. The process and motion data remain unchanged.
- An alternative to the current drive dimensioning can be created at any position in the navigation tree.
- You can compare the alternatives to the most important key data. The project comparison can be printed.

Examples

- A drive dimensioning may require several alternatives to make a decision based on technical or commercial considerations.
- We recommend several drive dimensioning with different components.
- The drive solution should be calculated with different reserves.

Application Tuner

Recommended use

- The drive should be dimensioned with different process and motion data. The components remain unchanged.

6.2.1 Creating an alternative

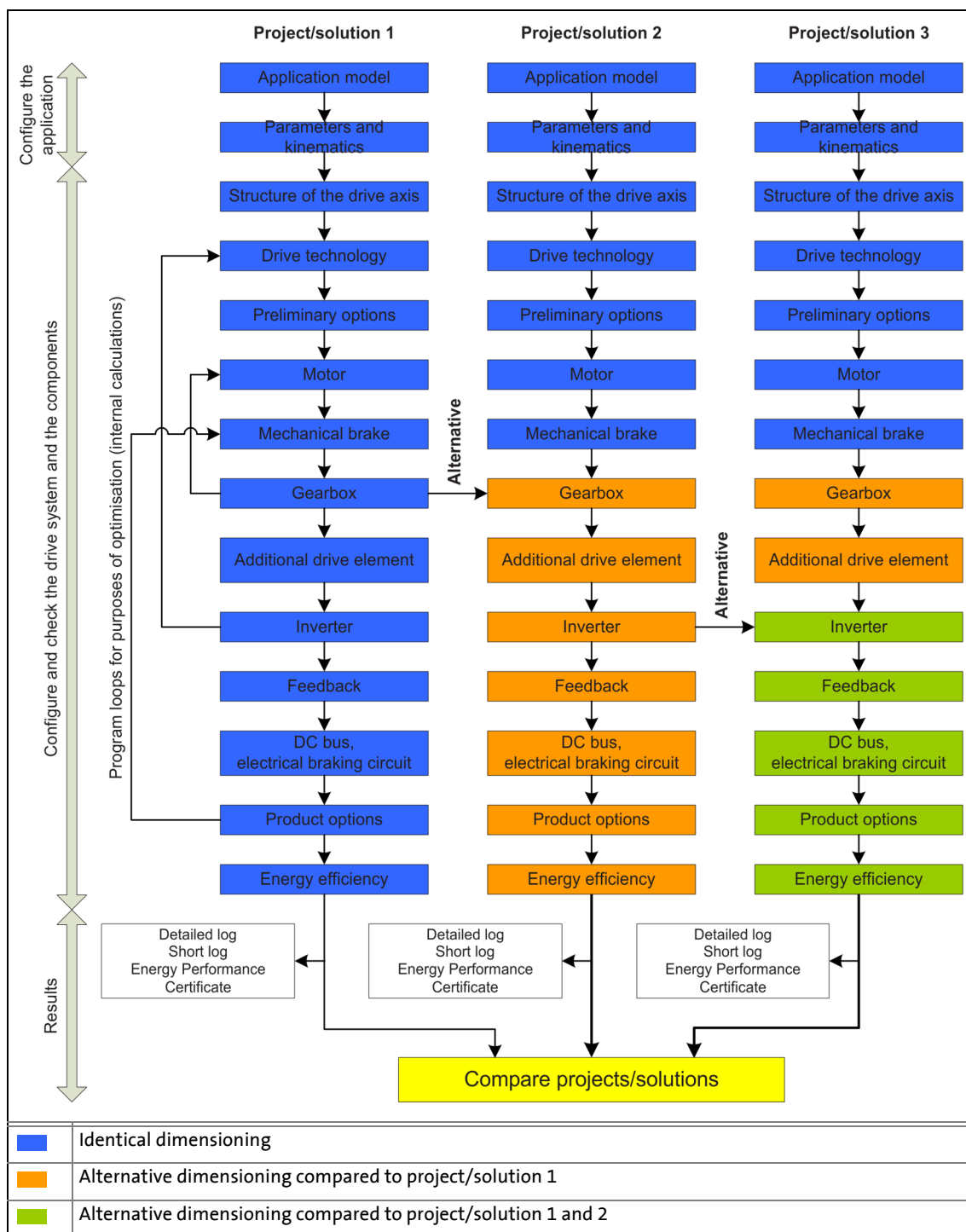
You can create alternatives to existing projects. A copy of the current project to the desired dimensioning step is created with a new file name. By the window technique of the DSD several projects can be opened at the same time. The open projects can be arranged via the **Windows** menu.

There are two possibilities of creating alternatives in DSD:

- A. Place the cursor in the desired position in the navigation tree of the current project. Now execute the **Create alternative** command using the right mouse button. A copy of the current project up to the highlighted dimensioning step is created.
- B. Complete the current project. Save it. Place the cursor in the desired position in the navigation tree. With the command **File→Save as** the project is saved under a new file name up to the dimensioning step highlighted.

**Tip!**

An alternative can be created from every dimensioning step in the navigation tree. Like this several alternatives can be created.



[6-2] Example of dimensioning with alternatives

6.2.2 Application Tuner

In the planning phase of a machine, there generally is only one worst-case-scenario or one reference scenario for the requirements of the machine. However, these scenarios are not able to include all operating statuses of the machine. Often, further requirements must be checked:

- Is the drive able to move an even greater mass?
- Is the drive able to accelerate even faster?
- Is there a need for considering an emergency stop with a short braking time?
- What is the utilisation or energy balance in the partial load operational range?
- What is the impact of different recipes on the drive?

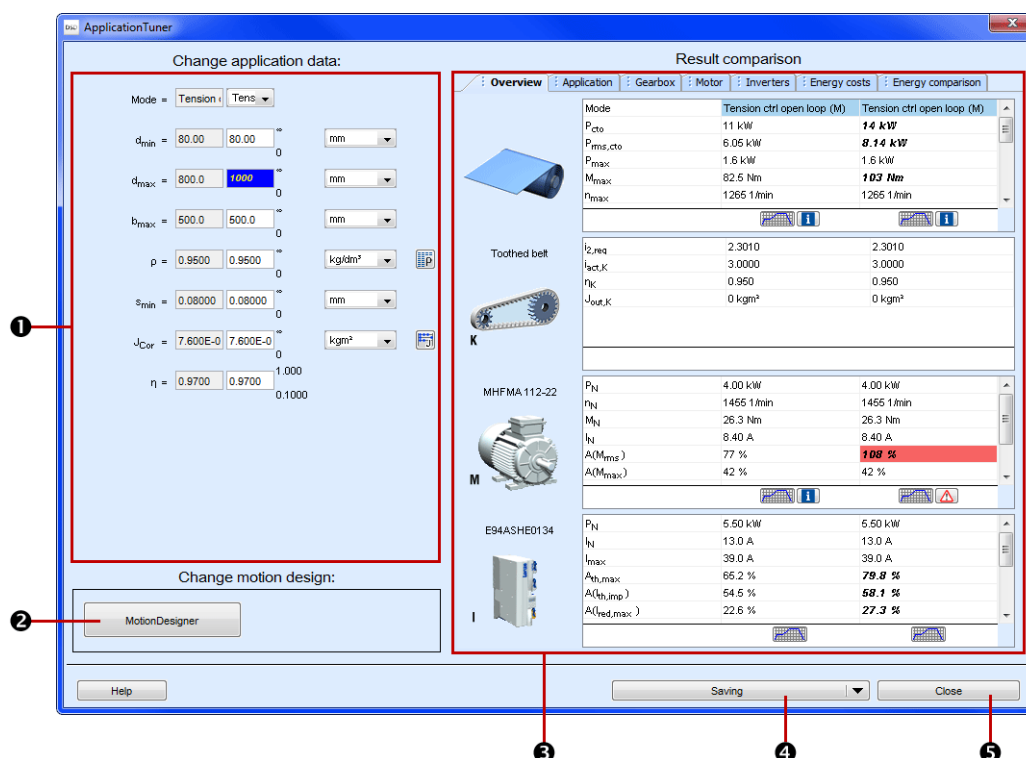
Features of the *Application Tuner*:

- Change the data of the application and the motion data as well as to observe and optimise the impacts on the drive if need be.
- integrate further possible operating statuses and material recipes into the dimensioning for the reference scenario.
- Create the optimised drive solution as individual DSD project.
- Output a protocol of the optimised drive solution.
- Support of the additional checks required for emergency stop scenarios for winding drives.

[Checking emergency-off scenarios](#) (214)



Change to the *Protocol* dimensioning step and click the  icon to open the *Application Tuner*.



Legend	Description
❶	Application data
	 Original data of the application. • Values cannot be changed.
	 Original data of the application. • In these input fields, values can be changed.
	 Changed data of the application. • Changes are accepted when the input field is exited.
❷	Motion design • Click the MotionDesigner button to change the motion data.
❸	Result comparison • The left column shows calculated values of the original application. • The <i>Overview</i> register provides an overview of the most important values. • The <i>Application</i> , <i>Gearbox</i> , <i>Motor</i> and <i>Inverter</i> registers show detailed values. • The <i>Energy costs</i> and <i>Energy comparison</i> registers show calculated values with regard to energy efficiency.
	 Newly calculated value.
	 Newly calculated value which exceeds the limit value. • If the limit value is exceeded, a message with a detailed description is provided.
	 Button to open diagrams of the application or of the component.
	 Buttons to open messages of the application or of the component.
❹	Click the black triangle in the Save button to open the selection menu. • Save the newly calculated dimensioning as separate DSD project. • Create a brief or detailed protocol about the newly calculated dimensioning. • Create an Energy Performance Certificate about the newly calculated dimensioning.
❺	Click the Close button to exit the <i>Application Tuner</i> .

6.2.3 Project comparison

A "project comparison" allows for comparing "Alternatives" in compressed form. Only the most important data required for a clear overview appears in a structured form.

- Data which deviate from project 1 are represented in italics and bold in projects 2 ... n. Fields with a blue or red background colour indicate that there are messages available for these data.

Parameter	Project_motion(1).dsd	Project_motion.dsd
Lenze gearbox		
Gearbox	GKS07	GKS07
Number of stages	3	3
Design	Direct mounting	Direct mounting
Actual gearbox ratio	12.71	12.71
Thermal utilisation of the gearbox with mineral oil	66 %	66 %
Gearbox utilisation	90 %	90 %
Utilisation, with reference to the equivalent torque	27 %	27 %
Gearbox utilisation	66 %	66 %
Utilisation, fatigue strength	0 %	0 %
Motor		
Motor group	MCA	MCA
Type designation	19S17	19S35
Rated motor power	6.40 kW	13.2 kW
Rated motor torque	36.3 Nm	36.0 Nm
Rated motor speed	1700 1/min	3510 1/min
Rated motor current	13.9 A	28.7 A
Rated motor voltage	390 V	390 V
Moment of inertia	72.0 kgcm ²	72.0 kgcm ²
Field weakening factor	2.1	1.0
Utilisation with reference to the effective torque	50 %	37 %
Utilisation, maximum torque (motor, inverter)	144 %	36 %
Short-time overload	104 %	105 %
Max. load-matching factor	14	14
Electromechanical brake		
Brake type	PMB	PMB
Brake size	14	14
Braking torque	40.0 Nm	40.0 Nm
Rated braking torque / dimensioned braking torque	10.0	10.0
Theoretical braking time	1.48 s	1.48 s

6.3

Dimensioning "easily and quickly" or "complex and precisely"

According to the application, the dimensioning process in the DSD can be clearly simplified.

- For an application, always enter the data of the application and describe the motion.
- Calculated utilisation values, diagrams, and options can be output.

For the quick and roughly estimated dimensioning several possibilities are provided. Like this, the number of parameters can be reduced, the motion profile presented in a simplified manner, or the product options can be left out. By this the amount of processing is considerably reduced for simple dimensioning processes.

If an application is to be optimised, and if dynamic processes play an important role, this can be taken into consideration by accordingly extending the dimensioning. In order to present the products in a thorough manner, the options required can also be specified.

In the *Input area* you carry out the actual entries for the drive dimensioning via the text and list fields:

Name	Information
A Input area for standard values	The upper half of the input area serves to enter the minimum required values for the application.
B Input area for detailed values	The lower half of the input area, if required, provides for the entry of detailed values for the application. • If you activate the option field With detailed values 5, the display fields 4 change to input fields where you can enter further values for the application.
1 Option field "With detailed values"	If you activate this option field, the display fields change to input fields where you can enter further values for the application.
2 Input field	By means of the input fields (text fields) in the input area you specify the respective parameter values.
3 List field (Dropdown list field)	By clicking on the list field, a list in the form of a menu is displayed, allowing for the selection of an entry (here: unit).
4 Call up auxiliary calculator	Via this button you can call up an auxiliary calculator for calculating the value to be entered. ▶ Auxiliary calculator (467)
5 Display field	Text fields with a grey background only serve to display a value; entering/ changing the value is not possible. • The values in the text fields with a grey background will be considered in the calculation. • If you activate the option field With detailed values , 5 the display fields change to input fields where you can enter further values for the application.

6.3.1 Roughly estimated calculation

For a roughly estimated determination of the requirements you can alternatively dimension a controlled drive with a predefined motion profile according to operating mode.

- The operating modes are scaled loads (VDE 0530) for a drive motor. The operating modes S1 ... S10 are distinguished.
 - ▶ [Predefined motion profile according to operating mode](#) (📖 288)
- If the starting/braking process has no noticeable impact on the machine, often also the operating modes S1, S2, S3, and S6 can be considered for calculation. These operating modes are also provided in the DSD.

6.3.2 Product features

Apart from the component data required for physical dimensioning, there are also important characteristics for mounting, extension, and operation. After dimensioning the drive system you can individually define the characteristics for each component via the *Product features* dimensioning step.

- For dimensioning a component, product features are not required.
- The dimensioning process can be completed without defining the product features.
- As an alternative, you can define the options in the »EASY Product Finder«.

6.4 Cost optimisation factors

Of course, costs are directly associated with the service factors and service durations of the individual drive components.

- Overdimensionings can render a drive system unattractive very quickly.
- Underdimensionings may make the drive system seem attractive at first. However, high follow-up costs and damage to the company's image can occur if the drive does not perform the tasks required.



Tip!

When carrying out dimensionings, always follow the principle "Not more and not less than required!"

Here the user has to make the best decisions with the help of the wizard in the DSD.

- For this purpose, the following table specifies important decision parameters with regard to costs:

Parameter	Effect	Notes
Gearbox size	Effect on useful life	
Torque overload factor of the motor	Effect on motor size	
Operation at least to the rated motor speed	Effect on motor size and controllability	Otherwise the inverter is not optimally utilised
Load-matching factor K_J	Effect on control quality and dynamics	
Selection of optimal motion profile	Can affect motor size and K_J	
Selection of the correct rated motor speed	High rated speed reduces size	Observe max. permissible input speed of the gearbox and acoustic emission!
Selection of optimal field weakening factor K_F	Has a considerable impact on the size of the inverter, especially in the case of winding drives	
Use of 87 Hz operation	Reduces the motor size • In the case of winding drives, only reasonable for a very low winding ratio q	
Selection of the switching frequency	At 16 kHz only 2/3 of the rated power	
Selection of 1-phase inverters at a power of ≤ 2.2 kW	Is cheaper than three-phase inverters at the same power	
Selection of double axis modules for i700 servo inverters	Reduced costs for inverters	
DC-bus operation	• Reduced mains load • Improved energy efficiency	

7 Applications

Currently the DSD contains 21 application models by means of which most of the application cases for the Lenze drives can be calculated.

In the following chapters each application is described in detail. Apart from a description of the application, all displayed parameters, selection tables, and options are explained.



Note!

During the dimensioning phase, the DSD can display warnings and notes!

- The "[Drive sizing messages](#)" chapter contains all warnings and notes with their possible causes and remedies as well as tips for optimising the dimensioning. ([book 506](#))

Application data

DSD is able to calculate an application "With detailed values" or "With standard values". Standard values serve to carry out quick and approximate dimensioning processes for which not all parameters of the application are known or are to be taken into consideration.

- When it is calculated "With standard values", the input area for detailed values is deactivated. The values in the text fields with a grey background, however, will be considered in the calculation. [Input area](#) ([book 34](#))

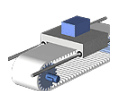
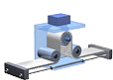
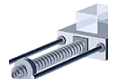
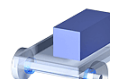
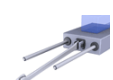
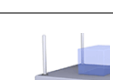
Alternative dimensioning

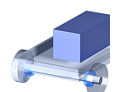
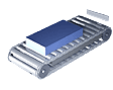
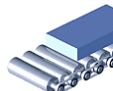
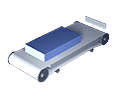
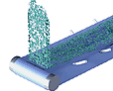
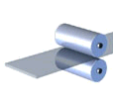
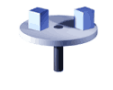
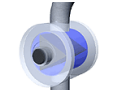
The *Data of the application* dimensioning step serves to quickly create e.g. an alternative "With detailed values" dimensioning" from a "With standard values" dimensioning".

- The "Alternative" function serves to create a copy of the current project in each dimensioning step. [Creating an alternative](#) ([book 55](#))

7.1

Overview

Group	Application	Note
 Moving linearly	 Belt drive, rotating	Also for belt-driven vehicles
	 Omega belt drive	Also for belt-driven vehicles
	 Rack drive	
	 Spindle drive	
	 Wheel drive	Application where operation is effected via the wheels.
	 Slider-crank mechanism	
	 Eccentric lift table	
 Move vertically, in a cable-guided manner	 Hoist drive without counterweight	
	 Hoist drive with counterweight	

Group	Application	Note
 Transporting continuously	 Wheel drive	Application where operation is effected via the wheels.
	 Chain conveyor	Drive solution is possible with Lenze Smart Motor. ► Applications using the Lenze Smart Motor (71)
	 Roller conveyor	Drive solution is possible with Lenze Smart Motor. ► Applications using the Lenze Smart Motor (71)
	 Belt conveyor, unit load	Drive solution is possible with Lenze Smart Motor. ► Applications using the Lenze Smart Motor (71)
	 Belt conveyor, bulk material	Drive solution is possible with Lenze Smart Motor. ► Applications using the Lenze Smart Motor (71)
 Actuate synchronously	 Synchronous drive - single roll	
	 Synchronous drive of squeegees	
 Move, actuate in a rotary manner	 General rotary drive	Rotary drive
	 Rotary table drive	Only for horizontal rotary tables
 Convey hydraulically, pneumatically	 Pump	
	 Fan	
 Importing M-n-operating points	Importing M-n-operating points	Import of the operating points for torque and speed from an ASCII file. From the ASCII file additionally the moment of inertia of the application, and the states of controller inhibit and of the brake can be imported.

Group	Application		Note
 Size the multi-axis system		Size the multi-axis system	Combine several DSD projects (drive axes) which are to form a multi-axis grouping and dimension the supply components for this purpose.
 Winding materials		Rewinder (single)	
		Unwinder (single)	

7.2 Basic calculations

In this chapter the basic calculations required for ascertaining the requirement of the application are described. The initial situation results from the calculations which have to be carried out for the respective application (e. g. travelling drive).

The requirement of the application results from

- The torque required,
- The speed required,
- The power resulting from the two.

7.2.1 Torque

To dimension the drive system correctly, the torque of the application is required. It should be calculated completely for the application, taking the losses (e. g. friction) into consideration. A division into a dynamic and a stationary component cannot be effected, as the friction partly has an effect on dynamic components, and to some extent it has not.

For instance, in the case of a spindle, due to the linearly moved masses losses are created with regard to the dynamic forces, and due to the moment of inertia of the spindle the dynamic torques act on the drive system without losses. Furthermore the losses depend on different factors depending on the application. It is therefore assumed that the required torque of the application M_{app} is given:

$$M_{sum} = M_{app}$$

[7-1] Equation 1: Total torque of the application



Tip!

The equation for calculating the torque can be found in the chapter for the respective application model.

Basically the total requirement of the torque results from the following.

- The dynamic torque of the application results from the multiplication of the moment of inertia and the angular acceleration:

$$M_{dyn} = J \cdot \alpha$$

[7-2] Equation 2: Dynamic torque of the application

- The stationary torque M_{sds} is calculated on the basis of the application-specific equations that are listed in the chapter for the respective application model.
- The total torque of the application results from adding the dynamic and the stationary component:

$$M_{sum} = M_{dyn} + M_{sds}$$

[7-3] Equation 3: Total torque of the application

Calculation of the effective torque of the application:

$$M_{rms} = \sqrt{\frac{1}{T} \cdot \int_0^T M^2(t) dt}$$

[7-4] Equation 4: Effective torque of the application

7.2.2 Application performance

Power P of the application in [W] results from multiplying the torque and the angular velocity:

$$P = M_{sum} \cdot \omega = M_{sum} \cdot n \cdot \frac{2 \cdot \pi}{60}$$

[7-5] Equation 5: Power of the application

The base process power P_{cto} of the application in [W] results from multiplying the max. torque and the max. angular velocity:

$$P_{cto} = M_{max} \cdot \omega_{max}$$

[7-6] Equation 6: Base process power of the application

The effective base process power $P_{rms,cto}$ of the application in [W] results from multiplying the effective torque and the max. angular velocity:

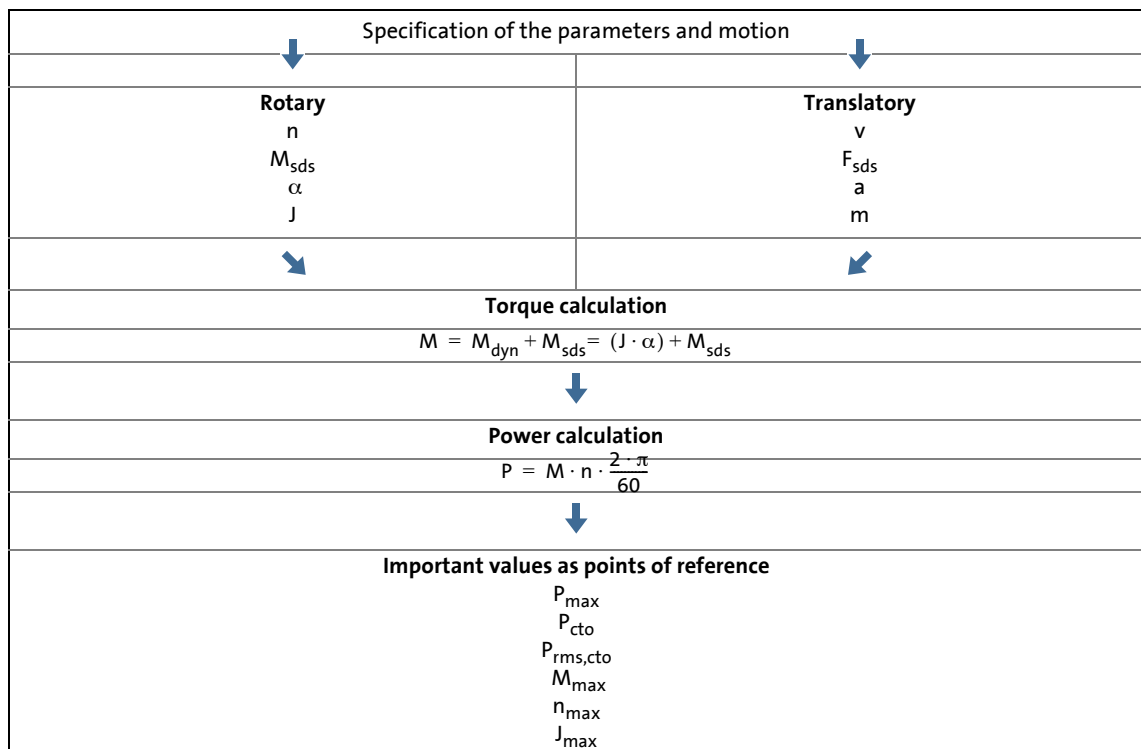
$$P_{rms,cto} = M_{rms} \cdot \omega_{max}$$

[7-7] Equation 7: Effective base process power of the application

7.2.3 Motion of the application

For the calculations, the motion must be taken into consideration. A distinction is made between the predefined and the user-definable motion profile.

- User-definable motion profile:
 - The motion profile is based on the standardised S8 ... S10 operating modes according to VDE 0530.
 - For calculating the motion profile the parameters at each time have to be calculated.
 - The maximum values for power, torque, and speed are important reference values for the calculation of the motion profile.
 - The motion profile can be created graphically, defined based on numerical values or be imported.
- Predefined motion profile:
 - The motion profile is based on the standardised S1 ... S7 operating modes according to VDE 0530.
 - For the calculation, apart from the stationary status also dynamic processes are taken into consideration.
 - The predefined motion profile provides a simple possibility of entering a motion profile with acceleration, constant travel, deceleration, and standstill.
 - The settings "Brake at standstill" and "Controller inhibit at standstill" can be selected.
 - The parameters "Deceleration time", "Starting time", "Cycle time", and "Direction of movement" can be altered.



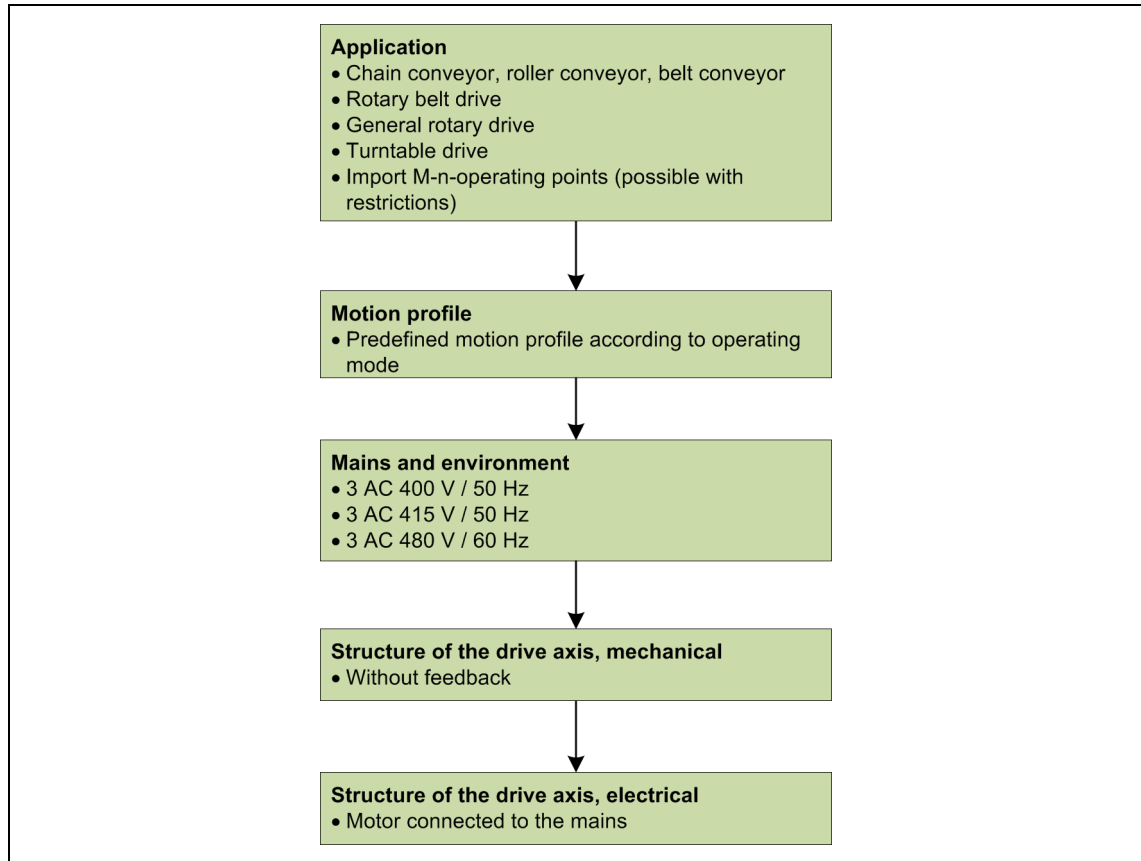
[7-8] Clarification of the possible calculations with different specifications

7.2.4 Symbols used

Symbol	Description	Dimension unit
a	Acceleration	m/s ²
F _{sds}	Stationary force	N
J	Moment of inertia of load	kgm ²
M _{dyn}	Dynamic torque of the application	Nm
M _{rms}	Effective torque of the application	Nm
m _{sum}	Total torque of the application	Nm
M _{sds}	Stationary torque of the application	Nm
n	Application speed	rpm
P	Application performance	W
r	Radius	m
s	Distance	m
t	Time	s
T	Period	s
v	Speed	m/s
α	Angular acceleration	rad/s ²
φ	Angle	rad
ω	Angular velocity	rad/s

7.3 Applications using the Lenze Smart Motor

Drive solutions using the Lenze Smart Motor are possible in the DSD under certain conditions. The diagram shows the required settings.



[7-9] The way to the Lenze Smart Motor - required settings

For a drive dimensioning process using the Lenze Smart Motor, selection of the "Import M-n operating points" application in the DSD may be reasonable.

- Advantages:
 - For instance in the case of a chain conveyor, you can take the breakaway torque into consideration.
 - Results of measurements on the application can be compared to the drive dimensioning by importing the measured data.
 - You can dimension drives for applications that are not available in the DSD.
- Additional, necessary actions:
 - The suitability of the motor control for the application has to be checked manually.
 - Have the data (output speed, direction of rotation, acceleration time, deceleration time) checked by your Lenze sales partner. In this way it is ensured that the drive solution can be implemented using the Lenze Smart Motor.

7.4 Belt drive, rotating

The vast majority of positioning systems require linear movements. If a rotating drive is used, the rotation of the motor has to be converted into a linear movement. The speeds that can be achieved, and therefore the dynamics of the positioning process and the repeat accuracy, and thus the quality of the positioning process to a great extent are defined by the mechanics.

Characteristics of a rotating belt drive

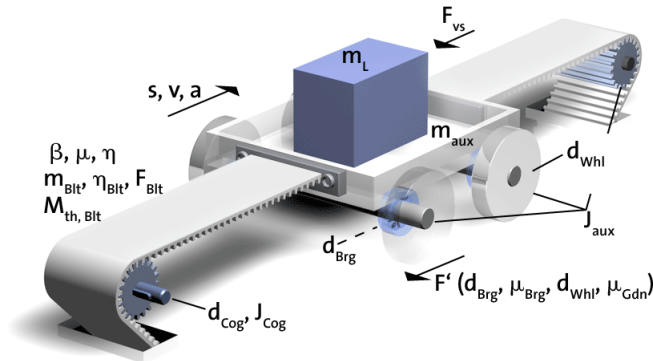
- A motor actuates a belt pulley which in turn actuates a toothed belt. The mass to be moved, which usually consists of a tool and the payload, is fastened to the toothed belt.
- Toothed belts allow for a higher speed, but a lower positioning accuracy of approx. 0.1 mm. The positioning path is greater than that for the spindle, but it also is limited.
- Toothed belt drives are very often used in applications for material handling, since they offer a high speed and an accuracy sufficient for this application.

Requirements with regard to a drive system for positioning

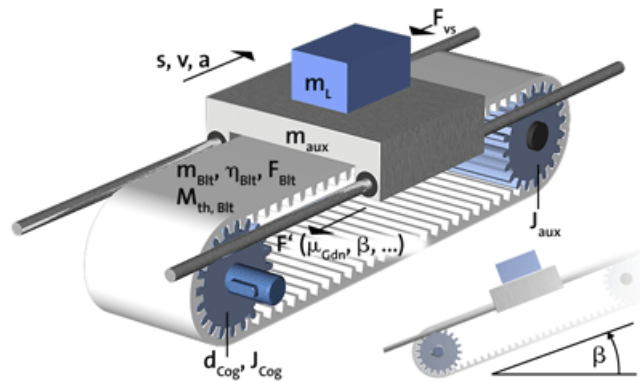
- High dynamic performance to achieve short positioning times
- High accuracy, according to the application
- High degree of reliability

7.4.1 Applications with a horizontal direction of movement

- Application of a rotating belt drive with wheel guide:



- Application of a rotating belt drive with linear guide:



Note!

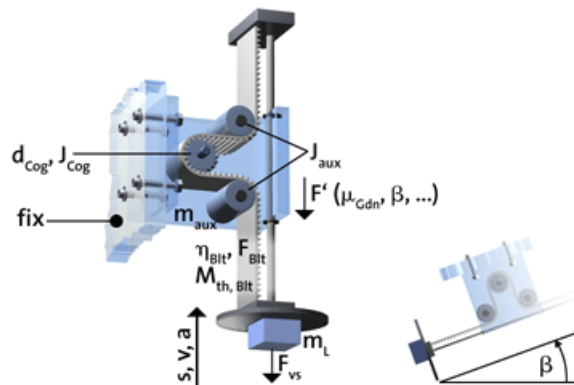
The losses have a relatively high constant proportion, i. e. the torque loss is almost irrespective of the load torque. The reason for this is the pretension of the belt, which is required if dynamic traversing with a high precision is to be carried out.

The DSD thus considers the efficiency to be entered as a constant torque. For the calculation always an efficiency at the highest load is assumed. Because of this definite dimensioning, no additional constant torque has to be specified.

7.4.2 Applications with a vertical direction of movement

For this model a tool is positioned by means of a toothed belt. A motor or geared motor with or without a downstream speed-transforming gear actuates a toothed belt. The motor is fixedly connected to the machine. A tool or payload m_L is fastened to the toothed belt. The tool or payload is operated via guide (coefficient of friction μ_{Gdn}).

- The positioning process can be carried out via time-controlled path generators (positioning software) or via path-controlled path generators (electronic cams).
- The movement is carried out within one of the three dimensional axes (horizontally x, y, and vertically z), or within a plane inclined to the horizontal by the angle β ($0 \dots 90^\circ$).
- For Z axes often an omega arrangement of the belt is selected, because less operating space is required.
 - An omega arrangement of the belt according to the following schematic diagram with a fixed motor is also taken into consideration by this DSD model:



Beating of the belt pulley

The toothed belt either is mounted directly to the motor shaft/gearbox shaft, or by means of a transmission gear (internal bearing support):

Arrangement A	Arrangement B
① Belt	① Belt

- In the case of arrangement A the bearing of the motor or gearbox has to be checked separately with regard to radial forces at the output end (see the following section). This function currently is not contained in the DSD yet.

Consideration of the radial and axial forces on the bearings in the gearbox and motor

In addition to the torques to be transmitted, considering the radial and axial forces on the rotor is also important for the selection of the gearbox and motor.

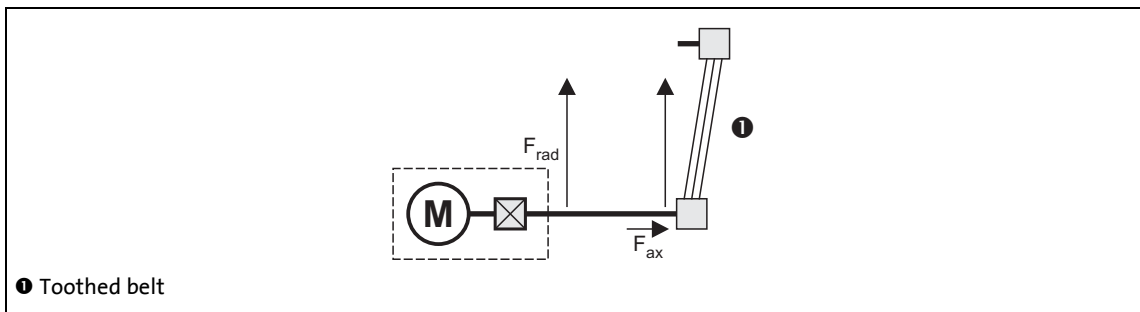


Note!

This calculation currently cannot be carried out by the DSD.

Axial forces occur if the belt pulley is not in alignment. Avoid a belt pulley that is not in alignment!

For these applications the axial forces can normally be disregarded.



[7-10] Radial and axial forces

- The radial force on the motor/gearbox output shaft can increase up to double the pretension $F_{prl,Blt}$ of the toothed belt.
- The pretension of the belt depends on the circumferential force $F_{Blt} \approx F_{aux}$ to be transmitted and on the positioning accuracy required and the permissible belt force.
- The pretension of the belt usually is $1 \dots 1.2 \times F_{Blt}$, in individual cases up to $2 \times F_{Blt}$. This has to be taken into consideration when the motor or gearbox is selected.
- If required, a transmission gear (see arrangement B) or a gearbox with reinforced bearings is to be used.

7.4.3 Calculations

For a linear axis with rotating toothed belts according to the drawing, the following applies:

The belt pulley has the following effective diameter, where p_{Cog} specifies the belt pitch:

$$d_{Cog}[\text{mm}] = \frac{p_{Cog}[\text{mm}] \cdot N_{Cog}}{\pi}$$

[7-11] Equation 1: Diameter of belt pulley

Conversion of translatory variables into rotary variables

$$\varphi = \frac{2000 \cdot s}{d_{Cog}} = \frac{2000 \cdot \pi \cdot s}{p_{Cog} \cdot N_{Cog}}$$

[7-12] Equation 2: Angle

$$\omega = \frac{2000 \cdot v}{d_{Cog}} = \frac{2000 \cdot \pi \cdot v}{p_{Cog} \cdot N_{Cog}}$$

[7-13] Equation 3: Angular velocity

$$\alpha = \frac{2000 \cdot a}{d_{Cog}} = \frac{2000 \cdot \pi \cdot a}{p_{Cog} \cdot N_{Cog}}$$

[7-14] Equation 4: Angular acceleration

Forces of the linear motion

First the mass which is to be moved linearly has to be calculated. The payload m_L can adopt different values during the travel cycle. The mass of carriage m_{aux} is considered separately.

$$m_{sum} = m_L + m_{aux}$$

[7-15] Equation 5: Total mass

The friction force F_μ can for instance occur on the guide rails of the slide. The force acts opposite to the direction of movement and is taken into consideration by the fraction $v/|v|$ in the following equation, where at $v = 0$ the force F_μ is 0. The static friction at standstill is not considered.

$$F_\mu = m_{sum} \cdot g \cdot \mu_{Gdn} \cdot \cos \beta \cdot \frac{v}{|v|}$$

[7-16] Equation 6: Friction force

If the friction force F_μ is related to the mass in motion, a specific travelling resistance results, which contains all parts depending on the mass:

$$F' = g \cdot \mu_{Gdn} \cdot \cos \beta$$

[7-17] Equation 7: Specific travelling resistance of the application

For vehicles with a wheel guide instead of a linear guide, here the travelling resistance F' is to be used:

$$F' = g \cdot \left(\frac{2 \cdot f \cdot \cos \beta}{d_{Whl}} + \frac{d_{BrG} \cdot \mu_{BrG}}{d_{Whl}} + \mu_{Gdn} \right)$$

[7-18] Equation 8: Specific travelling resistance of the application for vehicles with a wheel guide

Additionally a counterforce F_{Vs} opposite to the positive direction of movement and a component of the force due to weight (downhill force) caused by the slope β can act. Constant friction forces of the guide rails, which are independent of the mass, have to be taken into consideration with the correct sign in F_{Vs} .

$$F_{sum} = F_{Vs} + m_{sum} \cdot g \cdot \sin \beta$$

[7-19] Equation 9: Total translatory force

Required torque of the application

The required torque of the application M_{App} has to be calculated in three steps. First the force that is transmitted via the toothed belt has to be ascertained.

- The mass m_{Blt} of the toothed belt is considered by the specific mass m'_{Blt} and the length l_{Blt} .

$$F_{aux} = \left(F' \cdot m_{sum} \cdot \frac{v}{|v|} + F_{sum} \right) + (m_{sum} + l_{Blt} \cdot m'_{Blt}) \cdot a$$

[7-20] Equation 10: Force of the slide

For calculating the torque, the mass inertia of the application is required. It has to be divided into two types:

- An additional mass inertia on the belt pulley of the toothed belt is added to the mass inertia of the belt pulley:

$$J_{Cog} = J_n = \text{const} = \sum_{k=1}^n J_k \Big|_{n=\text{const}}$$

[7-21] Equation 11: Mass inertia on the side of the belt pulley

- Additional mass inertias that are connected via the toothed belts and rotate at the same speed (e.g. deflection pulleys, belt tighteners), are included in the moment of inertia J_{aux} of the deflection pulleys:

$$J_{aux} = J_v = \text{const} = \sum_{i=2}^m \left\{ J_i \cdot \left(\frac{d_{Cog}}{d_i} \right)^2 \right\} \Big|_{v=\text{const}}$$

[7-22] Equation 12: Mass inertia of the deflection pulleys

Now the required torque at the drive can be calculated:

$$M_D = \frac{d_{Cog}}{2000} \cdot F_{aux} + J_{aux} \cdot \alpha$$

[7-23] Equation 13: Required torque at the drive

The constant torque loss which occurs within the belt is determined under full load from the torque at the drive with the efficiency in motor mode of the prestressed belt:

$$M_{th} = \left(\frac{1}{\eta_{Blt}} - 1 \right) \cdot \max(|M_D|)$$

[7-24] Equation 14: Constant torque loss

The torque loss depends on the torque M_D which is to be transmitted, so that the resulting torque M_{App} defining the power of the application is calculated via the following equation.

- The deterioration of the efficiency within operation in generator mode (backward efficiency) is considered during this calculation.

$$M_{App} = \left(M_D + \frac{\omega}{|\omega|} \cdot M_{th} \right) + J_{Cog} \cdot \alpha$$

[7-25] Equation 15: Required torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.4.3.1 Symbols used

Symbol	Description	Dimension unit
a	Acceleration, translatory	m/s^2
α	Acceleration, rotary	rad/s^2
d_{Whl}	Wheel diameter for the wheel-guided system	mm
d_{Brg}	Bearing diameter for the wheel-guided system	mm
d_{Cog}	Belt pulley diameter	mm
f	Lever arm of the rolling friction for the wheel-guided system	mm
F_{μ}	Friction force of the guiding system	N
F'	Specific travelling resistance of the application	N/kg
F_{vs}	Counterforce	N
F_{sum}	Total translatory force	N
F_{Blt}	Circumferential force at the toothed belt	N
$F_{\text{prl,Blt}}$	Preload force at the toothed belt	N
F_{aux}	Force of slide	N
F_{rad}	Radial force	N
F_{ax}	Axial force	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J_{Cog}	Moment of inertia of the belt pulley	kgm^2
J_{aux}	Moment of inertia of the deflection pulleys	kgm^2
l_{Blt}	Length of the toothed belt	m
m_{L}	Mass of the payload	kg
m_{aux}	Mass of the slide	kg
m_{Blt}	Mass of toothed belts	kg
m'_{Blt}	Specific mass of the belt per meter	kg/m
m_{sum}	Total mass of the application	kg
$M_{\text{th,Blt}}$	Constant torque loss	Nm
M_{D}	Torque at the drive	Nm
M_{App}	Required torque of the application	Nm
p_{Cog}	Selected toothed belt pitch	mm
s	Path, translatory	m
v	Speed, translatory	m/s
N_{Cog}	Number of teeth of the belt pulley	
η_{Blt}	Transmission efficiency of the toothed belt with initial stress and in the operating point	
φ	Angle	rad
β	Angle of tilt	°
μ_{Gdn}	Coefficient of friction • Wheel flange and lateral friction of the wheel-guided system • Sliding friction of the linear guide	
μ_{Brg}	Coefficient of friction for the wheel-guided system	
ω	Angular velocity	rad/s

7.4.4 Data for the entry

7.4.4.1 Belt pulley diameter

Parameter	Description
d_{Cog}	Belt pulley diameter - The belt pulley is mounted at the end of the output shaft of the motor or gearbox. - The diameter can be calculated by the pitch and the number of teeth (in the case of a toothed belt). - Value can be entered directly or calculated using a diameter calculator.  "Pinion diameter" calculator (477)

7.4.4.2 Mass of the slide

Parameter	Description
m_{aux}	Mass of carriage - The mass is used in the calculation for the moment of inertia - The mass of the payload is entered when the motion profile is created. - By means of the mass calculator, an alternative value can be calculated.  Mass calculator (470)

7.4.4.3 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) The value can be entered in degrees or as a percentage.

7.4.4.4 Transmission efficiency of toothed belt

Parameter	Description
η_{Blt}	Efficiency of the toothed belt with initial stress and maximum stationary operating point. - Since the torque loss of a belt is not proportional to its load, i. e. it is not constant throughout the entire operating range, however, often only one efficiency factor is known, it is assumed that the value applies to maximum steady-state operation. The losses that can be calculated for this, in the worst case occur as a constant torque loss, so that they are taken into consideration in the DSD. - The losses of the guide can be covered separately with the specific travelling resistance.

7.4.4.5 Mass of toothed belts

Parameter	Description
m_{Blt}	Mass of the toothed belt - Can be disregarded in most applications; only in the case of a long traverse path the mass may have a crucial impact. - The mass of the belt is used in the calculation of the inertial moment. - The mass of the payload is entered when the motion profile is created. - The mass can be estimated by means of the mass calculator.  Mass calculator (470)

7.4.4.6 Moment of inertia, deflection pulleys

Parameter	Description
J_{aux}	Moment of inertia of the deflection pulleys • Can be disregarded in most applications, though in dynamic applications it may have an impact on the dimensioning. • The moment of inertia is to be entered relative to the driving pulley and has an impact on the dynamic torque! • The inertial moment can be estimated by means of the inertial calculator.  Inertial calculator (📘 472)

7.4.4.7 Moment of inertia of belt pulley

Parameter	Description
J_{Cog}	Moment of inertia of the belt pulley • Can be disregarded in most applications, though in dynamic applications it may have an impact on the dimensioning. • The moment of inertia has an effect on the dynamic torque! • The inertial moment can be estimated by means of the inertial calculator.  Inertial calculator (📘 472)

7.4.4.8 Specific travelling resistance

Parameter	Description
F'	Specific travelling resistance • Plays a minor role with regard to dynamic applications. • Can be a rolling and a friction resistance. • By means of the auxiliary calculator the travelling resistance can be estimated.  "Travelling resistance" calculator (📘 484)

7.4.4.9 Speed

Parameter	Description
v	Traversing speed • Value is entered in the <i>Motion</i> dimensioning step.

7.4.4.10 Mass of the payload

Parameter	Description
m_L	Mass of payload • Value is entered in the <i>Motion</i> dimensioning step.

7.4.4.11 Tensile force at the slide (counterforce)

Parameter	Description
F_{vs}	Force that works against the direction of movement. - Value is entered in the <i>Motion</i> dimensioning step. The sign of the counterforce determines its effective direction: - If the speed is positive, - positive values act opposite to the direction of travel - negative values act with the direction of travel. - If the speed is negative, - positive values act with the direction of travel - negative values act opposite to the direction of travel.



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.



Tip!

By means of the auxiliary calculator you can calculate the travelling resistance of wheel-guided drives and linear guides.

7.5**Omega belt drive**

The vast majority of positioning systems require linear movements. If a rotating drive is used, the rotation of the motor has to be converted into a linear movement. The speeds that can be achieved, and therefore the dynamics of the positioning process and the repeat accuracy, and thus the quality of the positioning process to a great extent are defined by the mechanics.

Characteristics of an omega belt drive

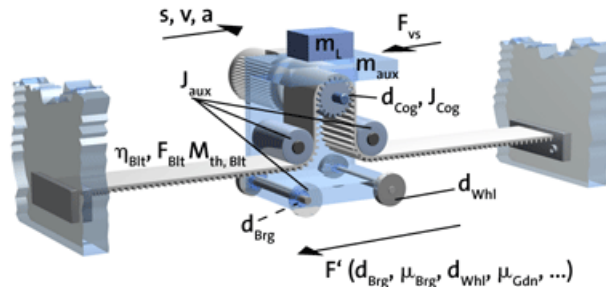
- A motor actuates a belt pulley which in turn actuates a belt or a toothed belt. The mass to be moved, which usually consists of the drive, a tool, and the payload, is fastened to the toothed belt.
- Toothed belts allow for a higher speed, but a lower positioning accuracy of approx. 0.1 mm. The positioning path is greater than that for the spindle, but it also is limited.
- Belt drives are very often used in applications for material handling, since they offer a high speed and an accuracy sufficient for this application.

Requirements with regard to a drive system for positioning

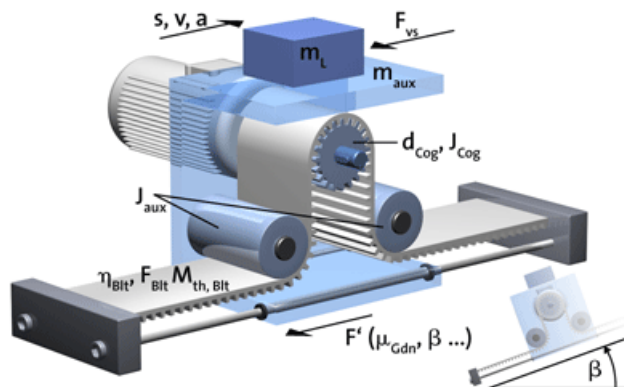
- High dynamic performance to achieve short positioning times,
- High accuracy, according to the application
- High degree of reliability

7.5.1 Applications with a horizontal direction of movement

- Application of an omega belt drive with wheel guide:



- Application of an omega belt drive with linear guide:



Note!

The losses have a relatively high constant proportion, i. e. the torque loss is almost irrespective of the load torque. The reason for this is the pretension of the belt, which is required if dynamic traversing with a high precision is to be carried out.

The application model thus considers the efficiency to be entered as a constant torque. For the calculation always an efficiency at the highest load is assumed. Because of this definite dimensioning, no additional constant torque has to be specified.

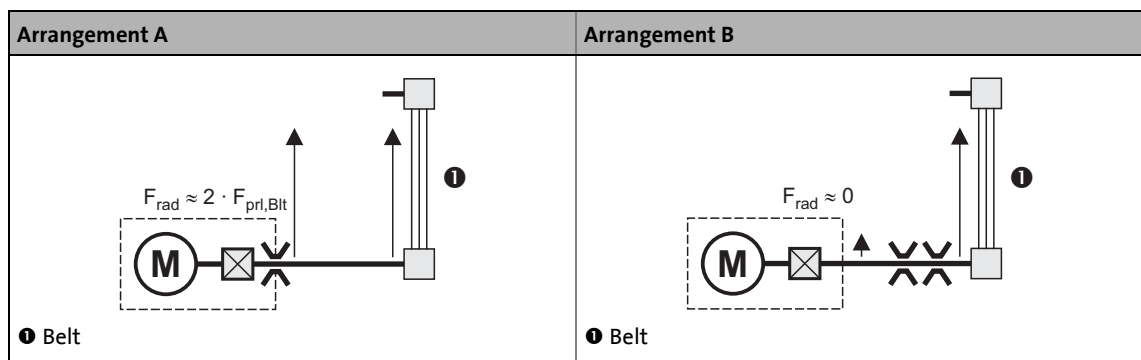
7.5.2 Applications with a vertical direction of movement

For this model a tool is positioned by means of a toothed belt. A motor or geared motor with or without a downstream speed-transforming gear travels along a fixedly clamped toothed belt. A tool or payload m_L is fastened to the motor. The drive is operated via guide (coefficient of friction μ_{Gdn}).

- The positioning process can be carried out via time-controlled path generators (positioning software) or via path-controlled path generators (electronic cams).
- The movement is carried out within one of the three dimensional axes (horizontally x, y, and vertically z), or within a plane inclined to the horizontal by the angle β ($0 \dots 90^\circ$).

Beating of the belt pulley

The toothed belt either is mounted directly to the motor shaft/gearbox shaft, or by means of a transmission gear (internal bearing support):



- In the case of arrangement A the bearing of the motor or gearbox has to be checked separately with regard to radial forces at the output end (see the following section). This function currently is not contained in the DSD yet.

Consideration of the radial and axial forces on the bearings in the gearbox and motor

In addition to the torques to be transmitted, considering the radial and axial forces on the rotor is also important for the selection of the gearbox and motor.

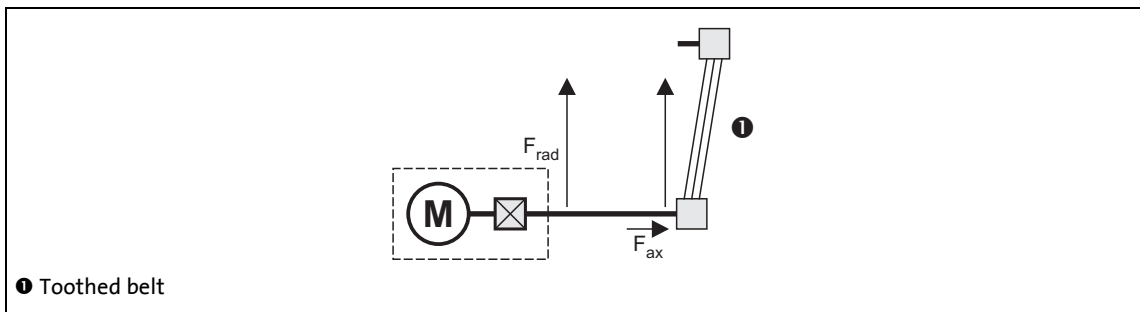


Note!

This calculation currently cannot be carried out by the DSD.

Axial forces occur if the belt pulley is not in alignment. Avoid a belt pulley that is not in alignment!

For these applications the axial forces can normally be disregarded.



[7-26] Radial and axial forces

- The radial force on the motor/gearbox output shaft can increase up to double the pretension $F_{prl,Blt}$ of the toothed belt.
- The pretension $F_{prl,Blt}$ depends on the circumferential force $F_{Blt} \approx F_D$ to be transmitted and the required positioning accuracy, and on the permissible belt force.
- The pretension $F_{prl,Blt}$ usually is $1 \dots 1.2 \times F_{Blt}$, in individual cases up to $2 \times F_{Blt}$. This has to be taken into consideration when the motor or gearbox is selected.
- If required, a transmission gear is to be used (see arrangement B).

7.5.3 Calculations

The following applies to a linear axis with an omega belt drive that is moved, as is shown in the drawing:

The belt pulley has the following effective diameter, where p_{Cog} specifies the belt pitch:

$$d_{Cog}[\text{mm}] = \frac{p_{Cog}[\text{mm}] \cdot N_{Cog}}{\pi}$$

[7-27] Equation 1: Diameter of belt pulley

Conversion of translatory variables into rotary variables

$$\varphi = \frac{2000 \cdot s}{d_{Cog}} = \frac{2000 \cdot \pi \cdot s}{p_{Cog} \cdot N_{Cog}}$$

[7-28] Equation 2: Angle

$$\omega = \frac{2000 \cdot v}{d_{Cog}} = \frac{2000 \cdot \pi \cdot v}{p_{Cog} \cdot N_{Cog}}$$

[7-29] Equation 3: Angular velocity

$$\alpha = \frac{2000 \cdot a}{d_{Cog}} = \frac{2000 \cdot \pi \cdot a}{p_{Cog} \cdot N_{Cog}}$$

[7-30] Equation 4: Angular acceleration

Forces of the linear motion

First the mass that is to be moved linearly is to be calculated. The payload m_L can adopt different values during the travel cycle. The mass of carriage m_{aux} and the mass of the drive motor and the gearbox m_D are taken into consideration separately.

$$m_{sum} = m_L + m_{aux} + m_D$$

[7-31] Equation 5: Total mass

The friction force F_μ can for instance occur on the guide rails of the slide. The force acts opposite to the direction of movement and is taken into consideration by the fraction $v/|v|$ in the following equation, where at $v = 0$ the force $F_{\mu is} 0$. The static friction at standstill is not considered.

$$F_\mu = m_{sum} \cdot g \cdot \mu_{Gdn} \cdot \cos \beta \cdot \frac{v}{|v|}$$

[7-32] Equation 6: Friction force

If the friction force F_μ is related to the mass in motion, a specific travelling resistance results, which contains all parts depending on the mass:

$$F' = g \cdot \mu_{Gdn} \cdot \cos \beta$$

[7-33] Equation 7: Specific travelling resistance of the application

For vehicles with a wheel guide instead of a linear guide, here the travelling resistance F' is to be used:

$$F' = g \cdot \left(\frac{2 \cdot f \cdot \cos \beta}{d_{\text{Whl}}} + \frac{d_{\text{Brg}} \cdot \mu_{\text{Brg}}}{d_{\text{Whl}}} + \mu_{\text{Gdn}} \right)$$

[7-34] Equation 8: Specific travelling resistance of the application

Additionally a counterforce F_{vs} opposite to the positive direction of movement and a component of the force due to weight (downhill force) caused by the slope β can act. Constant friction forces of the guide rails, which are independent of the mass, have to be taken into consideration with the correct sign in F_{vs} .

$$F_{\text{sum}} = F_{\text{vs}} + m_{\text{sum}} \cdot g \cdot \sin \beta$$

[7-35] Equation 9: Total translatory force

Required torque of the application

The required torque of the application M_{App} has to be calculated in three steps. First the force that is transmitted via the toothed belt has to be ascertained.

- The mass m_{Blt} of the belt is considered by the specific mass m'_{Blt} .

$$F_{\text{aux}} = \left(F' \cdot m_{\text{sum}} \cdot \frac{v}{|v|} + F_{\text{sum}} \right) + m_{\text{sum}} \cdot a$$

[7-36] Equation 10: Force of the slide

For calculating the torque, the mass inertia of the application is required. It has to be divided into two types:

- A. Additional mass inertias on the belt pulley are added to the moment of inertia of the belt pulley:

$$J_{\text{Cog}} = J_n = \text{const} = \sum_{k=1}^n J_k \Big|_{n=\text{const}}$$

[7-37] Equation 11: Mass inertia on the toothed belt pulley

- B. Additional mass inertias that are connected via the toothed belt and rotate at the same speed (e.g. deflection pulleys, belt tighteners), are included in the moment of inertia of the deflection pulleys J_{aux} :

$$J_{\text{aux}} = J_v = \text{const} = \sum_{i=2}^m \left\{ J_i \cdot \left(\frac{d_{\text{Cog}}}{d_i} \right)^2 \right\} \Big|_{v=\text{const}}$$

[7-38] Equation 12: Mass inertia of the deflection pulleys

Now the required torque at the drive can be calculated:

$$M_D = \frac{d_{\text{Cog}}}{2000} \cdot F_{\text{aux}} + J_{\text{aux}} \cdot \alpha$$

[7-39] Equation 13: Required torque at the drive

The constant torque loss which occurs within the belt is determined under full load from the torque at the drive with the efficiency in motor mode of the prestressed belt:

$$M_{th,Blt} = \left(\frac{1}{\eta_{Blt}} - 1 \right) \cdot \max(|M_D|)$$

[7-40] Equation 14: Constant torque loss

The torque loss depends on the torque M_D which is to be transmitted, so that the resulting torque defining the power of the application is calculated via the following equation.

- The deterioration of the efficiency within operation in generator mode (backward efficiency) is considered during this calculation.
- The equation is suitable to calculate different operating points for an application with a predefined motion profile (S1, S2, S3, S6).

$$M_{App} = \left(M_D + \frac{\omega}{|\omega|} \cdot M_{th,Blt} \right) + J_{Cog} \cdot \alpha$$

[7-41] Equation 15: Required torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.5.3.1 Symbols used

Symbol	Description	Dimension unit
a	Acceleration, translatory	m/s^2
d_{Whl}	Effective diameter of the wheel for the wheel-guided system	mm
d_{Brg}	Bearing diameter for the wheel-guided system	mm
d_{Cog}	Belt pulley diameter	mm
f	Lever arm of the rolling friction for the wheel-guided system	mm
F_{μ}	Friction force of the guiding system	N
F'	Specific travelling resistance of the application	N/kg
F_{vs}	Counterforce	N
F_{sum}	Total translatory force	N
F_{Blt}	Circumferential force at the toothed belt	N
$F_{\text{prl,Blt}}$	Pretension	N
F_{aux}	Force of slide	N
F_{rad}	Radial force	N
F_{ax}	Axial force	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J_{Cog}	Moment of inertia of belt pulley	kgm^2
J_{aux}	Moment of inertia, deflection pulleys	kgm^2
l_{Blt}	Length of the toothed belt	m
m_{L}	Mass of the payload	kg
m_{aux}	Mass of the slide	kg
m_{D}	Drive train mass	kg
m_{sum}	Total mass of the application	kg
$M_{\text{th,Blt}}$	Constant torque loss	Nm
M_{D}	Torque at the drive	Nm
M_{App}	Required torque of the application	Nm
p_{Cog}	Selected toothed belt pitch	mm
s	Path, translatory	m
v	Speed, translatory	m/s
N_{Cog}	Number of teeth of the toothed belt pulley	
α	Angular acceleration	rad/s^2
η_{Blt}	Transmission efficiency of the toothed belt with initial stress and in the operating point	
φ	Angle	rad
μ_{Gdn}	Coefficient of friction • Wheel flange and lateral friction of the wheel-guided system • Sliding friction of the linear guide	
μ_{Brg}	Coefficient of friction of the bearings for the wheel-guided system	

7.5.4 Data for the entry

7.5.4.1 Belt pulley diameter

Parameter	Description
d_{Cog}	Belt pulley diameter - The belt pulley is mounted at the end of the output shaft of the motor or gearbox. - The diameter can be calculated by the pitch and the number of teeth (in the case of a toothed belt). - Value can be entered directly or calculated using a diameter calculator.  "Pinion diameter" calculator (477)

7.5.4.2 Mass of the slide

Parameter	Description
m_{aux}	Mass of carriage - The mass is used in the calculation for the moment of inertia - The mass of the payload is entered when the motion profile is created. - As the mass of the drive train is not customer information, it can be separately entered in the "Extended data". - By means of the mass calculator, an alternative value can be calculated.  Mass calculator (470)

7.5.4.3 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) The value can be entered in degrees or as a percentage.

7.5.4.4 Transmission efficiency of toothed belt

Parameter	Description
η_{Blt}	Transmission efficiency of the toothed belt in the maximum stationary operating point. - Since the torque loss of a belt is not proportional to its load, i. e. it is not constant throughout the entire operating range, however, often only one efficiency factor is known, it is assumed that the value applies to maximum steady-state operation. The losses that can be calculated for this, in the worst case occur as a constant torque loss, so that they are taken into consideration in the DSD. - The losses of the guide can be covered separately with the specific travelling resistance.

7.5.4.5 Drive train mass

Parameter	Description
m_D	Mass of the drive train - Since the mass of the drive train is only determined by the dimensioning process, an iteration may be required here. - First you can enter an estimated value here. - If you have selected a drive, you can enter the actual value and check the calculation again. - The masses of the products can be gathered from the catalogues. - The mass is used in the calculation for the moment of inertia

7.5.4.6 Moment of inertia, deflection pulleys

Parameter	Description
J_{aux}	Moment of inertia of the deflection pulleys • Can be disregarded in most applications, though in dynamic applications it may have an impact on the dimensioning. • The moment of inertia is to be entered relative to the driving pulley and has an impact on the dynamic torque! • The inertial moment can be estimated by means of the inertial calculator.  Inertial calculator (📘 472)

7.5.4.7 Moment of inertia of belt pulley

Parameter	Description
J_{Cog}	Moment of inertia of the belt pulley • Can be disregarded in most applications, though in dynamic applications it may have an impact on the dimensioning. • The moment of inertia has an effect on the dynamic torque! • The inertial moment can be estimated by means of the inertial calculator.  Inertial calculator (📘 472)

7.5.4.8 Specific travelling resistance

Parameter	Description
F'	Specific travelling resistance • Plays a minor role with regard to dynamic applications. • Can be a rolling or frictional resistance. • By means of the auxiliary calculator the travelling resistance can be estimated.  "Travelling resistance" calculator (📘 484)

7.5.4.9 Speed

Parameter	Description
v	Traversing speed • Value is entered in the <i>Motion</i> dimensioning step.

7.5.4.10 Mass of the payload

Parameter	Description
m_L	Mass of payload • Value is entered in the <i>Motion</i> dimensioning step.

7.5.4.11 Counterforce

Parameter	Description
F_{vs}	Force that works against the direction of movement. - Value is entered in the <i>Motion</i> dimensioning step. The sign of the counterforce determines its effective direction: - If the speed is positive, - positive values act opposite to the direction of travel - negative values act with the direction of travel. - If the speed is negative, - positive values act with the direction of travel - negative values act opposite to the direction of travel.



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.



Tip!

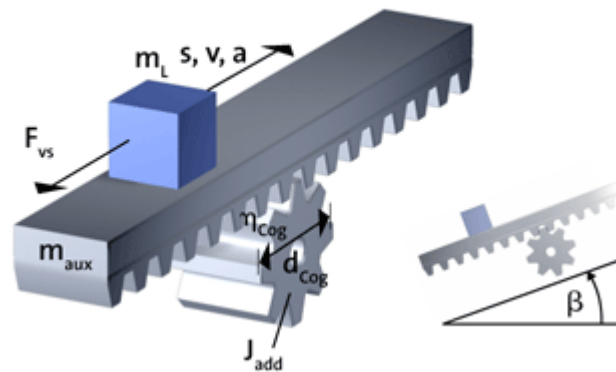
By means of the auxiliary calculator you can calculate the travelling resistance of wheel-guided drives and linear guides.

7.6 Rack drive

The vast majority of positioning systems require linear movements. If a rotating drive is used, the rotation of the motor has to be converted into a linear movement. The speeds that can be achieved, and therefore the dynamics of the positioning process and the repeat accuracy, and thus the quality of the positioning process to a great extent are defined by the mechanics.

Characteristics of a rack drive

- A motor actuates a pinion which in turn actuates a rack and pinion, or the motor actuates itself on a stationary rack and pinion.
- Rack and pinions provide an unlimited traverse path, however they are not very accurate and have a tendency for slip.



7.6.1 Calculations

For a rack drive according to the drawing the following applies:

The pinion diameter can be calculated from the module and the number of teeth:

$$d_{\text{Cog}} = N_{\text{Cog}} \cdot M_{\text{Cog}}$$

[7-42] Equation 1: Pinion diameter

Conversion of translatory variables into rotary variables

$$\varphi = \frac{2000 \cdot s}{d_{\text{Cog}}} = \frac{2000 \cdot s}{N_{\text{Cog}} \cdot M_{\text{Cog}}}$$

[7-43] Equation 2: Angle

$$\omega = \frac{2000 \cdot v}{d_{\text{Cog}}} = \frac{2000 \cdot v}{N_{\text{Cog}} \cdot M_{\text{Cog}}}$$

[7-44] Equation 3: Angular velocity

$$\alpha = \frac{2000 \cdot a}{d_{\text{Cog}}} = \frac{2000 \cdot a}{N_{\text{Cog}} \cdot M_{\text{Cog}}}$$

[7-45] Equation 4: Angular acceleration

Forces of the linear motion

First the mass which is to be moved linearly has to be calculated. The payload m_L can adopt different values during the travel cycle.

$$m_{\text{sum}} = m_L + m_{\text{aux}}$$

[7-46] Equation 5: Total mass

The friction force F_μ can for instance occur on the supporting elements of the rack and pinion. Generally it can be calculated according to the following equation.

- The force acts opposite to the direction of movement and is taken into consideration by the fraction $v/|v|$ in the following equation. For $v = 0$ the force F_μ is 0.

$$F_\mu = m_{\text{sum}} \cdot g \cdot \mu_{\text{Gdn}} \cdot \cos \beta \cdot \frac{v}{|v|}$$

[7-47] Equation 6: Friction force

Additionally a force F_{vs} can act, e. g. a force due to weight, which occurs during a slope of the linear movement.

- F_{vs} is an external counterforce that can act additionally on the rack and pinion. The direction of the force is to be observed.

$$F_{\text{sum}} = F_{vs} + m_{\text{sum}} \cdot g \cdot \sin \beta$$

[7-48] Equation 7: Total translatory force

The required torque of the application M_{App} has to be calculated in three steps. First the force that is transmitted via the rack and pinion has to be ascertained:

$$F_{\text{App}} = (F_{\text{sum}} + F_\mu) + m_{\text{sum}} \cdot a$$

[7-49] Equation 8: Force that is transmitted to the rack and pinion

The friction force depends on the force F_{App} to be transmitted, so that the resulting force that is to be transmitted via the spindle is calculated by means of the following equation.

- It is assumed that η_{Cog} is the leadscrew efficiency in motor mode. The deterioration of the efficiency for operation in generator mode (backward efficiency) is taken into consideration during this calculation.

$$F_{\text{App},\eta} = F_{\text{App}} + |F_{\text{App}}| \cdot \frac{v}{|v|} \cdot \left(\frac{1}{\eta_{\text{Cog}}} - 1 \right)$$

[7-50] Equation 9: Force transmitted to the rack and pinion, taking the spindle friction into consideration

Consideration of radial forces

Depending on the bearing, radial forces may occur in a rack drive which act on the gear shaft at the output end of the gearbox. DSD does not check whether the radial forces exceed limit values. This must be checked manually. The radial forces must be considered in the drive dimensioning.

Consideration of axial forces

In the case of racks and pinions with helical bearings, axial forces occur which act on the shaft bearings at the output end of the gearbox or at the motor. DSD does not check whether the axial forces exceed limit values. This must be checked manually. The radial forces must be considered in the drive dimensioning.

Required torque of the application

During the calculation of the required torque of the application additional moments of inertia, like for example that of the pinion or of additional shafts, are also taken into consideration.

$$M_{\text{App}} = \frac{d_{\text{Cog}}}{2000} \cdot F_{\text{App},\eta} + J_{\text{add}} \cdot \alpha$$

[7-51] Equation 11: Required torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.6.1.1 Symbols used

Symbol	Description	Dimension unit
a	Acceleration (translatory)	m/s^2
d_{Cog}	Pinion diameter	mm
F_{μ}	Friction force	N
F_{vs}	Counterforce	N
F_{sum}	Total translatory force	N
F_{App}	Force transmitted on the rack and pinion	N
$F_{\text{App},\eta}$	F_{App} , taking the spindle friction into consideration	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J_{add}	Additional moment of inertia (e. g. pinion)	kgm^2
J_{sum}	Total moment of inertia	kgm^2
m_{L}	Mass of the payload	kg
m_{aux}	Mass of the rack and pinion or slide	kg
m_{sum}	Total mass	kg
M_{App}	Required torque of the application	Nm
M_{Cog}	Pinion module	mm
s	Path (translatory)	m
v	Speed (translatory)	m/s
N_{Cog}	Number of teeth of the pinion	
α	Angular acceleration	rad/s^2
η_{Cog}	Efficiency of the pinion/rack and pinion	
φ	Angle	rad
μ_{Gdn}	Coefficient of friction of the guide rail	
ω	Angular velocity	rad/s

7.6.2 Data for the entry

7.6.2.1 Pinion diameter

Parameter	Description
d_{Cog}	Pinion diameter - The pinion is mounted at the end of the output shaft of the motor or gearbox. - The pitch diameter can be calculated from the module number and the number of teeth. - The value can be entered directly or calculated using the diameter calculator.  "Pinion diameter" calculator (477)

7.6.2.2 Rack and pinion mass

Parameter	Description
m_{aux}	Mass of rack and pinion (or vehicle weight) • Incl. the carriage that is moved by the rack. • The mass is used in the calculation for the moment of inertia • The mass of the payload is entered separately when the profile is entered. • By means of the mass calculator an alternative value can be calculated.  Mass calculator (📖 470)

7.6.2.3 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) • The value can be entered in degrees or as a percentage.

7.6.2.4 Efficiency, rack/pinion

Parameter	Description
η_{Cog}	Efficiency of the rack and pinion and the pinion

7.6.2.5 Additional moment of inertia

Parameter	Description
J_{add}	The additional inertial moment can be, for instance, the pinion or another shaft. • The proportion of inertia by the payload is calculated separately for a user-definable motion profile. • Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.6.2.6 Coefficient of friction of the guide rail

Parameter	Description
μ_{Gdn}	By entering the coefficient of friction μ_{Gdn}, an increased requirement of the torque due to the sliding friction in the guide rail is considered. • With the coefficient of friction the force F_{μ} that counteracts the actual direction of movement is calculated. • If the static friction is to be taken into account for the start-up, the static coefficient of friction is to be used in this connection. • Value can be entered directly or selected from the "Physical coefficients" table. ▶ Physical coefficients (📖 488)  Coefficient of sliding friction

7.6.2.7 Speed

Parameter	Description
v	Speed (translatory) Value is entered in the <i>Motion</i> dimensioning step.

7.6.2.8 Counterforce

Parameter	Description
F_{vs}	Force that works against the direction of movement. - Value is entered in the <i>Motion</i> dimensioning step. The sign of the counterforce determines its effective direction: - If the speed is positive, - positive values act opposite to the direction of travel - negative values act with the direction of travel. - If the speed is negative, - positive values act with the direction of travel - negative values act opposite to the direction of travel.



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.

7.6.2.9 Mass of the payload

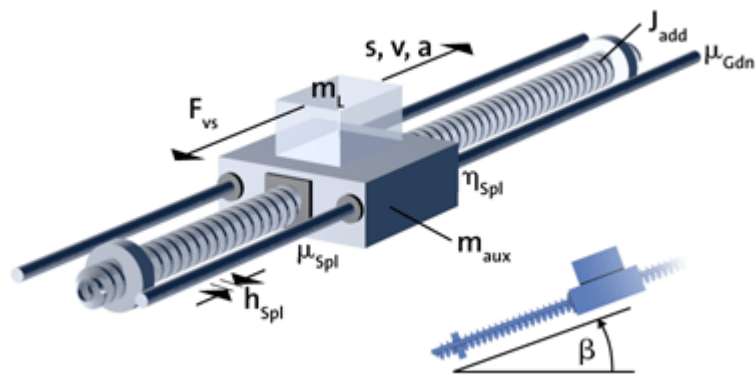
Parameter	Description
m_L	Mass of the payload without vehicle. Value is entered in the <i>Motion</i> dimensioning step.

7.7 Spindle drive

The vast majority of positioning systems require linear movements. If a rotating drive is used, the rotation of the motor has to be converted into a linear movement. The speeds that can be achieved, and therefore the dynamics of the positioning process and the repeat accuracy, and thus the quality of the positioning process to a great extent are defined by the mechanics.

Characteristics of a spindle drive

- A motor (if required with a gearbox) actuates a spindle that moves the spindle slide with the load.
- Spindles are used for a high positioning accuracy and low speeds. The positioning path is limited.
- For the accurate adjustment of limit stops and the accurate positioning of the workpiece in production machines, spindles are generally used.



7.7.1 Calculations

For a spindle drive according to the drawing the following applies:

First the leadscrew pitch is converted to a resulting radius.

$$r_{\text{Res}} = \frac{h_{\text{Spl}}}{2000 \cdot \pi}$$

[7-52] Equation 1: Resulting radius of the spindle

The moment of inertia of the spindle can be determined if its geometry is known.

- The following, for instance, applies to a solid cylinder:

$$J_{\text{add}} = \frac{\pi}{32 \cdot 1000^4} \cdot d_{\text{Spl}}^4 \cdot l_{\text{Spl}} \cdot \rho$$

[7-53] Equation 2: Moment of inertia of the spindle

The efficiency of the spindle is calculated according to the following equation.

- The coefficient of friction μ_{spl} of the spindle depends on the spindle type. Here, rolling spindles and trapezoidal spindles are distinguished.

$$\eta_{spl} = \frac{1 - k \cdot \mu_{spl}}{1 + \frac{\mu_{spl}}{k}} \quad \text{with } k = \frac{h_{spl}}{\pi \cdot d_{spl}}$$

[7-54] Equation 3: Leadscrew efficiency

Conversion of translatory variables into rotary variables

$$\varphi = 2000 \cdot \pi \cdot \frac{s}{h_{spl}}$$

[7-55] Equation 4: Angle

$$\omega = 2000 \cdot \pi \cdot \frac{v}{h_{spl}}$$

[7-56] Equation 5: Angular velocity

$$\alpha = 2000 \cdot \pi \cdot \frac{a}{h_{spl}}$$

[7-57] Equation 6: Angular acceleration

Forces of the linear motion

First the mass which is to be moved linearly has to be calculated. The payload m_L can adopt different values during the travel cycle. The mass of carriage m_{aux} is considered separately.

$$m_{sum} = m_L + m_{aux}$$

[7-58] Equation 7: Total mass

The friction force F_μ acts opposite to the direction of movement and is taken into consideration by $v/|v|$ in the following equation, where $F_\mu = 0$ if $v = 0$.

$$F_\mu = m_{sum} \cdot g \cdot \mu_{Gdn} \cdot \cos\beta \cdot \frac{v}{|v|}$$

[7-59] Equation 8: Friction force

Additionally a force F_{vs} can act, e. g. a force due to weight during a slope of the linear movement.

- F_{vs} is an external counterforce that can act additionally on the slide or the spindle. The direction of the force is to be observed.

$$F_{sum} = F_{vs} + m_{sum} \cdot g \cdot \sin \beta$$

[7-60] Equation 9: Total translatory force

Required torque of the application

The required torque of the application M_{App} has to be calculated in three steps. First the force that is transmitted via the spindle has to be ascertained:

$$F_{App} = (F_{sum} + F_{\mu}) + m_{sum} \cdot a$$

[7-61] Equation 10: Force of the slide on the spindle

The friction force depends on the force F_{App} to be transmitted, so that the resulting force that is transmitted via the spindle is calculated by means of the following equation.

- It is assumed that η is the leadscrew efficiency in motor mode. The deterioration of the efficiency for operation in generator mode (backward efficiency) is taken into consideration during this calculation.

$$F_{App,\eta} = F_{App} + |F_{App}| \cdot \frac{v}{|v|} \cdot \left(\frac{1}{\eta_{spl}} - 1 \right)$$

[7-62] Equation 11: Force transmitted to the slide, taking the spindle friction into consideration

Consideration of axial forces

In the case of rack and pinions with helical teeth, there are axial forces resulting in a stress for the shaft bearings on the gearbox output end or on the motor.

The DSD does not calculate axial forces. You have to check them separately and take them into consideration during the dimensioning process.

Torque

For calculating the required torque of the application, the additional moments of inertia (e. g. that of the spindle) are to be taken into consideration.

$$M_{App} = r_{Res} \cdot F_{App,\eta} + J_{add} \cdot \alpha$$

[7-63] Equation 13: Required torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.7.1.1 Symbols used

Symbol	Description	Dimension unit
a	Acceleration (translatory)	m/s^2
d_{Spl}	Friction diameter of the spindle	mm
F_{μ}	External friction force	N
F_{Vs}	Counterforce	N
F_{sum}	Total translatory force	N
F_{App}	Force of slide on the spindle	N
$F_{\text{App},\eta}$	F_{App} , taking the spindle friction into consideration	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
h_{Spl}	Leadscrew pitch	mm
J_{add}	Additional moment of inertia, e. g. of the spindle	kgm^2
J_{L}	Moment of inertia of load	kgm^2
J_{sums}	Total moment of inertia	kgm^2
l_{Spl}	Spindle length	mm
m_{L}	Mass of the payload	kg
m_{aux}	Mass of the slide	kg
m_{sum}	Total mass	kg
M_{App}	Required torque of the application	Nm
ρ	Density of the spindle material	kg/dm^3
r_{res}	Resulting radius of the spindle	m
s	Path (translatory)	m
v	Speed (translatory)	m/s
α	Angular acceleration	rad/s^2
β	Angle of tilt	°
η_{Spl}	Spindle efficiency	
φ	Angle	rad
μ_{Gdn}	Coefficient of friction of the guide rail	
μ_{Spl}	Coefficient of friction of the spindle	
ω	Angular velocity	rad/s

7.7.2 Data for the entry

7.7.2.1 Leadscrew pitch

Parameter	Description
h_{Spl}	Leadscrew pitch Path moved per spindle revolution

7.7.2.2 Mass of the slide

Parameter	Description
m_{aux}	Mass of carriage - The spirally formed guide of the leadscrew thread moves the carriage. - The mass of the carriage is used in the calculation of the inertial moment. - By means of the mass calculator an alternative value can be calculated.  Mass calculator (470)

7.7.2.3 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) The value can be entered in degrees or as a percentage.

7.7.2.4 Spindle efficiency

Parameter	Description
η_{Spl}	Leadscrew efficiency - If the efficiency is known it can be entered directly. - The leadscrew efficiency can also be calculated from the coefficient of friction.  "Leadscrew efficiency" calculator (487)

7.7.2.5 Spindle moment of inertia

Parameter	Description
J_{add}	Moment of inertia of the spindle (without mass of the payload) - The proportion of inertia by the mass of the payload is calculated separately by the creation of the motion profile. - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (472)

7.7.2.6 Coefficient of friction of the guide rail

Parameter	Description
μ_{Gdn}	Coefficient of friction of the guide rail • If there are guide rails absorbing the payload mass, a value for the friction is to be entered. • Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (488)  Coefficient of sliding friction

7.7.2.7 Speed

Parameter	Description
v	Traversing speed • Value is entered in the <i>Motion</i> dimensioning step.

7.7.2.8 Mass of the payload

Parameter	Description
m_L	Mass of payload • Value is entered in the <i>Motion</i> dimensioning step.

7.7.2.9 Counterforce

Parameter	Description
F_{vs}	Force that works against the direction of movement. • Value is entered in the <i>Motion</i> dimensioning step. The sign of the counterforce determines its effective direction: • If the speed is positive, • positive values act opposite to the direction of travel • negative values act with the direction of travel. • If the speed is negative, • positive values act with the direction of travel • negative values act opposite to the direction of travel



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.

7.8

Wheel drive

Wheel drives are used in non-continuous conveyors. The drives are on the vehicle and therefore on the non-stationary part. Compared to continuous conveyors, non-continuous conveyors have a greater flexibility, but also higher costs for the individual vehicle. Therefore they are usually used for cases where the transport volume and the use of the conveyor section is lower than for continuous conveyors.

There are railway vehicles and non-railway vehicles. For railway vehicles the effort for tracking is lower, however, they are not as flexible with regard to the routing. Since many automated internal transport tasks have a defined travel way, they are frequently found in automated operation. For non-automated internal transport the manually operated fork lift still is the most frequently used means of transport in the field of industrial trucks.

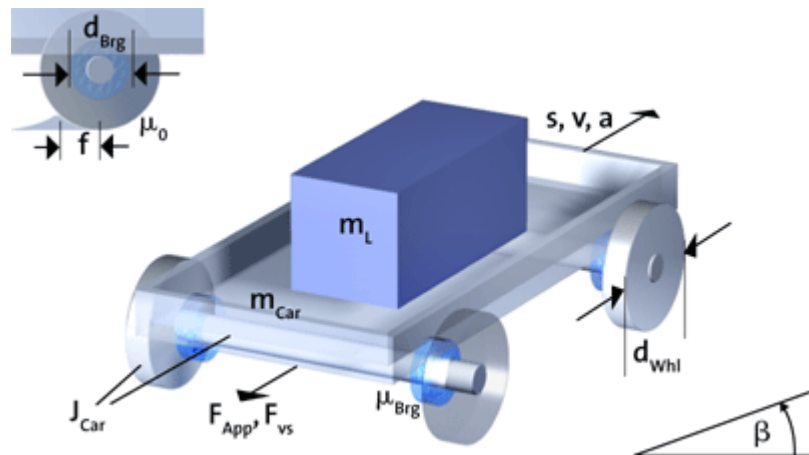
Wheel drives in non-continuous conveyors can be found in the following applications:

- In rail vehicles (e. g. transfer carriages)
- In monorail overhead conveyors (MOC)
- In travelling and gantry cranes
- In storage and retrieval units (SRU)
- In automated guided vehicle systems (AGV).

**Note!**

The calculation only applies to travelling drives which are solely actuated by means of wheels (no rope or rack and pinion).

Applications with toothed belts can be found in connection with the belt models.



7.8.1 Calculations

For a wheel drive according to the drawing the following applies:

Moment of inertia

The moment of inertia J_{Car} is the part of inertia which does not change during the processing cycle, e. g. mass of the vehicle (m_{Car}), axes, and wheels.

$$J_{Car} = J_{add} + \left(\frac{d_{Whl}}{2000}\right)^2 \cdot m_{Car}$$

[7-64] Equation 1: Moment of inertia of the vehicle

The part of the payload mass (m_L) is added. This mass can adopt different values within the processing cycle.

$$J_{sum} = J_{Car} + \left(\frac{d_{Whl}}{2000}\right)^2 \cdot m_L$$

[7-65] Equation 2: Total moment of inertia

Stationary torque

The ascertainment of the stationary torque is based on the determination of the vehicle travelling resistance. It can consist of the proportion of rolling friction, bearing friction, and wheel flange and lateral friction. Additionally tensile and hoisting forces can act.

$$m_{sum} = m_{Car} + m_L$$

[7-66] Equation 3: Total mass

$$M_{sds} = M_{\mu} + M_{vs} + M_g$$

[7-67] Equation 4: Stationary torque

$$M_{\mu} = m_{sum} \cdot g \cdot \frac{v}{|v|} \cdot \left(\frac{f}{1000} \cdot \cos \beta + \frac{d_{Brg}}{2000} \cdot \mu_1 + \frac{d_{Whl}}{2000} \cdot c \right)$$

[7-68] Equation 5: Friction torque

$$M_{vs} = F_{vs} \cdot \frac{d_{Whl}}{2000}$$

[7-69] Equation 6: Counter-torque

$$M_g = m_{sum} \cdot g \cdot \sin \beta \cdot \frac{d_{Whl}}{2000}$$

[7-70] Equation 7: Lifting torque

Alternatively the travelling resistance F' can be related to the mass [N/t]:

$$F' = g \cdot \left(\frac{2 \cdot f \cdot \cos \beta}{d_{\text{Whl}}} + \frac{d_{\text{BrG}} \cdot \mu_{\text{BrG}}}{d_{\text{Whl}}} + c \right) \cdot 1000$$

[7-71] Equation 8: Travelling resistance

$$M_{\mu} = F_{\mu} \cdot \frac{d_{\text{Whl}}}{2000} = \frac{F' \cdot m_{\text{sum}}}{1000} \cdot \frac{d_{\text{Whl}}}{2000} \cdot \frac{v}{|v|}$$

[7-72] Equation 9: Friction torque

Application torque

$$M_{\text{App}} = M_{\text{sds}} + J_{\text{sum}} \cdot \alpha$$

[7-73] Equation 10: Torque of the application

Spinning

In order to prevent the drive wheels from spinning, a maximum permissible acceleration can be determined. In the calculation the wheel load, the angle of tilt, the total mass, and the friction coefficient and a possible counterforce (F_{vs}) are taken into consideration.

$$a_{\text{per}} = g \cdot \left(\mu_0 \cdot \frac{m_{\text{Whl}}}{m_{\text{sum}}} \cdot \cos \beta - \sin \beta \right) + \frac{F_{\text{vs}}}{m_{\text{sum}}}$$

[7-74] Equation 11: Permissible spinning acceleration

Driving against a limit stop

The maximum torque during driving against a limit stop depends on the friction force and the diameter of the driving wheels. After the friction force has been overcome, the torque is reduced by spinning wheels.

$$M_{\mu 0} = m_{\text{sum}} \cdot g \cdot \mu_0 \cdot \frac{d_{\text{Whl}}}{2000} \cdot \cos \beta$$

[7-75] Equation 12: Torque at the gearbox output during driving against a limit stop



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.8.1.1 Symbols used

Symbol	Description	Dimension unit
a_{per}	Slip acceleration	m/s^2
C	Wheel flange and lateral friction	
d_{Whl}	Wheel diameter	mm
d_{Brg}	Bearing diameter	mm
f	Lever arm of the rolling friction	mm
F'	Specific travelling resistance	N/t
F_{μ}	Force of travelling resistance	N
F_{vs}	Counterforce	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J_{add}	Additional moment of inertia	kgm^2
J_{Car}	Moment of inertia of vehicle	kgm^2
J_{sum}	Total moment of inertia	kgm^2
m_{L}	Mass of the payload	kg
m_{Car}	Mass of the vehicle	kg
m_{sum}	Total mass	kg
m_{Whl}	Wheel load of the driven wheel	kg
M_{vs}	Counter-torque	Nm
M_{g}	Lifting torque	Nm
M_{App}	Required torque of the application	Nm
M_{sds}	Stationary torque	Nm
M_{μ}	Friction torque	Nm
$M_{\mu 0}$	Max. torque during driving against a limit stop	Nm
β	Angle of tilt	°
μ_{Brg}	Bearing friction	
μ_0	Static friction of wheel/road surface	

7.8.2 Data for the entry

7.8.2.1 Wheel diameter

Parameter	Description
d_{Whl}	Diameter of the wheel that is used to drive the vehicle.

7.8.2.2 Mass of the vehicle

Parameter	Description
m_{Car}	Mass of the vehicle without payload - The value can be entered directly or calculated using the mass calculator. - When the motion profile is entered, the payload is assigned to the individual subprofiles.  Mass calculator (470)

7.8.2.3 Additional moment of inertia

Parameter	Description
J_{add}	Additional moment of inertia due to wheels, axes, etc. - Has an impact on the dynamic torque! - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (472)

7.8.2.4 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) - The value can be entered in degrees or as a percentage. - The max. angle of tilt as a first approximation is: $\arctan(\mu_0)$ (static friction between the wheel and road surface). - The angle of tilt of the travel path must be considered when determining the travelling resistance. For a tilted travel path ($\beta \neq 0$), the specific travelling resistance must be recalculated by means of the "Travelling resistance" calculator and the values for the wheel diameter and the angle of tilt.  "Travelling resistance" calculator (484)

7.8.2.5 Specific travelling resistance

Parameter	Description
F'	Specific travelling resistance If the specific travelling resistance is calculated via the "travelling resistance" calculator, the values for wheel diameter and angle of tilt must be entered in the calculator for this purpose.  "Travelling resistance" calculator (484)

VULKOLLAN wheels



Note!

VULKOLLAN is a registered trademark of BAYER AG.

VULKOLLAN wheels are particularly suitable for conveyors and drives for loads up to 10 t or even more.

- For the determination of the travelling resistance the following table can be included:

	Travelling resistance in %	Travelling resistance in N/t
Rolling resistance at 20 °C in % of load	0.8 to 0.9	80 to 90
Start-up resistance at 20 °C in % of load	1.1 to 1.4	110 to 140

- Usually the consideration of the rolling friction is sufficient with regard to determining the travelling resistance. Only for applications featuring frequent start-stop processes, the travelling resistance increases due to the starting resistance.

7.8.2.6 Speed

Parameter	Description
v	Velocity of the vehicle Value is entered in the <i>Motion</i> dimensioning step.

7.8.2.7 Mass of the payload

Parameter	Description
m_L	Mass of the payload without vehicle. Value is entered in the <i>Motion</i> dimensioning step.

7.8.2.8 Counterforce

Parameter	Description
F_{vs}	Force that acts in the opposite direction to the movement, caused, for instance, by a trailer or wind resistance. - Value is entered in the <i>Motion</i> dimensioning step. The sign of the counterforce determines its effective direction: - If the speed is positive, - positive values act opposite to the direction of travel, - negative values act with the direction of travel. - If the speed is negative, - positive values act with the direction of travel, - negative values act opposite to the direction of travel.



Note!

If the force is to have a supporting function, the opposed sign is to be entered.

7.9

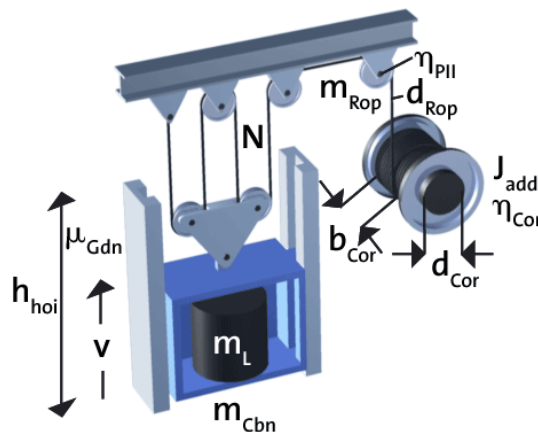
Hoist drive without counterweight

In the case of winches, power is transmitted from the drive on the load via a cable drum and a rope. The load can be arranged with or without a vertical guide (rolls, slide rails). The rope can be deflected once or several times or have reevings (pulley block principle). By means of ropes or belts only one direction of force can be transmitted. Therefore it is only used for applications with a low acceleration clearly below the acceleration due to gravity of 1 g ($1\text{ g} = 9.81\text{ m/s}^2$). Typical winch applications are load cranes of all types, scenery winches in theatres, storage and retrieval units, and manually operated hoists. A winch installation controlled by the winch speed is connected to the winch mechanically or electrically via an individual installation drive and carries out the correct installation of the cable in one or several layers. One-layer systems partly have grooves in the cable drum, into which the cable is installed.

- Cranes that are designed as overhead cranes, gantry cranes and construction cranes or as simple hoists lift loads by means of cable winches and operate with different types of reeving. The drive units, just like the wheel drives, are often mounted to constructional elements that travel along.
- In order to move sceneries in theatres vertically, often several cables are required next to each other for each scenery, which act on the sceneries via cross members. The cables of the stage and scenery lifters are wound synchronously on mechanically coupled winches that are axially arranged next to each other. The winches are actuated by a central hoist drive. Tangential pressure rollers provide for a safe cable guide in the grooves of the cable drum. The cables can have lengths of up to 50 m.
- When the application is calculated in the DSD, changes of the cable drum radius during winding and additional losses can be taken into consideration.

**Note!**

This application model of the DSD is only suitable for applications in which the cable drum diameter does not change at all or only changes slightly. The impact of the changing cable drum diameter is only taken into consideration in the torque diagrams, but not in the interaction of speed and velocity diagrams.



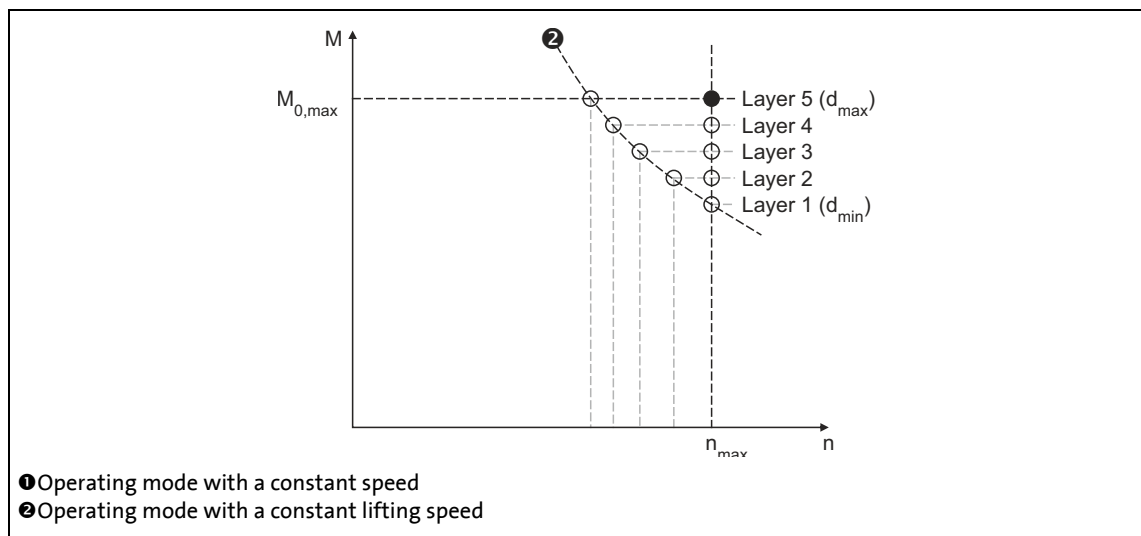
7.9.1 Calculations

For a hoist without counterweight according to the drawing the following applies:

When a cable drum is wound up and unwound, the effective radius changes, which is required for the calculation of the torque acting on the cable drum. Since, depending on the operating mode (constant speed or constant lifting speed), the speed or velocity changes, the dimensioning process is carried out according to the base process power, and the most unfavourable case is assumed:

$$P_{cto} = M_{App} \cdot n_{max} \cdot \frac{2 \cdot \pi}{60}$$

[7-76] Equation 1: Base process power



[7-77] Operating modes

1. Operating mode with a constant speed

- In the case of this operating mode which is the most frequently used, the input speed – irrespective of the respective layer – is kept constant on the winding drum.
- During a layer change, the lifting speed increases abruptly with every additional layer.
- The torque required changes abruptly during a layer change (layer 1, 2, ... n).

2. Operating mode with a constant lifting speed

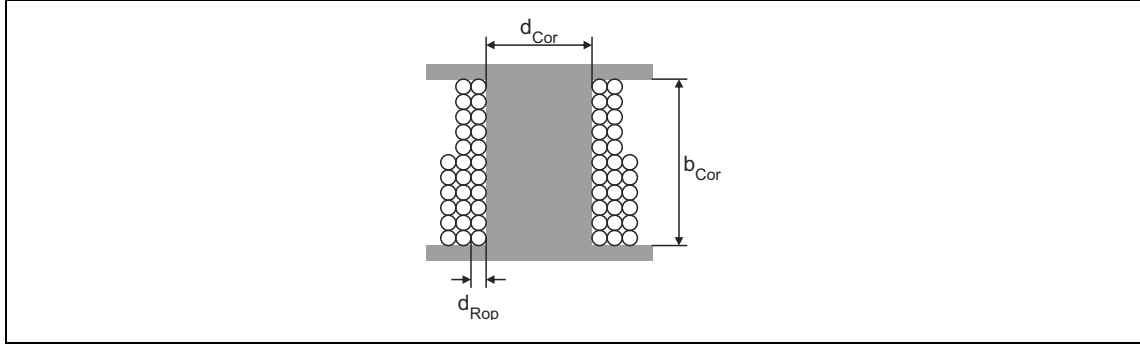
- In this operating mode, the input speed is altered depending on the current layer on the cable drum, so that always a constant lifting speed ($v = d_{Cor} \cdot n \cdot \pi / 60$) is reached. For this, the inverter or an external control has to update the speed depending on the layer.
- The required torque also changes abruptly during a layer change. The difference with regard to the operating mode with a constant speed is that the highest speed and the highest torque do not occur simultaneously.

The DSD carries out the dimensioning process identically for both operating modes according to the base process power (product from max. torque and max. speed). During all calculation routines and graphic representations only the maximum values are ascertained and displayed.

Minimum/maximum diameter

If a cable drum is used a minimum and maximum diameter for the dimensioning has to be determined.

- The following illustration shows the parameters required for the calculation for a cable drum:



[7-78] Example: Cable drum

For the determination of the required speed n_{max} at the required lifting speed v , the minimum effective reel diameter d_{min} has to be specified:

$$d_{Min} = d_{Cor} + d_{Rop}$$

[7-79] Equation 2: Minimum diameter

For the determination of the moments of inertia and the stationary torque the maximum effective diameter d_{max} is required. For this the number of cable layers on the drum at maximum lifting height has to be determined.

If we assume that the reel diameter increases by the cable thickness (d_{Rop}) with every winding layer, the achievable height h_N per winding layer N_{Cor} can be calculated by means of the equation below:

$$h_N = \sum_{N_L=1}^{N_{Cor}} \frac{b_{Cor}}{d_{Rop}} \cdot \pi \cdot [d_{Cor} + d_{Rop} \cdot (2 \cdot N_{Cor} - 1)]$$

[7-80] Equation 3: Achievable height for the winding layer N_{Cor}

The winding layer $N_{Cor}(\Delta h)$ can be calculated depending on h_{hoi} using the following equation:

$$N_{Cor}(\Delta h) = \sqrt{\left(\frac{d_{Cor}}{2 \cdot d_{Rop}}\right)^2 + \frac{h_{hoi} \cdot 1000 \cdot N_L}{\pi \cdot b_{Cor}}} - \frac{d_{Cor}}{2 \cdot d_{Rop}}$$

[7-81] Equation 4: Winding layer $N_{Cor}(\Delta h)$

The winding layer N_{Cor} which only exists as integer thus results from the rounded up value of $N_{Cor}(\Delta h)$:

$$N_{Cor} = \lceil N_{Cor}(\Delta h) \rceil$$

[7-82] Equation 5: Winding layer N_{Cor}

The maximum effective diameter d_{max} of the cable drum is calculated according to the following equation:

$$d_{\max} = d_{\text{Cor}} + d_{\text{Rop}} \cdot (2 \cdot N_{\text{Cor}} - 1)$$

[7-83] Equation 6: Maximum diameter

Moment of inertia

The moment of inertia J does not change during the lifting cycle. It is, for instance, determined by the mass of the hoisting cage (m_{Cbn}) and the additional moment of inertia (J_{add}).

$$J = J_{\text{add}} + \left(\frac{d_{\max}}{2000} \right)^2 \cdot \left(\frac{m_{\text{Cbn}}}{N_L^2} + m_{\text{Rop}} \right)$$

[7-84] Equation 7: Fixed moment of inertia

In the case of applications with many cable rolls and a long cable, the cable rolls and the cable mass substantially contribute to the peak torque value. For the determination of the cable mass the following equation can be used:

$$m_{\text{Rop}} = \rho_{\text{Rop}} \cdot l_{\text{Rop}} = 10 \cdot \pi \cdot \left(\frac{d_{\text{Rop}}}{2000} \right)^2$$

[7-85] Equation 8: Cable mass

For the total moment of inertia (J_{sum}) of the application the mass of the payload is taken into consideration. During the lifting cycle the mass of the payload can be different.

$$J_{\text{sum}} = J + \left(\frac{d_{\max}}{2000} \right)^2 \cdot \frac{m_L}{N_L^2}$$

[7-86] Equation 9: Total moment of inertia

Stationary torque

The stationary torque is calculated from the masses assessed with the reeving N_L .

$$M_{\text{sds}} = \frac{g \cdot d_{\max}}{2000} \cdot \left(\frac{m_L}{N_L} + \frac{m_{\text{Cbn}}}{N_L} + m_{\text{Rop},1} \right)$$

[7-87] Equation 10: Stationary torque



Tip!

The cable mass usually can be disregarded, since the force due to weight of the cable cancels itself out in the case of a pulley block.

In few cases (e. g. in the case of long lifting paths), however, the cable force due to weight has to be taken into consideration. Since it is not the total cable mass that acts effectively, an active cable mass for the stationary torque ($m_{\text{acv,Rop}}$) has to be specified.

Ascertainment of the active cable mass

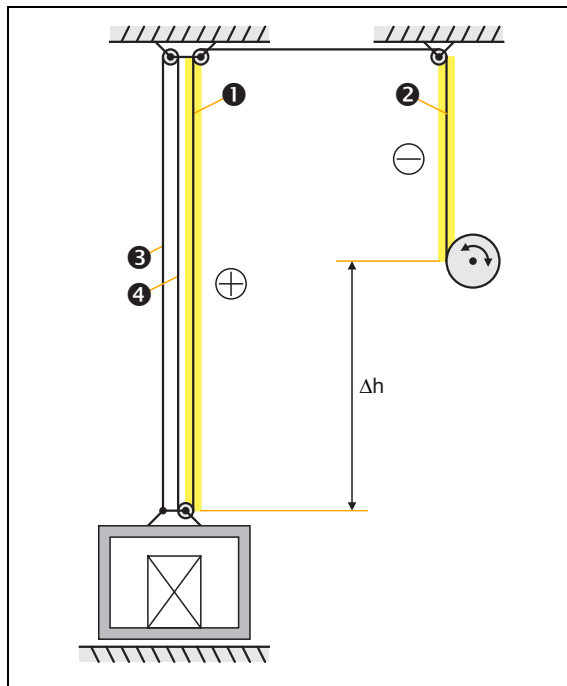
The active cable mass is ascertained by means of the mass calculator (field: cylinder) and is calculated with the following equation:

$$m_{acv, Rop} = \rho_{Rop} \cdot \Delta h \cdot 10 \cdot \pi \cdot \left(\frac{d_{Rop}}{200} \right)^2$$

[7-88] Equation 11: Active cable mass for the stationary torque

Ascertainment of the height difference

For the stationary torque the maximum height difference Δh is required.



[7-89] Determination of Δh

- The height Δh typically is the height difference from the winding drum to the cable end of the payload at the lowest position of the payload.
- The yellow highlighted cable sections (1+2) are decisive for the steady-state torque.
- The other cable sections (3+4) cancel each other out.

Torque loss

In order to take the losses for the hoist into consideration, the friction torque is calculated from the individual efficiencies. In the case of a dimensioning process with a user-definable motion profile, the efficiency is assumed for a run with the maximum steady-state torque.

- The sign is considered with the fraction $n/|n|$.
- The following equation calculates the torque loss in generator and motor mode:

$$M_{th} = \left(\frac{1}{\eta_{Gdn} \cdot \eta_{PII} \cdot \eta_{Cor}} - 1 \right) \cdot \max(|M_{sds}|) \cdot \frac{n}{|n|}$$

[7-90] Equation 12: Torque loss

Application torque

$$M_{App} = M_{sds} + J_{sum} \cdot \alpha + M_{th}$$

[7-91] Equation 14: Torque of the application

Required speed

For the determination of the required speed (n) of the cable drum apart from the previously mentioned parameters the required lifting speed (v) has to be specified:

$$n = \frac{60}{2 \cdot \pi} \cdot \frac{v}{60} \cdot \frac{N_L \cdot 2000}{d_{Min}}$$

[7-92] Equation 15: Speed of the cable drum



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.9.1.1 Symbols used

Symbol	Description	Dimension unit
b _{Cor}	Width of cable drum	mm
d _{Cor}	Diameter of cable drum	mm
d _{max}	Maximum effective diameter of cable drum	mm
d _{min}	Minimum effective diameter of cable drum	mm
d _{Rop}	Cable diameter	mm
g	Gravitational acceleration (g = 9.81 m/s ²)	m/s ²
h _{hoi}	Lifting height for the determination of the winding layers	m
Δh	Height difference for the determination of the stationary torque	m
h _N	Achievable height for winding layer N	m
J _{add}	Additional moment of inertia (e. g. by the cable drum)	kgm ²
J	Stationary moment of inertia without payload mass	kgm ²
J _{sum}	Total moment of inertia with payload mass	kgm ²
N _{Cor}	Number of winding layers on the cable drum	
N _L	Reeving of the pulley block with regard to the payload	
l _{Rop}	Cable length	m
m _L	Mass of the payload	kg
m _{Cbn}	Mass of the hoisting cage for the payload	kg
m _{Rop}	Cable mass	kg
m _{acv,Rop}	Active cable mass (for stationary torque)	kg
m _{sum}	Total mass	kg
M _{App}	Required torque of the application	Nm
M _{sds}	Stationary torque	Nm
M _{th}	Torque loss	Nm
n	Speed of the cable drum	rpm
v	Lifting speed of the payload	m/min
α	Angular acceleration	rad/s ²
η _{Gdn}	Shaft efficiency	
η _{PII}	Efficiency of the cable rolls	
η _{Cor}	Efficiency of the cable drum	
ρ _{Rop}	Specific cable weight	kg/dm ³

7.9.2 Data for the entry

7.9.2.1 Diameter of cable drum

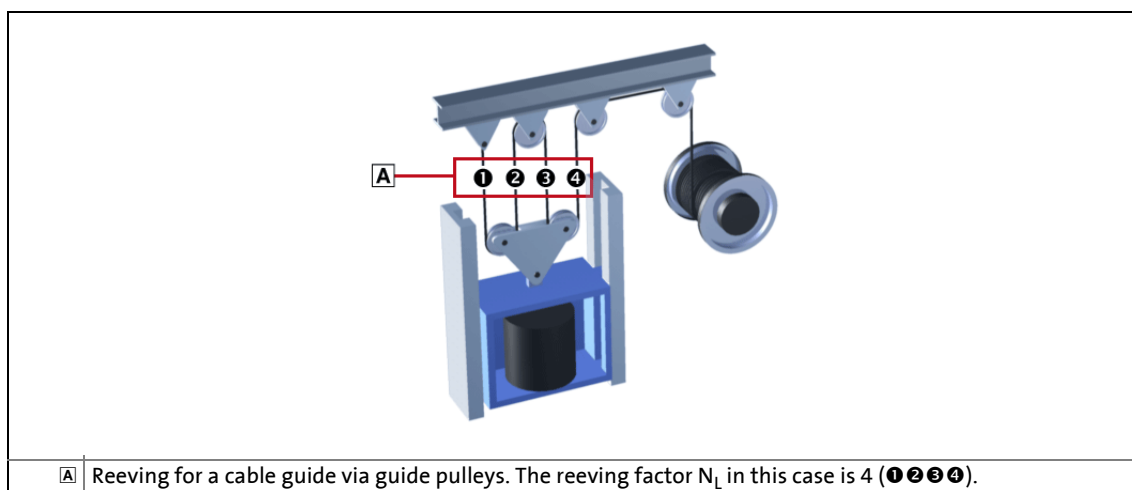
Parameter	Description
d_{Cor}	Diameter of the cable drum without cable

7.9.2.2 Reeving, load

Parameter	Description
N_L	The reeving of the cable to the payload. • The reeving is the ratio of cable velocity of the cable drum to the lifting speed of the payload.

Cable guided hoists have both simple- and multi-cable guides via guide pulleys, so-called reevings (pulley block principle). For multi-cable guides, the circumferential speed of the cable drum is an integer multiple of the lifting speed. Here, the required torque on the cable drum decreases by the reeving factor N_L and the speed increases by this factor.

The reeving has no impact on the drive power (except for highly dynamic movements).



A Reeving for a cable guide via guide pulleys. The reeving factor N_L in this case is 4 (1 2 3 4).

[7-93] Reeving

7.9.2.3 Mass of hoisting cage

Parameter	Description
m_{Cbn}	Mass of the hoisting cage for the payload • Value can be entered directly or calculated using the mass calculator.  Mass calculator (470)

7.9.2.4 Efficiency of the cable drum

Parameter	Description
η_{Cor}	Efficiency limited by friction between cable drum and cable

7.9.2.5 Additional moment of inertia

Parameter	Description
J_{add}	Moment of inertia of the cable drum, the deflection and guiding rollers, etc. • The moment of inertia of the hoisting cage does not have to be taken into consideration here since it is already included. • The moment of inertia has an effect on the dynamic torque! • Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.9.2.6 Cable diameter

Parameter	Description
d_{Rop}	Outside diameter of cable

7.9.2.7 Width of cable drum

Parameter	Description
b_{Cor}	Width of the cable drum • Is used to determine the number of layers of the cable on the drum, and thus the increase in the effective drum diameter.

7.9.2.8 Max. lifting height

Parameter	Description
h_{hoi}	Maximum achievable lifting height • Is used to determine the number of layers of the cable on the drum, and thus the increase in the effective drum diameter. • If the winding layers do not have to be taken into consideration, h_{hoi} is set to 0.

7.9.2.9 Cable mass

Parameter	Description
m_{Rop}	Mass of cable • Value can be entered directly or calculated using the auxiliary calculator.  "Mass of rope/cable (hoist drive)" calculator (📖 479)

Determination of the mass

The cable mass is either calculated by means of the mass calculator (field: cylinder) or with the following equation:

$$m_{\text{Rop}} = \rho_{\text{Rop}} \cdot l_{\text{Rop}} \cdot 10 \cdot \pi \cdot \left(\frac{d_{\text{Rop}}}{200} \right)^2$$

7.9.2.10 Active cable mass

Parameter	Description
$m_{\text{acv,Rop}}$	Active mass of cable - Is the mass that is relevant for the stationary moment, i.e. the mass that acts as a weight on the cable drum. - Value can be entered directly or calculated using the auxiliary calculator.  "Mass of rope/cable (hoist drive)" calculator (📖 479)

7.9.2.11 Shaft efficiency

Parameter	Description
η_{Gdn}	Efficiency resulting from the friction of the hoisting cage at the hoisting shaft

7.9.2.12 Efficiency of the rolls

Parameter	Description
η_{pII}	Efficiency resulting from friction between the cable rolls and the cable

7.9.2.13 Lifting speed

Parameter	Description
v	Lifting speed of the payload Value is entered in the <i>Motion</i> dimensioning step.

7.9.2.14 Mass of the payload

Parameter	Description
m_{L}	Mass of payload Value is entered in the <i>Motion</i> dimensioning step.

7.10

Hoist drive with counterweight

**Danger!**

The DSD must not be used for designing lifts!

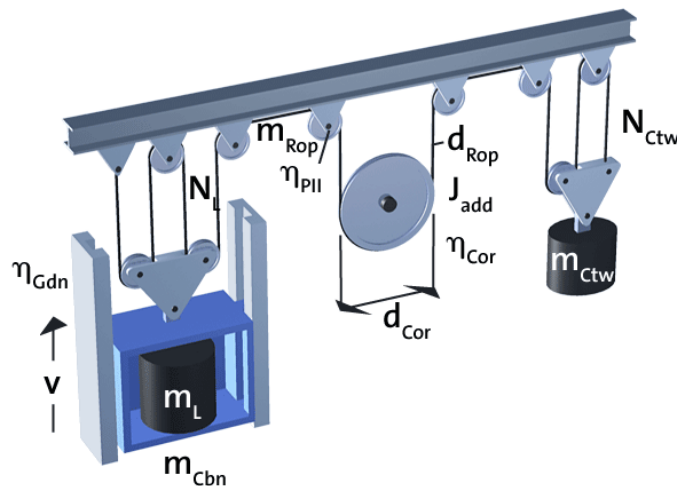
- The DSD can only calculate hoist drives with counterweight for freight elevators.
- The safety-relevant calculations required for lifts are not carried out by the DSD.
- Only design hoist drives for lifts in accordance with the applicable national and regional regulations.

In comparison to winches, hoists with driving pulleys and counterweights have the advantage that the cable length practically is only limited by the dead weight of the cables. Hoists with driving pulleys are basically equipped with counterweights that are conducted to the sides of the shaft, parallel to the cabin.

Normally the counterweight is dimensioned for half the payload. This means that the hoist is in equilibrium when half the payload is loaded. Apart from the two directions of rotation, according to the payload also two torque directions (in motor mode, in generator mode) can occur.

The cables directly connect the cabin to the counterweight, or by means of mounting suspensions and run through V-shaped grooves over the driving pulleys with a minimum angle of wrap. The driving pulleys that are wrapped by the cables transmit the drive torque to the cables, and thus to the system consisting of the hoisting cage and the counterweight, by frictional locking.

For safety reasons always several parallel cables (6 to 8 cables) with a very high safety factor (factor 12) are used, so that the total load can actually be held by an individual cable. A redundant safety concept provides for an extremely high degree of safety, also in the event of a power failure or conductor failure.



7.10.1 Calculations

For a hoist with counterweight according to the drawing the following applies:

Effective diameter

The following equations require the effective diameter of the traction sheave, resulting from the reel diameter of the traction sheave plus the diameter of the wire:

$$d = d_{\text{Cor}} + d_{\text{Rop}}$$

[7-94] Equation 1: Effective diameter of the driving pulley

Moment of inertia

The moment of inertia J does not change during the lifting cycle. Basically it is determined by the mass of the hoisting cage m_{Cag} , the mass of the counterweight, and the additional moment of inertia J_{add} .

$$J = J_{\text{add}} + \left(\frac{d}{2000}\right)^2 \cdot \left(\frac{m_{\text{Ctw}}}{N_{\text{Ctw}}^2} + \frac{m_{\text{Cbn}}}{N_{\text{L}}^2} + m_{\text{Rop}}\right)$$

[7-95] Equation 2: Fixed moment of inertia

Typical masses of counterweight m_{Ctw} can be determined from the mass of the hoisting cage m_{Cbn} , half of the payload m_{L} and the reeving ratio $N_{\text{Ctw}}/N_{\text{L}}$:

$$m_{\text{Ctw}} = \frac{N_{\text{Ctw}}}{N_{\text{L}}} \cdot \left(m_{\text{Cbn}} + \frac{m_{\text{L}}}{2}\right)$$

[7-96] Equation 3: Mass of counterweight

In the case of applications with many guide pulleys and a long cable, the rolls and the cable mass substantially contribute to the peak torque value. For the determination of the cable mass m_{Rop} the following equation can be used:

- If a cable pull with a shear was used, the effective cable mass would be reduced. The following equation does not take a shear into consideration, so that in this case there is a safety reserve.

$$m_{\text{Rop}} = \rho_{\text{Rop}} \cdot l_{\text{Rop}} \cdot 10 \cdot \pi \cdot \left(\frac{d_{\text{Rop}}}{200}\right)^2$$

[7-97] Equation 4: Mass of the entire cable

For the total moment of inertia J_{sum} of the application additionally the mass of the payload is taken into consideration. During the lifting cycle the mass of the payload can be different.

$$J_{\text{sum}} = J + \left(\frac{d}{2000}\right)^2 \cdot \frac{m_{\text{L}}}{N_{\text{L}}^2}$$

[7-98] Equation 5: Total moment of inertia

Stationary torque

The stationary torque is calculated from the difference of the masses assessed with the reeving.

$$M_{sds} = \frac{d}{2000} \cdot \left(F_{add} + g \cdot \left(\frac{m_L}{N_L} + \frac{m_{Cbn}}{N_L} - \frac{m_{Ctw}}{N_{Ctw}} + m_{acv,Rop} \right) \right)$$

[7-99] Equation 6: Stationary torque



Tip!

The mass of the cables usually can be disregarded, since the force due to weight of the cables cancels itself out in the case of a pulley block.

For some applications the cable mass in the most unfavourable position of the hoist is quite important (e. g. in the case of great lifting heights), so that it can be considered as the active cable mass $m_{acv,Rop}$.

For the drive the stationary torque, also on the pulley block, is only the mass of a simple cable, since the masses of the other cables cancel themselves out by the fixed cable rolls. The cable mass for the counterweight can be deducted.

Ascertainment of the active cable mass

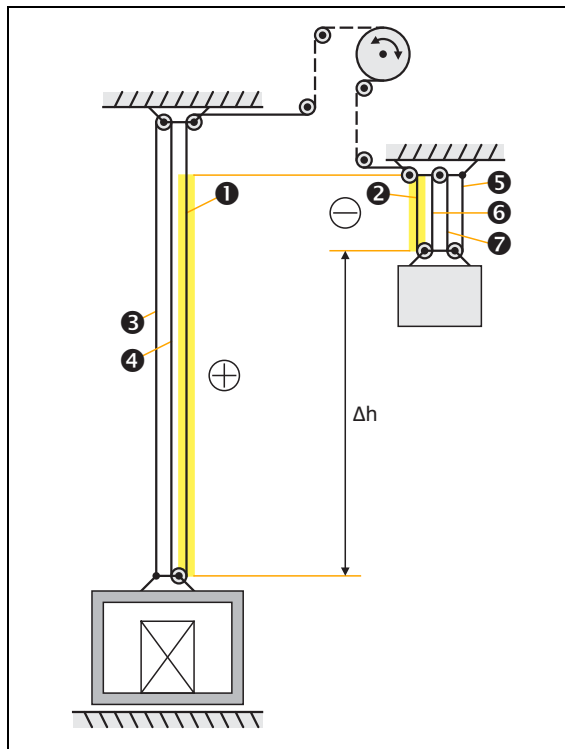
The active cable mass is ascertained by means of the mass calculator (field: cylinder) and is calculated with the following equation:

$$m_{acv,Rop} = \rho_{Rop} \cdot \Delta h \cdot 10 \cdot \pi \cdot \left(\frac{d_{Rop}}{200} \right)^2$$

[7-100] Equation 7: Active cable mass for the stationary torque

Ascertainment of the height difference

For the stationary torque the maximum height difference Δh is required.



[7-101] Determination of Δh

- The height Δh usually is the height difference from the cable end of the counterweight to the cable end of the payload at the lowest position of the payload or the counterweight.
- The yellow highlighted cable sections (1+2) are decisive for the steady-state torque.
- The cable sections (3+4, 6+7) cancel themselves out or are borne by the mounting parts 5.

Torque loss

In order to take the losses for the hoist into consideration, the friction torque is calculated from the individual efficiencies. In the case of a dimensioning process with a user-definable motion profile, the efficiency is assumed for a run with the maximum steady-state torque.

- The sign is considered with the fraction $n/|n|$.
- The friction of the cable rolls is considered as efficiency η_{PII} in a simplified manner. The efficiency depends on the number of cable rolls, the reeving, and the efficiency of the individual rolls.
- The following equation calculates the torque loss in generator and motor mode:

$$M_{th} = \left(\frac{1}{\eta_{Gdn} \cdot \eta_{PII} \cdot \eta} - 1 \right) \cdot \max(|M_{sds}|) \cdot \frac{n}{|n|}$$

[7-102] Equation 8: Torque loss

Application torque

$$M_{\text{App}} = M_{\text{sds}} + J_{\text{sum}} \cdot \alpha + M_{\text{th}}$$

[7-103] Equation 9: Torque of the application

Required speed

For the determination of the required speed n_{Cor} of the driving pulley, apart from the previously mentioned parameters the required lifting speed v has to be specified.

$$n = \frac{60}{2 \cdot \pi} \cdot \frac{v}{60} \cdot \frac{N_L \cdot 2000}{d_{\text{Cor}}}$$

[7-104] Equation 10: Speed of the driving pulley

The speed of the counterweight v_{Ctw} is calculated as follows:

$$v_{\text{Ctw}} = \frac{N_L}{N_{\text{Ctw}}} \cdot v$$

[7-105] Equation 11: Speed of the counterweight

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

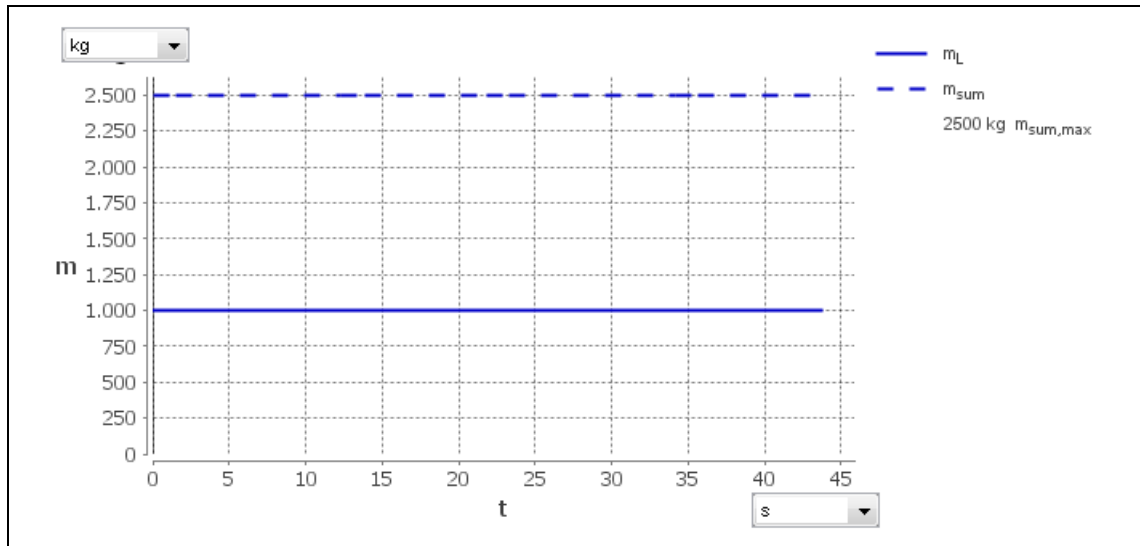
7.10.1.1 Symbols used

Symbol	Description	Dimension unit
d	Effective diameter of the traction sheave	mm
d_{Cor}	Reel diameter of the traction sheave	mm
d_{Rop}	Cable diameter	mm
F_{add}	Additional force	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
Δh	Height difference for the determination of the stationary torque	m
J_{add}	Additional moment of inertia	kgm^2
J	Stationary moment of inertia without payload mass	kgm^2
J_{sum}	Total moment of inertia with payload mass	kgm^2
N_L	Reeving of the pulley block with regard to the payload	
N_{Ctw}	Reeving of the pulley block with regard to the counterweight	
l_{Rop}	Cable length	m
m_L	Mass of the payload	kg
m_{Ctw}	Mass of counterweight	kg
m_{Cbn}	Mass of the hoisting cage for the payload	kg
m_{Rop}	Cable mass	kg
$m_{acv,Rop}$	Active cable mass for stationary torque	kg
M_{App}	Required torque of the application	Nm
M_{sds}	Stationary torque	Nm
M_{th}	Torque loss	Nm
n	Speed of the driving pulley	rpm
v	Speed of the payload/hoisting cage	m/min
v_{Ctw}	Speed of the counterweight	m/min
α	Angular acceleration of the driving pulley	rad/s^2
η_{Gdn}	Shaft efficiency	
η_{PII}	Efficiency of the cable rolls	
η	Efficiency of the driving pulley	
ρ_{Rop}	Specific cable weight	kg/dm^3

7.10.2 Mass in motion

Only the mass on the load side is referred to as "mass in motion". The mass of counterweight m_{ctw} is not taken into consideration.

- The mass in motion is the sum of the m_{cbn} hoisting cage mass and the m_{L} payload mass.



[7-106] Application diagram: Mass in motion

Description	
m_{L}	Mass of the payload
m_{sum}	Mass in motion

7.10.3 Data for the entry

7.10.3.1 Diameter of traction sheave

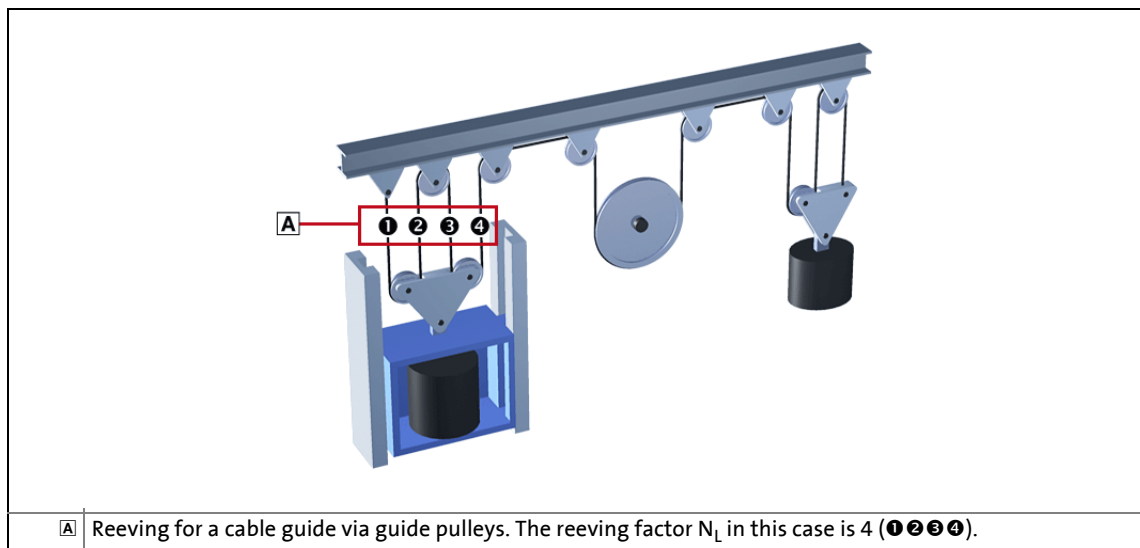
Parameter	Description
d_{Cor}	Diameter of traction sheave

7.10.3.2 Reeving, load

Parameter	Description
N_L	The reeving of the cable to the payload. The reeving is the ratio of the cable velocity of the winding drum to the lifting speed of the payload.

For cable-guided hoists both single- and multi-cable guides via guide pulleys, so-called reevings (pulley block principle) are used. In the case of multi-cable guides the circumferential speed of the driving pulley is an integer multiple of the lifting speed. The required torque at the driving pulley is decreased by the reeving factor k_L , and the speed increases by this factor.-

The reeving has no impact on the drive power (except for highly dynamic movements).

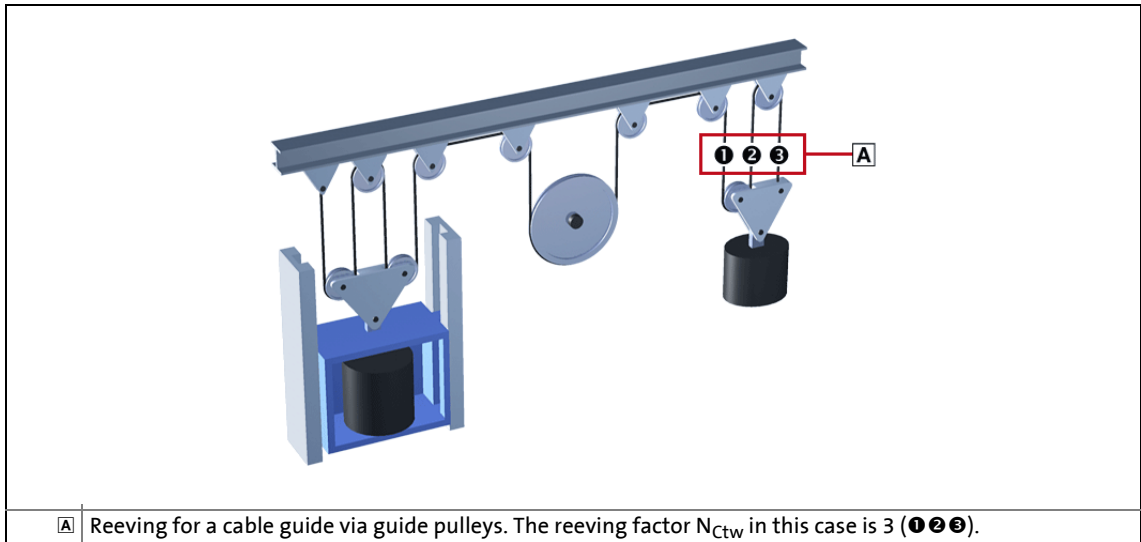


[7-107] Reeving of the load

7.10.3.3 Reeving, counterweight

Parameter	Description
N_{Ctw}	The reeving of the cable to the counterweight. The reeving is the ratio of the driving pulley cable velocity to the lifting speed of the counterweight.

For cable-guided hoists, also with counterweight, both single- and multi-cable guides via guide pulleys, so-called reevings (pulley block principle) are used.



[7-108] Reeving of counterweight

7.10.3.4 Mass of counterweight

Parameter	Description
m_{Ctw}	Mass of counterweight Value can be entered directly or calculated using the auxiliary calculator. "Mass of counterweight (hoist drive)" calculator (478)

7.10.3.5 Mass of hoisting cage

Parameter	Description
m_{Cbn}	Mass of the hoisting cage or conveying tools for the payload Value can be entered directly or calculated using the mass calculator. Mass calculator (470)

7.10.3.6 Additional moment of inertia

Parameter	Description
J_{add}	Moment of inertia of the driving pulley, the guide pulleys and guide rollers, etc. • The moment of inertia of the hoisting cage does not have to be taken into consideration here since it is already included. • The moment of inertia has an effect on the dynamic torque! • Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.10.3.7 Cable diameter

Parameter	Description
d_{Rop}	Outside diameter of cable

7.10.3.8 Cable mass

Parameter	Description
m_{Rop}	Mass of cable • Value can be entered directly or calculated using the auxiliary calculator.  "Mass of rope/cable (hoist drive)" calculator (📖 479)

7.10.3.9 Active cable mass

Parameter	Description
$m_{acv,Rop}$	Active mass of cable • Is the mass that is relevant for the stationary moment, i.e. the mass that acts as a weight on the cable drum. • Value can be entered directly or calculated using the auxiliary calculator.  "Mass of rope/cable (hoist drive)" calculator (📖 479)

7.10.3.10 Shaft efficiency

Parameter	Description
η_{Gdn}	Efficiency resulting from the friction of the hoisting cage at the hoisting shaft

7.10.3.11 Efficiency of the rolls

Parameter	Description
η_{pII}	Efficiency resulting from friction between cable pulleys and cable

7.10.3.12 Efficiency of the driving pulley

Parameter	Description
η	Efficiency limited by friction between traction sheave and cable

7.10.3.13 Lifting speed

Parameter	Description
v	Lifting speed of the load. • Value is entered in the <i>Motion</i> dimensioning step.

7.10.3.14 Mass of payload

Parameter	Description
m _L	Mass of payload • Value is entered in the <i>Motion</i> dimensioning step.

7.11 Chain conveyor

In case of the chain conveyor, the load (unit loads, pallets, boxes) is transported via a transport chain. The chain slides or rolls (in case of a roller chain) on a surface in the upper strand. The connection between the drive sprocket and the transport chain is form-fit. For the transport of unit loads drag bar feeders are often used. They are predominantly used for the transport, sorting and distribution of unit loads with defined charge carriers, as for instance pallets or boxes.

The material to be conveyed has to be dimensionally stable with a plane installation surface or plane charge carriers. The drive technology used and the installation in the conveyors can be compared to that of the belt or roller conveyors. Depending on the design, bevel geared motors, helical-bevel geared motors, and helical geared motors are used.

In addition to the sliding friction, a static friction is usually generated during start-up. The static friction is only effective over a short distance and then changes over to sliding friction or rolling friction. The amount of the static friction depends on the type of chain, chain voltage and chain guide on the support in the upper strand (sliding, rolling, or a combination of both). Ageing and pollution can increase static friction and sliding friction.

Measurements on four-station palletizers with roller chains produced static friction torques of up to 250 % of the steady-state sliding friction torques. From the measurements, sliding friction coefficients of 0.08/0.13 (new/old chain) were determined.

In the default setting, the dimensioning step *application data* defines a **coefficient of friction - chain/support** of 0.2. This already includes a static friction.

The value of 0.2 can usually be reduced in case of chain conveyors with roller chains, e.g. to 0.15. As the coefficient of friction has a big influence on a tailor-made drive dimensioning, the value has to be adjusted with the customer.

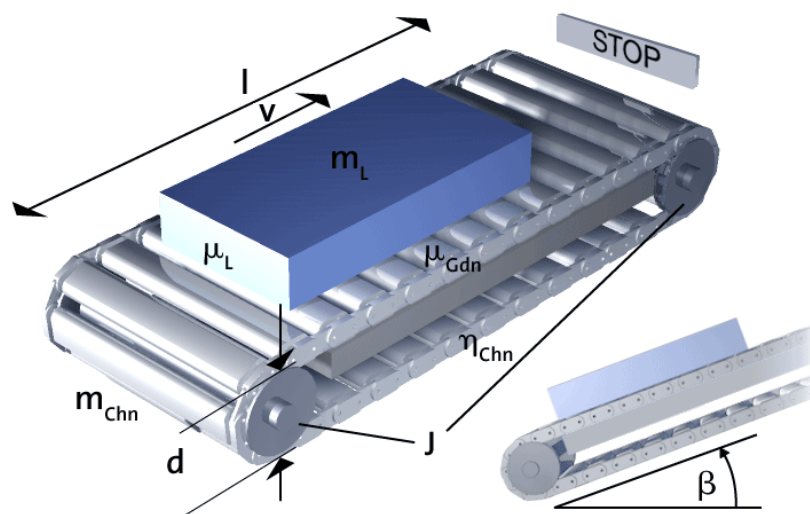
As there are many different mechanical active principles of chain conveyors, we recommend an empirical determination of the coefficient of friction during commissioning.

Measures in case of high friction

- Adapt the value **coefficient of friction - chain/support** to the application type.
- In order to overcome the static friction, select a control type with high starting torque, e.g. SLVC (sensorless vector control) or SC (servo control with encoder).
 - VFC operating modes develop a lower starting torque compared to SLVC and SC. The use has to be checked in individual cases.
 - Lenze inverters can usually overcome the static friction due to dynamic current reserves.
- In case of an extremely high static friction, select larger dimensions for the inverter.

Measures in case of oscillating torque and speed

In case of long chains, torques and speeds may oscillate due to the chain elasticity. The oscillation can be reduced by jerk-free motion profiles.



7.11.1 Calculations

For a chain conveyor according to the drawing the following applies:

Conversion of translatory variables into rotary variables

$$\varphi = \frac{2000 \cdot s}{d}$$

[7-109] Equation 1: Angle

$$\omega = \frac{2000 \cdot v}{d}$$

[7-110] Equation 2: Angular velocity

$$\alpha = \frac{2000 \cdot a}{d}$$

[7-111] Equation 3: Angular acceleration on the load side

Total moment of inertia

$$J_{\text{sum}} = \left(\frac{d}{2}\right)^2 \cdot (m_{\text{Chn}} + m_L(t)) + J$$

[7-112] Equation 4: Total moment of inertia

Stationary torque

The stationary part of the torque consists of different individual forces:

$$M_{sds} = (F_{\mu} + F_{pln} + F_{add}) \cdot \frac{1}{2} \cdot d$$

[7-113] Equation 5: Stationary torque

$$F_{\mu} = \left(m_L + \frac{m_{chn}}{2} \right) \cdot g \cdot \mu_{Gdn} \cdot \cos \beta \cdot \frac{v}{|v|} + F_{vs}$$

[7-114] Equation 6: Friction force

$$F_{pln} = m_L \cdot g \cdot \sin \beta$$

[7-115] Equation 7: Downhill-slope force

If the transported material drives against a limit stop (e. g. adjustment of the material), the force F_{add} is generated:

$$F_{add} = m_{add} \cdot g \cdot \frac{\sin(\rho - \beta)}{\cos \rho} \cdot \frac{v}{|v|} \quad \rho = \arctan \mu_L$$

[7-116] Equation 8: Additional force

The mass of the transport chain is calculated by the line load:

$$m_{chn} = m'_{chn} \cdot l_{chn}$$

[7-117] Equation 9: Mass of the transport chain

Required torque of the application (without losses)

In order to take the efficiency of the application by the transmission of the movement via chains into consideration, first the required torque of the application (M_{App}) has to be determined.

$$M_{App} = M_{sds} + J_{sum} \cdot \alpha$$

[7-118] Equation 10: Required torque of the application (without losses)

Required torque of the application (with losses)

Provided that the friction torque of the application is proportional to the transmitting torque, the torque of the application can be calculated with the following equation:

$$M_{th,App} = \left(\frac{1}{\eta_{chn}} - 1 \right) \cdot \frac{\omega}{|\omega|} \cdot |M_{App}| + M_{App}$$

[7-119] Equation 11: Required torque of the application (with losses)

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.11.1.1 Symbols used

Symbol	Description	Dimension unit
a	Acceleration (translatory)	m/s^2
d	Diameter of the drive roll	mm
F_{μ}	Friction force	N
F_{pln}	Downhill-slope force	N
F_{add}	Additional force (e. g. backing force)	N
F_{vs}	Counterforce	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J	Moment of inertia of driving roller	kgm^2
J_{sum}	Total moment of inertia	kgm^2
l	Conveying length	m
m_L	Mass of the payload	kg
m'_L	Mass of the line load	kg/m
m_{Chn}	Mass of the transport chain	kg
m_{add}	Additional mass (e. g. by deflectors)	kg
M_{App}	Required torque of the application (without losses)	Nm
$M_{\text{th,App}}$	Required torque of the application (with losses)	Nm
M_{sds}	Stationary torque	Nm
s	Path (translatory)	m
v	Speed (translatory)	m/s
α	Angular acceleration	rad/s^2
β	Angle of tilt	°
η_{Chn}	Chain efficiency	
φ	Angle	rad
μ_{Gdn}	Coefficient of friction of the chain to the supporting surface	
μ_L	Coefficient of friction of the load to the chain	
ω	Angular velocity	rad/s

7.11.2 Data for the entry

7.11.2.1 Diameter of the drive roll

Parameter	Description
d	Outside diameter of drive roll

7.11.2.2 Mass of the chain

Parameter	Description
m_{Chn}	Mass of transport chain Value can be entered directly or calculated by the uniform load and conveying length.  "Uniform load mass (material handling technology)" calculator (📘 480)

7.11.2.3 Coefficient of friction of chain/supporting surface

Parameter	Description
μ_{Gdn}	Coefficient of friction between transport chain and supporting surface Value can be entered directly or selected from the "Physical coefficients" table.  Physical coefficients (📘 488)  Coefficient of friction for rolls

7.11.2.4 Chain efficiency

Parameter	Description
η_{Chn}	Efficiency of the transport chain $\eta_{\text{Chn}} = 0.90 - 0.96$ (depending on the chain size)

7.11.2.5 Moment of inertia of driving roller

Parameter	Description
J	Moment of inertia of the drive roll and all rolls that may be available - Has an impact on the dynamic torque! - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📘 472)

7.11.2.6 Additional force

Parameter	Description
F_{add}	The additional force results from backing forces, lateral friction, deflectors, etc. The backing force can be calculated using the auxiliary calculator.  "Backing force (material handling technology)" calculator (📘 483)

7.11.2.7 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) The value can be entered in degrees or as a percentage.

Application with a slope (slide)

For the angle of tilt, only a positive value (slope) can be entered. However, you can dimension an application with a slope by specifying a negative speed. If the application is moving on a slope with a negative speed, it goes backwards.

Procedure:

- Enter the value of the slope into the **Angle of tilt** input field.
- Enter the value with a negative sign into the **Speed** input field.

7.11.2.8 Speed

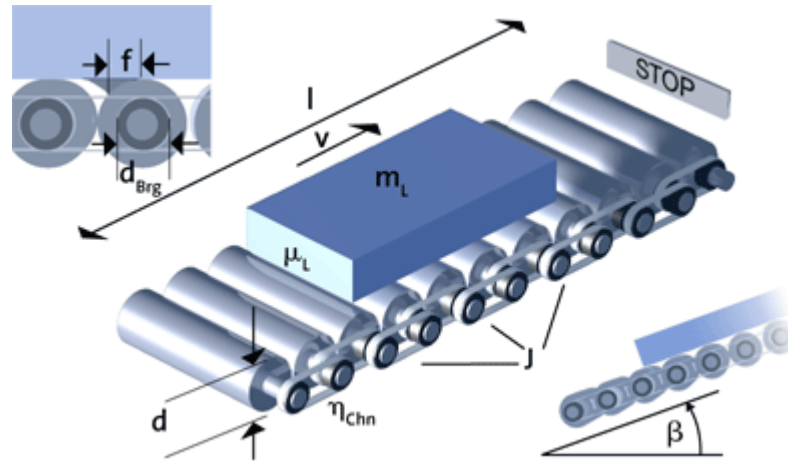
Parameter	Description
v	Speed of the transport chain Value is entered in the <i>Motion</i> dimensioning step.

7.11.2.9 Mass of the payload

Parameter	Description
m_L	Mass of payload Value is entered in the <i>Motion</i> dimensioning step.

7.12 Roller conveyor

Roller conveyors are multi-purpose conveyors for the transport of small unit loads like for example tanks, cardboard boxes, boxes and packages, and greater material to be conveyed, e. g. pallets and containers. They are suitable for transport, buffering (accumulating roller conveyors), and in connection with supplementary devices for the distribution of piece goods. The load is transported by means of transport rolls, which are interconnected by a chain, belt, or strap. Like belt conveyors, roller conveyors can be designed with an end drive or centre drive in the form of a geared motor. Alternatively there is the possibility of directly actuating individual rolls via a tubular roller motor, in the case of which the motor is directly integrated within the roll.



7.12.1 Calculations

For a roller conveyor according to the drawing the following applies:

Conversion of translatory variables into rotary variables

$$\varphi = \frac{2000 \cdot s}{d}$$

[7-120] Equation 1: Angle

$$\omega = \frac{2000 \cdot v}{d}$$

[7-121] Equation 2: Angular velocity

$$\alpha = \frac{2000 \cdot a}{d}$$

[7-122] Equation 3: Angular acceleration

Total moment of inertia

$$J_{\text{sum}} = m_L \cdot \left(\frac{d}{2}\right)^2 + J$$

[7-123] Equation 4: Total moment of inertia

Stationary torque

The stationary part of the torque consists of different individual forces:

$$M_{sds} = (F_{\mu} + F_{pln} + F_{add}) \cdot \frac{d}{2}$$

[7-124] Equation 5: Stationary torque

Friction force

In relation to the payload, the mass of the rollers is largely low. Its share in the friction force can usually be neglected and is therefore not taken into consideration in the DSD. If, in individual cases, the mass of the rollers constitutes a significant proportion in relation to the payload, a manual calculation is to be added to the drive dimensioning as correction.

$$F_{\mu} = \frac{m_L \cdot g \cdot \cos \beta}{d} \cdot (2f + d_{Brg} \cdot \mu_{Brg}) \cdot \frac{\omega}{|\omega|}$$

[7-125] Equation 6: Friction force

Downhill-slope force

$$F_{pln} = m_L \cdot g \cdot \sin \beta$$

[7-126] Equation 7: Downhill-slope force

Additional force (e. g. backing force)

If the transported material drives against a limit stop (e. g. for adjustment, the force F_{add} is generated.

If the mass of the rollers has to be considered as the mass of the material to be conveyed is relatively small, the resulting friction force can be entered as additional force F_{add} .

$$F_{add} = m_{add} \cdot g \cdot \cos \beta \cdot \mu_L \cdot \frac{v}{|v|}$$

[7-127] Equation 8: Additional force

Mass of payload

The mass of the payload is calculated by the line load:

$$m_L = m'_L \cdot l$$

[7-128] Equation 9: Mass of the payload

Required torque of the application (without losses)

In order to take the efficiency of the application by the transmission of the movement via chains into consideration, first the required torque of the application has to be determined:

$$M_{App} = M_{sds} + J_{sum} \cdot \alpha$$

[7-129] Equation 10: Required torque of the application (without losses)

Required torque of the application (with losses)

Provided that the friction torque of the application is proportional to the transmitting torque, the required torque of the application can be calculated with the following equation:

$$M_{th,App} = M_{App} + |M_{App}| \cdot \frac{\omega}{|\omega|} \cdot \left(\frac{1}{\eta_{sum}} - 1 \right)$$

[7-130] Equation 11: Required torque of the application (with losses)

$$\eta_{sum} = \eta_{Chn}^n$$

[7-131] Equation 11: Total chain efficiency

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.12.1.1 Symbols used

Symbol	Description	Dimension unit
d	Diameter of the transport rolls	mm
d_{Brg}	Diameter of the bearings	mm
f	Lever arm of the rolling friction	mm
F_{μ}	Friction force	N
F_{pln}	Downhill-slope force	N
F_{add}	Additional force (e. g. backing force)	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J	Moment of inertia of transport rollers	kgm^2
J_{sum}	Total moment of inertia	kgm^2
l	Conveying length	m
m_L	Mass of the payload	kg
m'_L	Mass of the line load	kg/m
m_{add}	Additional mass (e. g. by deflectors)	kg
M_{App}	Required torque of the application (without losses)	Nm
$M_{th,App}$	Required torque of the application (with losses)	Nm
M_{sds}	Stationary torque	Nm
s	Path (translatory)	m
v	Speed (translatory)	m/s
ω	Angular velocity (rotatory)	rad/s
a	Acceleration (translatory)	m/s^2
α	Angular acceleration (rotatory)	rad/s^2
β	Angle of tilt	°
η_{sum}	Total chain efficiency	
η_{chn}	Efficiency of one chain	
φ	Angle	rad
μ_L	Coefficient of friction of the load/roll	
μ_{Brg}	Coefficient of friction of the bearing	

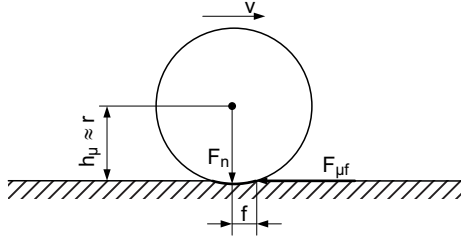
7.12.2 Data for the entry

7.12.2.1 Diameter of the transport rolls

Parameter	Description
d	Outside diameter of feed rolls

7.12.2.2 Leverage of rolling friction

Parameter	Description
f	The lever arm of the rolling friction serves to calculate the friction force. Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (488)  Lever arm of the rolling friction

	
f	Lever arm of the rolling friction
$F_{\mu f}$	Rolling friction (absolute value)
F_n	Pinch pressure of rollers
v	Speed

[7-132] Principle of the rolling friction

7.12.2.3 Chain efficiency

Parameter	Description
η_{Chn}	Values for the efficiency η_{Chn} per complete wrap: Chain = 0.90 - 0.96 (depending on the chain size) Toothed belt = 0.96 - 0.98 (depending on the material) Flat belt = 0.93 - 0.98 (depending on the material) V-belt = 0.88 - 0.95 Rubber strap = 0.80 - 0.85 Non-metallic strap = 0.80 - 0.85 Wire rope = 0.90 - 0.95



Note!

When the power is transmitted from the drive to the transport rollers, the efficiency η_{Chn} of the chain is reduced with every chain wrap.

- The efficiency η_{Chn} exponentiates with the number of chain wraps N_{Chn} .
- Position the drive centrally if necessary to distribute the power transmission to two paths. That way, the number of chain wraps per path is also reduced.
- Realistic values must be assumed for the efficiency η_{Chn} .

7.12.2.4 Bearing diameter

Parameter	Description
d_{Brg}	The diameter for calculating the bearing friction.

7.12.2.5 Moment of inertia of transport rollers

Parameter	Description
J	Moment of inertia of the transport rolls, shafts, etc. - Has an impact on the dynamic torque! - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.12.2.6 Number of wrapped chain turns

Parameter	Description
N_{Chn}	Number of chain wraps which distribute the torque to the single rolls. For calculation, the most unfavourable efficiency is assumed (load is applied to the last driven roll).



Note!

When the power is transmitted from the drive to the transport rollers, the efficiency η_{Chn} of the chain is reduced with every chain wrap.

- The efficiency η_{Chn} exponentiates with the number of chain wraps N_{Chn} .
- Position the drive centrally if necessary to distribute the power transmission to two paths. That way, the number of chain wraps per path is also reduced.
- Realistic values must be assumed for the efficiency η_{Chn} .

7.12.2.7 Additional force

Parameter	Description
F_{add}	The additional force results from backing forces, lateral friction, deflectors, etc. The backing force can be calculated using the auxiliary calculator.  "Backing force (material handling technology)" calculator (📖 483)



Note!

If the mass of the rollers has to be considered as the mass of the material to be conveyed is relatively small, the resulting friction force can be entered as additional force F_{add} .

► [Additional force \(e. g. backing force\)](#)

7.12.2.8 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) • The value can be entered in degrees or as a percentage. • The max. angle of tilt as a first approximation is: $\arctan(\mu_L)$ (static friction between load and roll).

Application with a slope (slide)

For the angle of tilt, only a positive value (slope) can be entered. However, you can dimension an application with a slope by specifying a negative speed. If the application is moving on a slope with a negative speed, it goes backwards.

Procedure:

- Enter the value of the slope into the **Angle of tilt** input field.
- Enter the value with a negative sign into the **Speed** input field.

7.12.2.9 Coefficient of friction of the bearing

Parameter	Description
μ_{Brg}	Coefficient of friction for the bearing friction • Value can be entered directly or selected from the "Physical coefficients" table. ▶ Physical coefficients (488)
	 Bearing and leadscrew friction

7.12.2.10 Speed

Parameter	Description
v	Speed of the goods to be conveyed • Value is entered in the <i>Motion</i> dimensioning step.

7.12.2.11 Mass of the payload

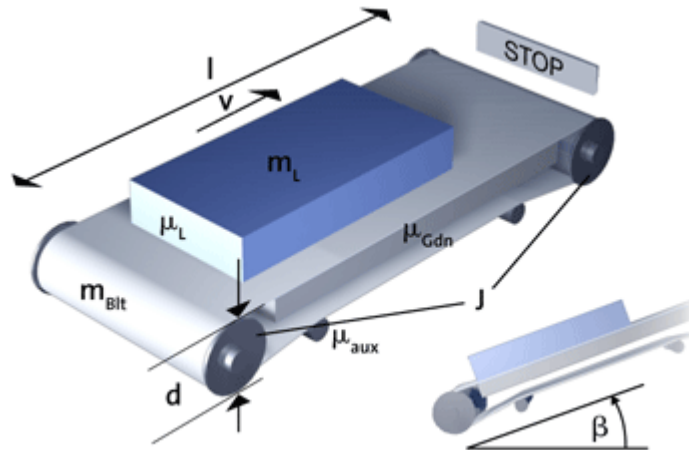
Parameter	Description
m_L	Mass of payload • Value is entered in the <i>Motion</i> dimensioning step.

7.13 Belt conveyor, unit load

A belt conveyor for unit loads transports the material to be conveyed (e. g. boxes, pallets) by means of a transport belt. Because of the smooth surface it is suitable for different sizes of unit loads and unstable packaged goods. Basic features are the smooth and noiseless running and the careful transport of goods. Depending on the material to be conveyed, belt conveyors can usually be used for slopes of up to 20°, in individual cases and with specific designs even for slopes up to 60°.

In the upper strand the conveying belt slides on a surface, in the lower strand it can be guided by rolls. In the lower strand usually also the belt is tightened by means of a clamping device or clamping unit in the form of guide pulleys that can be shifted. The power transmission between the belt and drive roll is effected by means of adhesion.

With regard to the mounting position of the drive, end drives (position at the end, below the belt, or at the side next to the belt) and centre drives (position in the centre, below the belt) are differentiated. In the case of the end drive that is located at the side usually a bevel gearbox or helical-bevel gearbox is used. The output shaft of the gearbox directly actuates the drive roll. In the case of the end drive that is located below the belt predominantly helical gearboxes are used and the drive roll is actuated by means of belts.



7.13.1 Calculations

For a belt conveyor for unit loads according to the drawing the following applies:

Total moment of inertia

$$J_{\text{sum}} = (m_{\text{aux}} + m_{\text{Blt}}) \cdot \left(\frac{d}{2}\right)^2 + J_{\text{aux}}$$

[7-133] Equation 1: Total moment of inertia

Stationary torque

The stationary part of the torque consists of different individual forces:

$$M_{sds} = (F_{\mu} + F_{pln} + F_{add} + F_{aux}) \cdot \frac{d}{2}$$

[7-134] Equation 2: Stationary torque

$$F_{\mu} = \left(m_L + \frac{m_{Blt}}{2}\right) \cdot g \cdot \mu_{Cdn} \cdot \cos \beta \cdot \frac{v}{|v|}$$

[7-135] Equation 3: Friction force

$$F_{pln} = m_L \cdot g \cdot \sin \beta$$

[7-136] Equation 4: Lifting force

If the transported material drives against a limit stop (e. g. adjustment of the material), the force F_{add} is generated:

$$F_{add} = m_{add} \cdot g \cdot \frac{\sin(\rho - \beta)}{\cos \rho} \cdot \frac{v}{|v|} \quad \rho = \arctan \mu_L$$

[7-137] Equation 5: Additional force

The friction of the rolls is taken into consideration by the friction force F_{aux} :

$$F_{aux} = \left(m_{aux} + \frac{m_{Blt}}{2}\right) \cdot g \cdot \mu_{aux} \cdot \frac{v}{|v|}$$

[7-138] Equation 6: Friction force by run via rolls

The mass of the payload is calculated by the line load:

$$m_L = m'_L \cdot l$$

[7-139] Equation 7: Mass of the payload

Required torque of the application (without losses)

$$M_{App} = M_{sds} + J_{sum} \cdot \alpha$$

[7-140] Equation 8: Required torque of the application (without losses)

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.13.1.1 Symbols used

Symbol	Description	Dimension unit
d	Diameter of the drive roll	mm
F_{μ}	Friction force	N
F_{pln}	Downhill-slope force	N
F_{add}	Additional force (e. g. backing force)	N
F_{aux}	Friction force by supporting rolls	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J	Moment of inertia of driving roller	kgm^2
J_{aux}	Moment of inertia of supporting rollers	kgm^2
J_{sum}	Total moment of inertia	kgm^2
l	Conveying length	m
m_L	Mass of the payload	kg
m'_L	Mass of the line load	kg/m
m_{Blt}	Mass of the belt	kg
m_{aux}	Total mass of the supporting rolls	kg
m_{add}	Additional mass (e. g. by deflectors)	kg
M_{App}	Required torque of the application (without losses)	Nm
M_{sds}	Stationary torque	Nm
v	Material speed	m/s
α	Angular acceleration	rad/s^2
β	Angle of tilt	°
μ_{Gdn}	Coefficient of friction of belt/supporting surface	
μ_{aux}	Coefficient of friction belt/supporting rollers	
μ_L	Coefficient of friction of load/belt	

7.13.2 Data for the entry

7.13.2.1 Diameter of the drive roll

Parameter	Description
d	Outside diameter of drive roll

7.13.2.2 Mass of the belt

Parameter	Description
m_{Blt}	Mass of belt Value can be entered directly or calculated by the uniform load and conveying length.  "Uniform load mass (material handling technology)" calculator (480)

7.13.2.3 Mass of supporting rollers

Parameter	Description
m_{aux}	Total mass of supporting rolls • If $\mu_{aux} = 0$, the friction by the supporting rolls is disregarded, a value for the mass then does not have to be entered. • Value can be entered directly or calculated using the mass calculator.  Mass calculator (📖 470)



Note!

The mass of the supporting rolls is used for calculating the friction forces.

7.13.2.4 Moment of inertia of rollers

Parameter	Description
J_{sum}	Moment of inertia of the drive roll and all supporting rolls. • Has an impact on the dynamic torque! • Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)



Note!

When calculating the mass inertia, bear in mind that the supporting rolls and the drive roll can have different diameters!

7.13.2.5 Additional force

Parameter	Description
F_{add}	The additional force results from backing forces, lateral friction, deflectors, etc. • The backing force can be calculated using the auxiliary calculator.  "Backing force (material handling technology)" calculator (📖 483)

7.13.2.6 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) - The value can be entered in degrees or as a percentage. - The max. angle of tilt as a first approximation is: $\arctan(\mu_L)$ (static friction between load and belt). $\beta \geq$

Application with a slope (slide)

For the angle of tilt, only a positive value (slope) can be entered. However, you can dimension an application with a slope by specifying a negative speed. If the application is moving on a slope with a negative speed, it goes backwards.

Procedure:

- Enter the value of the slope into the **Angle of tilt** input field.
- Enter the value with a negative sign into the **Speed** input field.

7.13.2.7 Coefficient of friction belt/supporting surface

Parameter	Description
μ_{Gdn}	Coefficient of friction between the belt and the supporting surface Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (488)
	 Coefficient of friction for rolls

7.13.2.8 Coefficient of friction belt/supporting rollers

Parameter	Description
μ_{aux}	Coefficient of friction between the supporting rolls and the belt - If $\mu_{aux} = 0$, the friction by the supporting rolls is disregarded. - Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (488)
	 Coefficient of friction for rolls

7.13.2.9 Speed

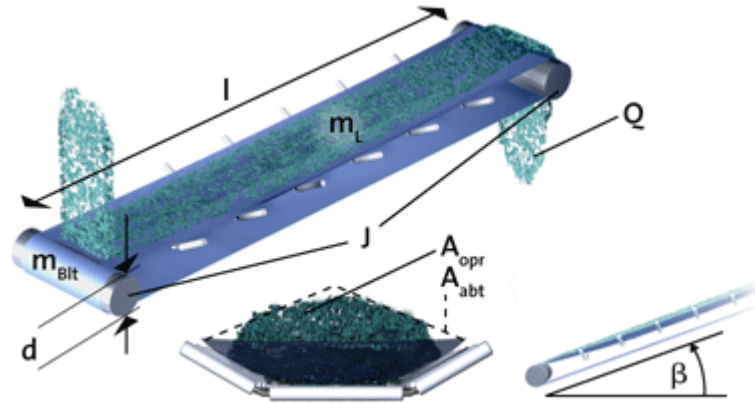
Parameter	Description
v	Speed of the belt Value is entered in the <i>Motion</i> dimensioning step.

7.13.2.10 Mass of the payload

Parameter	Description
m_L	Mass of payload Value is entered in the <i>Motion</i> dimensioning step.

7.14 Belt conveyor, bulk material

The belt conveyor for bulk material transports the material to be conveyed by means of rotating conveyor belts with tension carriers of a fabric or steel cable reinforcement and a rubber or plastic cover. The conveyor belts are supported by idlers and are actuated or decelerated via drums by means of friction. These conveyors are often designed as trough conveyors or pipe conveyors.



7.14.1 Calculations

For a belt conveyor for bulk material according to the drawing the following applies:

Total moment of inertia

$$J_{\text{sum}} = (m_L + m_{\text{Blt}}) \cdot \left(\frac{d}{2}\right)^2 + J + J_{\text{aux}}$$

[7-141] Equation 1: Total moment of inertia

Stationary torque

The stationary part of the torque consists of different individual forces:

$$M_{\text{ds}} = (F_{\text{opr}} + F_{\text{pln}} + F_{\text{add}}) \cdot \frac{d}{2}$$

[7-142] Equation 2: Stationary torque

The conveying force is calculated by the line loads, the conveying length, and the filling factor f (the coefficient is a fictitious value):

$$F_{\text{opr}} = l \cdot f_{\text{Blt}} \cdot g \cdot \left(m'_{\text{aux}} + (2 \cdot m'_{\text{Blt}} + m'_L) \cdot \cos \beta \cdot \frac{v}{|v|} \right)$$

[7-143] Equation 3: Conveying force

$$m'_L = \frac{m_L}{l} \quad m_L = \frac{Q}{v \cdot 3600 \frac{\%}{h}} \cdot l$$

[7-144] Equation 4: Line load of the payload

$$m'_{\text{Blt}} = \frac{m_{\text{Blt}}}{l}$$

[7-145] Equation 5: Line load of the belt

$$m'_{\text{aux}} = \frac{m_{\text{aux}}}{l}$$

[7-146] Equation 6: Line load of the rolls

Fill level coefficient

The coefficient f_{Blt} of the filling degree is of major importance for the size of the main resistor. The impact of the value is the greater the lower the grade resistances of the conveyor are.

The effort of always being on the safe side when carrying out the dimensioning process, together with the inaccurate description of the operational characteristics and the large span for the coefficient (see the following table) produces the possibility of considerable overdimensioning.

In order to prevent this overdimensioning, a more precise determination of the coefficient is necessary.

- The coefficient of the filling degree is basically defined by the resistance to rolling of the carrying rollers and the indentation rolling resistance.
- If the belt is very slack, the flexing resistance of the material to be conveyed also represents a great part of the filling factor.

The coefficient f_{Blt} applies to the filling degrees of the belt in the range from $\varphi = 0.7 \dots 1.1$:	
Systems that are horizontally inclined and that only slightly convey downwards (operation in motor mode)	
Advantageous operating conditions • For instance good adjustment, smooth running idlers, and a low internal friction of the material to be conveyed, low speeds.	0.017
Conventionally designed and operated systems (according to standard)	0.020
Disadvantageous operating conditions • For instance dusty operation, low temperatures, material to be conveyed has high internal friction, overload, high speeds.	0.023 ... 0.027
In the case of extremely low temperatures and, apart from that, conventionally designed and operated systems	0.027 ... 0.035
Systems with a strong inclination to convey downwards (operation in generator mode) • A smaller value f in this case results in a greater reliability during dimensioning. • For operation in motor mode this is achieved by a greater value f .	0.012 ... 0.016

The filling degree is the ratio of the actual to the theoretically filled surface of the belt:

$$\varphi = \frac{A_{opr}}{A_{abt}}$$

[7-147] Equation 7: Filling degree

$$F_{pln} = m_L \cdot g \cdot \sin\beta$$

[7-148] Equation 8: Downhill-slope force

The additional force takes the frictional resistance and inertial resistance occurring in different positions of the belt conveyor into consideration:

$$F_{add} = (C - 1) \cdot F_{opr}$$

[7-149] Equation 9: Additional force

- The additional force (F_{add}) results from:
 - The inertial and frictional resistance between the material to be conveyed and the belt at the feeding position
 - Frictional resistance between the material to be conveyed and lateral chutes
 - Frictional resistance by the belt cleaner
 - Flexural resistance of the belt

Shunt-force factor C

The coefficients f apply to filling degrees of the belt in the range of $\varphi = 0.7 \dots 1.1$:

l [m]	80	100	150	200	300	400	500	600	700	800	900	1000	1500	> 2000
C	1.92	1.78	1.58	1.45	1.31	1.25	1.20	1.17	1.14	1.12	1.10	1.09	1.06	1.05

Required torque of the application

$$M_{App} = M_{sds} + J_{sum} \cdot \alpha$$

[7-150] Equation 10: Torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.14.1.1 Symbols used

Symbol	Description	Dimension unit
A_{opr}	Filling cross-section of the belt	M^2
A_{abt}	Theoretical filling cross-section of the belt	M^2
C	Shunt-force factor	
d	Diameter of the drive roll	mm
F_{add}	Additional force	N
f_{Blt}	Filling factor	
F_{opr}	Conveying force	N
F_{pln}	Downhill-slope force	N
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
J	Moment of inertia of driving roller	kgm^2
J_{aux}	Moment of inertia of supporting rollers	kgm^2
J_{sum}	Total moment of inertia	kgm^2
l	Conveying length	m
m_L	Mass of payload	kg
m'_L	Line load of the payload	kg/m
m_{Blt}	Mass of the belt	kg
m'_{Blt}	Line load of the belt	kg/m
m_{aux}	Mass of the supporting rolls	kg
m'_{aux}	Line load of the supporting rolls	kg/m
M_{App}	Required torque of the application	Nm
M_{sds}	Stationary torque	Nm
Q	Delivery rate	kg/h
v	Speed of the belt	m/s
α	Angular acceleration	rad/s^2
β	Angle of tilt	°

7.14.2 Data for the entry

7.14.2.1 Diameter of the drive roll

Parameter	Description
d	Outside diameter of drive roll

7.14.2.2 Length of conveyor line

Parameter	Description
l	Total conveying length

7.14.2.3 Mass of the payload

Parameter	Description
m_L	Mass of payload Value can be entered directly or calculated by the uniform load and conveying length.  "Uniform load mass (material handling technology)" calculator (480)

7.14.2.4 Mass of the belt

Parameter	Description
m_{Blt}	Mass of belt Value can be entered directly or calculated by the uniform load and conveying length.  "Uniform load mass (material handling technology)" calculator (480)

7.14.2.5 Angle of tilt

Parameter	Description
β	Angle of tilt (gradient) - The value can be entered in degrees or as a percentage. - The max. angle of tilt as a first approximation is: $\beta \approx \arctan(\mu)$ (static friction between load and surface).

Application with a slope (slide)

For the angle of tilt, only a positive value (slope) can be entered. However, you can dimension an application with a slope by specifying a negative speed. If the application is moving on a slope with a negative speed, it goes backwards.

Procedure:

- Enter the value of the slope into the **Angle of tilt** input field.
- Enter the value with a negative sign into the **Speed** input field.

7.14.2.6 Fill level coefficient

Parameter	Description
f_{Blt}	Filling factor - The guide value applies to filling degree of the belt from 0.7 ... 1.1. - Value can be entered directly or selected from the "Physical coefficients" table. Fill level coefficient (152) Physical coefficients (488)

 **Filling factor for belt conveyors**

7.14.2.7 Shunt-force coefficient

Parameter	Description
C	Shunt-force factor - The sum of all the peripheral resistances, such as belt bending resistance, friction resistance from chutes, belt cleaners etc. is taken into consideration in this factor. - Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (📖 488)  Shunt-force factor C

7.14.2.8 Mass of supporting rollers

Parameter	Description
m_{aux}	Total mass of supporting rolls - If $\mu_{aux} = 0$, the friction by the guide pulleys and guide rollers is disregarded, a value for the mass then does not have to be entered. - Value can be entered directly or calculated using the mass calculator.  Mass calculator (📖 470)



Note!

The mass of the supporting rolls is used for calculating the friction forces.

7.14.2.9 Moment of inertia of driving roller

Parameter	Description
J	Moment of inertia of the drive roll Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)



Note!

When calculating the mass inertia, bear in mind that the supporting rolls and the drive roll can have different diameters!

► [Moment of inertia of supporting rollers](#) (📖 157)

7.14.2.10 Moment of inertia of supporting rollers

Parameter	Description
J_{aux}	Moment of inertia of the supporting rolls Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)



Note!

When calculating the mass inertia, bear in mind that the supporting rolls and the drive roll can have different diameters!

▶ [Moment of inertia of driving roller](#) (📖 156)

7.14.2.11 Speed

Parameter	Description
v	Speed of the belt Value is entered in the <i>Motion</i> dimensioning step.

7.15 Synchronous drive - single roll

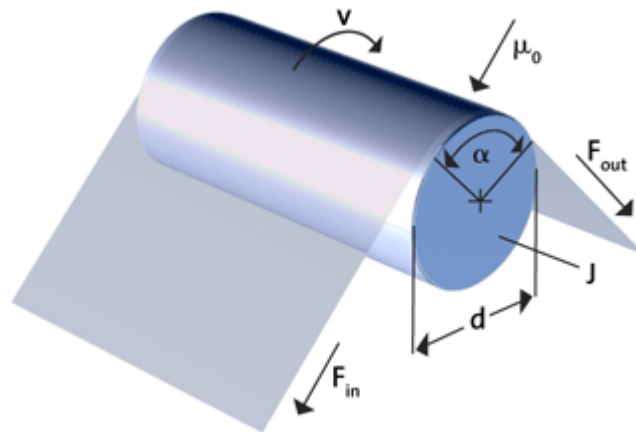
Synchronous drives are part of the production process of continuous material which is produced or refined at a high speed. At the starting and end point of these systems they are often combined with winding drives. Alternatively also cross cutters and flying saws can separate the material at the end of a production line and thus provide the transition from continuous production to a quickly clocked job production. In production lines the synchronous drives are the most important drives, since they control the material flow and therefore the machining process.

The individual rolls can be equipped with single drives and can be mechanically coupled. Apart from factors resulting from fixed mechanical conditions, the torque to be transmitted basically depends on the friction coefficient between the material and roll surface. In application cases where the friction coefficient can be strongly reduced, e. g. due to pollution, corresponding measures like an anti-spin control within the control structure are to be provided to avoid slip between the circumferential roller speed and the web.

In order to be able to couple high tensile forces into the web, usually roll arrangements with great angles of wrap in the form of S- or omega rolls are designed.

Application examples

- Production, refinement of paper or film webs
- Production and refinement of textile webs
- Rolling of slabs, plates
- Rolling, annealing, and refinement of metal plates
- Wire drawing machines
- Printing of paper or film webs, textiles



7.15.1 Calculations

For a synchronous drive with a single roll according to the drawing the following applies:

Conditions

The force ratio always has to be smaller than the static friction to avoid slippage. The forces F_{in} and F_{out} must not be negative. The safety coefficient S provides for a safety reserve that can be individually adapted to the application. During the application both a motor torque and a regenerative torque can occur.

For a reliable power transmission from the drive roll to the material the following conditions have to be met. Otherwise the DSD outputs a message.

For the motor torque ($F_{in} > F_{out}$):	For the regenerative torque ($F_{in} < F_{out}$):
$\frac{ F_{in} }{ F_{out} } < e^{\mu_0 \cdot \alpha} \cdot \left(1 - \frac{S}{100}\right)$	$\frac{ F_{out} }{ F_{in} } < e^{\mu_0 \cdot \alpha} \cdot \left(1 - \frac{S}{100}\right)$

[7-151] Equation 1: Balance of forces

Stationary torque

Under the previously mentioned conditions the stationary torque of the roll is calculated as follows:

$$M_{sds} = \frac{(F_{in} - F_{out}) \cdot d}{1000 \cdot 2}$$

[7-152] Equation 2: Stationary torque

Friction torque

In order to take the friction into consideration, usually a system efficiency η is specified. Since the friction torque is a torque that is constantly applied, a friction torque M_{μ} is calculated by means of the efficiency and the max. steady-state torque, which is then taken into consideration as a constant torque.

- The direction of the friction torque is always opposed to the direction of movement and is expressed mathematically by the fraction $v/|v|$.

$$M_{\mu} = \left(\frac{1}{\eta_{Brg}} - 1\right) \cdot \max(|M_{sds}|) \cdot \frac{v}{|v|}$$

[7-153] Equation 3: Friction torque

Moment of inertia

The total moment of inertia consists of the moments of inertia of the individual components:

$$J_{sum} = J + J_L$$

[7-154] Equation 4: Total moment of inertia

Application torque

$$M_{App} = M_{sds} + M_{\mu} + J_{sum} \cdot \alpha$$

[7-155] Equation 5: Torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.15.1.1 Symbols used

Symbol	Description	Dimension unit
d	Diameter of the drive roll	mm
F _{in}	Tension on input side (only positive tensile forces possible)	N
F _{out}	Tension on output side (only positive tensile forces possible)	N
J	Moment of inertia of the drive roll	kgm ²
J _L	Moment of inertia of the effective mass of the material to be conveyed	kgm ²
J _{sum}	Total moment of inertia (rolls/material)	kgm ²
S	Safety coefficient for the static friction	%
M _{App}	Required torque of the application	Nm
M _μ	Friction torque	Nm
M _{sds}	Stationary torque	Nm
v	Speed of the material	m/min
α	Angle of wrap	°
η _{Brg}	Mechanical efficiency of the roll bearing	
μ ₀	Coefficient of friction of the roll surface	

7.15.2 Data for the entry

7.15.2.1 Roll diameter

Parameter	Description
d	Outside diameter of drive roll

7.15.2.2 Tensile force, infeed

Parameter	Description
F_{in}	The tensile force on the material belt at the input side of the roll, i.e. where the material approaches the roll. • Only positive values possible. • The difference in force between the input side and the output side has to be provided by the drive.

Possible messages	
	▶ Ratio of the tensile forces $F_{in}/F_{out} > \text{limit value}$ (📖 506) ▶ Ratio of the tensile forces $F_{out}/F_{in} > \text{limit value}$ (📖 506)

7.15.2.3 Tensile force, outfeed

Parameter	Description
F_{out}	The tensile force on the material belt at the output side of the roll, i.e. where the material moves away from the roll. • Only positive values possible. • The difference in force between the input side and the output side has to be provided by the drive.

Possible messages	
	▶ Ratio of the tensile forces $F_{in}/F_{out} > \text{limit value}$ (📖 506) ▶ Ratio of the tensile forces $F_{out}/F_{in} > \text{limit value}$ (📖 506)

7.15.2.4 Efficiency, roll mechanics

Parameter	Description
η_{Brg}	Efficiency • Takes into account the overall mechanical losses, e.g. those resulting from friction between the material belt and the roller or serrations on the roller.

7.15.2.5 Moment of inertia, rolls/material

Parameter	Description
J	Moment of inertia of the drive roll of the material to be conveyed (if relevant), etc. • The moment of inertia has an effect on the dynamic torque! • Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.15.2.6 Static friction coefficient of roll surface

Parameter	Description
μ_0	Static friction coefficient - The power transmission between the roll and the web is effected by friction. The coefficient of static friction specifies how great the force to be transmitted can be in proportion to the normal force on the roll. - Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (📖 488)  Static friction

Possible messages	
	► Ratio of the tensile forces $F_{in}/F_{out} > \text{limit value}$ (📖 506) ► Ratio of the tensile forces $F_{out}/F_{in} > \text{limit value}$ (📖 506)

7.15.2.7 Angle of wrap

Parameter	Description
α	Angle of wrap - The power transmission between the drive roll and the web is effected by friction. - The greater the angle of wrap, the greater the normal force on the drive roll, and thus the force to be transmitted on the web.

Possible messages	
	► Ratio of the tensile forces $F_{in}/F_{out} > \text{limit value}$ (📖 506) ► Ratio of the tensile forces $F_{out}/F_{in} > \text{limit value}$ (📖 506)

7.15.2.8 Safety coefficient static friction

Parameter	Description
S	Safety coefficient The differential force always has to be smaller than the Static friction to prevent slippage. The safety coefficient S provides for a safety reserve that can be individually adapted to the application.

Conditions

For a reliable power transmission from the drive roll to the material the following conditions have to be met. Otherwise a warning appears.

- For a motor torque, i. e. $F_{in} > F_{out}$:

$$\frac{|F_{in}|}{|F_{out}|} < e^{\mu_0 \cdot \alpha} \cdot \left(1 - \frac{S}{100}\right)$$

- For a regenerative torque, i. e. $F_{in} < F_{out}$:

$$\frac{|F_{out}|}{|F_{in}|} < e^{\mu_0 \cdot \alpha} \cdot \left(1 - \frac{S}{100}\right)$$

Possible messages	
	▶ Ratio of the tensile forces F_{in}/F_{out} > limit value (📖 506) ▶ Ratio of the tensile forces F_{out}/F_{in} > limit value (📖 506)

7.15.2.9 Speed

Parameter	Description
v	Speed of the web Value is entered in the <i>Motion</i> dimensioning step.

7.16 Synchronous drive of squeegees

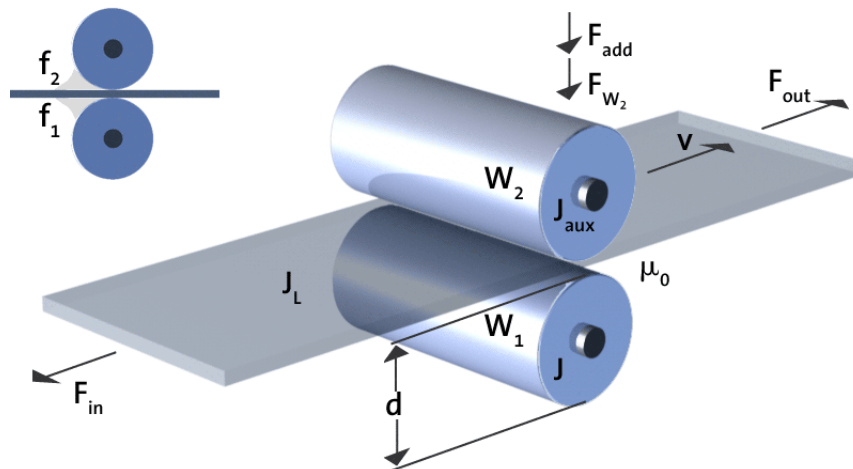
Synchronous drives are part of the production process of continuous material which is produced or refined at a high speed. At the starting and end point of these systems they are often combined with winding drives. Alternatively also cross cutters and flying saws can separate the material at the end of a production line and thus provide the transition from continuous production to a quickly clocked job production. In production lines the synchronous drives are the most important drives, since they control the material flow and therefore the machining process.

A synchronous drive with squeegees consists of an upper roll (W_2) and a lower roll (W_1). The drive is solely actuated via the lower roll (W_1).

The material flow can be gathered from the following drawing. Since the rolls can have different surfaces, this has to be taken into consideration in the different lever arms of the rolling friction (f_1 and f_2).

Application examples

- Production, refinement of paper or film webs
- Production and refinement of textile webs
- Rolling of slabs, plates
- Rolling, annealing, and refinement of metal plates
- Wire drawing machines
- Printing of paper or film webs, textiles



7.16.1 Calculations

For a synchronous drive with squeegees according to the drawing, the following applies:

Conditions

The differential force always has to be smaller than the static friction to prevent slippage. The coefficient S provides for a safety reserve that can be individually adapted to the application.

For a reliable power transmission from the drive roll to the material the following condition has to be met. Otherwise a warning appears.

$$|F_{in} - F_{out}| < F \cdot \mu_0 \cdot \left(1 - \frac{S}{100}\right)$$

[7-156] Equation 1: Differential force

Contact pressure

The lower roll W_1 is mounted rigidly. The upper roll W_2 is pressed against roll W_1 with the contact pressing force F . The contact pressing force F consists of the force due to weight F_{W2} and an additionally acting force F_{add} (e.g. by a pneumatic cylinder).

The proportion of the force due to weight F_{W2} depends on the mounting position (angle of tilt β) of the roll pair W_1, W_2 , with regard to the vertical.

$$\begin{aligned} F &= F_{W2} + F_{add} \\ F &= m_{W2} \cdot g \cdot \cos \beta + F_{add} \end{aligned}$$

[7-157] Equation 2: Contact pressing force

Stationary torque

The stationary torque for the lower roll W_1 (drive roll) is calculated as follows:

$$M_{sds} = (f_1 + f_2) \cdot \frac{F}{1000} \cdot \frac{v}{|v|} + (F_{in} - F_{out}) \cdot \frac{d}{1000 \cdot 2}$$

[7-158] Equation 3: Stationary torque

Friction torque

The friction of the roller bearings is usually specified by the efficiency η_{Brg} . Since the friction torque is a torque that is constantly applied, a friction torque M_μ is calculated by means of the efficiency and the maximum steady-state torque, which is taken into consideration as a constant torque.

- The direction of the friction torque is always opposed to the direction of movement and is expressed mathematically by the fraction $v/|v|$.

$$M_\mu = \left(\frac{1}{\eta_{Brg}} - 1\right) \cdot \max(|M_{sds}|) \cdot \frac{v}{|v|}$$

[7-159] Equation 4: Friction torque

Moment of inertia

The total moment of inertia consists of the moments of inertia of the individual components:

$$J_{\text{sum}} = J + J_{\text{aux}} + J_L$$

[7-160] Equation 5: Total moment of inertia

Application torque

$$M_{\text{App}} = M_{\text{sds}} + M_{\mu} + J_{\text{sum}} \cdot \alpha$$

[7-161] Equation 6: Torque of the application



Tip!

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

7.16.1.1 Symbols used

Symbol	Description	Dimension unit
d	Diameter of roll 1 (drive roll)	mm
F _{in}	Tension on input side (only positive tensile forces possible)	N
F _{out}	Tension on output side (only positive tensile forces possible)	N
F	Contact pressure	N
F _{W2}	Force due to weight of roll 2	N
F _{add}	Additionally acting force on roll 2	N
m _{W2}	Mass of roll 2	N
g	Gravitational constant	9.81 m/s ²
s	Safety factor - static friction	%
f ₁	Lever arm of the rolling friction - roll 1	
f ₂	Lever arm of the rolling friction - roll 2	
J	Moment of inertia of the lower roll (drive roll)	kgm ²
J _{aux}	Moment of inertia of the upper roll	kgm ²
J _L	Moment of inertia of the effective mass of the material to be conveyed	kgm ²
J _{sum}	Total moment of inertia	kgm ²
S	Safety coefficient for the static friction	%
M _{App}	Required torque of the application	Nm
M _μ	Friction torque	Nm
M _{sds}	Stationary torque	Nm
v	Speed of the web	m/min
α	Angular acceleration	rad/s ²
β	Vertical mounting position (angle of tilt) of the roll pair W ₁ , W ₂ , with regard to the vertical	°
η _{Brg}	Mechanical efficiency of the roll bearing W ₁ , W ₂	
μ ₀	Coefficient of friction of the roll surface	

7.16.2 Data for the entry

7.16.2.1 Roll diameter

Parameter	Description
d	Outside diameter of drive roll

7.16.2.2 Tensile force, infeed

Parameter	Description
F_{in}	The tensile force on the material belt at the input side of the rolls, i.e. where the material approaches the rolls. - Only positive values possible. - The difference in force between the input side and the output side has to be provided by the drive.

Possible messages	
	► Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$ (📖 506)

7.16.2.3 Tensile force, outfeed

Parameter	Description
F_{out}	The tensile force on the material belt at the output side of the rolls, i.e. where the material moves away from the rolls. - Only positive values possible. - The difference in force between the input side and the output side has to be provided by the drive.

Possible messages	
	► Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$ (📖 506)

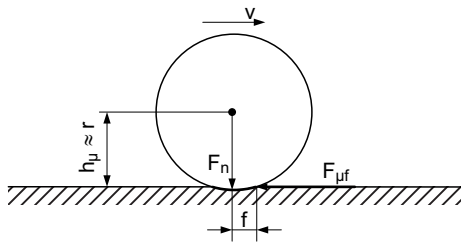
7.16.2.4 Roll contact force

Parameter	Description
F	Pinch pressure of rollers - The power transmission between the drive roll and the web is effected by friction. It depends on the friction coefficient and the contact pressure of the rolls. - The force that is applied is created by the weight of the upper roller, by spring pressure, hydraulic or pneumatic pressure, or by a combination of these.

Possible messages	
	► Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$ (📖 506)

7.16.2.5 Leverage of rolling friction, lower roll

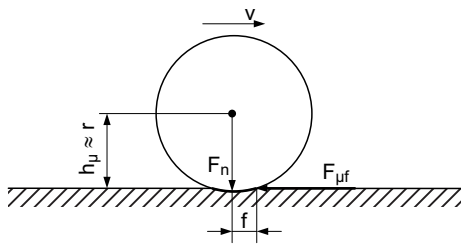
Parameter	Description
f_1	Leverage of rolling friction for the lower roll - Used for calculating the rolling resistance of the rolls with regard to the web. - Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (488)
 f	Lever arm of the rolling friction

	
f	Lever arm of the rolling friction
$F_{\mu f}$	Rolling friction (absolute value)
F_n	Pinch pressure of rollers
v	Speed

[7-162] Principle of the rolling friction

7.16.2.6 Leverage of rolling friction, upper roll

Parameter	Description
f_2	Leverage of rolling friction for the upper roll - Used for calculating the rolling resistance of the rolls with regard to the web. - Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (488)
 f	Lever arm of the rolling friction

	
f	Lever arm of the rolling friction
$F_{\mu f}$	Rolling friction (absolute value)
F_n	Pinch pressure of rollers
v	Speed

[7-163] Principle of the rolling friction

7.16.2.7 Efficiency, roll mechanics

Parameter	Description
η_{Brg}	Efficiency Takes into account the overall mechanical losses, e.g. those resulting from friction between the material belt and the roller, serrations on the roller etc.

7.16.2.8 Moment of inertia, rolls/material

Parameter	Description
J	Moment of inertia of the drive roll of the material to be conveyed (if relevant), etc. - The moment of inertia has an effect on the dynamic torque! - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.16.2.9 Static friction coefficient of roll surface

Parameter	Description
μ_0	Static friction coefficient - The power transmission between roll and material length is effected by friction. The coefficient of static friction specifies how great the force to be transmitted can be in proportion to the normal force on the roll. - Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (📖 488)  Static friction

Possible messages	
	Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$ (📖 506)

7.16.2.10 Safety coefficient static friction

Parameter	Description
S	Safety coefficient The differential force $F_{in} - F_{out}$ always has to be smaller than the Static friction to prevent slippage. The coefficient S provides for a safety reserve that can be individually adapted to the application.

Conditions

For a reliable power transmission from the drive roll to the material the following condition has to be met. Otherwise a warning appears.

$$|F_{in} - F_{out}| < F \cdot \mu_0 \cdot \left(1 - \frac{S}{100}\right)$$

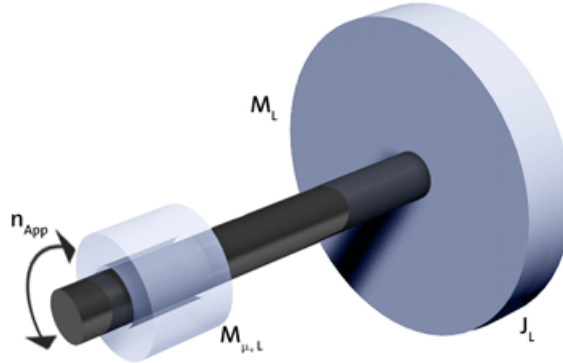
Possible messages	
	▶ Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$ (📖 506)

7.16.2.11 Speed

Parameter	Description
v	Speed of the web Value is entered in the <i>Motion</i> dimensioning step.

7.17 General rotary drive

The general rotary drive is the basic and classical form of a drive system. The essential calculations for this are based on the determination of the mass inertia.



7.17.1 Calculations

For a general rotary drive according to the drawing the following applies:

$$\omega = \frac{2 \cdot \pi \cdot n_{App}}{60}$$

[7-164] Equation 1: Angular velocity of the application

$$\alpha = \frac{d\omega}{dt}$$

[7-165] Equation 2: Angular acceleration of the application

Dynamic torque of the application

$$M_{dyn} = J_L \cdot \alpha$$

[7-166] Equation 3: Dynamic torque of the application

Total torque of the application

The total torque is produced by addition of the dynamic and the steady-state proportion. The steady-state torque can for instance be a friction torque.

$$M_{App} = M_{dyn} + M_{\mu, L} \cdot \frac{\omega}{|\omega|} + M_{vs}$$

[7-167] Equation 4: Total torque of the application

Required power of the application

$$P_{App} = M_{App} \cdot \omega = M_{App} \cdot n_{App} \cdot \frac{2 \cdot \pi}{60}$$

[7-168] Equation 5: Required power of the application

7.17.1.1 Symbols used

Symbol	Description	Dimension unit
J_L	Moment of inertia of load	kgm^2
M_{dyn}	Dynamic torque of the application	Nm
M_{App}	Total torque of the application	Nm
$M_{\mu,L}$	Friction torque of the load	Nm
M_{vs}	Counter-torque of the application	Nm
n_{App}	Application speed	rpm
P_{App}	Application performance	W
α	Angular acceleration of the application	rad/s^2
ω	Angular velocity of the application	rad/s

7.17.2 Data for the entry

7.17.2.1 Moment of inertia of load

Parameter	Description
J_L	Moment of inertia of load • Has an impact on the dynamic torque! • Value can be entered directly or calculated using a inertia calculator.  Inertial calculator (📖 472)

7.17.2.2 Friction torque of load

Parameter	Description
$M_{\mu,L}$	Friction torque counteracting the direction of movement.

7.18 Rotary table drive

A rotary table drive is often used for positioning processes in filling and packaging machines. The table is placed horizontally, the payloads are arranged symmetrically.

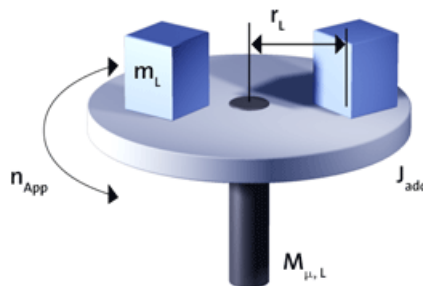
The mechanics define the achievable speed and thus the dynamic performance of the positioning process to a great extent, as well as the repeat accuracy and therefore the quality of the positioning.

Characteristics of a rotary table drive

- In the case of a rotary table drive a mass inertia has to be accelerated and decelerated again in a rotary manner.
- Friction torques that may be caused by bearing friction and in the machining process must be overcome.

Requirements with regard to a drive system for positioning

- High dynamic performance to achieve short positioning times,
- High accuracy, according to the application
- High degree of reliability



7.18.1 Calculations

For a rotary table drive according to the drawing the following applies:

$$\omega = \frac{2 \cdot \pi \cdot n_{App}}{60}$$

[7-169] Equation 1: Angular velocity of the application

$$\alpha = \frac{d\omega}{dt}$$

[7-170] Equation 2: Angular acceleration of the application

Moment of inertia

For the calculation of the moment of inertia no eccentric masses are taken into consideration.

$$J_{sum} = J_{add} + m_L \cdot r_L^2$$

[7-171] Equation 2: Moment of inertia

Dynamic torque of the application

$$M_{\text{dyn}} = J_{\text{sum}} \cdot \alpha$$

[7-172] Equation 3: Dynamic torque of the application

Total torque of the application

$$M_{\text{App}} = M_{\text{dyn}} + M_{\mu, L} \cdot \frac{\omega}{|\omega|}$$

[7-173] Equation 4: Total torque of the application

A consideration of the angle of tilt for the stationary torque currently is not yet included. For this the torque has to be determined for each angle position.

Required power of the application

$$P_{\text{App}} = M_{\text{App}} \cdot n_{\text{App}} \cdot \frac{2 \cdot \pi}{60}$$

[7-174] Equation 5: Required power of the application

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)

7.18.1.1 Symbols used

Symbol	Description	Dimension unit
J_{add}	Moment of inertia of the rotary table	kgm^2
J_{sum}	Total moment of inertia	kgm^2
m_L	Mass of payload	kg
M_{dyn}	Dynamic torque of the application	Nm
M_{App}	Required torque of the application	Nm
$M_{\mu, L}$	Friction torque of the load	Nm
n_{App}	Application speed	rpm
P_{App}	Application performance	W
r_L	Radius of movement of the payload	m
α	Angular acceleration of the application	rad/s^2
ω	Angular velocity of the application	rad/s

7.18.2 Data for the entry

7.18.2.1 Radius, payload

Parameter	Description
r_L	Radius of movement of the payload • Path from the centre of rotation of the table to the supporting point of the payload. • This radius is relevant for the inertia proportion of the payload. For the calculation one has to think of the payload as a point mass. The mass of the payload is entered when the motion profile is created.

7.18.2.2 Additional moment of inertia

Parameter	Description
J_{add}	The additional inertial moment can for instance be the table or an additional shaft. • The proportion of inertia by the mass of the payload is calculated separately by the creation of the motion profile. • Value can be entered directly or calculated using a inertia calculator.  Inertial calculator (472)

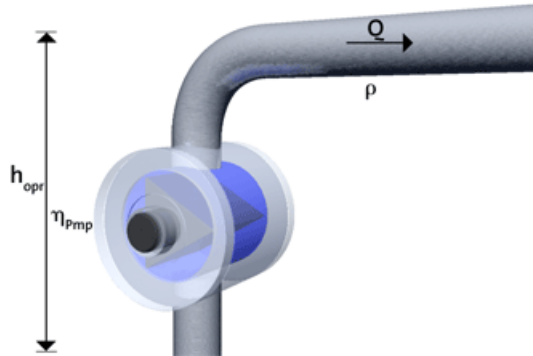
7.18.2.3 Friction torque of load

Parameter	Description
$M_{\mu,L}$	Friction torque counteracting the direction of movement.

7.19 Pump

Pumps have the task to move a medium with a specific density against a stationary pressure. The power (P) that has to be applied hydraulically for this purpose can be calculated by means of the flow rate (Q).

- The required data (efficiency, rated speed) of the pump can be gathered from the pump manufacturer's data sheet.



7.19.1 Calculations

For a pump according to the drawing the following applies:

$$P_{pmp} = \frac{\rho \cdot g \cdot Q \cdot h_{opr}}{\eta_{pmp} \cdot 3600}$$

[7-175] Equation 1: Power of the pump

$$\omega_{N,pmp} = \frac{2 \cdot \pi}{60} \cdot n_{N,pmp}$$

[7-176] Equation 2: Angular velocity at rated pump speed

$$\omega = \frac{2 \cdot \pi \cdot n_{App}}{60}$$

[7-177] Equation 3: Angular velocity of the application

$$\alpha = \frac{d\omega}{dt}$$

[7-178] Equation 4: Angular acceleration of the application

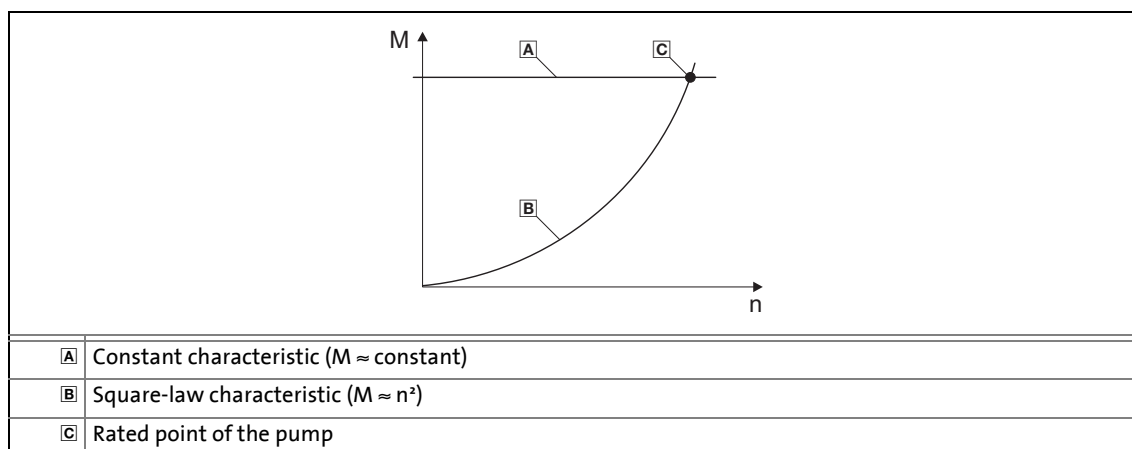
Rated torque of the pump

$$M_{N,pmp} = \frac{P_{pmp} \cdot 60}{2 \cdot \pi \cdot n_{N,pmp}}$$

[7-179] Equation 5: Rated pump torque

Required torque of the pump

From the data entered and the load characteristic selected the DSD calculates the required torque.



[7-180] Load characteristics of the pump

Calculation of the required torque with a square-law load characteristic ($M \approx n^2$):

$$M_{th,App} = M_{N,pmp} \cdot \left(\frac{\omega}{\omega_{N,pmp}} \right)^2 + J_{add} \cdot \alpha$$

[7-181] Equation 6: Required torque with a square-law load characteristic

Calculation of the required torque with a constant load characteristic ($M \approx \text{constant}$):

$$M_{th,App} = M_{pmp,N} + (J_{add} \cdot \alpha)$$

[7-182] Equation 7: Required torque with a constant load characteristic



Tip!

- Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (67)
- The host computer "Energy efficiency fan/pump" serves to compare the energy demand in an inverter-controlled and mechanically controlled system.

7.19.1.1 Symbols used

Symbol	Description	Dimension unit
g	Gravitational acceleration ($g = 9.81 \text{ m/s}^2$)	m/s^2
Q	Volume flow	m^3/h
h_{opr}	Pumping height	m
J_{add}	Additional moment of inertia	kgm^2
$M_{\text{th,App}}$	Required torque of the application (with losses)	Nm
$M_{\text{N,Pmp}}$	Rated torque of the pump	Nm
n_{App}	Application speed	rpm
$n_{\text{N,Pmp}}$	Rated speed of the pump	rpm
P_{Pmp}	Power of the pump	kW
η_{Pmp}	Efficiency of the pump	
ρ	The specific density of the conveyed medium .	kg/dm^3
α	Angular acceleration of the application	rad/s^2
ω	Angular velocity of the application	rad/s
$\omega_{\text{N,Pmp}}$	Angular velocity at rated pump speed	rad/s

7.19.2 Data for the entry

7.19.2.1 Volume flow

Parameter	Description
Q	Volume of the medium to be pumped per time unit

7.19.2.2 Pumping height

Parameter	Description
h_{opr}	Pumping height

7.19.2.3 Medium density

Parameter	Description
ρ	Specific density of the medium to be pumped Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (488)  Density of liquids

7.19.2.4 Efficiency of the pump

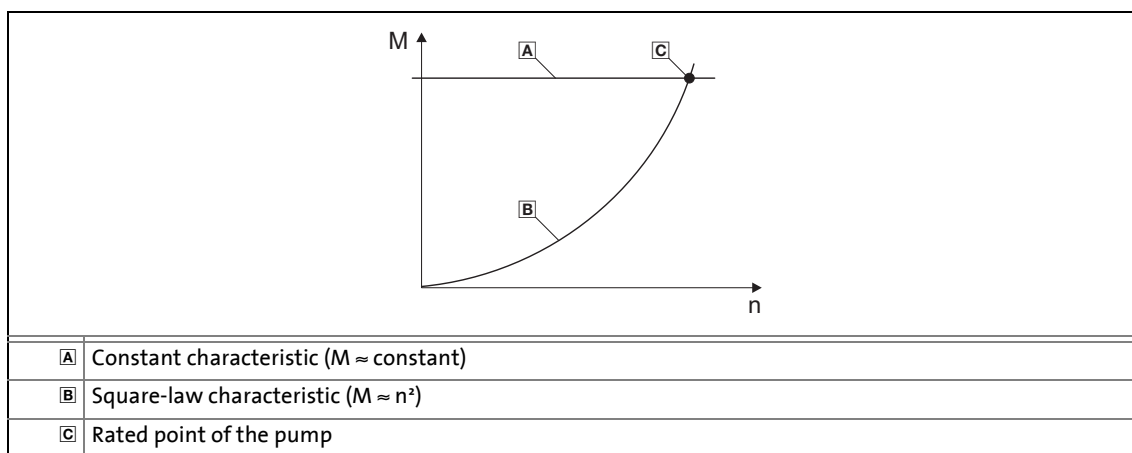
Parameter	Description
η_{Pmp}	Efficiency of the pump (data sheet of the pump)

7.19.2.5 Rated speed of the pump

Parameter	Description
$n_{N,pmp}$	Rated speed of the pump (see data sheet of the pump)

7.19.2.6 Load characteristic of the pump

Parameter	Description
$M(n)$	Selection of the load characteristic of the pump Centrifugal pumps (flow principle) generally have a square-law, reciprocating pumps (principle of positive displacement) a constant load characteristic.



[7-183] Load characteristics of the pump



Note!

Use the 8400 frequency inverter in the operating mode "VFC plus eco".

- The energy-optimised and sensorless operation as well as motor management with demand-oriented motor control are very well suited for pumps with quadratic load characteristics.

7.19.2.7 Additional moment of inertia

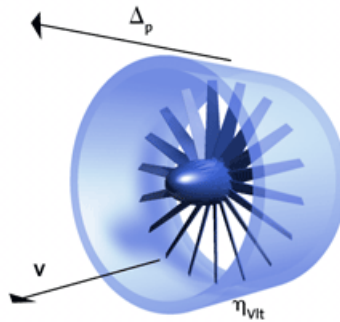
Parameter	Description
J_{add}	Moment of inertia of the pump impeller. - The moment of inertia can generally be disregarded. - Value can be entered directly or calculated using a inertia calculator. Inertia calculator (472)

7.20

Fan

Fans have the task to move a medium with a specific density against a stationary pressure. The power (P) that has to be applied pneumatically for this purpose can be calculated by means of the differential pressure (Δp) and the volume flow (Q).

- The required data (efficiency, rated speed) of the fan can be gathered from the fan manufacturer's data sheet.

**Note!**

When altering the gas temperature, the torque requirement of the application changes. This is to be taken into account with regard to the safety reserve!

Because of the square-law load characteristic the dimensioning is especially to be checked with regard to undervoltage! Voltage drops at EMC components and the inverter also have to be taken into account!

7.20.1

Calculations

For a fan according to the drawing the following applies:

$$P_{Vlt} = \frac{Q \cdot \Delta p}{\eta_{Vlt} \cdot 1000}$$

[7-184] Equation 1: Power of the fan

$$\omega_{N,Vlt} = \frac{2 \cdot \pi}{60} \cdot n_{N,Vlt}$$

[7-185] Equation 2: Angular velocity at rated fan speed

$$\omega = \frac{2 \cdot \pi \cdot n_{App}}{60}$$

[7-186] Equation 3: Angular velocity of the application

$$\alpha = \frac{d\omega}{dt}$$

[7-187] Equation 4: Angular acceleration of the application

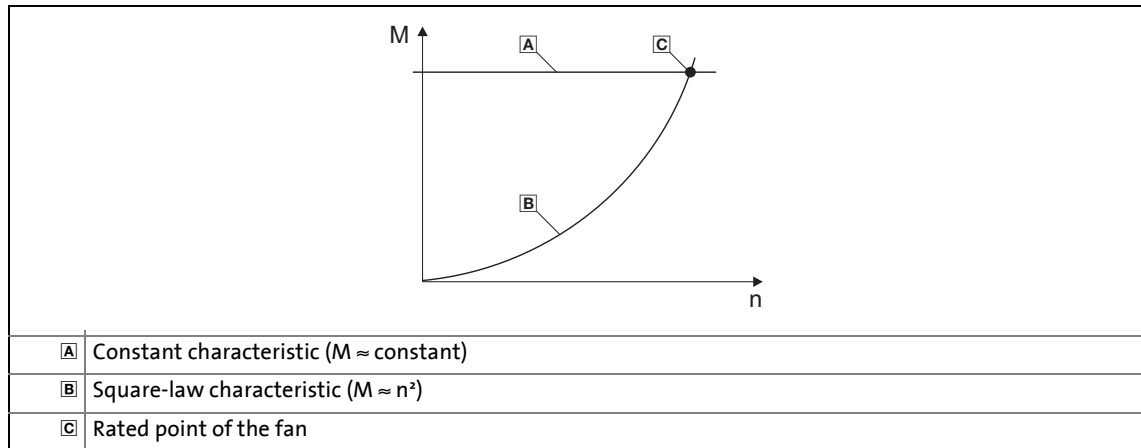
Rated torque of the fan

$$M_{N,Vlt} = \frac{P_{Vlt} \cdot 60}{2 \cdot \pi \cdot n_{N,Vlt}}$$

[7-188] Equation 5: Rated fan torque

Required torque of the fan

From the data entered and the load characteristic selected the DSD calculates the required torque.



[7-189] Load characteristics of the fan

Calculation of the required torque with a square-law load characteristic ($M \approx n^2$):

$$M_{th,App} = M_{N,Vlt} \cdot \left(\frac{\omega}{\omega_{N,Vlt}} \right)^2 + J_{add} \cdot \alpha$$

[7-190] Equation 6: Required torque with a square-law load characteristic

Calculation of the required torque with a constant load characteristic ($M \approx \text{constant}$):

$$M_{th,App} = M_{N,Vlt} + (J_{add} \cdot \alpha)$$

[7-191] Equation 7: Required torque with a constant load characteristic

**Tip!**

Further equations to complete the calculations required for an application can be found in the chapter "[Basic calculations](#)". (□ 67)

- The host computer "Energy efficiency fan/pump" serves to compare the energy demand in an inverter-controlled and mechanically controlled system.

7.20.1.1 Symbols used

Symbol	Description	Dimension unit
J_{add}	Additional moment of inertia	kgm^2
$M_{th,App}$	Required torque of the application (with losses)	Nm
$M_{N,Vlt}$	Rated torque of the fan	Nm
n_{App}	Application speed	rpm
$n_{N,Vlt}$	Rated speed of the fan	rpm
P_{Vlt}	Power of the fan	kW
Q	Volume flow	m^3/s
Δp	Pressure increase	N/m^2
η_{Vlt}	Efficiency of the fan	
α	Angular acceleration of the application	rad/s^2
ω	Angular velocity of the application	rad/s
$\omega_{N,Vlt}$	Angular velocity at rated fan speed	rad/s

7.20.2 Data for the entry

7.20.2.1 Volume flow

Parameter	Description
Q	Volume of the fluid to be transported per time unit

7.20.2.2 Pressure increase

Parameter	Description
Δp	Pressure difference between intake and outlet

7.20.2.3 Efficiency of the fan

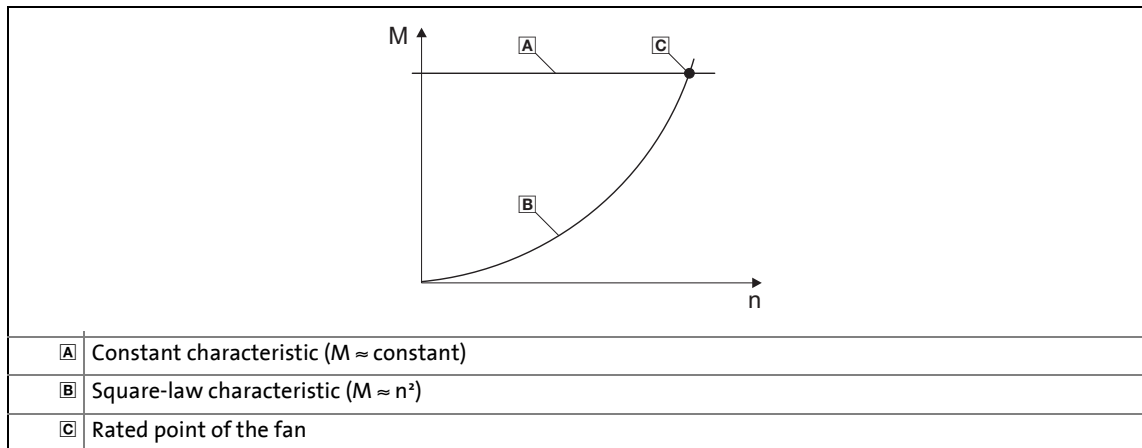
Parameter	Description
η_{Vlt}	Fan efficiency (see fan data sheet)

7.20.2.4 Fan rated speed

Parameter	Description
n_{rated}	Rated speed of the fan (see fan data sheet)

7.20.2.5 Fan load characteristic

Parameter	Description
M(n)	Selection of the load characteristic of the fan Fans generally have a square-law load characteristic.



[7-192] Load characteristics of the fan



Note!

Use the 8400 frequency inverter in the operating mode "VFC plus eco".

- The energy-optimised and sensorless operation as well as motor management with demand-oriented motor control are very well suited for fans with quadratic load characteristics.

7.20.2.6 Additional moment of inertia

Parameter	Description
J _{add}	Moment of inertia of the fan. Value can be entered directly or calculated using a inertia calculator. Inertia calculator (472)

7.21 Importing M-n-operating points

This application serves to dimension a rotary drive independent of a specific application. The application data is determined via the motion profile to be created.

After the selection of the application, the *MotionDesigner* is opened automatically.

You have various options to create a rotary motion profile:

- Import operating points for torque/speed, moment of inertia and control signal for controller inhibit and brake from an ASCII file.
 - [Importing profile data](#) (📖 254)
 - After the import, you can scale the individual profiles and add more elements.
- Open an Imp file with saved motion profile, moment of inertia and control signals for controller inhibit and brake.
- Create the motion profile graphically.
 - A detailed description of the operation of the *MotionDesigner* is provided in the chapter "[Motion design](#)". (📖 242)



Note!

- You can only create rotary motion profiles.
- The preselected parameters (torque, moment of inertia, controller inhibit, brake) cannot be removed. You cannot add more.
- The load-matching factor k_j (ratio of moment of inertia of the load to moment of inertia of the motor) is only calculated if the moment of inertia is imported.

7.21.1 Data for the entry

Parameter	Description	Dimension unit
n	Application speed	rpm, rad/s, °/s
M	Torque of the application, including components due to moment of inertia	Nm, kNm, ozfin, lbfin, lbfft
J	Moment of inertia • Only required if k_j must be calculated. • Required for the calculation of the torque.	kgm ² , kgcm ² , ozin ² , lbin ² , lbft ² , ozins ² , lbsins ²
t	Time	s, ms, min, h
BRK	Control signal for the holding brake (BRK)	-
CINH	Control signal for controller inhibit of the inverter (CINH)	-

**Note!**

- DSD can import ASCII files with approx. 300 operating points without problems. The greater the number of interpolation points, the longer the import takes.
- The data for the motion profile can be easily entered in Microsoft® Excel and then be saved as an ASCII file.
- The *CamManager* in the »Engineer« has an DSD export for CAM curve profiles. This serves to write profile data to an ASCII file.
- All metric and imperial units used in the DSD can be interpreted by the DSD.

See also:

► [Importing profile data](#) (📖 254)

7.22 Size the multi-axis system

Electrical drives are frequently accelerated and braked. Then, electrical energy is converted into kinetic or potential energy which is partly fed back in the braking or lowering process. This recovered energy is often converted into heat via a brake resistor and is then lost unused.

Often, it is well worth passing on this braking energy for another use, thereby improving energy efficiency. In a multi-axis system, the brake energy can be used completely under ideal conditions.

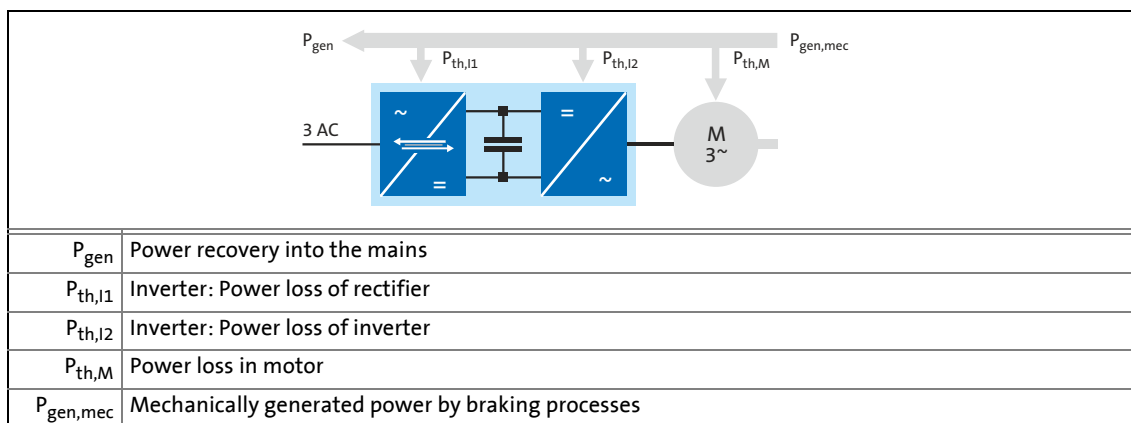
7.22.1 Using braking energy

If one or several inverters of a multi-axis system operate in generator mode (braking operation), the generated energy is transmitted to the common DC bus or the DC voltage source. Thus, the energy is available for the inverters in the multi-axis system that operate in motor mode.

Advantages:

- Smaller dimensioning of the power supply module or regenerative power supply module.
- Generally, the use of a central braking unit is sufficient.
- Less energy is taken from the three-phase system.
- The number of mains input modules and the connected expense (e.g. for wiring) can be optimally adapted to the application.
- The wiring effort is minimal for the 9400 HighLine servo inverter and the i700 servo inverter with central power supply.
- The multi-axis system is the most cost-effective version to use recovered energy.

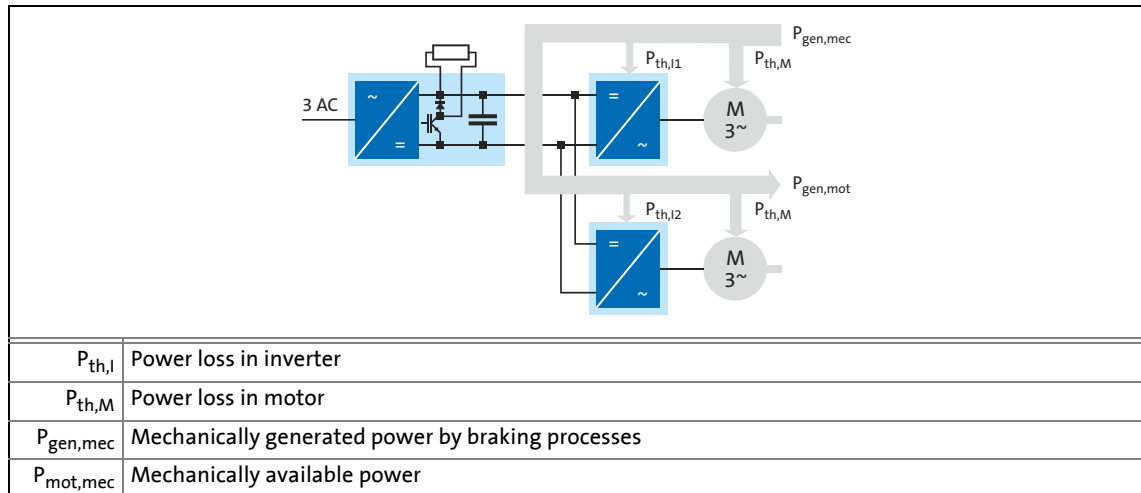
Operation in generator mode with power recovery into the mains



[7-193] Operation in generator mode with power recovery into the mains

- For power recovery into the mains, inverters must be connected to a regenerative power supply module via the DC bus.
- The use of a regenerative power supply module may be economically reasonable if the drive power exceeds 5 kW.

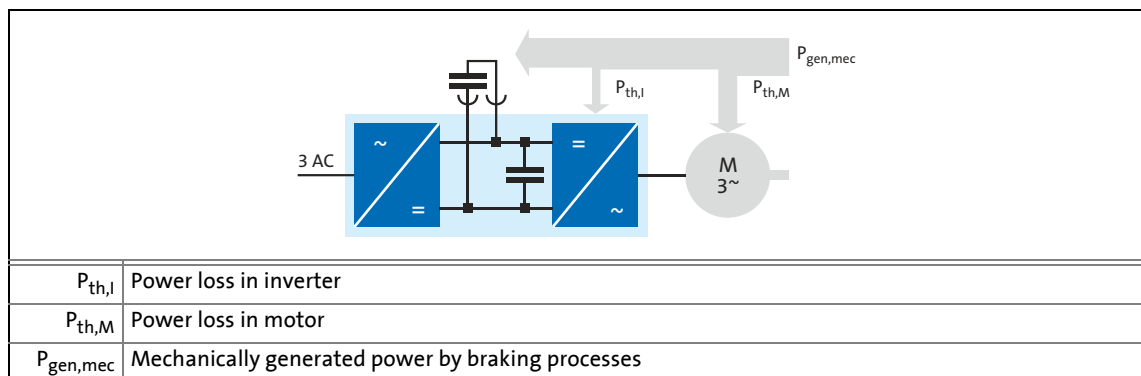
Energy exchange between two drives



[7-194] Energy exchange between two drives

- Other drive axes in the multi-axis system must be able to absorb recovered energy.
- In case of a quick stop for all drive axes, a brake chopper is usually required in addition since no drive axis is able to absorb the regenerative power.

Buffering braking energy

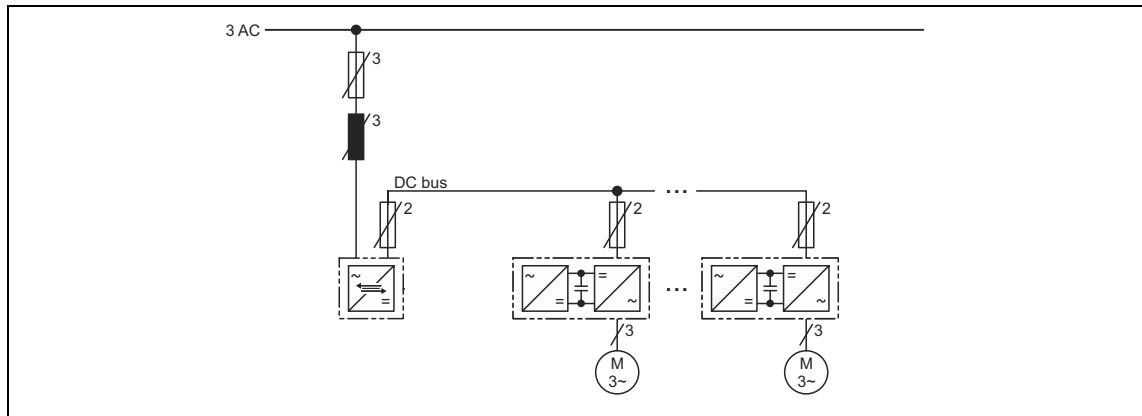


[7-195] Energy storage in the capacitor

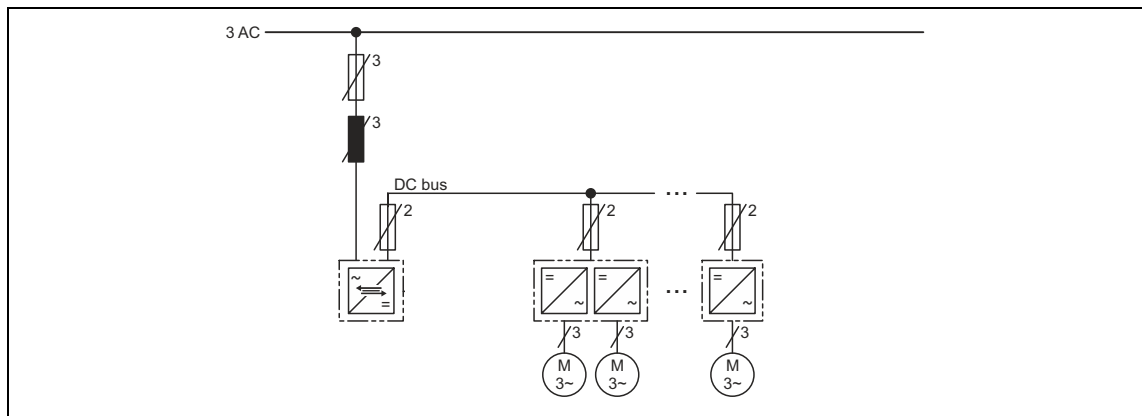
- The braking energy is stored in a capacitor in order to make it available again in the next acceleration or lifting process.
- Compared to a regenerative power supply module, the costs are lower, but the storage capacity of the capacitor is limited.
- Energy storage is cost-effective for fast cycled drives (e.g. cross cutters).

7.22.2 Combining drive axes

7.22.2.1 Central mains supply via regenerative power supply module



[7-196] Inverter with rectifier and inverted rectifier on central mains supply via regenerative power supply module

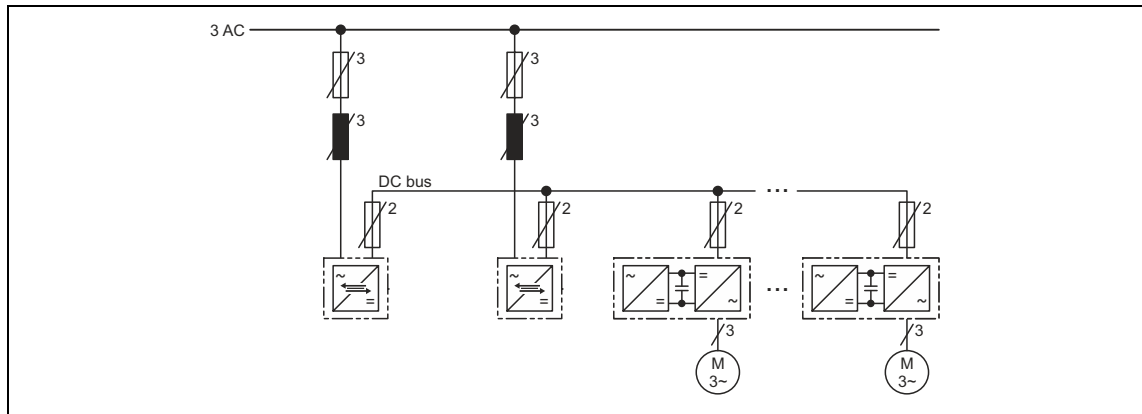


[7-197] Single-axis and double-axis devices (e.g. i700 servo inverter) on central mains supply via regenerative power supply module

Excessive electrical energy (braking energy) is made available to the drive axes in the DC-bus connection or is fed to the mains via the regenerative power supply module.

- The arrangement can be dimensioned in the DSD.
 - The drive axes can be each dimensioned separately in the DSD.
 - In the "Dimension the multi-axis system" application you combine the drive axes and dimension the regenerative power supply module.
 - DSD calculates the entire power requirement. For operation in generator mode it is checked whether the braking power needs to be dissipated via an additional brake resistor if the regenerative power of the regenerative power supply module is not sufficient.

Parallel connection of several regenerative power supply modules

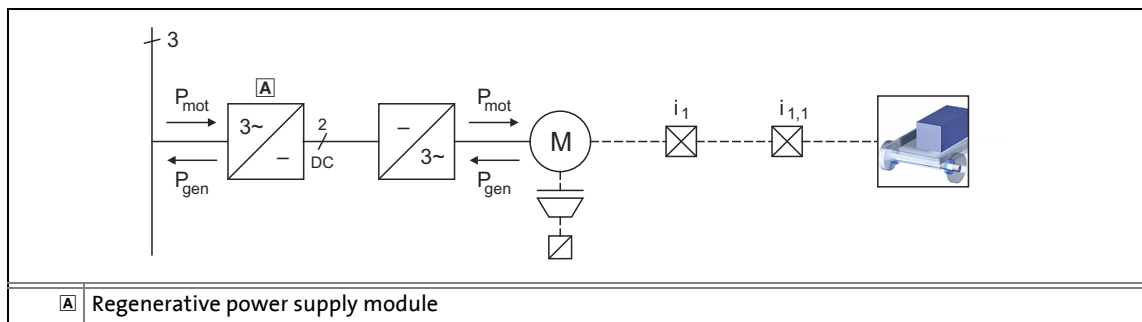


[7-198] Parallel connection of several regenerative power supply modules

- When the derating factors are complied with, the operation of several regenerative power supply modules in the DC-bus connection is permitted.
- The arrangement in the DSD can only be dimensioned with regenerative power supply modules 9400.
 - The regenerative power supply modules can be each dimensioned separately in the DSD.
 - The selection table in the DSD provides regenerative power supply modules 9400 connected in parallel ($2 \times E94...$ or $3 \times E94...$).

Single-axis application

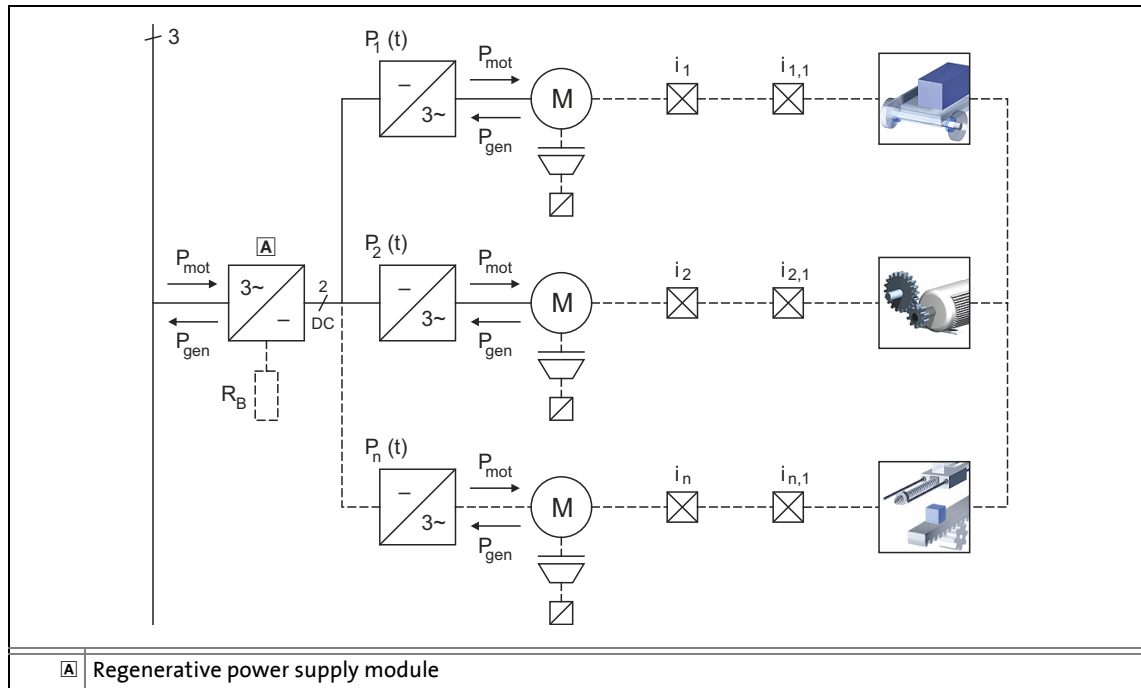
For applications with a high regenerative power (e. g. unwinders and hoists) it may also be reasonable to use a regenerative power supply module for a drive axis.



[A] Regenerative power supply module

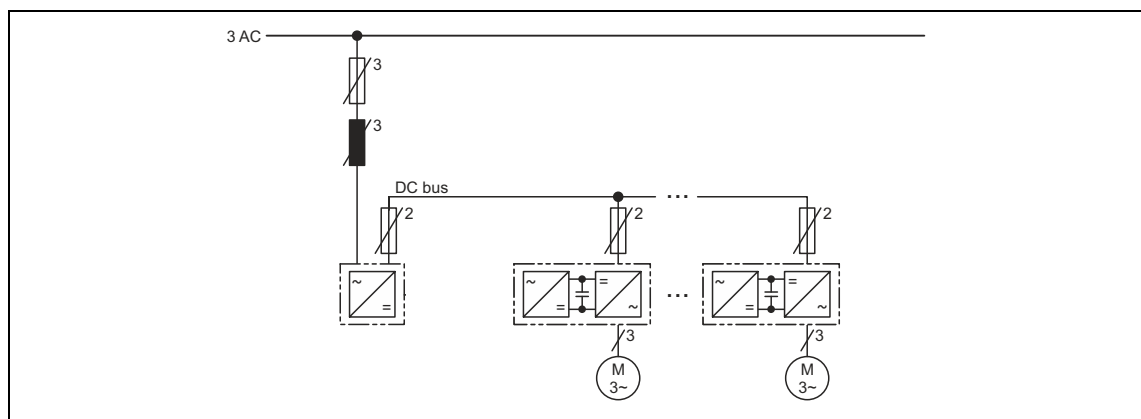
[7-199] One drive axis with supply/feedback

Multi-axis application



[7-200] Multi-axis application with supply/feedback

7.22.2.2 Central mains supply via power supply module

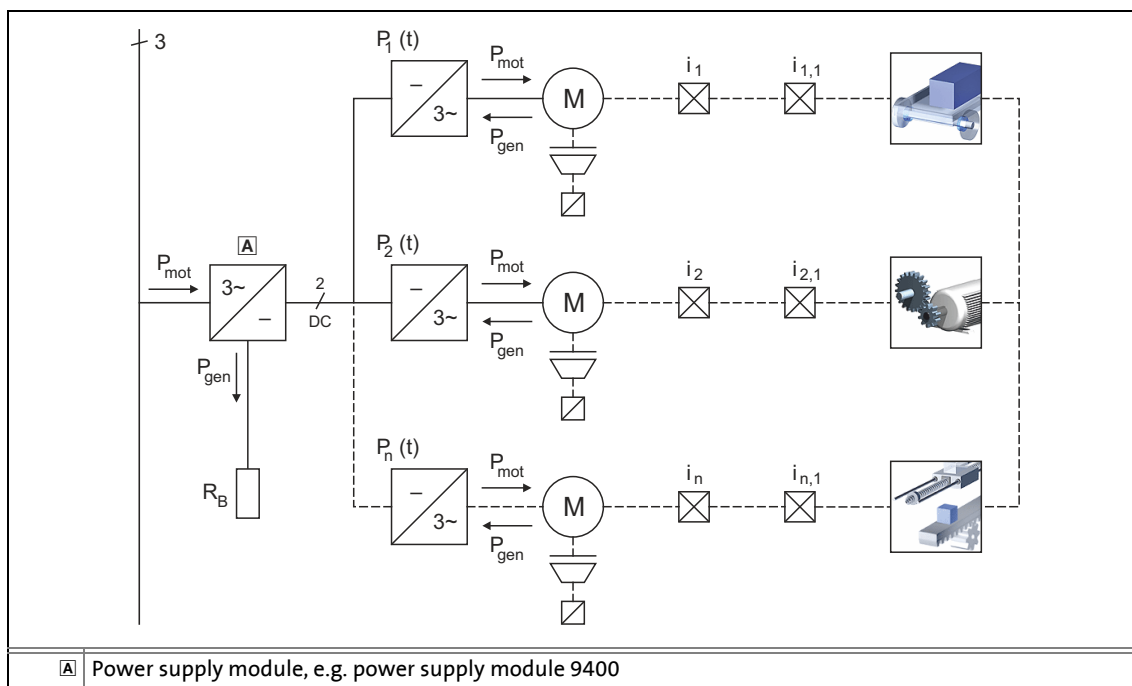


[7-201] Central mains supply via power supply module

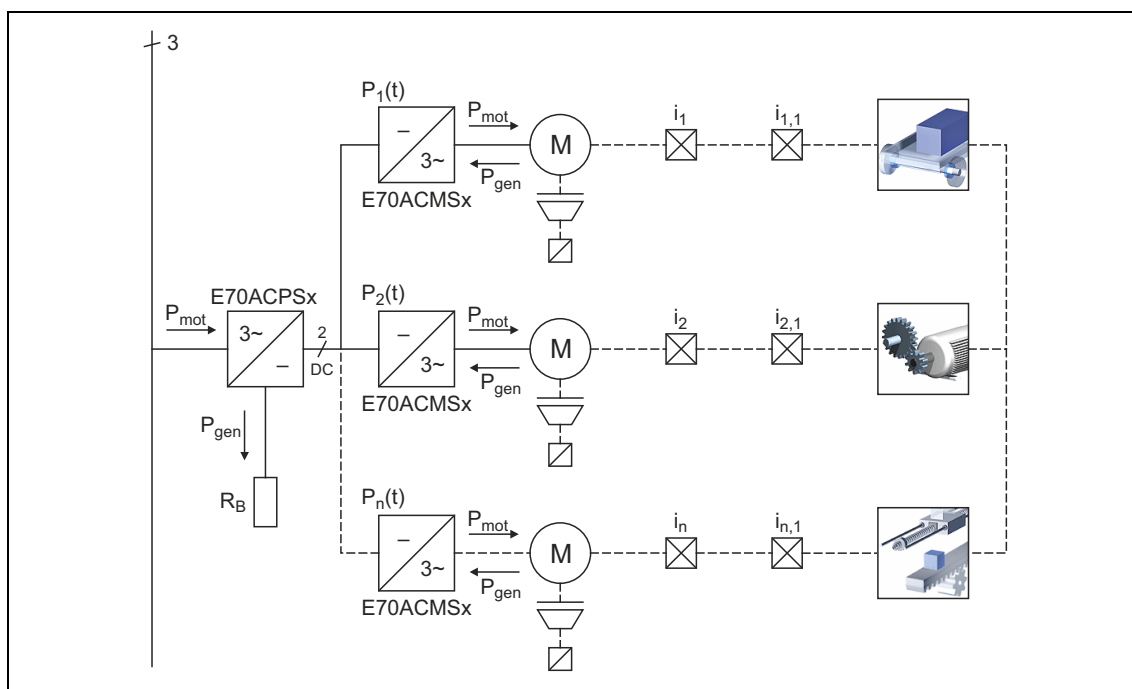
Excessive electrical energy (braking energy) is made available to the drive axes in the DC-bus connection.

- The arrangement can be dimensioned in the DSD.
 - The drive axes can be each dimensioned separately in the DSD.
 - In the "Dimension the multi-axis system" application you combine the drive axes and dimension the power supply module.
 - DSD calculates the entire power requirement. For operation in generator mode it is checked whether the braking power needs to be dissipated via an additional brake resistor.

Multi-axis application

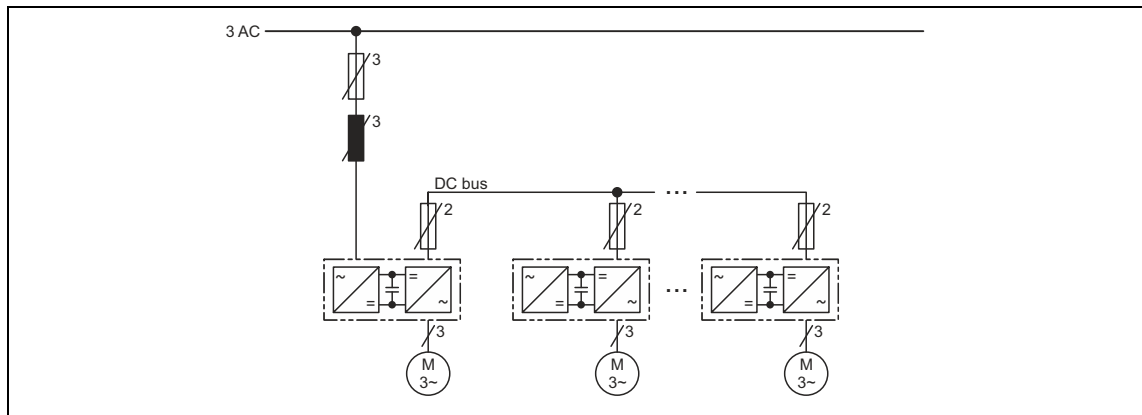


[7-202] Multi-axis application with central supply and central brake resistor



[7-203] Multi-axis application with central power supply and i700 servo inverters as axis modules

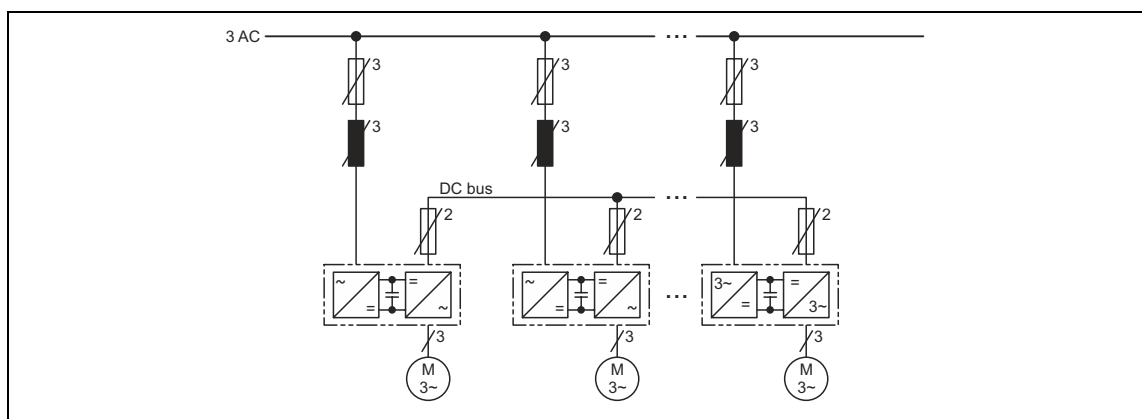
7.22.2.3 Central mains supply via inverter



[7-204] Central mains supply via inverter

- The arrangement cannot be dimensioned in the DSD.
 - The drive axes can be each dimensioned separately in the DSD.
 - The DC parameters for the inverter on the mains must be calculated manually. The required intermediate results are provided by DSD.
 - The entire power balance must be calculated manually.
- In general, it is possible to operate i700 servo inverters as axis modules via the DC bus of an inverter.
 - The drive axes can be each dimensioned separately in the DSD.
 - The DC parameters for the inverter on the mains must be calculated manually. The required intermediate results are provided by DSD.

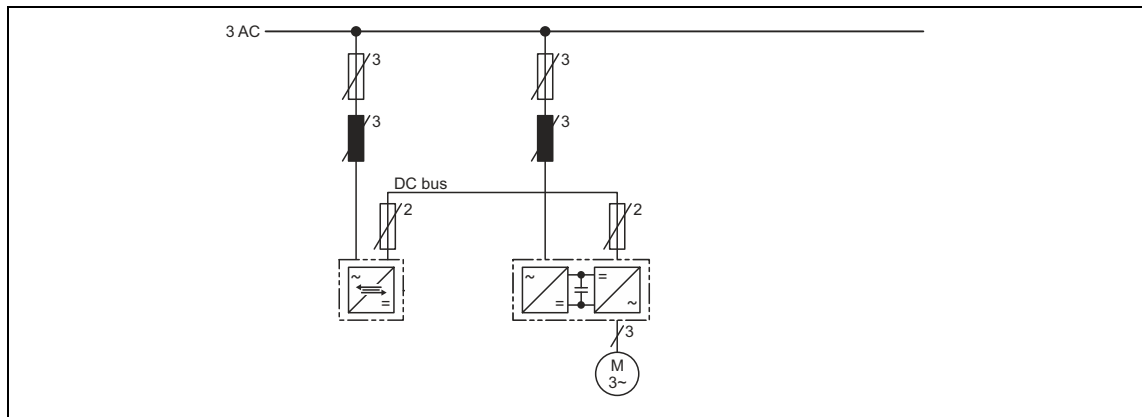
7.22.2.4 Decentralised mains supply via several inverters



[7-205] Decentralised mains supply via several inverters

- The arrangement cannot be dimensioned in the DSD.
 - The drive axes can be each dimensioned separately in the DSD.
 - Additional parameters for the DC bus connection must be determined manually.

7.22.2.5 Decentralised mains supply via regenerative power supply modules and inverters



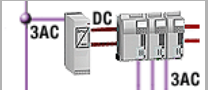
[7-206] Decentralised mains supply via regenerative power supply modules and inverters

- The regenerative power supply module increases the power of the drive in motor mode (reasonable for e.g. hoist drives).
 - The regenerative power is not increased.
- The arrangement cannot be dimensioned in the DSD.
 - The regenerative power supply module and the drive axis can be each dimensioned separately in the DSD.
 - The parallel connection must be calculated manually. The required intermediate results are provided by DSD.
 - The entire power balance must be calculated manually.

7.22.3 Combining Lenze products

Overview of combinability of inverters and additional components with power supply modules or regenerative power supply modules.

Equations for the calculation of the effective moment of inertia for linear motors				
$z_p = \text{Integer}\left(\frac{s}{2\tau_{\text{pole pair}}}\right)$			$J = m \cdot \left(\frac{z_p \cdot 2\tau_{\text{pole pair}}}{2\pi}\right)^2$	
Axis A	Axis B	Symbol	Description	Dimension unit
-	-	s	Length which is the basis of the number of encoder increments. (e.g. pole spacing or total length)	m
-	-	$2\tau_{\text{pole pair}}$	Pole spacing of the permanent magnets, pole pair width	m
-	-	J	Mass moment of inertia	kg m ²
-	-	m	Mass of carriage	kg

		Power supply module		Regenerative power supply module
		E94APN $I_{DC} = 10 \dots 245 \text{ A}$ $P_{DC} = 5.6 \dots 137 \text{ kW}$	E70ACPSx $I_{N,DC} = 30/60 \text{ A}$	E94xx $P_{DC,mot} = 15/30 \text{ kW}$ $P_{DC,gen} = 7.5/15 \text{ kW}$
Servo inverter				
9400 HighLine servo inverter (single drives)				
0.37 ... 11 kW	B	✓	✓	✓
15 ... 30 kW	A B	✓	✓	✓
45 ... 55 kW	A B	C	C	C
75 ... 370 kW	✓	C D	C D	C D
9400 HighLine servo inverter (multi drives)	✓	✓	✓	✓
Frequency inverter 8400 TopLine	B	✓	✓	✓
i700 servo inverter	✓	✓	✓	✓
Frequency inverter				
Frequency inverter 8400 StateLine	B	✓	✓	✓
Frequency inverter 8400 HighLine	B	✓	✓	✓
Additional component				
Brake resistor ERBx	✓	✓	✓	✓

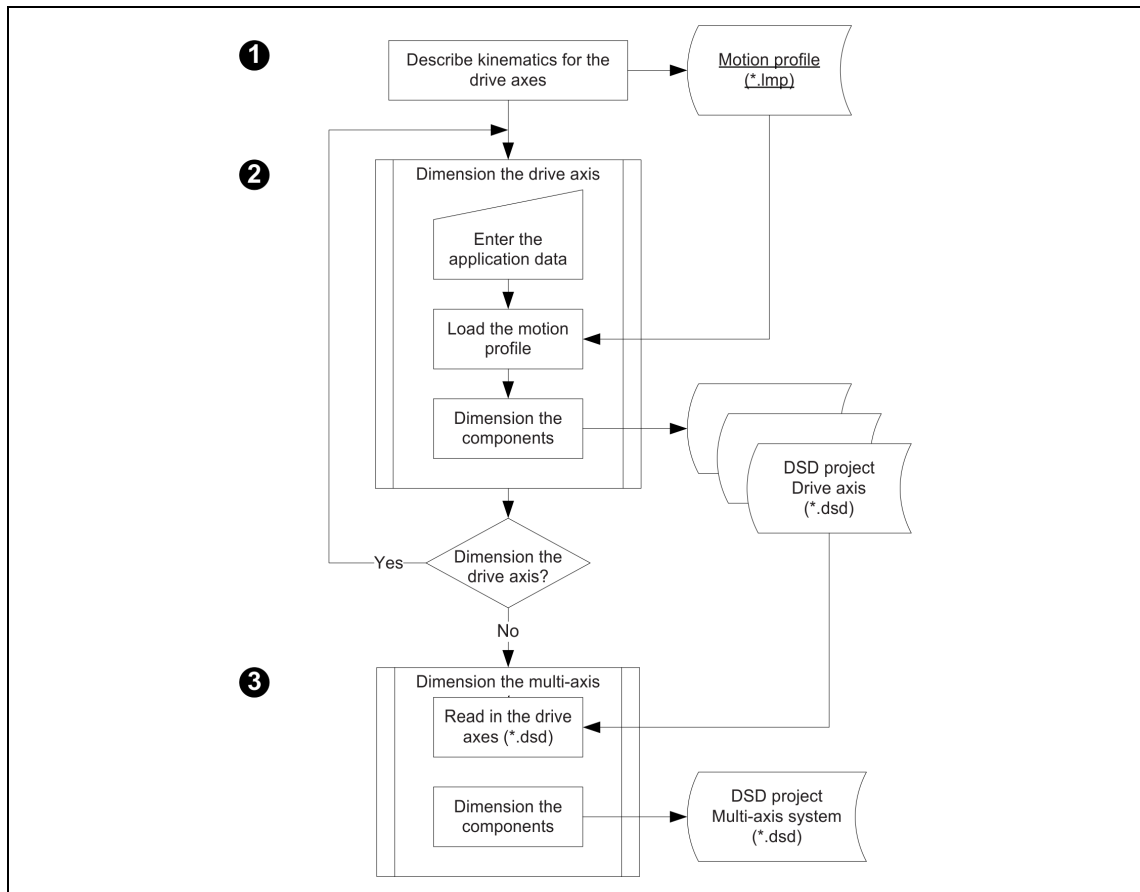
✓ The combination is possible without restrictions.

The combination is possible with restrictions:

- A** The EMC protection of the device is not effective in the DC-bus connection. Check whether EMC measures are required for the entire DC-bus connection or machine.
- B** The braking circuit of the drive axis cannot be dimensioned in the DSD. DSD only dimensions a central braking circuit as it is for example contained in the 9400 power supply module.
If alternative or additional brake choppers are to be set in the drive axes, these braking circuits have to be checked manually.

- Ⓒ No or no sufficient starting current limitation available. Special measures have to be taken. Please contact your Lenze sales partner.
- Ⓓ The combination is not reasonable since the power range of the power supply module or the regenerative power supply module is too low. If the DSD does not display an active message when the module is selected, you can use this combination.

7.22.4 Dimensioning

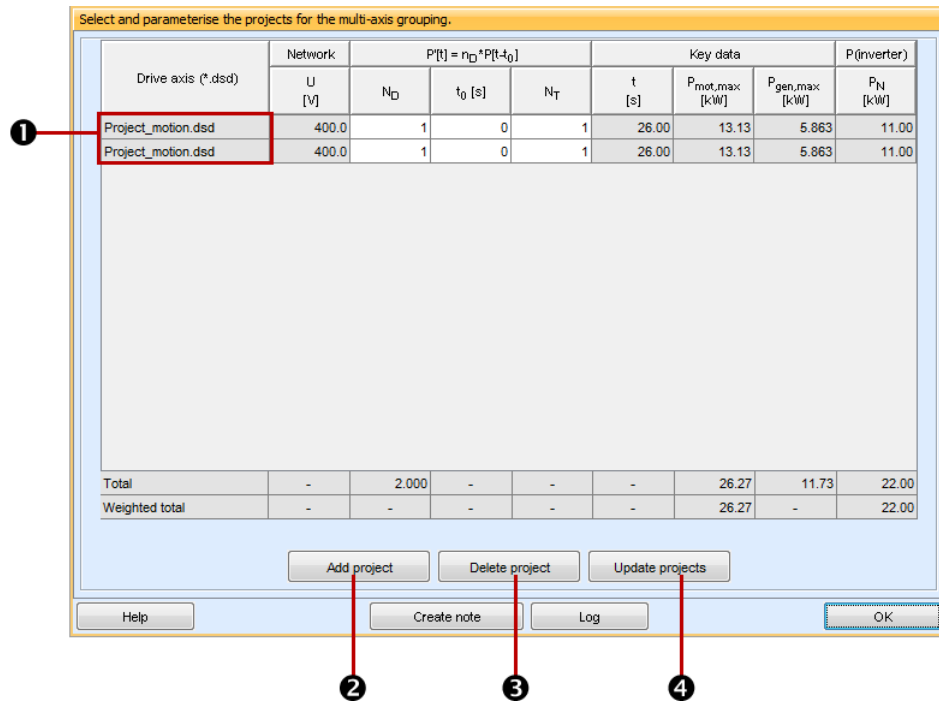


[7-207] General procedure of dimensioning a coordinated multi-axis system

Description	
❶	Go to the independent <i>MotionDesigner</i> , create the motion profiles for all drive axes and save them to a file (*.Imp). • Movement of drive axes (📖 199)

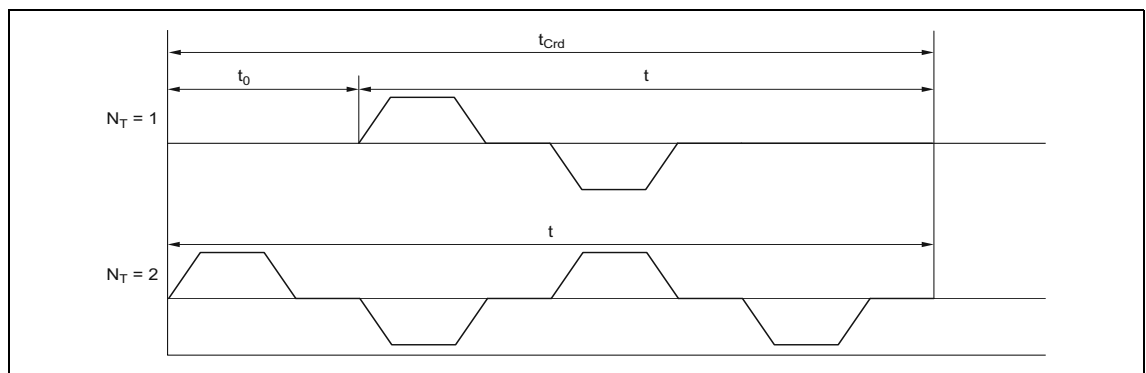
Description	
②	Dimension all drive axes of the multi-axis system. • Load the Imp file with the motion profiles in the <i>MotionDesigner</i> of the drive axis, select and accept the corresponding motion profile. • Select "Inverter with DC supply (multi-axis application)" as electrical drive concept. DSD automatically reduces the selection and only offers inverters that are suitable for the DC-bus connection. • Dimension components and consider the compatibility of the products in the DC bus. • Combining Lenze products (□ 194) • The power in generator and motor mode in the DC bus is calculated separately. DSD considers influencing values as power required of the application, power loss of the drive components and kinetic energy demand due to mass inertia.
③	Select the "Dimension multi-axis system" application and read in the DSD projects of the drive axes. • Optional processing for each DSD project: • Time displacement of the motion profile. • Multiple repetition of the motion profile. • Number of drive axes for a DSD project. • Dimension components and define possible supply strategies: • Central mains supply via regenerative power supply module (□ 188) • Central mains supply via power supply module (□ 190)

7.22.5 Parameterising projects



Legend	Description
❶	Drive axis (*.dsd) - Added DSD projects. - The file name is displayed.
❷	Add project button - Adds a DSD project to the multi-axis application. - In order to add several DSD projects at the same time, select several files in the <i>Add project</i> dialog box: - In order to select single files, keep <Ctrl> pressed and left-click the respective files. - In order to select an area, keep <Shift> pressed and left-click the first and the last file.
❸	Delete project button Deletes a highlighted DSD project from the multi-axis application.
❹	Update project button - Updates the parameters if an added DSD project was changed. The DSD projects of the individual drive axes are linked to the multi-axis application. - Recommendation: Save the DSD project of the multi-axis application and the DSD projects of the single drive axes to the same directory. - The linking remains active if the entire directory is shifted and the multi-axis application is opened. - The linking gets lost if a project file is shifted.

Parameter	Unit		Description
	Metric	Imperial	
U	V	V	Mains voltage of the AC supply system. The DC-bus voltage is expected to be generated by rectifying the mains voltage. • Read only. • You can only add DSD projects that have been dimensioned with the same mains voltage.
Drive axis (*.dsd)			Names of the inserted DSD projects. • Read only. • An added DSD project makes at least one drive axis.
N_D			Number of drive axes that are assigned to the DSD project.
t_0	s	s	Postpone the starting time of the motion profile.
N_T			Number of how often the motion profile is repeated.
t	s	s	Time in which the motion profile is running. • Read only.
$P_{mot,max}$	kW	kW	Max. required power to be provided by the supply component. • Read only.
$P_{gen,max}$	kW	kW	Max. regenerative power which may occur in the DC bus. • If multiple regenerative power supply modules are connected in parallel, the occurring peak braking power is distributed to the individual modules. • Read only.
P_{rated}	kW	kW	Rated power of the inverter. • Corresponds to the typical motor power of a standard asynchronous four-pole motor.
P(inverter)	kW	kW	
Total			Sum of the values per column. Read only.
Weighted total			Average consisting of the sum of the values and the number of axes. • Read only.



[7-208] Motion profiles: Relationship of starting time t_0 , number of repetitions N_T and cycle time t_{Crd}

7.22.6 Defining options

Specify options for the multi-axis grouping.

Movement of drive axes = Axes coordinated

Cycle time for coordinated multi-axis grouping t_{Crd} = 46,7 s

Help Create note Log OK

7.22.6.1 Movement of drive axes

Parameter	Description
Motion of axes	• Axes coordinated • There are definitions governing the movements of the individual axes in relation to one another which are fixed in time. • Axes uncoordinated • The movements of the individual axes are not defined and are not coordinated to each other.

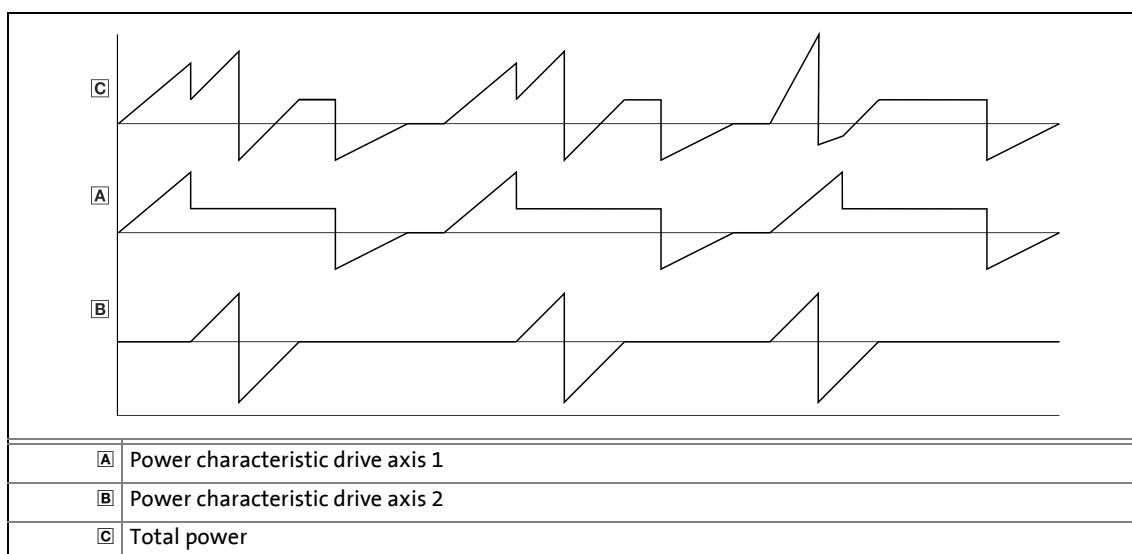
For dimensioning the power supply module or regenerative power supply module and the braking circuit, the selection "coordinated axes" or "uncoordinated axes" is decisive.

- The DC-bus power of coordinated and uncoordinated motion sequences is calculated differently.

Coordinated multi-axis system

In a coordinated multi-axis system, the motion sequences are in a permanently time-defined relationship (e.g. applications with cams or clock-related systems).

- In the DSD, you can optimally dimension a multi-axis system with coordinated drive axes relating to energy.
- *Lenze BlueGreen Solutions* serves to calculate amortisation times quickly. The cost-cutting potentials are documented in an Energy Performance Certificate.
[Energy efficiency \(417\)](#)

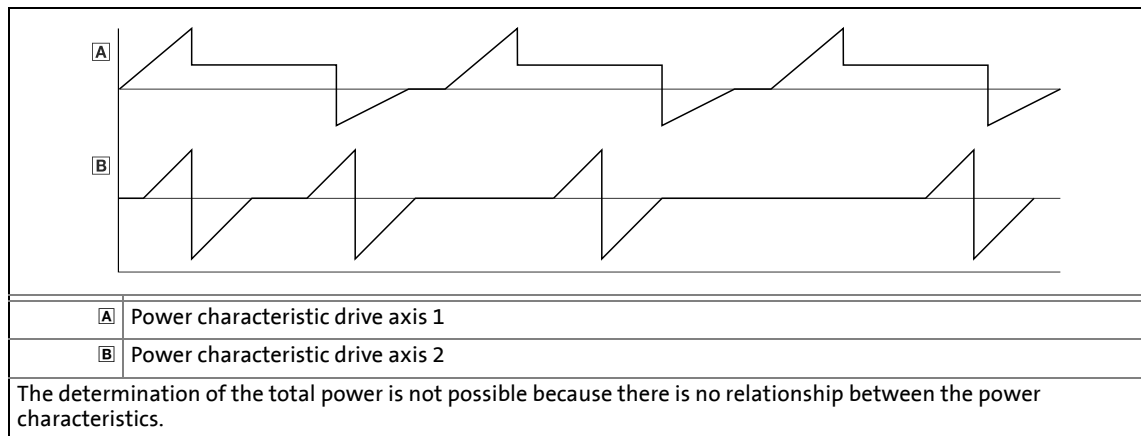


[7-209] Power characteristic of two coordinated drive axes

Uncoordinated multi-axis system

Uncoordinated motion sequences are not associated with regard to time. Even if only single drive axes of the multi-axis system are uncoordinated, the DSD calculates with the most unfavourable power characteristic:

- The peak powers of all single axes occur at the same time.
- The supply components of the network must provide the sum of peak powers in generator mode and in motor mode of all drive axes.



[7-210] Power characteristic for two uncoordinated drive axes

7.22.6.2 Cycle time for coordinated multi-axis grouping

Parameter	Description
t_{Crd}	Cycle time for coordinated multi-axis grouping. For drive axes with motion profiles with different time lengths, the DSD calculates with the longest motion profile. For the shorter motion profiles, the DSD considers until the end of the entire cycle the performance values that are provided at the end of each motion profile defined with regard to time. The min. adjustable cycle time results from the product $t \times N_T$. • t: Cycle time of the longest motion profile • N_T: Number of how often the motion profile is repeated. • It is not possible to fall below the cycle times of the motion profiles of the individual drive axes. • Parameter is only available in case of a coordinated multi-axis system. ► Parameterising projects (197)

7.23 Winding drive for rewinder/unwinder

7.23.1 Rewinder (single)

Rewinders are used in many production processes. They are able to store continuous material after the machining process.

The roller of a single rewinder can only be changed at standstill. The winding drive is braked to standstill and then accelerated to production speed again after changing the roller. A web accumulator serves to change the roller without the need for a production downtime. When the winding drive is at standstill, the web accumulator stores the produced material.

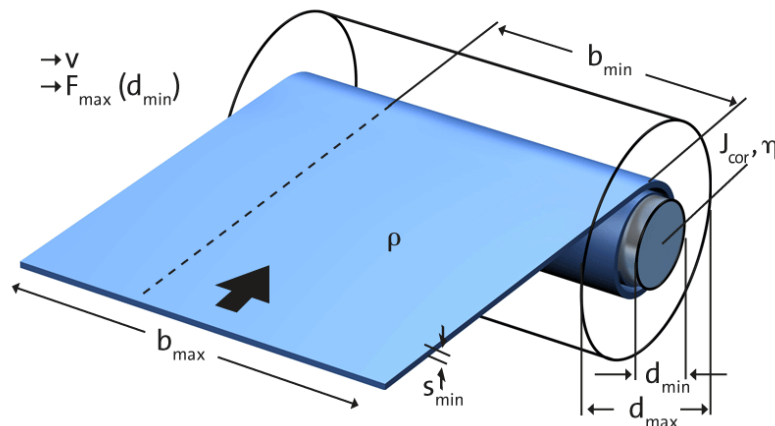
Materials to be processed are e.g.: homogeneous webs (e.g. paper webs), fabrics, meshwork, wires, threads or fibres. From a mathematical point of view, the wound up material is a spiral. Depending on the application range and industry sector, the spiral is called reel, spool, coil or tree.

There are two winding technologies:

- Lay-up winding (e.g. foils, paper, plates).
- Filament winding (e.g. threads, fibres, wires, cables). This winding technology is not supported by DSD.

The requirements for the winding drive depend on the winding material and may be very high:

- No impacts on the winding material during the winding process.
- High speed and torque setting ranges.
- Dynamic phase must not have any negative impacts on the tensile force.



7.23.1.1 Calculations

Translatory acceleration

$$a = \frac{dv}{dt} = \frac{\Delta v}{\Delta t}$$

[7-211] Equation 1: Translatory acceleration

Sizing diameter

$$d_{\text{dim}} = \sqrt{\frac{2 \cdot v_{\text{max}} \cdot t_{\text{acc}} \cdot s_{\text{Min}}}{\pi} + d_{\text{Min}}^2}$$

[7-212] Equation 2: Dimensioning diameter for the reel

Max. winding ratio

$$q_{\text{max}} = \frac{d_{\text{max}}}{d_{\text{Min}}}$$

[7-213] Equation 3: Max. winding ratio

Dimensioning winding ratio

The DSD limits the q_{dim} dimensioning winding ratio to 200.

$$q_{\text{dim}} = \frac{d_{\text{max}}}{d_{\text{dim}}}$$

[7-214] Equation 4: Dimensioning winding ratio

Winding characteristic

$$HW = \frac{\frac{F_{\text{max}}(d_{\text{max}})}{F_{\text{max}}(d_{\text{Min}})} \cdot q - 1}{q - 1}$$

[7-215] Equation 5: Winding characteristic

Diameter characteristic

$$d = \sqrt{\frac{2}{\pi} \cdot (v_0 + v_1) \cdot (t_1 - t_0) \cdot s + d_i^2}$$

[7-216] Equation 6: Diameter characteristic of the reel

Mass of the winding material

$$m_L = \rho \cdot \frac{\pi}{4} \cdot (d_i^2 - d_{\text{Min}}^2) \cdot b_{\text{max}}$$

[7-217] Equation 7: Mass of the winding material

Length of the winding material

$$l = \frac{\pi}{4} \cdot \frac{(d_{\max}^2 - d_{\min}^2)}{s_{\min}}$$

[7-218] Equation 8: Length of the winding material

Angular acceleration

$$\alpha = \frac{a}{r}$$

[7-219] Equation 9: Angular acceleration

Angular velocity

$$\omega = 2\pi \cdot n$$

[7-220] Equation 10: Angular velocity

Tensile force profile

$$F_{\text{pll}} = F_{\max} \cdot \left(\frac{d_{\min} \cdot (1 - HW)}{d_i} + HW \right)$$

[7-221] Equation 11: Tensile force profile

Tensile force setting range

$$k_F = \frac{F_{\max}(d_{\max})}{F_{\min}(d_{\min})}$$

[7-222] Equation 12: Tensile force setting range

Torque setting range

$$k_M = K_F \cdot q$$

[7-223] Equation 13: Torque setting range

Stationary torque

$$M_{\text{sds}} = F_{\text{pll}} \cdot \frac{d_i}{2 \cdot \eta_{\text{App}}}$$

[7-224] Equation 14: Stationary torque

Total torque

$$M_{\text{sum}} = M_{\text{sds}} + J_{\text{Wnd}} \cdot \frac{\alpha}{\eta_{\text{App}}}$$

[7-225] Equation 15: Total torque

Required process power

$$P_{App} = F_{max} \cdot \frac{v_{max}}{\eta}$$

[7-226] Equation 16: Required power of the application

Field weakening factor

$$k_f = \frac{n_{max}}{n_N}$$

[7-227] Equation 17: Field weakening factor of the motor

Required motor output

$$P_M = \frac{F_{max}(d_{max}) \cdot v_{max} \cdot d_{max}}{\eta \cdot k_f \cdot d_{dim}}$$

[7-228] Equation 18: Required motor power

7.23.1.2 Symbols used

Symbol	Description	Dimension unit
a	Translatory acceleration	m/s^2
$b_{\max}$	Max. width of the winding material	mm
d	Diameter characteristic	mm
d_{dim}	Sizing diameter • Diameter which is reached after termination of the acceleration phase.	mm
$d_{\min}$	Minimum reel diameter (initial diameter)	mm
$d_{\max}$	Maximum reel diameter	mm
$F_{\min}(d_{\min})$	Min. tensile force with min. reel diameter (initial diameter)	N
$F_{\max}(d_{\min})$	Max. tensile force with min. reel diameter	N
$F_{\max}(d_{\max})$	Max. tensile force with max. reel diameter	N
HW	Winding characteristic (hard/soft) • describes the tensile force drop as a function of the reel diameter	
k_f	Field weakening factor	
k_f	Tensile force setting range	
k_M	Torque setting range	
l	Length of the winding material	m
M_{sds}	Stationary torque	Nm
m_{sum}	Total torque	Nm
$n_{\max}$	Max. motor speed	rpm
n_{rated}	Rated speed of the motor	rpm
ρ	Average density of winding material	kg/dm^3
P_{App}	Required process power	
P_M	Required motor output	kW
q	Winding ratio	
$q_{\max}$	Maximum winding ratio	
q_{dim}	Dimensioning winding ratio • The DSD limits q_{dim} to 200.	
$s_{\min}$	Thickness of the winding material • If multiple materials are wound, the smallest material thickness must be indicated.	mm
t_{acc}	Acceleration time of the winding drive	m/s
t_{dec}	Deceleration time of the winding drive	m/s
$v_{\max}$	Max. material speed	m/min
α	Angular acceleration	rad/s^2
η	Mechanical efficiency of the winding system (coil and coil intake)	
ω	Angular velocity	rad/s

7.23.2 Unwinder (single)

Unwinders are used in many production processes. They store continuous material and feed it to a production process which can be carried out in a continuous or discontinuous manner.

The roller of a single rewinder can only be changed at standstill. The winding drive is braked to standstill and then accelerated to production speed again after changing the roller. A web accumulator serves to change the roller without the need for a production downtime. When the winding drive is at standstill, the web accumulator feeds the winding material to the production process.

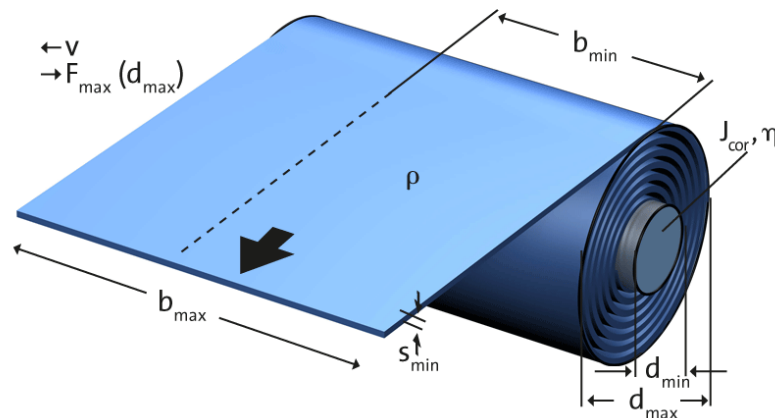
Materials to be processed are e.g.: homogeneous webs (e.g. paper webs), fabrics, meshwork, wires, threads or fibres. From a mathematical point of view, the wound up material is a spiral. Depending on the application range and industry sector, the spiral is called reel, spool, coil or tree.

There are two winding technologies:

- Lay-up winding (e.g. foils, paper, plates).
- Filament winding (e.g. threads, fibres, wires, cables). This winding technology is not supported by DSD.

The requirements for the winding drive depend on the winding material and may be very high:

- High speed and torque setting ranges.
- Dynamic phase must not have any negative impacts on the tensile force.



7.23.2.1 Calculations

Translatory acceleration

$$a = \frac{dv}{dt} = \frac{\Delta v}{\Delta t}$$

[7-229] Equation 1: Translatory acceleration

Sizing diameter

$$d_{\text{dim}} = \sqrt{\frac{2 \cdot v_{\text{max}} \cdot t_{\text{acc}} \cdot s_{\text{Min}}}{\pi} + d_{\text{Min}}^2}$$

[7-230] Equation 2: Dimensioning diameter for the reel

Max. winding ratio

$$q_{\text{max}} = \frac{d_{\text{max}}}{d_{\text{Min}}}$$

[7-231] Equation 3: Max. winding ratio

Dimensioning winding ratio

The DSD limits the q_{dim} dimensioning winding ratio to 200.

$$q_{\text{dim}} = \frac{d_{\text{max}}}{d_{\text{dim}}}$$

[7-232] Equation 4: Dimensioning winding ratio

Diameter characteristic

$$d = \sqrt{\frac{2}{\pi} \cdot (v_0 + v_1) \cdot (t_1 - t_0) \cdot s_{\text{Min}} + d_i^2}$$

[7-233] Equation 5: Diameter characteristic of the reel

Mass of the winding material

$$m_L = \rho \cdot \frac{\pi}{4} \cdot (d_i^2 - d_{\text{Min}}^2) \cdot b_{\text{max}}$$

[7-234] Equation 6: Mass of the winding material

Length of the winding material

$$l = \frac{\pi}{4} \cdot \frac{(d_{\text{max}}^2 - d_{\text{Min}}^2)}{s}$$

[7-235] Equation 7: Length of the winding material

Angular acceleration

$$\alpha = \frac{a}{r}$$

[7-236] Equation 8: Angular acceleration

Angular velocity

$$\omega = 2\pi \cdot n$$

[7-237] Equation 9: Angular velocity

Tensile force setting range

$$k_F = \frac{F_{\max}}{F_{\min}}$$

[7-238] Equation 10: Tensile force setting range

Torque setting range

$$k_M = K_F \cdot q$$

[7-239] Equation 11: Torque setting range

Speed setting range

$$k_n = \frac{n_{\max}}{n_{\min}}$$

[7-240] Equation 12: Speed setting range

Speed setting range

$$k_v = \frac{v_{\max}}{v_{\min}}$$

[7-241] Equation 13: Velocity setting range

Stationary torque

$$M_{sds} = F_{pll} \cdot \frac{d_i}{2} \cdot \eta_{App}$$

[7-242] Equation 15: Stationary torque

Total torque

$$M_{sum} = M_{sds} + J_{Wnd} \cdot \frac{d}{\eta_{App}}$$

[7-243] Equation 16: Total torque

Required process power

$$P_{App} = F_{max} \cdot v_{max} \cdot \eta$$

[7-244] Equation 17: Required power of the application

Field weakening factor

$$k_f = \frac{n_{max}}{n_N}$$

[7-245] Equation 18: Field weakening factor of the motor

Required motor output

$$P_M = \frac{F_{max} \cdot v_{max} \cdot d_{max} \cdot \eta}{k_f \cdot d_{dim}}$$

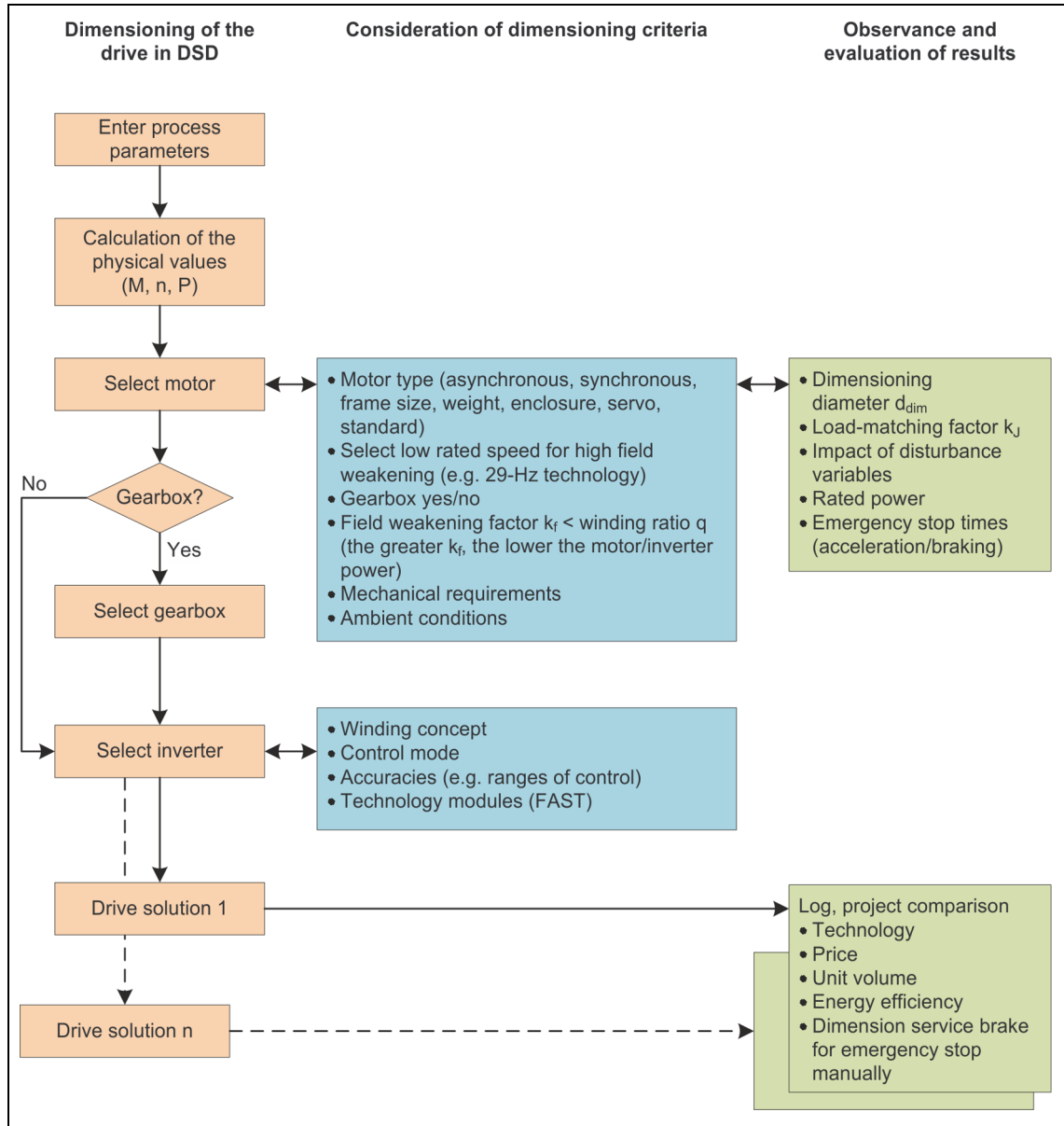
[7-246] Equation 19: Required motor power

7.23.2.2 Symbols used

Symbol	Description	Dimension unit
a	Translatory acceleration	m/s^2
b_{max}	Max. width of the winding material	mm
d	Diameter characteristic	mm
d_{dim}	Sizing diameter • Diameter which is reached after termination of the acceleration phase.	mm
d_{min}	Minimum reel diameter (initial diameter)	mm
d_{max}	Maximum reel diameter	mm
F_{min}	Tensile force with min. reel diameter	N
F_{max}	Tensile force with max. reel diameter (initial diameter)	N
k_f	Field weakening factor	
k_f	Tensile force setting range	
k_M	Torque setting range	
k_n	Speed setting range	
k_v	Speed setting range	
l	Length of the winding material	m
M_{sds}	Stationary torque	Nm
m_{sum}	Total torque	Nm
n_{max}	Max. motor speed	rpm
n_{rated}	Rated speed of the motor	rpm
ρ	Average density of winding material	kg/dm^3
P_{App}	Required process power	
P_M	Required motor output	kW
q	Winding ratio	
q_{max}	Maximum winding ratio	
q_{dim}	Dimensioning winding ratio • The DSD limits q_{dim} to 200.	
s_{min}	Thickness of the winding material • If multiple materials are wound at the same time, the smallest material thickness must be indicated.	mm
t_{acc}	Acceleration time of the winding drive	m/s
t_{dec}	Deceleration time of the winding drive	m/s
v_{max}	Max. speed of the material	m/min
α	Angular acceleration	rad/s^2
η	Mechanical efficiency of the winding system (coil and coil intake)	
ω	Angular velocity	rad/s

7.23.3 Dimensioning strategies

The diagram below shows the basic procedure for dimensioning a winding drive. DSD automatically guides you through the required dimensioning steps.



[7-247] Strategy for dimensioning a winding drive in DSD

The following functions are efficient tools for comparing drive solutions and representing different scenarios.

Generate alternative

For an optimal drive dimensioning, it is wise to create different motor technologies, field weakening factors, mechanical ratios and inverters as separate projects and to compare them.

The [Creating an alternative](#) function serves to create a copy - from the current project up to the desired dimensioning step. Every project can be dimensioned with different parameters. ([📖 55](#))

Project comparison

The [Project comparison](#) function serves to compare all important parameters relevant to the dimensioning in the opened DSD projects (alternative dimensionings). Other comparison criteria such as price, construction volume and mass must be compared manually. This information helps select an optimal drive solution together with the customer. ([📖 59](#))

Application Tuner

Based on a determined drive solution (reference solution), the [Application Tuner](#) function is used to check operation under different conditions (e.g. emergency stop scenarios) or with different parameters (e.g. different recipes, other materials, alternative motion profile) and to draw a comparison with the reference. ([📖 57](#))

The drive solution found via Application Tuner can be logged in DSD and saved as separate project.

7.23.4 Traction-controlled winding drive

In winding drives, the tensile force is generated by the static torque M_{stat} . During the acceleration and deceleration phases, the drive requires an additional dynamic torque M_{dyn} .

In order to prevent the tensile force from exceeding the limit values and in order to avoid empty reels, the dynamic component of the torque should be smaller than the static component for traction-controlled winders. If the disturbance compensation works well and is repeatable, the dynamic component may be a little greater than the static component. Critical phases are accelerations during the start of winding to an empty reel with minimum tensile force.

- Guide value: $M_{\text{dyn}} < 1 \dots 3 \times M_{\text{stat}}$

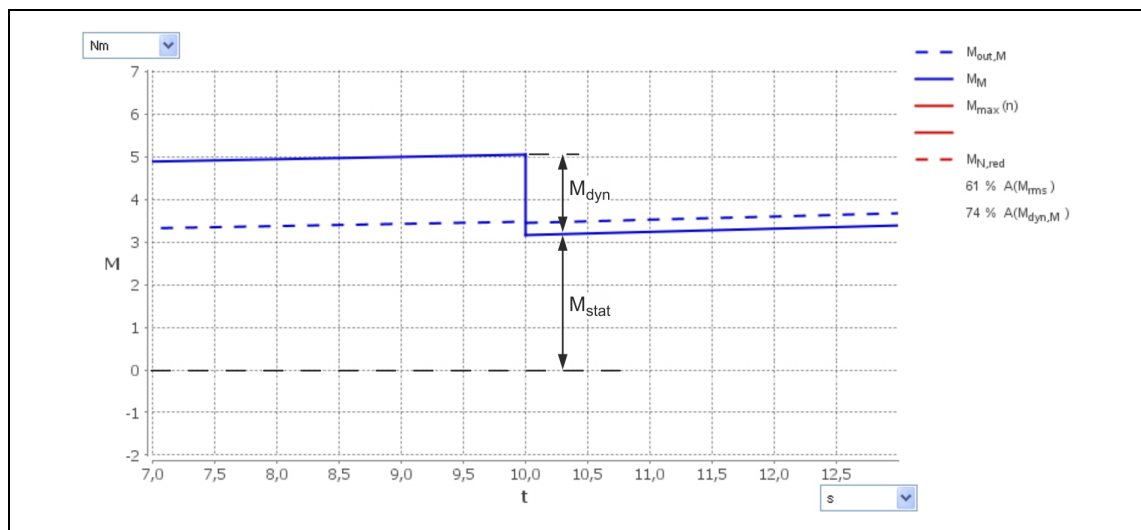


Tip!

How to limit the dynamic torque:

- Select moderate acceleration and deceleration times
- Create an S-shaped motion profile

The $M_{\text{dyn}}/M_{\text{stat}}$ ratio can be read from the torque-time characteristic of the motor. Dimension the drive completely and zoom in on the start of the characteristic (starting time) to be able to see the dynamic torque. Use the Zoom function for this purpose. [Diagrams for the components](#) (434)



[7-248] Torque-time characteristic of the motor

7.23.5 Checking emergency-off scenarios

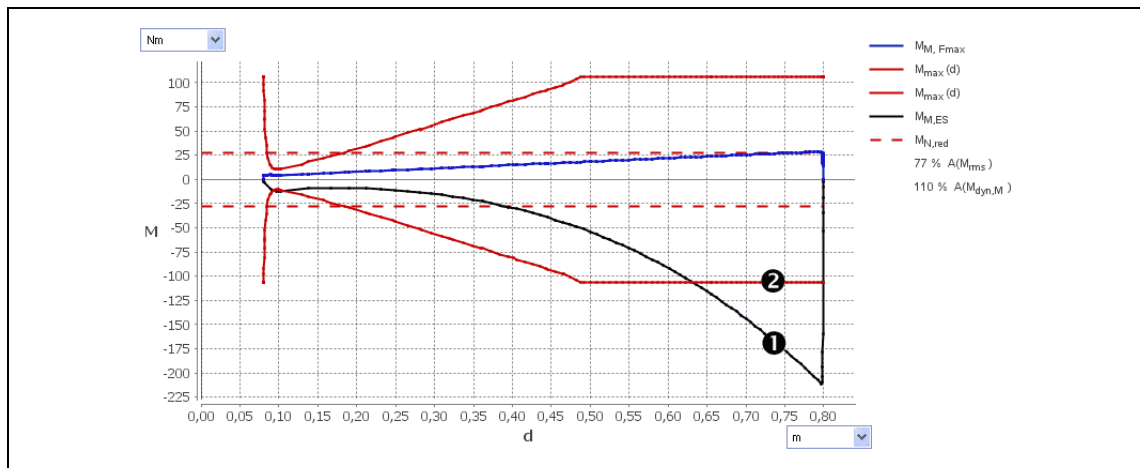
DSD is only partially able to check emergency-off scenarios. The user interface and the DSD protocol display a note.



Note!

The torque required for emergency stop is greater than the drive torque available.

- The torque required for emergency stop is calculated and represented in the diameter-dependent torque diagram of the motor. The calculation is based on the emergency stop time, a linear motion profile, and a tensile force = 0 N (material crack).
- The thermal utilisation of the drive components is not checked.
- Braking circuits are not dimensioned.



[7-249] Motor diagram: winder torque (diameter-related)

Description	
❶	Torque required for emergency stop
❷	Max. available drive torque

The *Application Tuner* may help with the required additional checks. [Application Tuner](#) (□ 57)

7.23.6 Application data

Enter the application-specific data in the *Data of the application* dimensioning step.

7.23.6.1 Winder control mode

A DSD wizard supports you in the optimal dimensioning of the winding drive and the selection of the components. DSD displays messages (tips, notes, and warnings) if the further dimensioning influences certain settings:

- Winder control mode
- Data of the application and motion
- Type of inverter control

The messages are also included in the DSD protocol.

Parameter	Description
Mode	• Tension control (M) • Dancer position control (n) • Tension control (M) • Tension control (n) • Speed control (n)

Overview

	Tension ctrl open loop (M)	Tension control closed loop (M) ¹⁾	Tension control closed loop (n) ¹⁾	Dancer position control (n)	Speed control (n)
Winder control mode					
Traversing motor control	Open-loop torque control	Open-loop torque control	closed-loop speed control	Closed-loop speed control/ open-loop speed control	Open-loop speed control/ closed-loop speed control

	Tension ctrl open loop (M)	Tension control closed loop (M) ¹⁾	Tension control closed loop (n) ¹⁾	Dancer position control (n)	Speed control (n)
Description	Indirect tension control via the drive torque with disturbance compensation (friction, acceleration).	Torque-controlled process with a higher-level tension control closed loop and interference compensation (friction, acceleration). The actual tensile force value is recorded by means of a sensor at the material web.	Speed-controlled process with a higher-level tension control closed loop and interference compensation (friction, acceleration). The actual tensile force value is recorded by means of a sensor at the material web.	Tension control open loop via dancers. The drive is actuated in a speed- and position-controlled fashion. Further tasks of the dancer: detection of the actual position. Web accumulator for the compensation of eccentricities of the winding reel (e.g. in the case of the unwinder) and of discontinuities.	The tensile force is determined by the upstream system. The winder works as master in the drive system and conveys the material with a constant circumferential speed. The circumferential speed is treated with closed-loop control, the speed is treated with closed- or open-loop control.
Application area	Universal, cost-effective winding procedure for low to high requirements with regard to tensile force quality and tensile force profile.	Winding procedure for high requirements with regard to tensile force quality and tensile force profile.	Winding procedure for high requirements with regard to tensile force quality and tensile force profile.	Universal, cost-effective winding procedure for low to high requirements with regard to tensile force quality and tensile force profile. Well suited for eccentric reels, e.g. in the case of unwinders.	Unwinders for slitting lines.
Control system					
SC					
Rewinder/unwinder	++/++	++/++	++/++	++ ³⁾ /++ ³⁾	++ ³⁾ /++ ³⁾
VFC plus without encoder					
Rewinder/unwinder	-/-	-/-	-/-	O/O	O/O
SLVC					
Rewinder/unwinder	O/-	-/-	-/-	O/-	O/-
VFC plus with encoder					
Rewinder/unwinder	O/-	-/-	-/-	O/O	O/O
VFC plus eco					
Rewinder/unwinder	-/-	-/-	-/-	-/-	-/-

++ Well-suited

O Suitable with restrictions

- Not suitable

¹⁾ [Comparison of tension-controlled winder control modes](#) (📖 217)

²⁾ Diameter measurement, e.g. with an ultrasonic sensor (optional)

³⁾ Motorgeber erforderlich

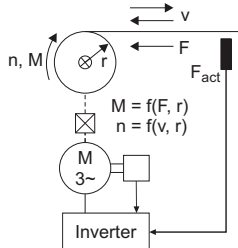
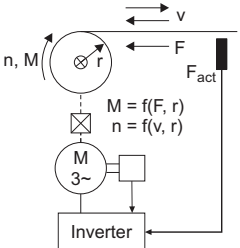
SC Servo control

VFC plus V/f control

VFC plus eco V/f control with energetically optimised field injection in the partial load operational range

SLVC Sensorless vector control

Comparison of tension-controlled winder control modes

Requirement	Tension control (M)	Tension control (n)	Note
Winder control mode			
Description	Torque-controlled mode with compensation for the interference caused by friction and acceleration	Speed-controlled mode (optionally with compensation for friction and acceleration to the torque setpoint)	Both control modes are suitable for demanding winding applications with a high consistency in tensile force and large setting ranges
Tensile force / torque setting range	max. 100	no upper limit	
Acceleration behaviour	+++	+++	Both modes feature acceleration compensation
Behaviour in the case of tensile force sensor failure	+++ (operation possible in case of an emergency)	– (operation not possible)	
Combined winder control modes: Closed-loop controlled for lower and open-loop controlled for upper tensile force setting ranges	+++	–	Application in case of a large range of materials with a large tensile force setting range
Control mode as a function of material elasticity	suitable for no or low material elasticity (e.g. metal strips, foils, plates, glass non-woven)	suitable for medium material elasticity, e.g. paper, films, coated composite material	Tensile force sensor is a pathless detection system
Influence of the friction on the tensile force / torque setting range	+ (great influence)	+++ (little to no influence)	
Suitable for unwinders with eccentric reels	++ (non-sensitive behaviour)	O (sensitive behaviour)	If stored for a longer period of time, reels may deform eccentrically
System management in case of material crack	++	+++	
Control engineering requirements	Medium	High	Adaptations to a variable moment of inertia, variable speed
Required encoder resolution	Medium	High	
Accuracy for the detection of the line speed	Medium	High	Reasons for the differences between the actual and the detected speed: coated squeegees, slip between material and roll, tolerances in material thickness

+++ Very well suited

++ Well-suited

+ Suited

O Suitable with restrictions

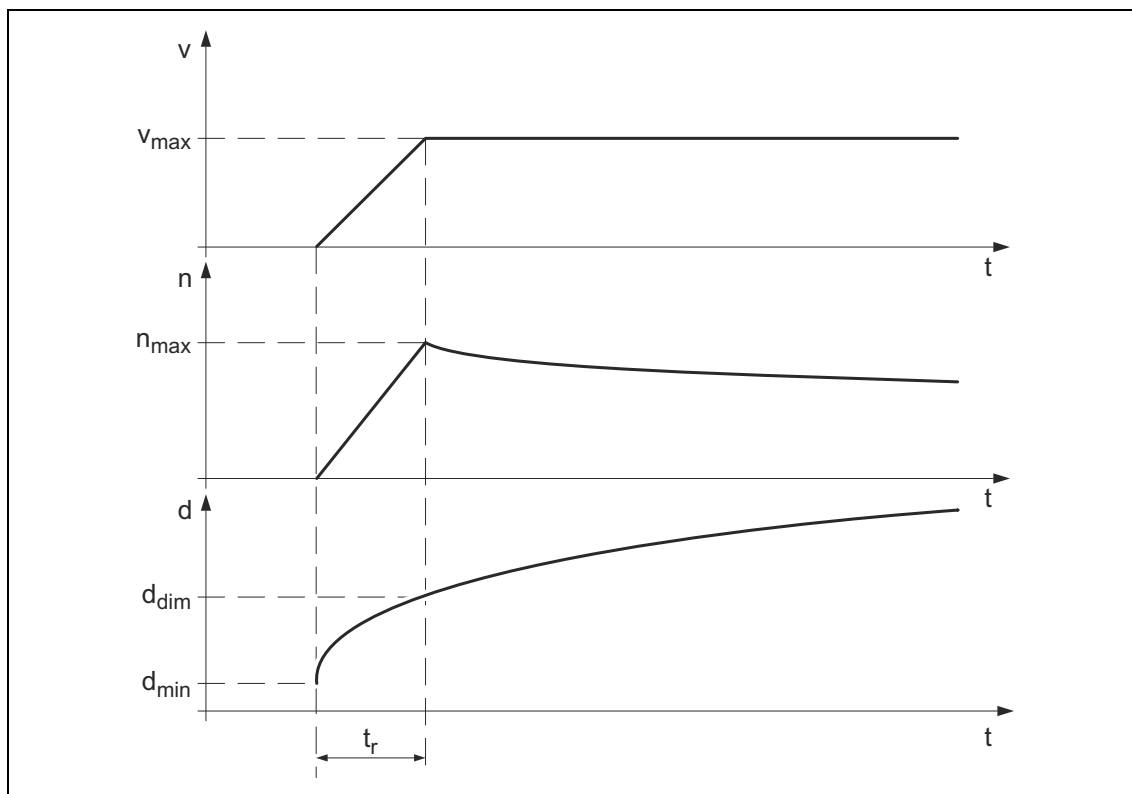
– Not suitable

7.23.6.2 Min. reel diameter (rewinder)

Parameter	Description
$d_{\min}$	Smallest reel diameter at the beginning of the winding process (initial diameter)

Sizing diameter

The dimensioning diameter is the diameter which results at the end of the acceleration phase. DSD calculates this value automatically and considers it in the drive dimensioning.



$d_{\min}$	Min. reel diameter (initial diameter)
$d_{\dim}$	Sizing diameter
$n_{\max}$	Max. winding drive speed
$v_{\max}$	Max. line speed
t_r	Acceleration time

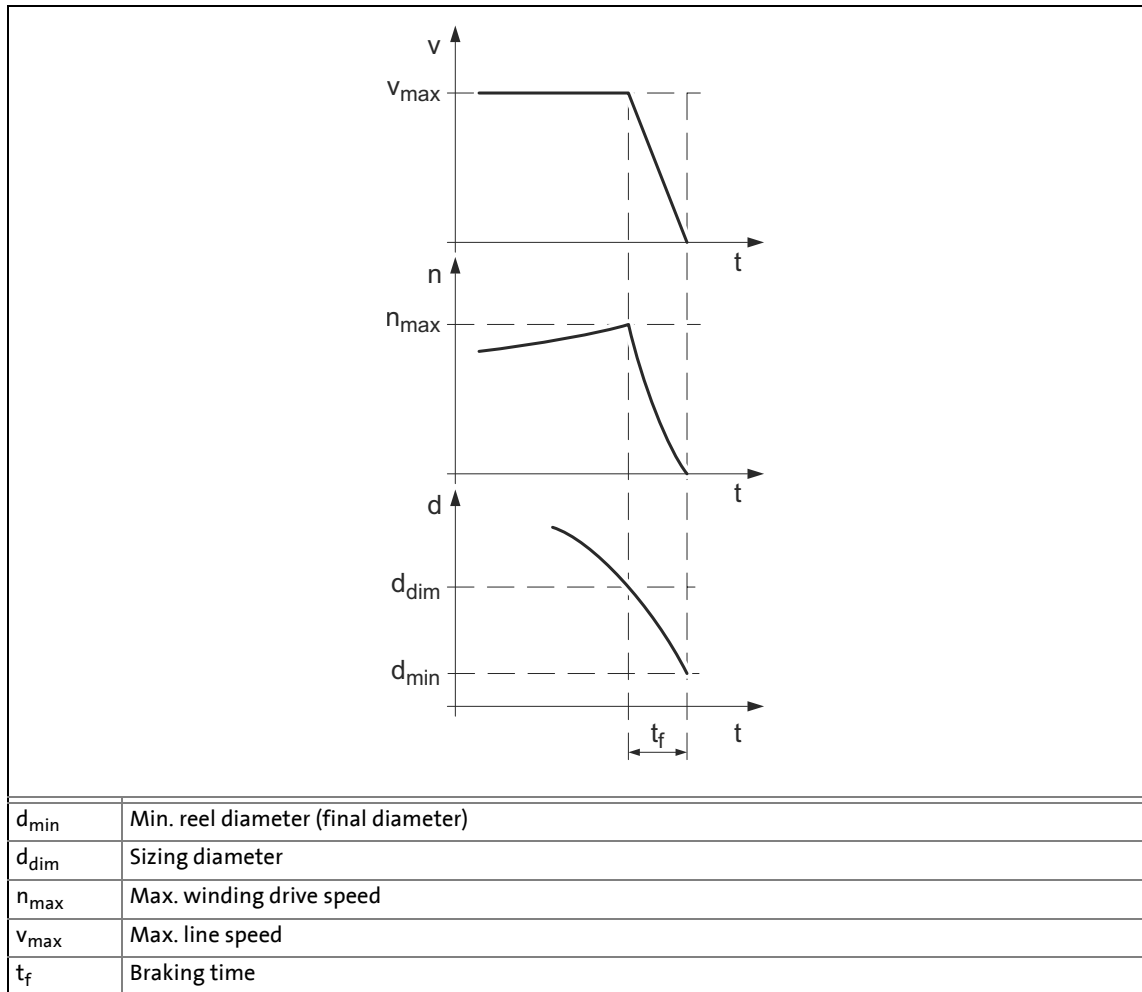
[7-250] Increase in the reel diameter during the acceleration phase without reduction of the winding speed

7.23.6.3 Min. reel diameter (unwinder)

Parameter	Description
$d_{\min}$	Smallest reel diameter at the end of the winding process (final diameter)

Sizing diameter

The dimensioning diameter is the diameter which results at the beginning of the braking phase. DSD calculates this value automatically and considers it in the drive dimensioning.



[7-251] Decrease in the reel diameter during the braking phase without reduction of the winding speed

7.23.6.4 Max. reel diameter

Parameter	Description
$d_{\max}$	• Rewinder: Diameter of the finished reel. • Unwinder: Diameter at the beginning of the winding process.

7.23.6.5 Max. material width

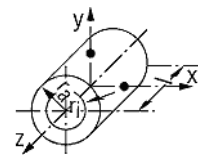
Parameter	Description
$b_{\max}$	Max. width of the reel.

Determining the material width from the mass and the diameter of the reel

The drive can also be dimensioned if only the mass, the minimum and the maximum reel diameter are known.

DSD uses the data of the application to calculate the moment of inertia of the reel and uses this value for the further dimensioning. The formula [7-252] for calculating the moment of inertia shows the quantities used for the description of the reel in the dimensioning process.

$J = \frac{m}{2} \cdot (r_a^2 + r_i^2)$	
J	Moment of inertia - reel
m	Mass - reel
$r_a = d_{\max}$	Max. reel diameter
$r_i = d_{\min}$	Min. reel diameter



[7-252] Calculation of the moment of inertia

If m , $d_{\max}$, $d_{\min}$ are given and ρ is approximately known, the DSD mass calculator serves to determine the max. material width $b_{\max}$ iteratively.

**How to determine the max. material width:**

- Click the  symbol or select the **Tools→Mass calculator...** command to open the mass calculator.
 - The *Mass calculator* dialog box is displayed:
- In the **Field** selection field, select *Thick-walled hollow cylinder*.
- Enter the values for the outside diameter ($d_{\max}$), inside diameter ($d_{\min}$), and density (ρ).
- In the **Length** input field, change the value by approximation until the **Result** field displays the required weight.
 - In addition, the value for the density can be adapted to achieve an accurate result.
- Change to the *Data of the application* dimensioning step and enter the determined values for the max. material width (length) and density.

**Note!**

- The mass $m_{\text{mat,max}}$ of the reel can be seen from the sketch of the drive train in the data of the application.
- Since the max. material width and the density are not given but have been determined iteratively, these data must be removed from the DSD protocol. Enter the mass of the reel instead.

7.23.6.6 Medium material density

Parameter	Description
ρ	Specific density of winding material Value can be entered directly or selected from the "Physical coefficients" table. ► Physical coefficients (□ 488)  Density of winding material

7.23.6.7 Min. material thickness (rewinder)

Parameter	Description
$s_{\min}$	If different material thicknesses are used, the smallest material thickness must be entered (worst case). DSD uses this value to calculate the increase in diameter during the acceleration phase starting from the min. reel diameter (standstill) to the dimensioning diameter (max. speed).

If paper is used as material, usually only the grammage [g/m^2] is known.

Conversion from grammage [g/m^2] to material thickness [s]:

$s = \frac{m}{\rho \cdot 1000}$	
s	Material thickness [mm]
m	Grammage [g/m^2]
ρ	Density [kg/dm^3] Paper: $\rho = 0.9 \text{ kg/dm}^3$ ► Physical coefficients (□ 488)

Example:

$s = \frac{80}{0.9 \cdot 1000} = 0.088 \text{ mm}$	
m	80 g/m^2
ρ	0.9 kg/dm^3

7.23.6.8 Min. material thickness (unwinder)

Parameter	Description
$s_{\min}$	If different material thicknesses are used, the smallest material thickness must be entered (worst case). DSD uses this value to calculate the decrease in diameter during the braking phase starting from the dimensioning diameter (max. speed) to the min. reel diameter (standstill).

7.23.6.9 Coil and winding shaft moment of inertia

Parameter	Description
J_{Cor}	Moment of inertia of the empty coil and winding shaft / coil intake Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (□ 472)

7.23.6.10 Winding system and winding shaft efficiency

Parameter	Description
η	Mechanical efficiency of the empty coil and winding shaft / coil intake

7.23.7 Data for the motion

Enter the data for the motion profile in the *Motion* dimensioning step.

7.23.7.1 Max. velocity

Parameter	Description
$v_{\max}$	Max. velocity of the application.

7.23.7.2 Acceleration time

Parameter	Description
t_{acc}	Starting time from standstill to the max. velocity $v_{\max}$ of the application. ▶ Traction-controlled winding drive (□ 213)

7.23.7.3 Deceleration time

Parameter	Description
t_{dec}	Deceleration time from the max. velocity $v_{\max}$ to standstill. ▶ Traction-controlled winding drive (□ 213)

7.23.7.4 Max. tensile force with $d_{\min}$ (rewinder)

Parameter	Description
$F_{\max}(d_{\min})$	Max. tensile force with min. reel diameter.

Generally, the operators of the plant know the optimal values for the tensile force range $F_{\max}(d_{\min})$ to $F_{\max}(d_{\max})$ and also know about tensile force drops for rewinders, if any. They are familiar with the technical winding process and the material to be wound and are experienced with these often empirical data.

Chapter 5.10 of the "Drive solutions - formulae, dimensioning and tables" Lenze documentation provides recommendations for tensile forces and the winding process. The values are based on many years of experience from many winding applications implemented.

- Select the **Tools→Formulary** command to open the documentation as PDF.

7.23.7.5 Max. tensile force with $d_{\max}$ (rewinder)

Parameter	Description
$F_{\max}(d_{\max})$	Max. tensile force with max. reel diameter.

Generally, the operators of the plant know the optimal values for the tensile force range $F_{\max}(d_{\min})$ to $F_{\max}(d_{\max})$ and also know about tensile force drops for rewinders, if any. They are familiar with the technical winding process and the material to be wound and are experienced with these often empirical data.

Chapter 5.10 of the "Drive solutions - formulae, dimensioning and tables" Lenze documentation provides recommendations for tensile forces and the winding process. The values are based on many years of experience from many winding applications implemented.

- Select the **Tools→Formulary** command to open the documentation as PDF.

7.23.7.6 Min. tensile force with $d_{\min}$ (rewinder)

Parameter	Description
$F_{\min}(d_{\min})$	Min. tensile force with min. reel diameter.

7.23.7.7 Max. tensile force with $d_{\max}$ (unwinder)

Parameter	Description
$F_{\max}(d_{\max})$	Max. tensile force with max. reel diameter.

7.23.7.8 Min. tensile force (unwinder)

Parameter	Description
$F_{\min}$	Min. tensile force of the winding drive

7.23.7.9 Motion profile shape

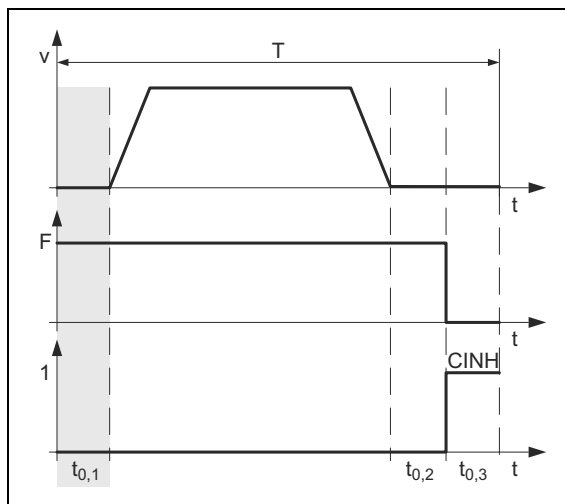
Parameter	Description
	• S-rounding • For an S-shaped motion profile, the acceleration is linearly shown and hidden. This acts as jerk limitation. Recommended for winding drives. • linear • Linear motion profiles have no jerk limitation. The maximum values of torque and speed are reached simultaneously. ► Traction-controlled winding drive (□ 213)

7.23.7.10 Jerk ratio

Parameter	Description
	Jerk ratio for the acceleration time and deceleration time. • An S-shaped acceleration/deceleration consists of three sections: • Showing the acceleration/deceleration • Linear acceleration/deceleration • Hiding the acceleration/deceleration • The value defines the share of the two sections 'Showing' and 'Hiding'.

7.23.7.11 Downtime 1

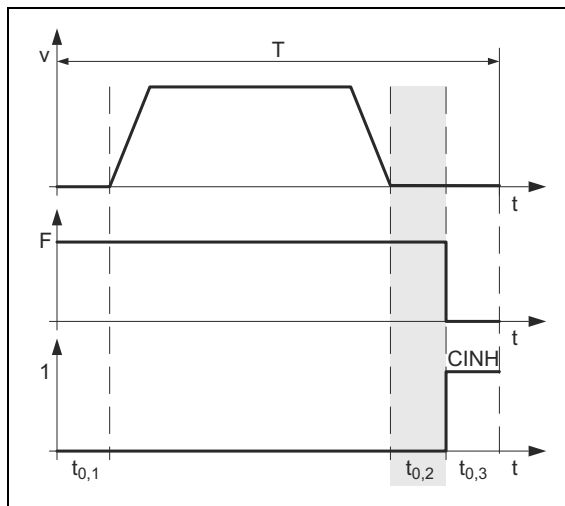
Parameter	Description
$t_{0.1}$	Downtime before the acceleration phase while the max. tensile force $F_{\max}$ already acts on the winding material. • Condition: CINH = 0



CINH	Controller locked
F	Tensile force of the winding drive
T	Cycle of one winding process
$t_{0.1}$	Downtime 1
$t_{0.2}$	Downtime 2
$t_{0.3}$	Downtime 3
v	Line speed

7.23.7.12 Downtime 2

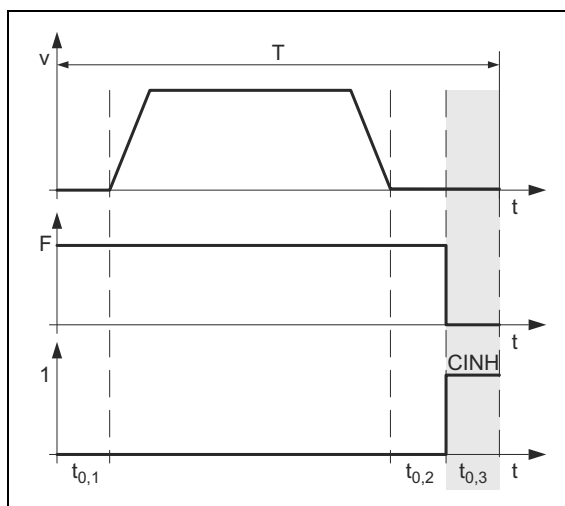
Parameter	Description
$t_{0,2}$	Downtime after the deceleration phase while the max. tensile force $F_{\max}$ still acts on the winding material. • Condition: CINH = 0



CINH Controller locked
 F Tensile force of the winding drive
 T Cycle of one winding process
 $t_{0,1}$ [Downtime 1](#)
 $t_{0,2}$ Downtime 2
 $t_{0,3}$ [Downtime 3](#)
 v Line speed

7.23.7.13 Downtime 3

Parameter	Description
$t_{0,3}$	Downtime after the winding process during which no tensile force ($F_{\max} = 0$) acts on the winding material. • The controller is always inhibited during downtime 3. The thermal load of the inverter and the motor is reduced.



CINH Controller locked
 F Tensile force of the winding drive
 T Cycle of one winding process
 $t_{0,1}$ [Downtime 1](#)
 $t_{0,2}$ [Downtime 2](#)
 $t_{0,3}$ Downtime 3
 v Line speed

7.23.7.14 Brake at standstill

Parameter	Description
Active	• Yes: The brake is active during downtimes 1 ... 3. If the brake is activated, the motor does not have to provide a torque. • No: The brake is not active during downtimes 1 ... 3.

7.23.7.15 Controller inhibit at standstill

Parameter	Description
Active	• Yes: The controller of the inverter is inhibited during downtimes 1 ... 3. The thermal load of the inverter and the motor is reduced. • No: The controller of the inverter is enabled during downtimes 1 ... 2. • The controller is always inhibited during downtime 3.

7.23.7.16 Emergency-off time (without material, M-calculation only)

Parameter	Description
t_{ES}	Deceleration time until the drive is at standstill, e.g. if the web breaks. • Only the required motor torque is calculated. • The dimensioning must be checked manually.

7.24 Slider-crank mechanism

The rotation of a crank is converted into a translatory motion that oscillates between two dead centres by means of a slider-crank mechanism.

The fixed point in the application is the crankshaft where the input speed is applied. It is possible to transmit high forces and implement energetically favorable movements.

The nonlinear mechanics of the slider-crank mechanism are widely used in practice. Typical applications:

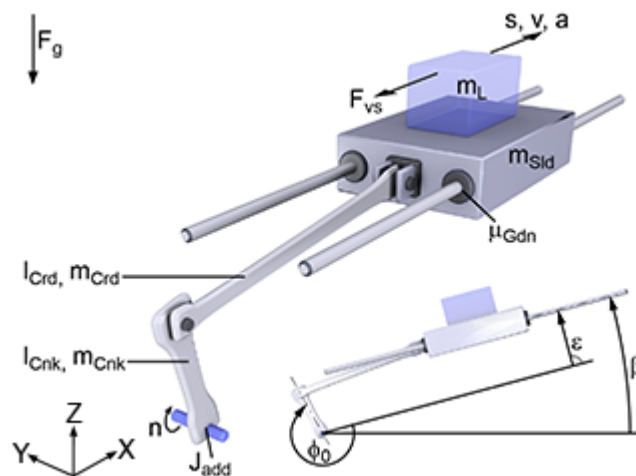
- Crank lifter in materials handling technology
- Crank press for benders and punching devices
- Pusher

The mechanics of the slider-crank mechanism moves in two dimensions, on the X axis (horizontal) and the Z axis (vertical). The gravitation acts with 9.81 m/s^2 in negative direction of the Z axis. The Y axis is not relevant.

The position of the slider-crank mechanism determined via the angle of tilt β . This serves to size both horizontal and vertical slider-crank mechanisms. The slider path can also be sized on an inclined plane.

Depending on the type of mechanics, a sliding friction must be considered for the linear guide of the slider path. The friction in the pivot points can be neglected.

More process forces acting on the slider such as punching or joining forces can be indicated as counterforces F_{VS} .



The nonlinear mechanics cause an alternating torque load for the drive at continuous speed. The speed at the drive bearing of the crank (crankshaft) can be specified with a continuous speed or with a clocked speed profile.



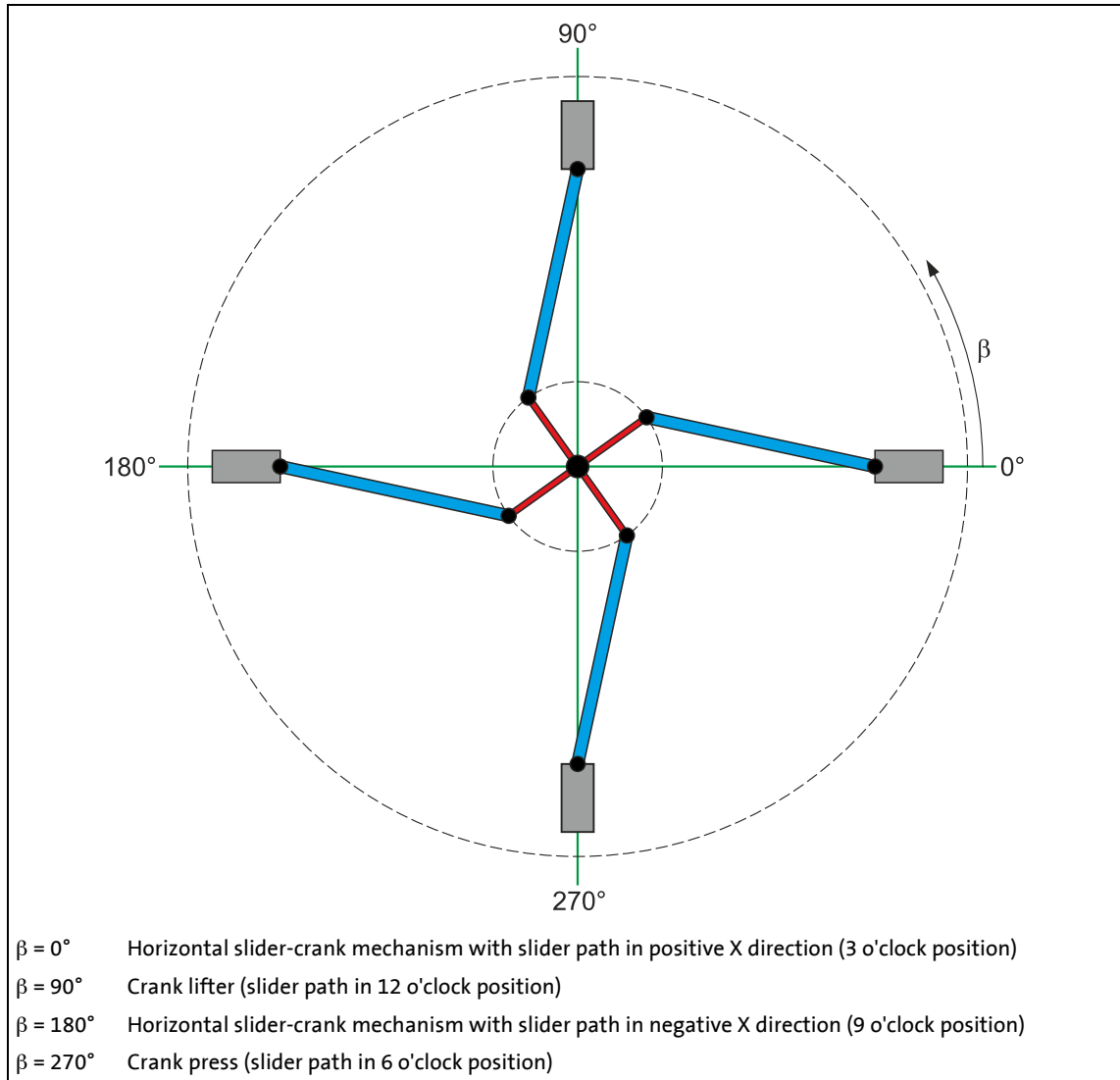
Note!

Motion profiles are specified via the *MotionDesigner*. Here, individual motion profiles can be created or imported.

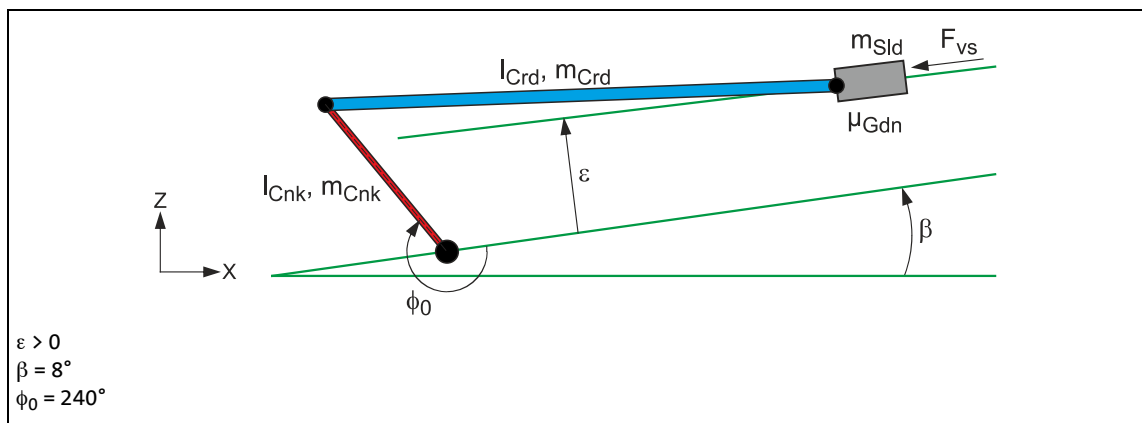
7.24.1 Angle of tilt of the slider-crank mechanism

The angle of tilt β defines the orientation of the slider path:

- Alignment in positive X direction defines $\beta = 0^\circ$. This corresponds to an orientation of the slider path in 3 o'clock position.
- The angle of tilt β is defined as positive counterclockwise.

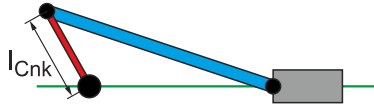
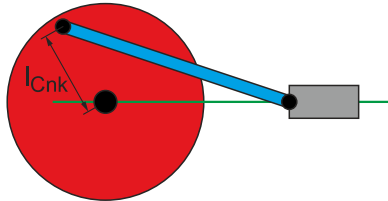


[7-253] Angle of tilt for the typical orientations



[7-254] Example: slider-crank mechanism on an inclined plane and offset of the slider path

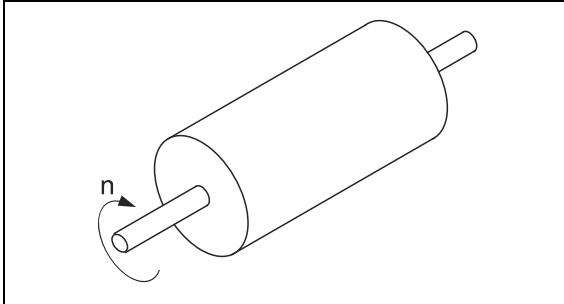
7.24.2 Physical data on crank rod and crank disk

	Crank rod	Crank disk
		
Parameters for describing the body	l_{Cnk} Length of the crank rod	l_{Cnk} effective radius of the crank disk
	m_{Cnk} Mass of the crank rod	
	The crank rod is assumed to be a thin rod with a homogeneous mass distribution.	
Determination of the inertia	$J_{Cnk} = J_{add} + \frac{1}{3} \cdot m_{Cnk} \cdot l_{Cnk}^2$ DSD automatically determines the inertia from the mass m_{Cnk} and the length l_{Cnk}.	The inertia is directly entered as J_{add} .

7.24.3 Starting angle of the crank

The starting angle ϕ_0 of the crank is given in relation to the orientation of the slider path.

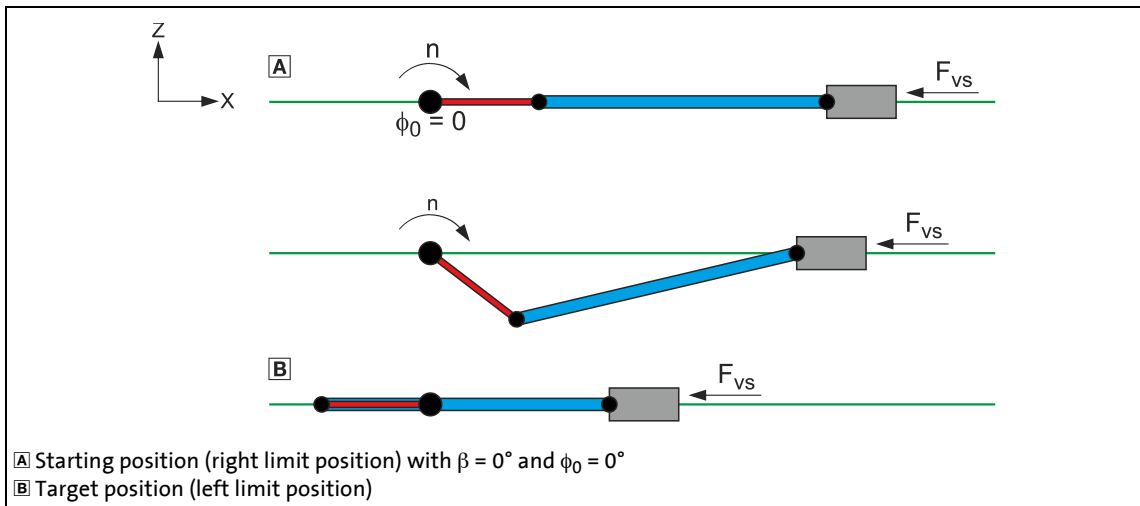
- The starting angle ϕ_0 is defined as positive clockwise.
- The input speed n is defined as positive clockwise.



The speed n at the drive is assumed to be positive clockwise when looking at the motor shaft from the front.

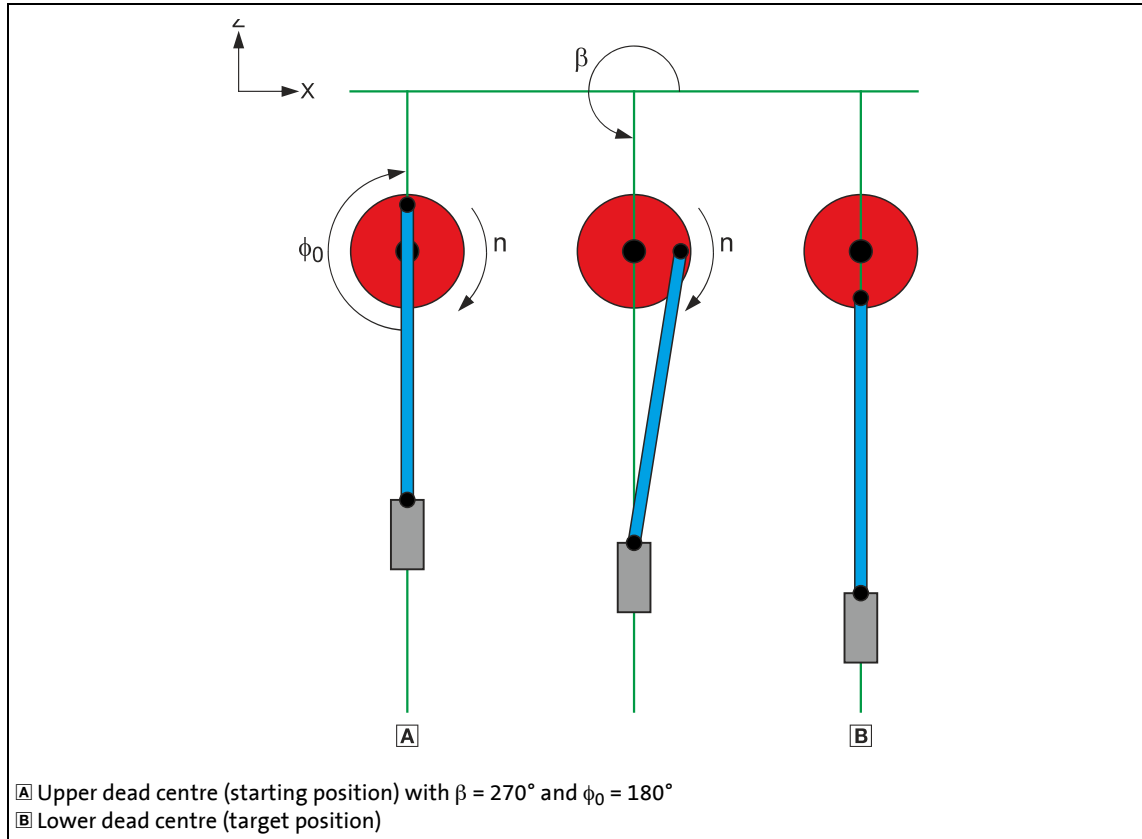
This results in the positive clockwise definition of the angle ϕ and the starting angle ϕ_0 of the crank.

With the starting angle $\phi_0 = 0$, the crank points in the same direction as the slider:



[7-255] Example: horizontal slider-crank mechanism without offset of the slider path

With the starting angle $\phi_0 = 180^\circ$, the crank points in the opposite direction as the slider:



[7-256] Example: typical motion sequence of a crank press without an offset of the slider path



Tip!

Often, a timed speed profile is defined for the crankshaft. For moving from a starting position to a target position, the crank must be rotated by a certain angle (e.g. 180°).

- The angle can be entered in the MotionDesigner in the *Basic values* area if "Angle/time" is set in the specification.

► ["Profile" tab](#) (266)

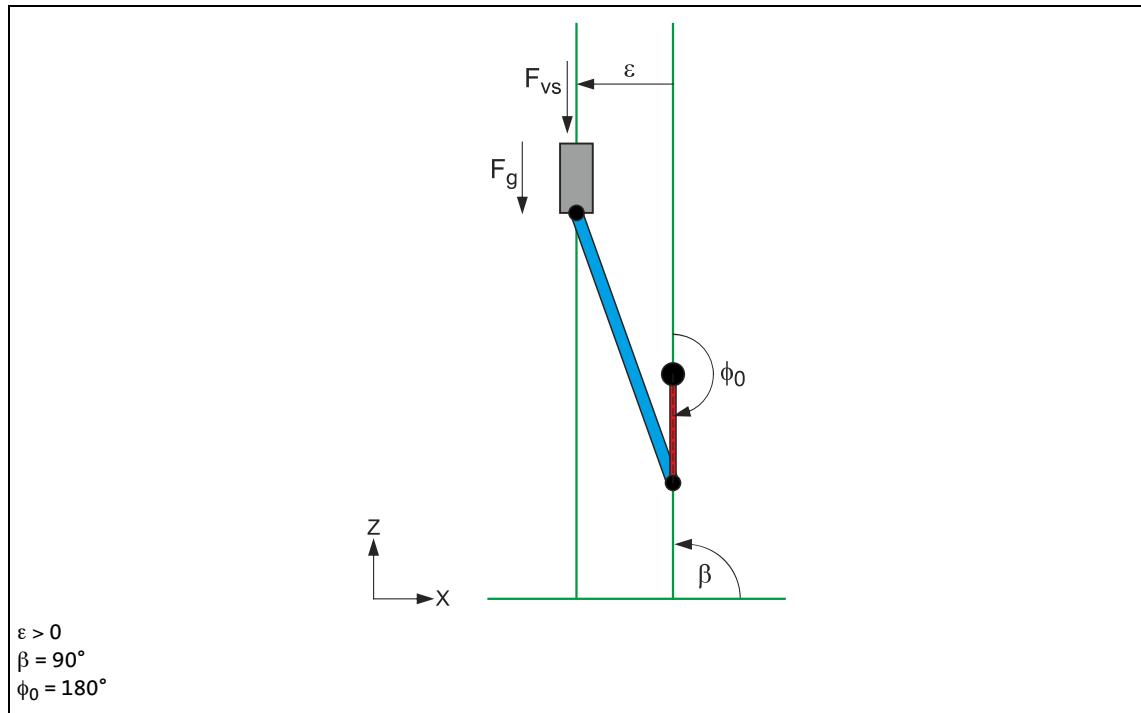
7.24.4 Offset of slider path

ε defines the offset between the slider path and the axis where the drive bearing of the crank is located.

In most applications, there is no offset of the slider path ($\varepsilon = 0$). For applications with an offset of the slider path ($\varepsilon \neq 0$), the parameter setting is described in this chapter.

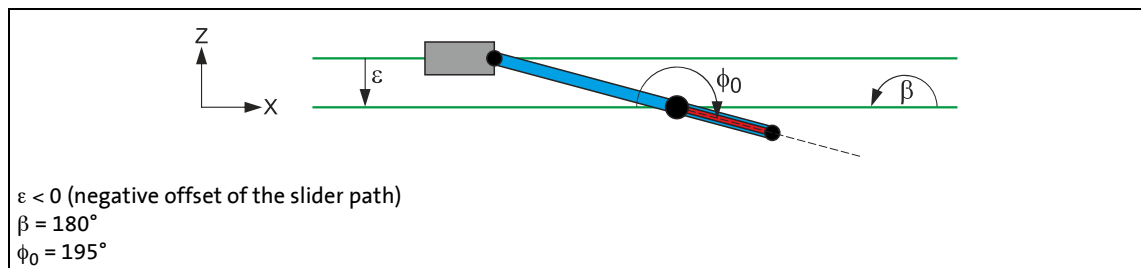
With an angle of tilt $\beta = 0^\circ$ and a shift in positive Z direction, the parameter value ε is positive (see figure [7-259]).

Slider path with an offset $\varepsilon > 0$:



[7-257] Example: crank lifter with an offset of the slider path

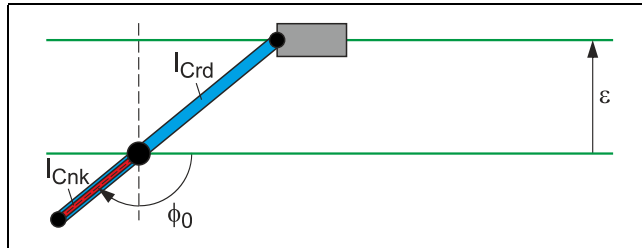
Slider path with an offset $\varepsilon < 0$:



[7-258] Example: horizontal slider-crank mechanism with the orientation of the slider path in negative X direction

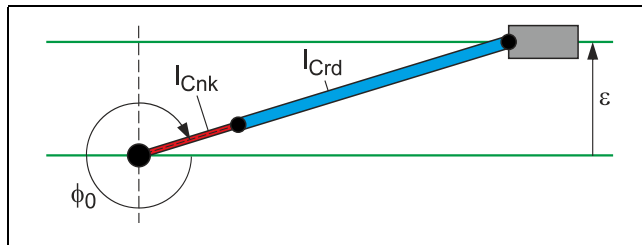
Typically, a slider-crank mechanism moves between the lower and upper dead centre or between two horizontal limit positions.

In case of constructions with an offset ε of the slider path, the starting angle ϕ_0 must be determined via trigonometric functions from the length l_{Cnk} of the crank, the length l_{Crd} of the connecting rod and the offset ε .



[7-259] Calculation of the starting angle for the left horizontal limit position

$$\Phi_0 = \arccos\left(\frac{\varepsilon}{l_{Crd} - l_{Cnk}}\right) + 90^\circ$$



[7-260] Calculation of the starting angle for the right horizontal limit position

$$\Phi_0 = -\arcsin\left(\frac{\varepsilon}{l_{Crd} + l_{Cnk}}\right)$$

7.24.5 Control modes for slider-crank mechanisms

Control modes recommended for slider-crank mechanisms:

- With feedback system:
 - SC (servo control)
 - VFC plus (V/f control)
- Without feedback system:
 - VFC plus (V/f control)

7.24.6 Calculated results

	Description	
$m_{\text{sum,max}}$	Max. mass in motion	The maximum mass in motion at the slider consists of the fixed mass m_{slid} of the slider and the variable mass m_L of the payload. The masses of the crank and the connecting rod are not added here. However, they are considered when the torque requirement is determined.
J_{max}	Max. load moment of inertia	The load moment of inertia considers the masses of all bodies moved (slider, payload, crank, connecting rod) and the additional moment of inertia J_{add} . The max. load moment of inertia serves to determine the load-matching factor. The calculation is performed using an approximation formula.
s	Path/distance of the slider	The distance covered by the slider and the payload starts from zero at the beginning of the motion cycle.

7.24.7 Data for the entry

7.24.7.1 Crank length

Parameter	Description
l_{Cnk}	Effective length of the crank between the drive bearing and the joint with the connecting rod.

7.24.7.2 Length of the connecting rod

Parameter	Description
l_{Crd}	Effective length of the connecting rod between the joint with the crank and the joint with the slider.

7.24.7.3 Slider mass

Parameter	Description
m_{Sld}	Mass of slider without payload The value can be entered directly or calculated using the mass calculator.  Mass calculator (📖 470)

7.24.7.4 Crank starting angle

Parameter	Description
ϕ_0	The starting angle of the crank is given in relation to the orientation of the slider path. ► Starting angle of the crank (📖 230)

7.24.7.5 Angle of tilt

Parameter	Description
β	Angle of tilt of the slider path. The following applies: $\beta = 0^\circ$ Horizontal slider-crank mechanism with slider path in 3 o'clock position $\beta = 180^\circ$ Horizontal slider-crank mechanism with slider path in 9 o'clock position $\beta = 90^\circ$ Crank lifter with slider path in 12 o'clock position $\beta = 270^\circ$ Crank press with slider path in 6 o'clock position ► Angle of tilt of the slider-crank mechanism (📖 228)

7.24.7.6 Crank mass

Parameter	Description
m_{Cnk}	- Mass of the crank if designed as crank rod - The crank rod is assumed to be a thin rod with a homogeneous mass distribution. The centre of mass is in the centre of the crank. - If the crank is designed as a crank disk, the value 0 is entered. - The moment of inertia J_{add} is given. Additional moment of inertia (📖 235)

7.24.7.7 Mass of the connecting rod

Parameter	Description
m_{Crd}	Mass of the connecting rod The connecting rod is assumed to be a thin rod with a homogeneous mass distribution. The centre of mass is in the centre of the connecting rod.

7.24.7.8 Coefficient of friction of the guide rail

Parameter	Description
μ_{Gdn}	Coefficient of sliding friction of the guide rail Value can be entered directly or selected from the "Physical coefficients" table. Physical coefficients (📖 488)  Coefficient of sliding friction

7.24.7.9 Offset of slider path

Parameter	Description
ε	Offset between the slider path and the axis where the drive bearing of the crank is located. With an angle of tilt $\beta = 0^\circ$ and a shift in positive Z direction, the parameter value is positive. Offset of slider path (📖 232)

7.24.7.10 Additional moment of inertia

Parameter	Description
J_{add}	The additional moment of inertia acts on the drive bearing of the crank. - If the crank is designed as a crank disk, the moment of inertia of the crank disk is entered. - Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.24.7.11 Speed

Parameter	Description
n	Speed at the drive bearing of the crank Value is entered in the Motion dimensioning step.

7.24.7.12 Mass of the payload

Parameter	Description
m_L	Mass of payload Value is entered in the Motion dimensioning step.

7.24.7.13 Counterforce

Parameter	Description
F_{vs}	Force that counteracts the moving direction of the slider. The force acts on the slider. - Value is entered in the Motion dimensioning step. The sign of the counterforce determines its effective direction. - If the speed is positive, - positive values act opposite to the moving direction, - negative values act with the moving direction. - If the speed is negative, - positive value act with the moving direction, - negative values act opposite to the moving direction.



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.

7.25 Eccentric lift table

Eccentric lift tables are used to overcome a low lifting height in materials handling technology, e.g. in the warehouse logistics and automobile production industry sectors.

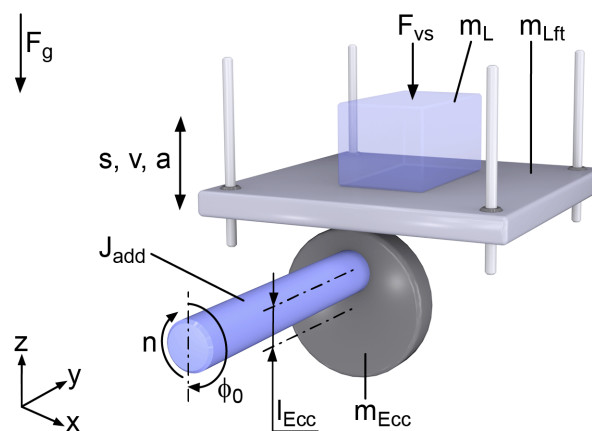
Typical applications are:

- Raise/lower a conveyor track, e.g. in a corner transfer unit.
- Level compensation in a conveyor line.

The rotation of the drive of an eccentric lifter is converted into a translatory motion that oscillates between two dead centres by means of an eccentric disk.

A fixed point in the system is the drive shaft to which the input speed is applied.

The nonlinear mechanics cause an alternating torque load for the drive at continuous speed.



- The eccentric lift table is moved vertically. The hoist axis is the positive Z axis.
- The gravitation acts with 9.81 m/s^2 in a negative Z direction.
- The friction between the eccentric disk and the lift table's support is disregarded.
- More process forces acting on the eccentric lift table such as joining forces can be indicated as counterforces F_{vs} .
- The eccentric lift table can be operated with a continuous or clocked speed. The speed is preselected at the drive's inverter.



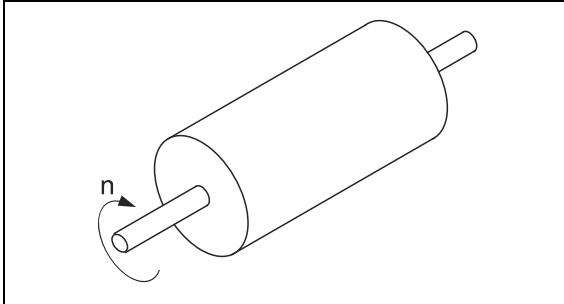
Note!

Motion profiles are specified via the *MotionDesigner*. Here, individual motion profiles can be created or imported.

7.25.1 Starting angle of the eccentric disk

The starting angle ϕ_0 of the eccentric disk is given in relation to the orientation of the hoist axis.

- The starting angle ϕ_0 is defined as positive clockwise.
- The input speed n is defined as positive clockwise.



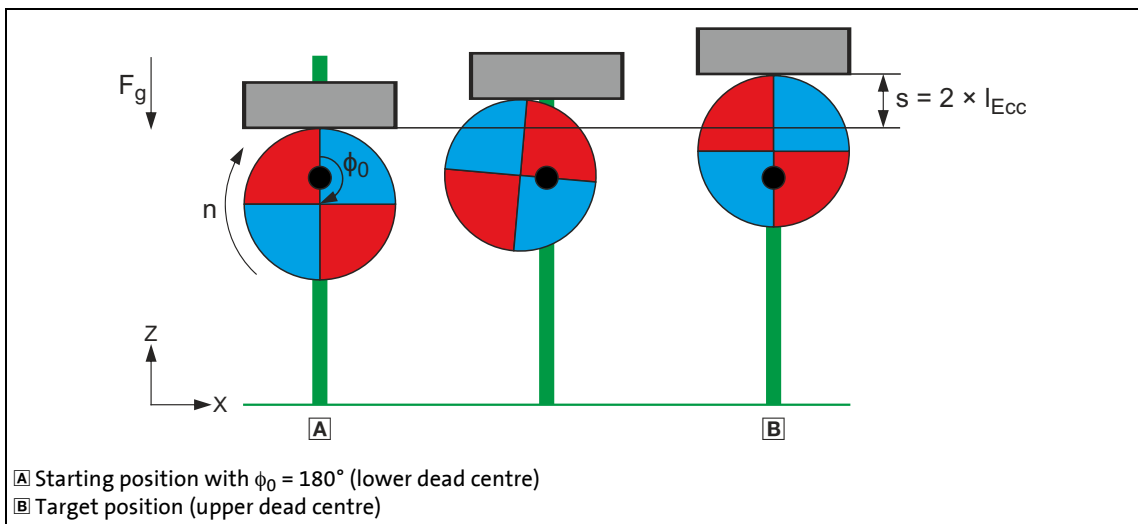
The speed n at the drive is assumed to be positive clockwise when looking at the drive shaft from the front.

This results in the positive clockwise definition of the angle ϕ and the starting angle ϕ_0 of the eccentric disk.

Typical motion sequence of an eccentric lift table

In the starting position, the lift table is at lower dead centre **A**. After half a revolution (180°) of the drive shaft (connected to the eccentric disk), the lift table is in the target position at upper dead centre **B**.

With the starting angle $\phi_0 = 180^\circ$, the eccentric disk points in the same direction as the hoist axis:



[7-261] Example: Typical motion sequence of an eccentric lift table



Tip!

For the movement from the starting position to the target position, the eccentric disk must be rotated by a certain angle (e.g. 180°).

- If a clocked speed profile has to be specified, the angle can be entered in the *MotionDesigner* under "[Profile](#)" tab in the *Basic values* area. "Angle/time" has to be set in the specification for this purpose.

7.25.2 Data for the entry

7.25.2.1 Eccentricity

Parameter	Description
l_{Ecc}	Offset between the drive bearing and the centre of the eccentric disk.

7.25.2.2 Mass of the lift table

Parameter	Description
m_{Lft}	Mass of the lift table without payload. The value can be entered directly or calculated using the mass calculator.  Mass calculator (📖 470)

7.25.2.3 Eccentric disk starting angle

Parameter	Description
ϕ_0	The starting angle of the eccentric disk is given as positive clockwise in relation to the orientation of the hoist axis (Z axis). ▶ Starting angle of the eccentric disk (📖 238)

7.25.2.4 Mass of the eccentric disk

Parameter	Description
m_{Ecc}	Mass of the eccentric disk with the centre of the mass in the centre of the disk. The value can be entered directly or calculated using the mass calculator.  Mass calculator (📖 470)

7.25.2.5 Additional moment of inertia

Parameter	Description
J_{add}	The additional moment of inertia acts on the drive bearing, e.g. moment of inertia of the eccentric disk. Value can be entered directly or calculated using the inertial calculator.  Inertial calculator (📖 472)

7.25.2.6 Speed

Parameter	Description
n	Speed at the drive shaft Value is entered in the Motion dimensioning step.

7.25.2.7 Mass of the payload

Parameter	Description
m_L	Mass of payload Value is entered in the Motion dimensioning step.

7.25.2.8 Counterforce

Parameter	Description
F_{vs}	Force that works against the direction of movement. The force acts on the lift table. - Value is entered in the Motion dimensioning step. The sign of the counterforce determines its effective direction. - If the speed is positive, - positive values act opposite to the moving direction, - negative values act with the moving direction. - If the speed is negative, - positive value act with the moving direction, - negative values act opposite to the moving direction.



Note!

If the force acts in a supporting manner, the opposite sign is to be entered.

7.25.2.9 Max. mass in motion

Parameter	Description
$m_{sum,max}$	The maximum mass in motion consists of the fixed mass m_{Lft} of the lift table and the variable mass m_L of the payload. The mass of the eccentric disk is not added here. However, it is considered when the torque requirement is determined.

7.25.2.10 Max. load moment of inertia

Parameter	Description
J_{max}	The load moment of inertia or moment of inertia of the application considers the masses of all moving bodies such as lift table, payload and the additional moment of inertia J_{add} . - The max. load moment of inertia serves to determine the load-matching factor. - An approximate formula is used for the calculation.

7.25.2.11 Path/distance of the lift table

Parameter	Description
s	The distance travelled by the lift table with the payload. The distance s begins at zero at the start of the motion cycle.

8

Motion design

The motion design describes how the application is to move. It is distinguished between rectilinear motion (translatory) and rotary motion.

- Quantities of a translatory motion: path, speed, acceleration.
- Quantities of a rotary motion: angle of rotation, angular velocity, angular acceleration.

The following chapters describe the various options how to create motion profiles for your drive in the DSD.

8.1

Selection of motion profile

Select how you would like to create the motion profile.



Create, import motion profile

User-definable motion profile, used for simulating operating modes S8, S9 and S10. The edition is carried out with the [MotionDesigner](#) (□ 243).

You have several options to create motion profiles:

- Parameters for motion, acceleration and jerk, if required.
- Create and compose linear, trapezoidal or S-shaped subprofiles graphically.
- Load already available motion profiles in Imp format.
- Import motion profiles from older DSD versions in dpr format.
- Import operating points from an ASCII file.
 - Apart from linear motion profiles, like this also s-shaped and $\sin^2$ -shaped motion profiles can be created.



[Predefined motion profile according to operating mode](#) (□ 288)

Motion profile according to VDE 0530. Operating modes S1, S2, S3 or S6 can be selected.

- Depending on the starting time and deceleration time, operating modes S4, S5 or S7 can also be simulated.

8.2

MotionDesigner

The *MotionDesigner* serves to create, process and manage motion profiles. The two options to open the *MotionDesigner* offer a flexible application. Either you create a motion profile during the drive dimensioning phase or you use it independent of it.

Application ranges:

Independent <i>MotionDesigner</i>	Application-dependent <i>MotionDesigner</i>
• Creating motion profiles for coordinated axis drives of a multi-axis application. • Importing, processing and saving individual, standardised motion profiles. • Creating the motion profiles of all drive axes simultaneously and coordinating them on a joint time axis. • Each motion profile can be saved separately and loaded into the project of the corresponding drive axis.	• Creating a motion profile for the selected application. • The project can be an individual application or an uncoordinated drive axis in a multi-axis system. • The <i>MotionDesigner</i> is opened automatically when the "Motion" dimensioning step is reached.



How to open the independent MotionDesigner:

Click on the  icon in the toolbar.

- or -

Execute the **Tools → MotionDesigner** command.



How to open the application-dependent MotionDesigner:

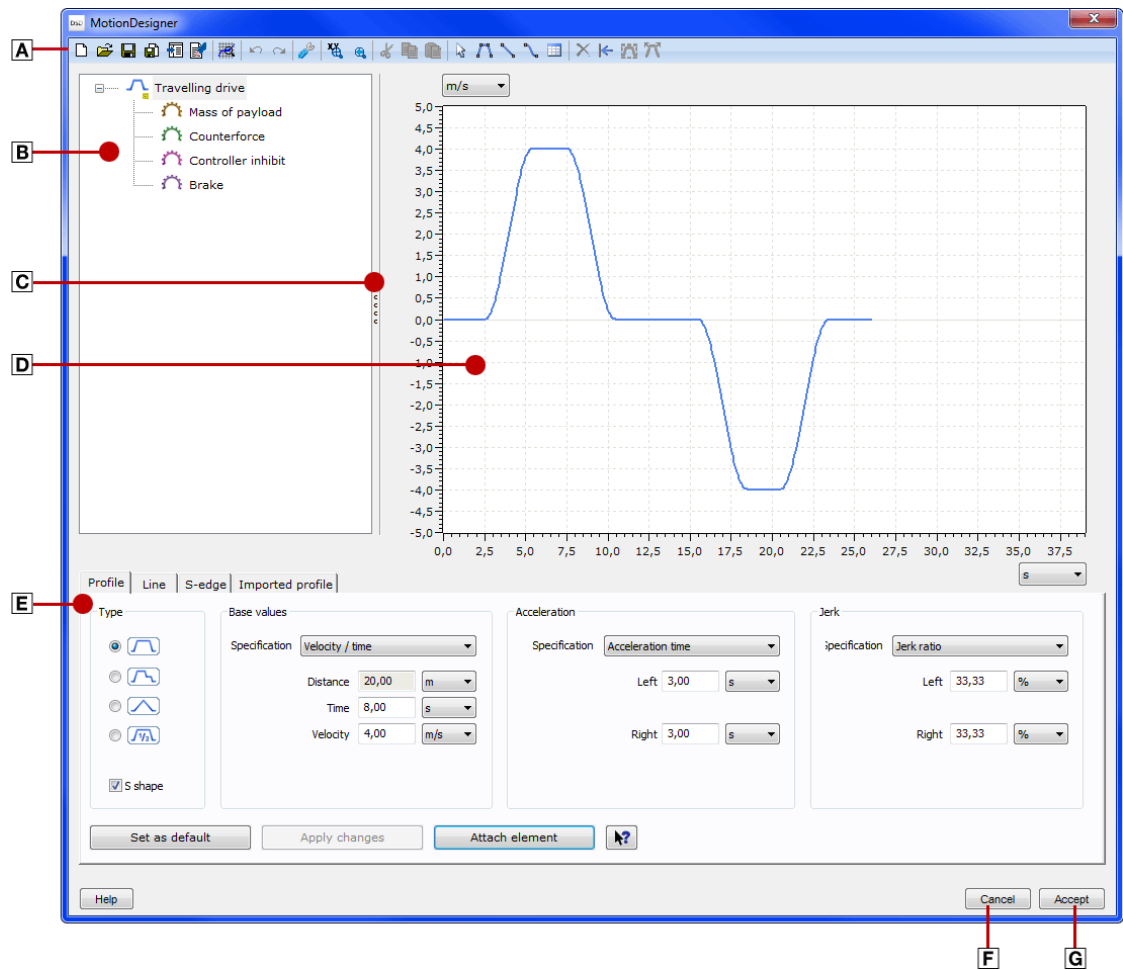
Click the **MotionDesigner** button in the "Motion" dimensioning step.

Quickly finding the information required:

- [Control and function elements](#) (📖 244)
- [Toolbar](#) (📖 245)
- [Object area](#) (📖 247)
 - [Load the motion profile](#) (📖 252)
 - [Save motion profile](#) (📖 253)
 - [Processing functions](#) (📖 247)
 - [Object properties](#) (📖 249)
 - [Exporting profile data](#) (📖 253)
 - [Importing profile data](#) (📖 254)
 - [Error messages during import](#) (📖 256)
- [Screen divider](#) (📖 246)
- [Graphic area](#) (📖 257)
 - [Creating motion profiles: Principles](#) (📖 257)
 - [Creating a parameter profile: Principles](#) (📖 258)
 - [Setting XY axes](#) (📖 259)
 - [Creating and editing elements](#) (📖 260)
 - [Error messages](#) (📖 264)
- [Parameter area: Description](#) (📖 265)
 - ["Profile" tab](#) (📖 266)
 - ["Line" tab: Motion profile](#) (📖 268)
 - ["Line" tab": Parameter profile](#) (📖 269)
 - ["S-edge" tab](#) (📖 271)
 - ["Imported profile" tab](#) (📖 272)

8.2.1 Control and function elements

The user interface has the following control and function elements:



A [Toolbar](#) ([book icon](#) 245)

B [Object area](#) ([book icon](#) 247)

C [Screen divider](#) ([book icon](#) 246)

D [Graphic area](#) ([book icon](#) 257)

E [Parameter area: Description](#) ([book icon](#) 265)

F **Accept** button with the application-dependent *MotionDesigner*

- Accept changes and exit the *MotionDesigner*.

Close button with the independent *MotionDesigner*.

- Exit the *MotionDesigner*.

G **Discard changes and exit the *MotionDesigner*.**

- Only available with the application-dependent *MotionDesigner*.

8.2.2 Toolbar

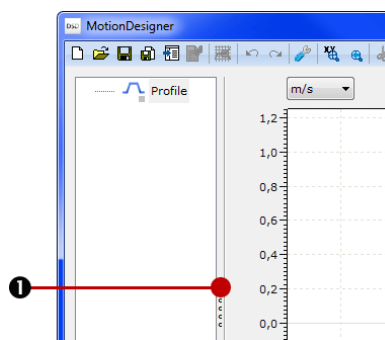
Click on an icon to carry out the respective function.

Symbol	Keyboard command	Function
	<Ctrl>+<N>	Create new motion profile.
	<Ctrl>+<O>	Load motion profile. ▶ Load the motion profile (□ 252)
	<Ctrl>+<S>	Save motion profile. • When a newly created motion profile is saved, you are asked for the destination of the Imp file. • When the motion profile is newly saved, the Imp file is updated. ▶ Save motion profile (□ 253)
	–	Import the motion profile with parameter profiles from an ASCII file. ▶ Importing profile data (□ 254)
	–	Create note for motion profile • The note is attached to the "Motion" dimensioning step. • The function is only available with the application-dependent <i>MotionDesigner</i> . ▶ Notes (□ 37)
	<Del>	Delete highlighted element. • The element is deleted permanently.
	–	Application analysis. • Shows diagrams and table of values via the entered and calculated values with regard to a cycle of the motion profile. • The function is only available with the application-dependent <i>MotionDesigner</i> .
	<Ctrl>+<Z>	Undo last action.
	<Ctrl>+<Y>	Redo last undone action.
	–	Default settings for the dialog box. • Identical to the "Motion" register in the DSD menu Extras→Settings . ▶ Settings (□ 42) ▶ "Motion" register (□ 43)
	–	Zoom x-axis and y-axis • Draw up a rectangle across the area to be zoomed in by keeping the left mouse button pressed.
	–	Return to standard view.
	<Ctrl>+<X>	Cut the highlighted element and drag to the clipboard.
	<Ctrl>+<C>	Copy the highlighted element into the clipboard.
	<Ctrl>+<V>	Paste the element from the clipboard.
	–	Select the element or deactivate an active symbol.
	–	Draw trapezoidal element. • The "Profile" register contains a selection of trapezoidal elements. ▶ Creating and editing elements (□ 260) ▶ Parameter area: Description (□ 265)

Symbol	Keyboard command	Function
	–	Draw line. ▶ Creating and editing elements (📖 260)
	–	Draw S-shaped element. ▶ Creating and editing elements (📖 260)
	–	Import an individual motion profile or parameter profile. ▶ Importing profile data (📖 254)
	–	Move elements to the left. • Moves separated elements on the drawing area to the left and connects them to its preceding element. ▶ Shift elements automatically to the left (📖 262)
	–	Combines the elements that form a trapezium so that an element is generated. • Only connected elements can be combined. • The elements to be combined must be highlighted. ▶ Combining elements (📖 263)
	–	Undo combination. • Deactivate the combination of a trapezoidal element so that the elements can be processed separately.
	–	Reflect highlighted element on the time axis. • This function can only be accessed via the context menu (click the left mouse button).
–	<Ctrl>+<Click>	Duplicates an element in the drawing area when the element is left-clicked while the Ctrl key is pressed.
–	<Ctrl>+<G>	Shows or hides the grid of the drawing area.
–	<Ctrl>+<A>	Highlights all elements on the drawing area.
–	<Shift>+<Click>	In order to highlight several elements keep the <Shift> button pressed and left-click the elements.

8.2.3 Screen divider

By dragging the screen divider, the size of the *Object area* or the drawing area is changed horizontally.

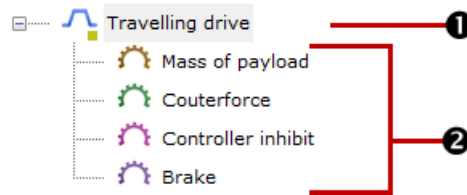


How to drag the screen divider:

1. Move the mouse pointer over the screen divider ❶ until it is visible as two vertical lines.
2. Press the left mouse button and drag the screen divider.
3. Release the mouse button at the desired position.

8.2.4 Object area

The *Object area* indicates the arrangement of the objects (motion profile, parameter). Use the [Processing functions](#) to process the objects.



Legend	Information
①	Motion profile
②	Parameter

8.2.4.1 Processing functions

Processing functions can only be executed via the context menu. Which processing functions are available depends on different conditions:

- If you create motion profiles and parameters in the independent *MotionDesigner*, all editing functions are available.
- If a motion profile with parameters has been created in the application-dependent *MotionDesigner*, only the object properties can be edited.

Overview of the editing functions that can be called in the *Object area* via the context menu (right mouse button).

Symbol	Processing function
	Create motion profile - Available with the independent <i>MotionDesigner</i>. - Place the mouse pointer in the <i>Object area</i> on a free space and select Add motion profile in the context menu.
	Create parameters independent of the motion profile - Available with the independent <i>MotionDesigner</i>. - Place the mouse pointer in the <i>Object area</i> on a free space and select Add parameter in the context menu.
	Add parameters to a motion profile - Available for motion profiles that were created with the independent <i>MotionDesigner</i>. - Highlight the motion profile and select Add parameters in the context menu.
	Copy parameters into the clipboard. - Available for parameters that were created with the independent <i>MotionDesigner</i>. - Highlight parameters and select Copy object in the context menu.
	Copy motion profile into the clipboard. - Available with the independent <i>MotionDesigner</i>. - Highlight the motion profile and select Copy object in the context menu.
	Paste copied parameter from the clipboard. - Available for parameters that were created with the independent <i>MotionDesigner</i>. - Highlight the motion profile and select Paste object in the context menu.
	Paste copied motion profile from the clipboard. - Available with the independent <i>MotionDesigner</i>. - Place the mouse pointer in the <i>Object area</i> on a free space and select Paste object in the context menu.
	Delete highlighted motion profile or parameter permanently. - Available for motion profiles that were created with the independent <i>MotionDesigner</i>. - Highlight a motion profile or parameter and select Delete object in the context menu.
	Call object properties. - Highlight a motion profile or parameter and select Object properties in the context menu. ▶ Object properties (📖 249)
	Export motion profile or parameter into an ASCII file. - Highlight a motion profile or parameter and select Export profile data in the context menu. ▶ Exporting profile data (📖 253)
	Import the motion profile with the corresponding parameters from an ASCII file. - Highlight the motion profile and select Import profile data in the context menu. ▶ Importing profile data (📖 254)
	Update imported motion profile if data in the ASCII file has been changed. - Only available for imported motion profiles. - Highlight the motion profile and select Update in the context menu. - If import data in the ASCII file is changed, this command serves to import the data again. Note: - During import, a linking to the ASCII file is established. The linking is preserved even after the motion profile (Imp file) is saved. If the absolute data path changes, the linking gets lost. ▶ Importing profile data (📖 254)

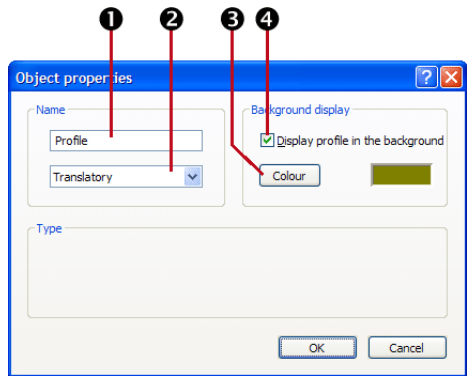
8.2.4.2

Object properties

Motion profile



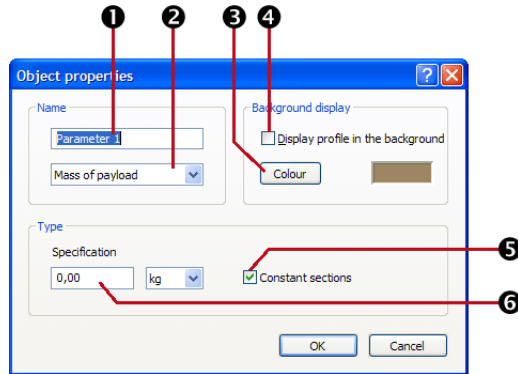
Highlight the motion profile, press the right mouse button and select **Object properties** from the context menu to open the *Object properties* dialog box.



Legend	Description
❶	Name of motion profile. Click into the input field and enter a name for the motion profile. ▶ Creating motion profiles: Principles (📖 257)
❷	Selection of the motion - Click into the list field to select a translatory or rotary motion profile. - The selection is only possible if the motion profile has been created with the independent <i>MotionDesigner</i>.
❸	Selection of the line colour. - The motion profile is displayed in this colour on the drawing area in the background. - Click the button to open the dialog box for selecting the desired colour. ▶ Graphic area (📖 257)
❹	Display of the motion profile in the background When you select a parameter, the motion profile remains visible on the drawing area in the background. ▶ Graphic area (📖 257)
	 Field activated: Motion profile is visible.
	 Field deactivated: Motion profile is invisible.

Parameter

 Highlight the parameter, press the right mouse button and select **Object properties** from the context menu to open the *Object properties* dialog box.



Legend	Description
❶	Parameter name. Click into the input field and enter a name for the parameter. ▶ Creating a parameter profile: Principles (📖 258)
❷	Selection of the parameter. - Click into the list field and select the desired parameter. - Possible selection: Mass of payload, counterforce, moment of inertia, torque, brake, controller inhibit. - The selection is only possible if the parameter has been created with the independent <i>MotionDesigner</i>.
❸	Selection of the line colour. - The parameter profile is displayed in this colour on the drawing area in the background. - Click the button to open the dialog box for selecting the desired colour. ▶ Graphic area (📖 257)
❹	Display of the parameter profile in the background When you select other parameters, the motion profile remains visible on the drawing area in the background. ▶ Graphic area (📖 257)
	 Field activated: Motion profile is visible.
	 Field deactivated: Motion profile is invisible.

Legend	Description
⑤	Selection whether elements of the parameter may have linearly changeable values. • Field activated: You can only enter one value. The element entered changes erratically between the previous value and the input value. • Field deactivated: You can enter two values. The entered element linearly changes between these two values. • No selection is possible for the "brake" and "controller inhibit" parameters, as these control signals can only have the states 1 or 0. • Special features: • Selection possible in the independent <i>MotionDesigner</i>. • Selection possible in the application-dependent <i>MotionDesigner</i> if a motion profile created in the independent <i>MotionDesigner</i> is loaded. • In the case of a mass of the payload that can be linearly changed, the force resulting from the mass alteration is not taken into consideration. • In the case of an inertia that can be linearly changed, the torque resulting from the change in inertia is not taken into consideration. Please note: Continuous or erratic changes of the mass during motion which have an impact on the torque are not taken into consideration for the calculation in DSD. ► Creating a parameter profile: Principles (📖 258)
⑥	Default value for the parameter. • The parameter is automatically created with this standard value. • The entry of more line elements creates an individual parameter profile. • The "brake" and "controller inhibit" parameters do not have a default value as these control signals can only have the states 1 or 0. ► Creating a parameter profile: Principles (📖 258)

8.2.5 Managing motion profiles

The *MotionDesigner* provides three formats for the management of the motion profiles and parameters.

File extension	Format	Description
Imp	Lenze Motion Profile	The <i>MotionDesigner</i> saves and opens motion profiles in this format. Created motion profiles are upwards compatible. They can be opened with previous DSD versions. There is no downward compatibility.
txt	ASCII file	The <i>MotionDesigner</i> can import or export motion profiles and parameters in the txt format. It is possible to export CAM curve profiles in the txt format with the <i>CamManager</i> in the »Engineer«.
dpr		Motion profile from a previous DSD version. Files in the dpr format can only be imported in the <i>MotionDesigner</i>.

8.2.5.1 Load the motion profile



How to load a motion profile:

1. Click the  icon in the toolbar.
2. In the *Load motion profile* dialog box, select a motion profile in the *.Imp format and activate the **Open** button.
 - It is only possible to load motion profiles that have been saved in DSD.
 - When the motion profile is loaded, it is checked whether the motion (translatory or rotary) matches the application.
 - If the motion profile contains working points with high values, the scaling in the *Graphic area* is adapted automatically.



Note!

- In the dimensioning-dependent *MotionDesigner*, you can only load motion profiles that match the motion (translatory or rotary) of the application.
- In the independent *MotionDesigner*, comprehensive editing functions are available. In the application-dependent *MotionDesigner*, the editing functions are limited.
 - If you have created a motion profile with the independent *MotionDesigner* and open it with the application-dependent *MotionDesigner*, all editing functions will be available.
 - If you have created a motion profile with the application-dependent *MotionDesigner* and open it with the independent *MotionDesigner*, the editing functions will be limited.

8.2.5.2 Save motion profile

Together with the motion profile, the type of motion (translatory or rotary) is saved as well.



How to save the motion profile:

1. Click the  icon in the toolbar.
 - The motion profile including all parameter profiles is saved.
 - When the motion profile is saved for the first time, you will be asked for the file name (*.Imp) and the target directory.



How to save the motion profile under another name:

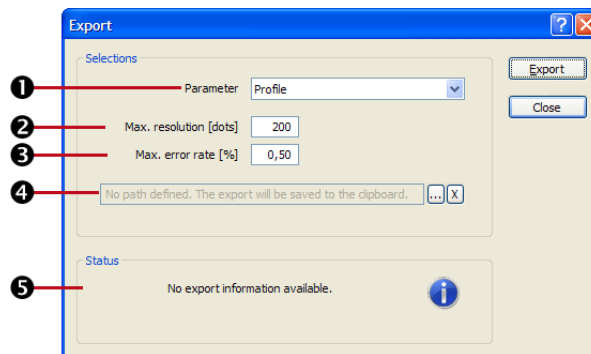
1. Click the  icon in the toolbar.
2. In the *Save motion profile* dialog box, enter another file name (*.Imp) and select another target directory if necessary, then activate the **Save** button.

8.2.5.3 Exporting profile data

A highlighted object in the *Object area* (motion profile or parameter) can be exported to an ASCII file or to clipboard.



In the *Object area*, highlight the motion profile or a parameter, activate the right mouse button and select **Export profile data** from the context menu.



Legend	Description
❶	Selection of the object to be exported. • Click the list field to select an object. • The list field displays all objects that belong to the motion profile.
❷	Specification of the max. resolution • Click into the input field to enter a value. • Value range: 10 ... 1000 points
❸	Specification of the max. error rate. • Click into the input field to enter a value. • Value range: 0.01 ... 99.99 %

Legend	Description
④	List field with target specification for the profile data to be exported.
	 In order to export the profile data into an ASCII file, click the button. Select a target directory and enter a file name.
	 In the Lenze setting, the export into the clipboard is selected in the list field. • The data in the clipboards can be e.g. directly entered into an Excel file. • In order to restore the Lenze setting, click the button.
⑤	Status display. • Shows the number of actually exported points and the error rate.

8.2.5.4 Importing profile data

The motion profile for the drive task can be imported from an ASCII file. The ASCII file contains working points of which the DSD creates the motion profile.

An imported motion profile can be combined with additional elements and scaled by dragging the selection points (resizing).



How to import a motion profile with the corresponding parameters:

1. Highlight the motion profile in the *Object area*.
2. Press the right mouse button and select **Import profile data** in the context menu or click the  icon in the toolbar.
 - The data from the ASCII file is read in. The motion profile and the parameter profiles are created.



How to import an individual motion profile or a parameter:

1. Highlight the motion profile or a parameter in the *Object area*.
2. Click the  icon in the toolbar.
 - The data from the ASCII file is read in. The motion profile or the parameter profile is created.



Note!

- DSD can import ASCII files with approx. 300 operating points without problems. The greater the number of interpolation points, the longer the import takes.
- The data for the motion profile can be easily entered in Microsoft® Excel and then be saved as an ASCII file.
- The *CamManager* in the »Engineer« has an DSD export for CAM curve profiles. This serves to write profile data to an ASCII file.
- All metric and imperial units used in the DSD can be interpreted by the DSD.
 - Units can be defined globally in the **Extras→Settings** menu in the ["Motion" register](#).  43)

Structure of the ASCII file

[s]	[m/s]	[kg]	[N]	[CINH]	[BRK]
0	0	500	10	1	1
0.0416667	0.00128174	500	10	0	0
0.0833333	0.00512695	500	10	0	0
0.125	0.0115356	500	10	0	0
0.166667	0.0205078	500	10	0	0
0.208333	0.0320435	500	10	0	0
0.25	0.0461426	500	10	0	0
0.291667	0.0628052	500	10	0	0
0.333333	0.0820313	500	10	0	0
0.375	0.103821	500	10	0	0
0.416667	0.128174	500	10	0	0
0.458333	0.15509	500	10	0	0
0.5	0.18457	500	10	0	0
0.541667	0.216614	500	10	0	0
0.583333	0.251221	500	10	0	0
0.625	0.288391	500	10	0	0
0.666667	0.328125	500	10	0	0
0.708333	0.370422	500	10	0	0
0.75	0.415283	500	10	0	0
0.791667	0.462708	500	10	0	0
0.833333	0.512695	500	10	0	0
0.875	0.565247	500	10	0	0
0.916667	0.620361	500	10	0	0
0.958333	0.67804	500	10	0	0
1	0.738281	500	10	0	0

Comply with the following conditions when creating the ASCII file. Thus, errors can be prevented during the import. [Error messages during import](#) (256)

Condition	Description
The parameters in the ASCII file must be arranged in columns.	Separate table columns using semicolons, tabulators or spaces.
Each table column has to contain a heading.	- The title is the unit of the quantity to be transmitted. - Example: "[s]" or "time [s]", "[m/s]" or "speed [m/s]", "[kg]" or "mass [kg]". - Indicate the quantity when being without a unit. - Examples: [BRK], [CINH]. - Set unit/quantity in squared brackets, e.g. [t].
Arrangement, number and identity of the parameters in the ASCII file and in the <i>Object area</i> of the <i>MotionDesigner</i> must comply with each other.	- DSD reads the table columns from the left to the right. The parameters in the <i>Object area</i> must be arranged accordingly from the top to the bottom. - The data of the motion profile must be defined in the first two table columns: 1. table column (X axis): Time [s] 2. table column (Y axis): Speed [m/s] (translatory) or speed [rpm] (rotary).
The data must be consistent and have valid value ranges.	- Table lines must be complete. No values should be missing. - Mass must not have any negative values. - Decimal numbers must not contain any characters. - Decimals must be written with comma or point. - In case of digital signals, the states must be indicated with "1" (High) and "0" (Low). - An activated brake (BRK) or a set controller inhibit (CINH) is displayed as "1". - A deactivated brake (BRK) or non-set controller inhibit (CINH) is displayed as "0".
During the import, other programs must not access the ASCII file.	—

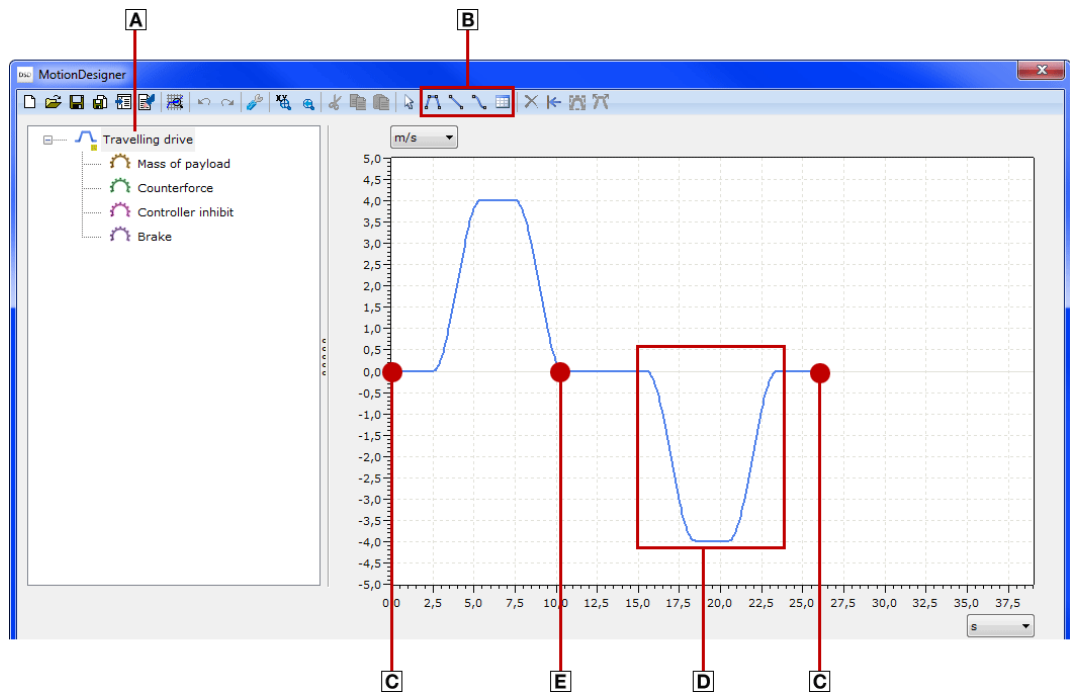
8.2.5.5 Error messages during import

Error message	Causes, possible remedies
Error during import.	The ASCII file cannot be read. Either it is defect or the data does not have a valid format.
The imported file contains parameters which are not available in the <i>MotionDesigner</i> . These parameters will not be imported. Check the motion profile with its parameters in the <i>MotionDesigner</i> .	Sequence and number of the parameters in the ASCII file do not comply with the structure created in the <i>Object area</i> of the <i>MotionDesigner</i> . Either correct the ASCII file or adapt the structure in the <i>Object area</i> .
Syntax error when evaluating the dimension units and the columns in the header.	The DSD does not know a unit in the ASCII file or the sequence of the columns is mixed up. Check the units in the ASCII file or correct the sequence of the columns.
The imported values are outside the valid value range.	The data in the ASCII file is not consistent. Examples: The lines do not contain data, masses are negative, digital signals do not have 0 or 1.
Error in line x	The ASCII file contains a wrong character in the named line. For instance, a decimal number contains a letter.
The imported file does not contain any data.	The ASCII file does not contain any data.
The motion profile in the <i>MotionDesigner</i> contains parameters which do not appear in the file to be imported. Check the motion profile including its parameters for completeness in the <i>MotionDesigner</i> .	The ASCII file contains less information than the <i>MotionDesigner</i> is able to process for the drive dimensioning. The ASCII file does not contain any values for individual tracks. These tracks are pre-assigned with zero. Check ASCII file.
Error reading the file to be imported or access error.	Another program accesses the ASCII file.
Syntax error when evaluating the imported data.	The ASCII file contains wrong delimiters. Permitted are semicolons, tabulators or spaces. The ASCII file contains invalid characters. For instance, a decimal number contains a letter.
The type of motion profile does not match the type specified in the imported file.	Instead of a translatory motion profile, a rotary one has been imported or vice versa. The motion profile to be imported must correspond to the motion profile set in the <i>MotionDesigner</i> .
At least one dimension unit in the file to be imported is unknown. The import is aborted.	A unit in the ASCII file is unknown to the DSD. Check the units in the ASCII file.
The imported values are not in ascending order.	Arrange the values in the ASCII file in ascending order. The temporal characteristic must have continuously ascending values.
Negative import values are not permissible for this parameter.	The track does not permit negative values (e.g. mass). Enter parameters with positive signs only.
The import values of a digital signal must be 0 or 1.	The data in the ASCII file are not consistent. Enter 0 or 1 for digital signals only.
The import values for the curve contain an impermissible step change.	Values with step changes are not permitted for the track (e.g. speed curve).
The import values for this parameter must be sectionally constant (discrete).	For this track, quantities are not permitted that change continuously (e.g. mass).

8.2.6 Graphic area

The *graphic area* presents the motion profile and parameters graphically. For drawing purposes, different trapezoidal elements, line elements and S-shaped elements are available which form a motion profile. Created elements can be revised or optimised by changing its values.

8.2.6.1 Creating motion profiles: Principles



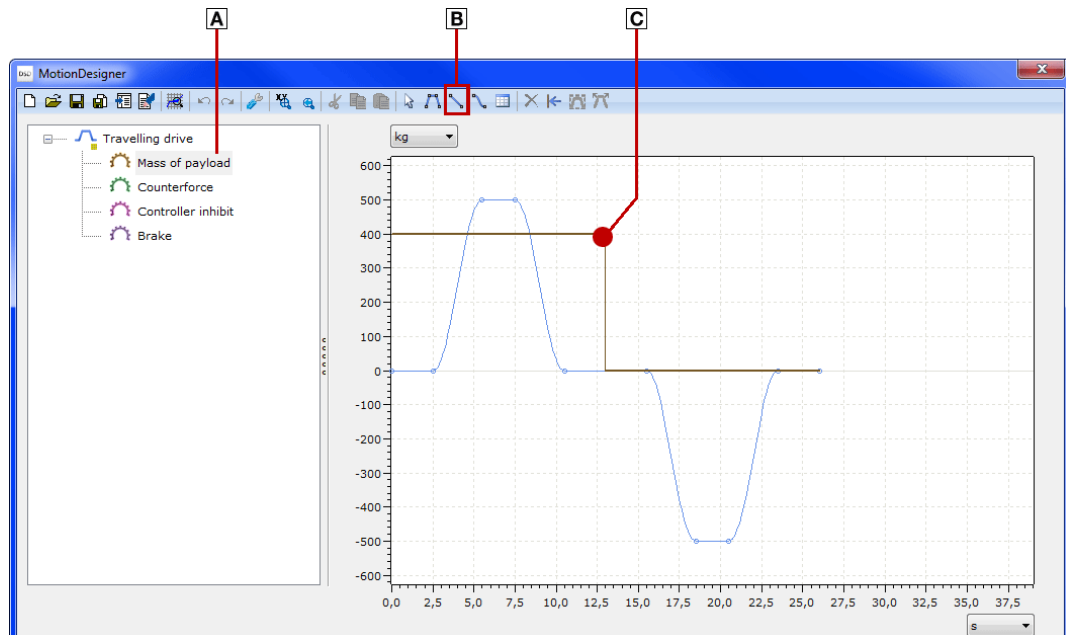
- Before creating or revising, select the motion profile in the *Object area*. A
- Motion profiles can consist of trapezoidal elements, S-shaped elements, line elements and imported elements. B
 - S-shaped elements may only be used for accelerations or decelerations.
- A motion profile must have the same initial value and final value C:

$$y(t = 0) \equiv y(t = T)$$

T Cycle time

- A trapezoidal element always starts and ends at standstill (y-value = 0). D
- Elements must be connected to each other. They must not overlap. E
 - Standstill phases (y-value = 0) between two elements are drawn automatically.
 - The automatic connectors are indicated as thin lines when the motion profile starts and ends at standstill.

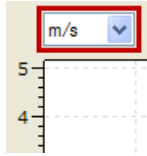
8.2.6.2 Creating a parameter profile: Principles



- Before creating or revising, select the corresponding parameter in the *Object area*. **A**
- Parameter profiles may only consist of line elements or imported elements. **B**
- Elements must be connected to each other. They must not overlap. **C**
 - Disconnected elements are connected automatically.
 - The y-value of the automatic connectors corresponds to the specification under the **Line** tab in the [Parameter area: Description](#).
 - The automatic connectors are indicated as thin lines.

8.2.6.3 Setting XY axes

Changing the units of the axes



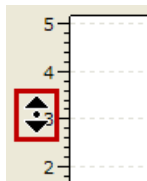
- Click the selection field using the mouse and select the desired unit.
- Values that have already been entered are converted to the newly selected unit.
- Units can be defined globally in the **Extras→Settings** menu in the ["Motion" register](#). (43)

Shifting the zero point of the XY axes



1. Move the mouse over the desired axis until the form of the mouse pointer changes.
2. Press left mouse button and shift the zero point of the axis.
3. Release the mouse button at the desired position.

Scaling the XY axes

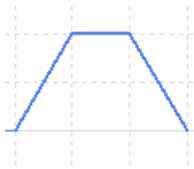


1. Keep the <Ctrl> key pressed and move the mouse of the desired axis until the form of the mouse pointer changes.
2. Press left mouse button and shift the mouse towards the shown arrows.
3. Release the mouse button at the desired scaling.

8.2.6.4 Creating and editing elements

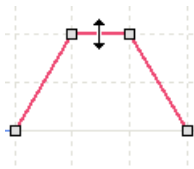
For creating and editing, use the functions in the [Toolbar](#) or the corresponding shortcuts.

Trapezoidal element



Creating:

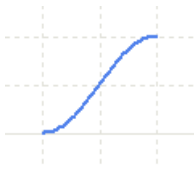
1. Highlight the motion profile in the *Object area*.
2. Select the desired trapezoidal shape in the [Parameter area: Description](#) under the **Profile** tab.
3. Click the  icon in the toolbar.
4. Keep the left mouse button pressed and zoom in the element in the *Graphic area*.



Editing:

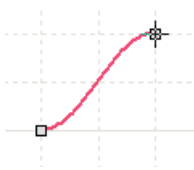
1. Select element.
2. Move mouse pointer over the element.
 - The pointer changes if editing is possible.
 - The reference points and the height can be shifted.
 - The proportions of the 1/3 trapezium cannot be changed.
3. Press the left mouse button and change the element.
 - If the trapezium is grabbed at the sides (pointer does not changed), the element can be shifted on the X axis.

S-shaped element



Creating:

1. Highlight the motion profile in the *Object area*.
2. Click the  icon in the toolbar.
3. Keep the left mouse button pressed and zoom in the element in the *Graphic area*.



Editing:

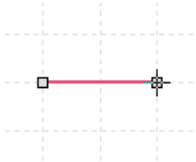
1. Select element.
2. Move mouse pointer over a nodal point.
 - The pointer changes.
3. Press left mouse button and shift the nodal point.
 - If the line is grabbed (pointer does not change), the element can be shifted.

Line element



Creating:

1. Highlight the motion profile or a parameter in the *Object area*.
2. Click the  icon in the toolbar.
3. Keep the left mouse button pressed and zoom in the element in the *Graphic area*.



Editing:

1. Select element.
2. Move mouse pointer over a nodal point.
 - The pointer changes.
3. Press left mouse button and shift the nodal point.
 - If the line is grabbed (pointer does not change), the element can be shifted.

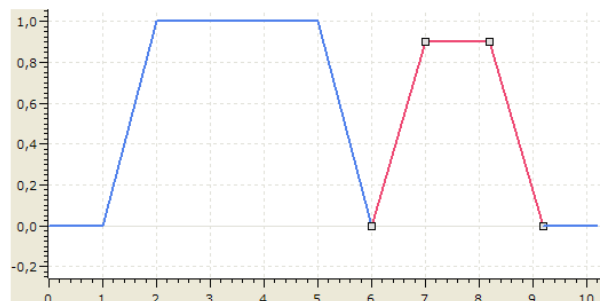
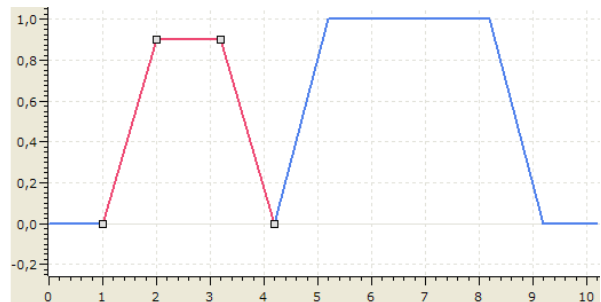
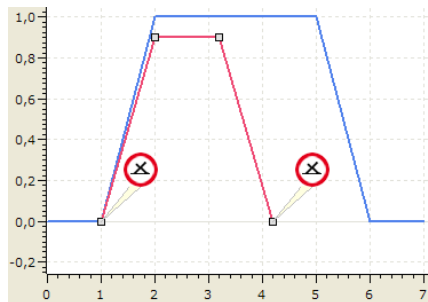
Shift elements automatically to the left

With one command, all elements on the drawing area can be quickly connected to a motion profile. Automatic connections are ignored and removed. The elements do not need to be selected for this action.



How to shift all elements automatically to the left:

1. Click the  icon in the toolbar.
 - Each element is shifted towards its left adjacent element and connected to it if a reasonable connection is possible.
 - The position of an element is defined by its center. An element is shifted if its center is positioned to the right of its adjacent element.
 - Line elements and S-shaped elements are also shifted on the Y axis if a sensible connection is possible.
 - The first element is not shifted.



Combining elements

A self-created trapezoidal element consisting of S-shaped or line elements can be combined for easy handling. At least two and maximally five elements can be combined. A combined element is seen as one element in the *MotionDesigner*.



How to combine several elements:

1. Select each element using the mouse while keeping the Shift key pressed.
2. Click the  icon in the toolbar.
 - The selected elements are combined.

Click the  icon in the toolbar to undo the combination again.



Tip!

A predefined trapezoidal element in the *MotionDesigner* consists of combined elements. The combination can be undone as well.

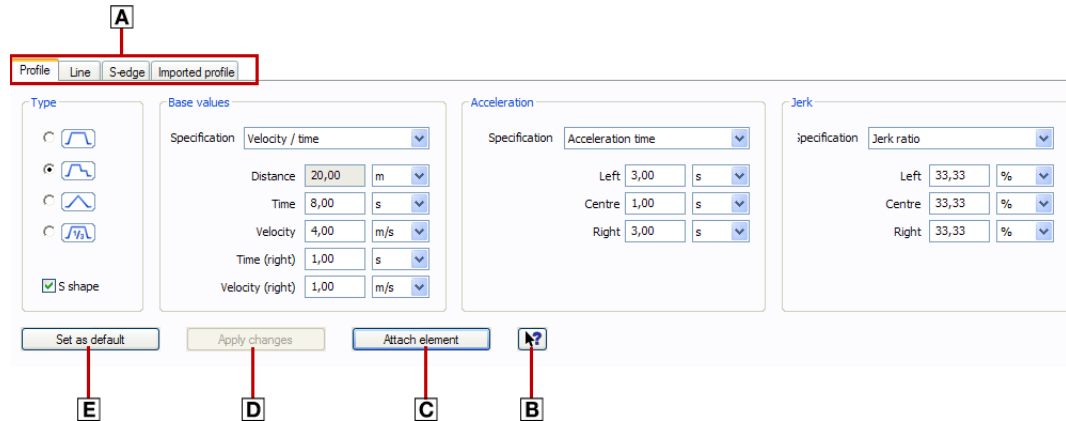
8.2.6.5 Error messages

Symbols signalise whether the motion or parameter profile are defective. A defective motion profile will not be accepted in the dimensioning-dependent *MotionDesigner*.

Symbol	Description
	The motion profile contains incorrectly arranged elements.
	The parameter profile contains incorrectly arranged elements.
	The motion profile does not start or end with the same Y value. Go to the parameter area and correct the starting value of the first element or the final value of the last element so that both values are identical.
	Two elements overlap on the X axis. The last or first nodal point of both elements are not connected to each other. - Shift or edit the elements so that they are connected. Use the flying restart function. - The flying restart function can be set in the Extras→Settings menu in the "Motion" register. (43)
	Two elements are positioned separately on the Y axis. The last or first nodal point of both elements are not connected to each other. - Shift or edit the elements so that they are connected. Use the flying restart function. - The flying restart function can be set in the Extras→Settings menu in the "Motion" register. (43)
	The first element on the left starts on the time axis (X axis), not at 0. Shift the element so that it starts at t = 0.
	The parameter profile takes longer than the motion profile. Limit the parameter profile to the length of the motion profile.
	The control signals in the "Controller inhibit" or "Brake" parameter profile do not match the motion profile. An active controller inhibit or activated brake are only permitted in standstill phases.

8.2.7 Parameter area: Description

In the parameter area, the values of a selected element of the motion profile or the parameter profile are indicated. Graphically created elements can be optimised by entering the values numerically. Elements can also be created by entering values numerically and attaching them to the motion profile. For the purpose of analysing, the values of the points of an imported profile are indicated in tabular form.



- A** Tabs under which the parameter areas are edited.

 - ▶ "Profile" tab ([book 266](#))
 - ▶ "Line" tab: Motion profile ([book 268](#))
 - ▶ "Line" tab: Parameter profile ([book 269](#))
 - ▶ "S-edge" tab ([book 271](#))
 - ▶ "Imported profile" tab ([book 272](#))
- B** Call of the context-sensitive help in the parameter area
- C** Attach an element with the specified values to the motion profile in the right *Graphic area*.

 - The button is only active if no element is selected in the *Graphic area*.
- D** Change the highlighted element in the *Graphic area* according to the entered values.

 - For the selected element, the respective tab is always active.
- E** Set the values in the input fields of the respective areas as a specification for the corresponding element.

 - The values do not need to be entered anew if you want to create several elements with the same values.
 - The values are specified until new values are set as specification.

8.2.7.1 "Profile" tab

In this tab, you create or edit the trapezoidal elements. Select an already created element to edit it. Values are always entered positively.

Legend	Description
Type	
	Trapezoidal element.
	Trapezoidal element with creep speed.
	Triangular element without constant travel. • The element has only one acceleration and deceleration phase.
	Trapezoidal element. • The three phases acceleration, constant travel, acceleration take 1/3 each of the total time of the element. These proportions cannot be changed.
S shape	Trapezoidal acceleration and deceleration phase. • When the selection field is activated, the Jerk input field is shown. ▶ Non-linear motion profiles (📖 285)
Base values	
	• Entry of the velocity or speed. • Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – basic values (📖 275)
Distance	▶ Distance / angle – basic values (📖 276)
Angle	
Time	▶ Time – basic values (📖 276)
Speed	▶ Velocity / speed – basic values (📖 276)
Speed	
Time (right)	▶ Time (right) – basic values (📖 276)
Velocity (right)	▶ Velocity (right) / speed (right) – basic values (📖 277)
Speed (right)	
Velocity limit	
Speed limit	
Acceleration	
Specification	▶ Specification – acceleration (📖 278)
Left	▶ Left – acceleration (📖 278)
Centre	▶ Middle – acceleration (📖 278)
Deceleration	▶ Right – acceleration (📖 278)

Legend	Description
Jerk	
	• An S-shaped acceleration consists of three sections: • Showing the acceleration (rounding) • Linear acceleration • Hiding the acceleration (rounding) • Values for rounding always apply to showing and hiding. • The input area is only displayed if the S shape selection field in the Type input area is activated.
Specification	▶ Specification – jerk (📖 279)
Left	▶ Left – jerk (📖 279)
Centre	▶ Middle – jerk (📖 279)
Right	▶ Right – jerk (📖 279)
Buttons	
Set as default	Accept values in the areas <i>Basic values</i> , <i>Acceleration</i> and <i>Jerk</i> as specification.
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. The button is only active if an element is selected in the <i>Graphic area</i> .
Attach element	Attach an element with the specified values to the motion profile in the right <i>Graphic area</i> . • The button is only active if no element is selected in the <i>Graphic area</i>.

8.2.7.2 "Line" tab: Motion profile

In this tab, you create or edit the line elements of a motion profile. Select an already created element to edit it. Values are always entered positively.

Legend	Description
Base values	
	- Entry of the speed. - Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – basic values (📖 275)
Distance	▶ Distance / angle – basic values (📖 276)
Angle	
Time	▶ Time – basic values (📖 276)
Speed	▶ Velocity / final speed – basic values (📖 277)
Final speed	
Starting velocity	▶ Starting velocity / starting speed – basic values (📖 277)
Starting speed	
Acceleration	▶ Acceleration – basic values (📖 277)
Buttons	
Set as default	Accept values in the <i>Basic values</i> area as specification.
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. The button is only active if an element is selected in the <i>Graphic area</i> .
Attach element	Attach an element with the specified values to the motion profile in the right <i>Graphic area</i> . The button is only active if no element is selected in the <i>Graphic area</i>.

8.2.7.3 "Line" tab: Parameter profile

In this tab, you create or edit the line elements of a parameter profile. Select an already created element to edit it. Values are always entered positively.

The screenshot shows the 'Line' tab interface. On the left, the 'Type' section contains a dropdown menu with 'Mass of the payload' selected and a 'Specification' field with the value '500,00 kg'. To the right, the 'Base values' section includes a 'Time' field (13,00 s), a 'Left' field (0,00 kg), and two radio buttons for 'Controller locked' (set to 1) and 'Controller released' (set to 0). At the bottom of the main panel are three buttons: 'Set as default', 'Apply changes', and 'Attach element'. To the right, there are two overlapping smaller panels, each showing a 'Base values' section with similar controls for 'Time', 'Controller locked', and 'Controller released'.

Legend	Description
Type	
<Parametername>	▶ <Parametername> – Type (📘 275)
Specification	▶ Specification – Type (📘 275) ▶ Object properties (📘 249)
Base values	
Time	▶ Time – basic values (📘 276)
Left	▶ Left – basic values (📘 277)
Right	▶ Right – basic values (📘 278)
Controller locked Controller released	▶ Controller / brake – basic values (📘 278)
Brake activated Brake released	
Buttons	
Set as default	Accept values in the areas <i>Type</i> and <i>Basic values</i> as specification.
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. The button is only active if an element is selected in the <i>Graphic area</i> .
Attach element	Attach an element with the specified values to the motion profile in the right <i>Graphic area</i> . • The button is only active if no element is selected in the <i>Graphic area</i>.

Notes on dimensioning

- Standstill phase
 - The torque (holding torque) which is generated during the standstill phase does not have to be absorbed by the motor. In the torque diagram of the motor it can be seen that the torque at standstill is set to zero. This torque can be taken over by the mechanical brake and is shown in the torque diagram of the brake. The corresponding diagrams can be selected in the result tree.
- Brake
 - For the activation of the brake, the Engagement time or Disengagement time is to be taken into consideration.
 - [Mechanical brake selection](#) (📖 362)
- Controller inhibit
 - In order to achieve an additional relief of the motor and the inverter, the setting of the controller inhibit can be activated when the motion profile is entered. Generally, controller inhibit is also set if the mechanical brake is activated. If controller inhibit is set, the motor at standstill is no longer supplied with current and the effective current load is reduced.
- Mass of the payload, counterforce
 - Depending on the application, a payload or counterforce can be entered for each subprofile, so that, for instance, empty movements or wind loads can be taken into consideration.

8.2.7.4 "S-edge" tab

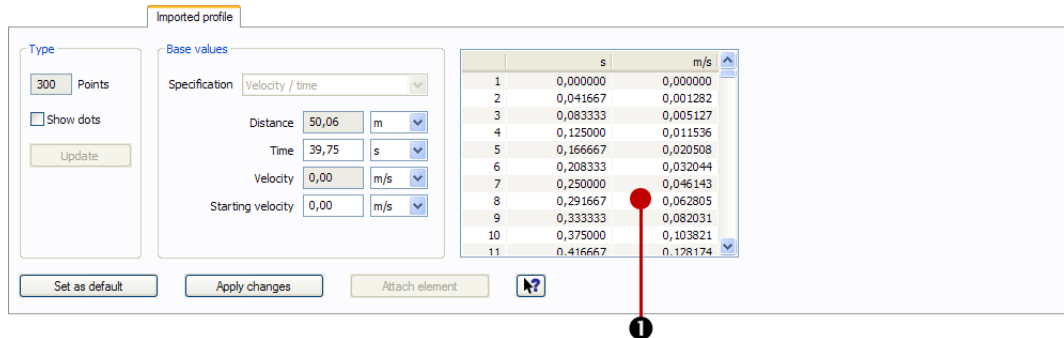
In this tab, you create or edit the S-shaped element of the motion profile. S-shaped elements can only be used for accelerations and decelerations. Select an already created element to edit it. Values are always entered positively.

Legend	Description
Base values	
	• Entry of the speed. • Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – basic values (📖 275)
Distance	▶ Distance / angle – basic values (📖 276)
Angle	
Time	▶ Time – basic values (📖 276)
Speed	▶ Velocity / final speed – basic values (📖 277)
Final speed	
Starting velocity	▶ Starting velocity / starting speed – basic values (📖 277)
Starting speed	
Jerk	
	• An S-shaped acceleration consists of three sections: • Showing the acceleration (rounding) • Linear acceleration • Hiding the acceleration (rounding) • Values for rounding always apply to showing and hiding. • Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – jerk (📖 279)
Jerk ratio	▶ Jerk ratio – jerk (📖 279)
S-ramp time	▶ S-ramp time – jerk (📖 279)
Jerk	▶ Jerk – jerk (📖 280)
Max. acceleration	▶ Max. acceleration – jerk (📖 280)
Buttons	
Set as default	Accept values in the areas <i>Basic values</i> and <i>Jerk</i> as specification.
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. • The button is only active if an element is selected in the <i>Graphic area</i>.
Attach element	Attach an element with the specified values to the motion profile in the right <i>Graphic area</i> . • The button is only active if no element is selected in the <i>Graphic area</i>.

8.2.7.5 "Imported profile" tab

In this tab, you can check an imported motion profile or parameter profile and edit it slightly. For this purpose, the profile must be selected. It can be shifted at will and be scaled in seize. The combination cannot be undone. Further elements can be preceded or attached to the profile.

The imported dots of the motion profile and the parameters can be checked in the parameter area. Moreover, you can add more elements to the profile.



Legend	Description
❶	Tabular display of the imported dots and data. If you select a line in the table, this imported value is displayed in the motion profile as a dot.
Type	
Points	Number of imported dots. Read only.
Show dots	When the selection field is activated, it shows the dots on the motion profile in the <i>Graphic area</i> .
Update	Update motion profile if data in the ASCII file has changed. - The Update button is only active if there is a linkage to the ASCII file. - During import, a linking to the ASCII file is established. The linking is preserved even after the motion profile (Imp file) is saved. If the absolute data path changes, the linking gets lost. Importing profile data (📖 254)
Base values	
	Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – basic values (📖 275)
Distance	▶ Distance / angle – basic values (📖 276)
Angle	
Time	▶ Time – basic values (📖 276)
Speed	▶ Velocity / final speed – basic values (📖 277)
Final speed	
Starting velocity	▶ Starting velocity / starting speed – basic values (📖 277)
Starting speed	
Buttons	
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. The button is only active if an element is selected in the <i>Graphic area</i> .
Attach element	Import an element from an ASCII file and attach it to the motion profile in the right <i>Graphic area</i> . The button is only active if no element is selected in the <i>Graphic area</i>.

8.2.8 Positioning



Change to the **Profile** register and go to the *Basic values* input area, in *Selection* select the **Positioning** mode.

This function serves to conveniently create motion profiles for positioning applications.

- Only the trapezoidal element and the acceleration, S shape and S-ramp time options are available.
- Selection and limit values which must not be exceeded are represented in red.
 - The speed is calculated from the values for the path and the time in accordance with the limit values. If the path cannot be travelled within the specified time, the time will be prolonged automatically.
- Simple optimisation of the temporal characteristic of an element.
 - In order to obtain the shortest time, select a very small value (e.g. 1 ms) in the *Time* input field. Accept the value. DSD calculates the smallest possible value.

The screenshot shows the 'Profile' register in the Motion Designer software. It contains four main sections: 'Type', 'Base values', 'Acceleration', and 'Jerk'. The 'Type' section has a dropdown menu set to 'Positioning' and a checkbox for 'S shape'. The 'Base values' section has input fields for 'Distance' (9,00 m), 'Time' (10,00 s), 'Velocity' (1,00 m/s), and 'Velocity limit' (4,00 m/s). The 'Acceleration' section has input fields for 'Max. (left)' (2,00 m/s²) and 'Max. deceleration' (2,00 m/s²). The 'Jerk' section has input fields for 'Left' (0,20 s) and 'Right' (0,20 s). At the bottom, there are buttons for 'Set as default', 'Apply changes', 'Attach element', and a help icon.

Legend	Description
Type	
	Trapezoidal element. • Other elements are not available in the Type input area.
S shape	Trapezoidal acceleration and deceleration phase. • When the selection field is activated, the Jerk input field is shown. ▶ Non-linear motion profiles (📖 285)
Base values	
	• Entry of the speed. • Grayed out input fields are deactivated. The values are calculated automatically.
Specification	▶ Specification – basic values (📖 275)
Distance	▶ Distance / angle – basic values (📖 276)
Angle	
Time	▶ Time – basic values (📖 276)
Speed	▶ Velocity / speed – basic values (📖 276)
Speed	
Velocity limit	
Speed limit	
Acceleration	
Max. (left)	▶ Left – acceleration (📖 278)
Max. deceleration	▶ Right – acceleration (📖 278)

Legend	Description
Jerk	
	• An S-shaped acceleration consists of three sections: • Showing the acceleration (rounding) • Linear acceleration • Hiding the acceleration (rounding) • Values for rounding always apply to showing and hiding. • The input area is only displayed if the S shape selection field in the Type input area is activated.
Left	▶ Left – jerk (📖 279)
Right	▶ Right – jerk (📖 279)
Buttons	
Set as default	Accept values in the areas <i>Basic values</i> , <i>Acceleration</i> and <i>Jerk</i> as specification.
Apply changes	Change the highlighted element in the <i>Graphic area</i> according to the entered values. The button is only active if an element is selected in the <i>Graphic area</i> .
Attach element	Attach an element with the specified values to the motion profile in the right <i>Graphic area</i> . • The button is only active if no element is selected in the <i>Graphic area</i>.

8.2.9 Parameter area: Data for the entry

The following chapters describe data that can be entered or selected in the parameter area.

8.2.9.1 <Parametername> – Type

Parameter	Description
<Parametername>	Name of the parameter that is selected in the object area. • Read only. ▶ "Line" tab: Parameter profile (📖 269) ▶ Object properties (📖 249)

8.2.9.2 Specification – Type

Parameter	Description
Specification	Standard value with which the parameter is automatically created. • The entry of more line elements creates an individual parameter profile. • The "brake" and "controller inhibit" parameters do not have a default value as these control signals can only have the states 1 or 0. ▶ "Line" tab: Parameter profile (📖 269) ▶ Object properties (📖 249)

8.2.9.3 Specification – basic values

Parameter	Description
Specification	Selection of the quantities to be entered. • Translatory motion profile: • Velocity / time • Distance/time • Distance / velocity • Rotary motion profile: • Speed / time • Angle / time • Angle / velocity Use of the parameter: ▶ "Profile" tab (📖 266) ▶ "Line" tab: Motion profile (📖 268) ▶ "S-edge" tab (📖 271) ▶ "Imported profile" tab (📖 272)
	• Positioning Use of the parameter: ▶ Positioning (📖 273)

8.2.9.4 Distance / angle – basic values

Parameter	Description
Distance Angle	• Translatory motion profile: • Covered distance when the operation of the element is completed. • Rotary motion profile: • Covered angle of rotation when the operation of the element is completed. Use of the parameter: ▶ "Profile" tab (266) ▶ "Line" tab: Motion profile (268) ▶ "S-edge" tab (271) ▶ "Imported profile" tab (272)

8.2.9.5 Time – basic values

Parameter	Description
Time	Time required for the operation of the element. Use of the parameter: ▶ "Profile" tab (266) ▶ "Line" tab: Motion profile (268) ▶ "Line" tab: Parameter profile (269) ▶ "S-edge" tab (271) ▶ "Imported profile" tab (272)

8.2.9.6 Velocity / speed – basic values

Parameter	Description
Speed Speed	• Translatory motion profile: • Max. velocity when the operation of the element is completed. • Rotary motion profile: • Max. speed when the operation of the element is completed. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.7 Time (right) – basic values

Parameter	Description
Time (right)	Duration of the constant travel after the second acceleration or deceleration. • The input field is only shown in case of an element for creep speed. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.8 Velocity (right) / speed (right) – basic values

Parameter	Description
Velocity (right) Speed (right)	• Translatory motion profile: • Velocity after the second acceleration or deceleration. • Rotary motion profile: • Speed after the second acceleration or deceleration. • The input field is only shown in case of an element for creep speed. Use of the parameter: ▶ "Profile" tab (📘 266)

8.2.9.9 Velocity / final speed – basic values

Parameter	Description
Speed Final speed	• Translatory motion profile: • Velocity when the operation of the element is completed. • Rotary motion profile: • Speed when the operation of the element is completed. Use of the parameter: ▶ "Line" tab: Motion profile (📘 268) ▶ "S-edge" tab (📘 271) ▶ "Imported profile" tab (📘 272)

8.2.9.10 Starting velocity / starting speed – basic values

Parameter	Description
Starting velocity Starting speed	• Translatory motion profile: • Velocity when the operation of the element starts. • Rotary motion profile: • Speed when the operation of the element starts. • The input field is only shown if an element is selected. ▶ "Line" tab: Motion profile (📘 268) ▶ "S-edge" tab (📘 271) ▶ "Imported profile" tab (📘 272)

8.2.9.11 Acceleration – basic values

Parameter	Description
Acceleration	Acceleration or deceleration from start to end of the element operation. ▶ "Line" tab: Motion profile (📘 268)

8.2.9.12 Left – basic values

Parameter	Description
Left	Value when the operation of the element starts. ▶ "Line" tab: Parameter profile (📘 269)

8.2.9.13 Right – basic values

Parameter	Description
Right	Value when the operation of the element is completed. ▶ "Line" tab: Parameter profile (269)

8.2.9.14 Controller / brake – basic values

Parameter	Description
Controller locked Controller released	Control signal for the inverter. ▶ "Line" tab: Parameter profile (269)
Brake activated Brake released	Control signal for the electromechanical brake. ▶ "Line" tab: Parameter profile (269)

8.2.9.15 Specification – acceleration

Parameter	Description
Specification	The following quantities can be selected: • Max. acceleration. • Acceleration time: • Elapsed time until the application has accelerated to setpoint speed. • Acceleration distance: • Covered distance until the application has accelerated to setpoint speed. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.16 Left – acceleration

Parameter	Description
Left	Acceleration from standstill to setpoint speed. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.17 Middle – acceleration

Parameter	Description
Centre	More acceleration or deceleration from a certain speed. • The input field is only shown in case of an element for creep speed. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.18 Right – acceleration

Parameter	Description
Right	Deceleration to standstill. Use of the parameter: ▶ "Profile" tab (266)

8.2.9.19 Specification – jerk

Parameter	Description
Specification	The following quantities can be selected: • Jerk ratio: • Percentage of the three sections "Show", "Linear acceleration" and "Hide" in the entire element. • S-ramp time: • Duration of the show and hide phase. • Jerk: • Acceleration during the show and hide phase. • Max. acceleration • Acceleration or deceleration from start to end of the element operation. • The selection is only shown for an S-shaped element. ▶ "Profile" tab (📖 266) ▶ "S-edge" tab (📖 271)

8.2.9.20 Left – jerk

Parameter	Description
Left	Jerk for the acceleration from standstill to setpoint speed. ▶ "Profile" tab (📖 266)

8.2.9.21 Middle – jerk

Parameter	Description
Centre	Jerk for further acceleration or deceleration. • The input field is only shown in case of an element for creep speed. ▶ "Profile" tab (📖 266)

8.2.9.22 Right – jerk

Parameter	Description
Right	Jerk for the deceleration to standstill. ▶ "Profile" tab (📖 266)

8.2.9.23 Jerk ratio – jerk

Parameter	Description
Jerk ratio	Percentage of the three sections "Show", "Linear acceleration" and "Hide" in the entire element. ▶ "S-edge" tab (📖 271)

8.2.9.24 S-ramp time – jerk

Parameter	Description
S-ramp time	Duration of the show and hide phase. ▶ "S-edge" tab (📖 271)

8.2.9.25 Jerk – jerk

Parameter	Description
Jerk	Acceleration during the show and hide phase. ▶ "S-edge" tab (📖 271)

8.2.9.26 Max. acceleration – jerk

Parameter	Description
Max. acceleration	Acceleration or deceleration from start to end of the element operation. ▶ "S-edge" tab (📖 271)

8.2.10 Motion profile: application instructions

8.2.10.1 Minimum acceleration and deceleration times

For increasingly lower acceleration and deceleration times the requirement with regard to the dynamic torque increases proportionally to the acceleration and reciprocal to the acceleration or deceleration time:

$$M_{\text{dyn}} \sim a \quad \text{or} \quad M_{\text{dyn}} \sim \alpha$$

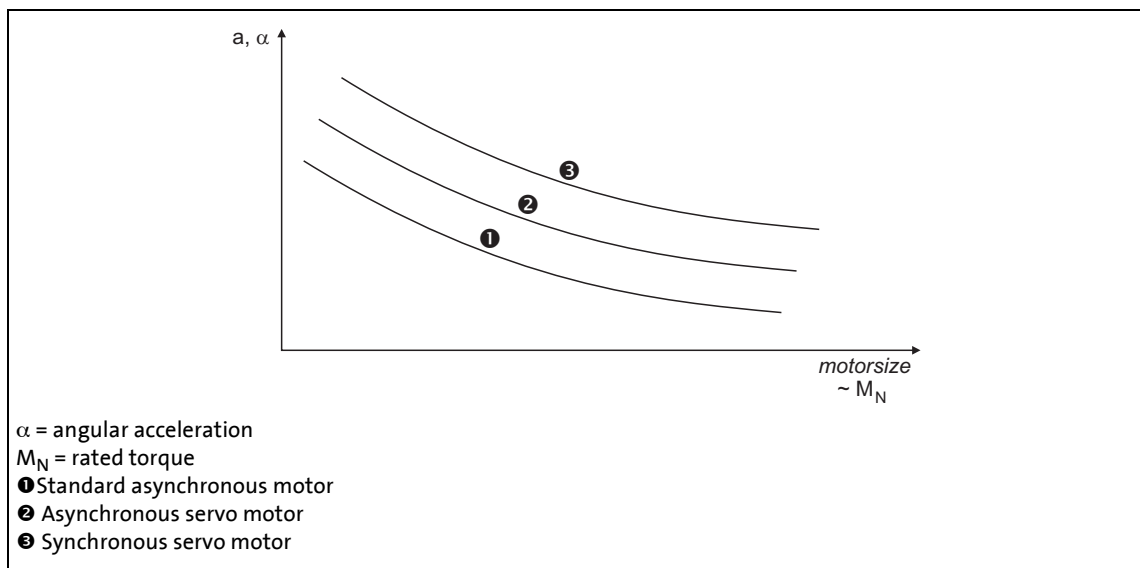
$$M_{\text{dyn}} \sim \frac{1}{t_r} \quad \text{or} \quad M_{\text{dyn}} \sim \frac{1}{t_f}$$

t_r = acceleration time

t_f = deceleration time

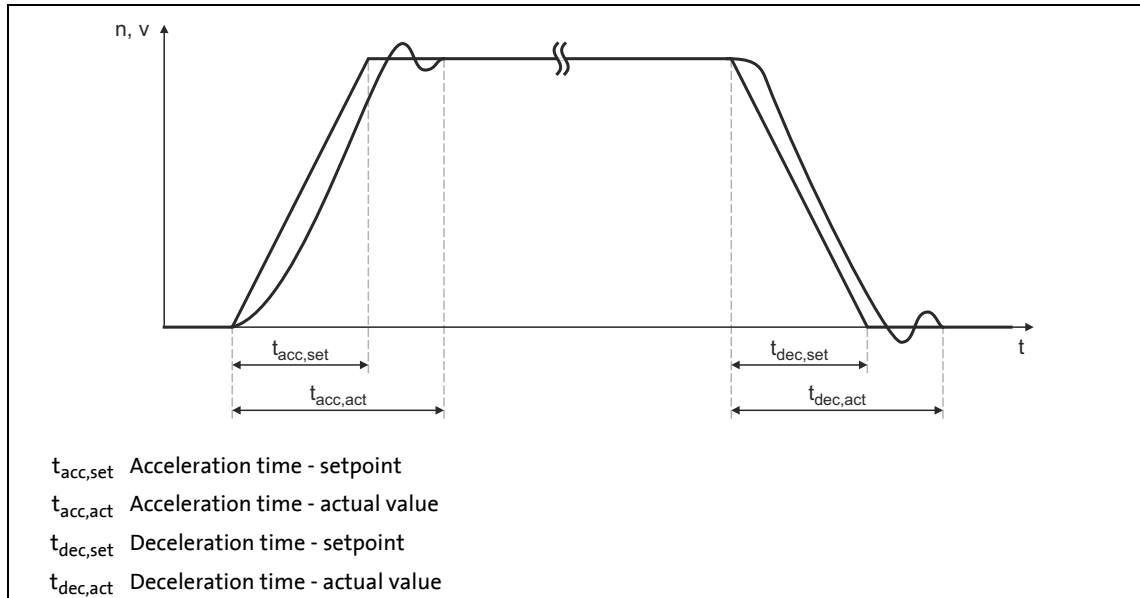
M_{dyn} = dynamic torque

- Thus a greater drive is required, which, however, has to accelerate itself as well.
- For greater motors the accelerating power is smaller than for smaller motors. It is therefore possible that a motor selected later on can no longer meet the specifications.
- These interdependencies are automatically taken into consideration in the DSD, so that a warning is output if limit values are exceeded.



[8-1] Acceleration capability as a function of the frame size

- If the values for acceleration and deceleration times are extremely low, the rise times and settling times of the drive become already noticeable and superimpose the desired speed profile. Although the acceleration and deceleration times can be physically provided by the drive, they are not feasible in a control-oriented manner, so that delays result.



[8-2] Drive behaviour for highly dynamic motion profiles

- These effects can occur in the case of highly dynamic clocked drives, like for example cam applications, cross cutters, handling devices, robots, packaging machines.

- The table below provides guide values for minimum acceleration and deceleration times. If the values fall below these values, the behaviour of the control system of the drive must be checked in addition.

	VFC plus $t_{acc,set}/t_{dec,set}$	SLVC $t_{acc,set}/t_{dec,set}$	SC $t_{acc,set}/t_{dec,set}$
Servo inverter			
i700 servo inverters	< 100 ms	—	< 50 ms
9400 HighLine servo inverters			
8400 TopLine frequency inverters			
Frequency inverter			
8400 BaseLine frequency inverters	< 100 ms	< 500 ms	< 50 ms
8400 StateLine frequency inverters			
8400 HighLine frequency inverters			
8400 TopLine frequency inverters			
Decentralised inverters			
8400 motec frequency inverters	< 100 ms	< 500 ms	—
8400 protec frequency inverters	< 100 ms	< 500 ms	< 50 ms

The following conditions must be complied with:

- $t_{r,set} > t_{dyn,min}$
- $t_{f,set} > t_{dyn,min}$

VFC plus Voltage frequency control

SLVC Sensorless vector control

SC Servo control

$t_{acc,set}$ Acceleration time - setpoint

$t_{acc,act}$ Acceleration time - actual value

$t_{dec,set}$ Deceleration time - setpoint

$t_{dec,act}$ Deceleration time - actual value

$t_{dyn,min}$ Dynamic acceleration and deceleration time that the control system of the inverter is able to realise at least



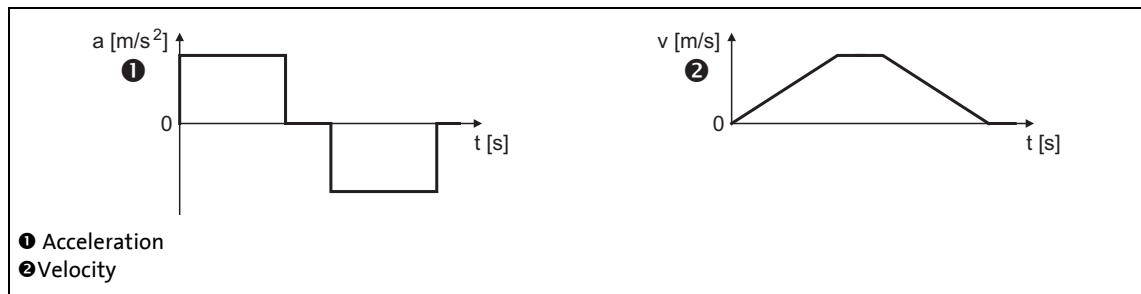
Note!

Without a specific feedforward control of the required acceleration torque within the inverter, these control-related deceleration times are to be taken into consideration.

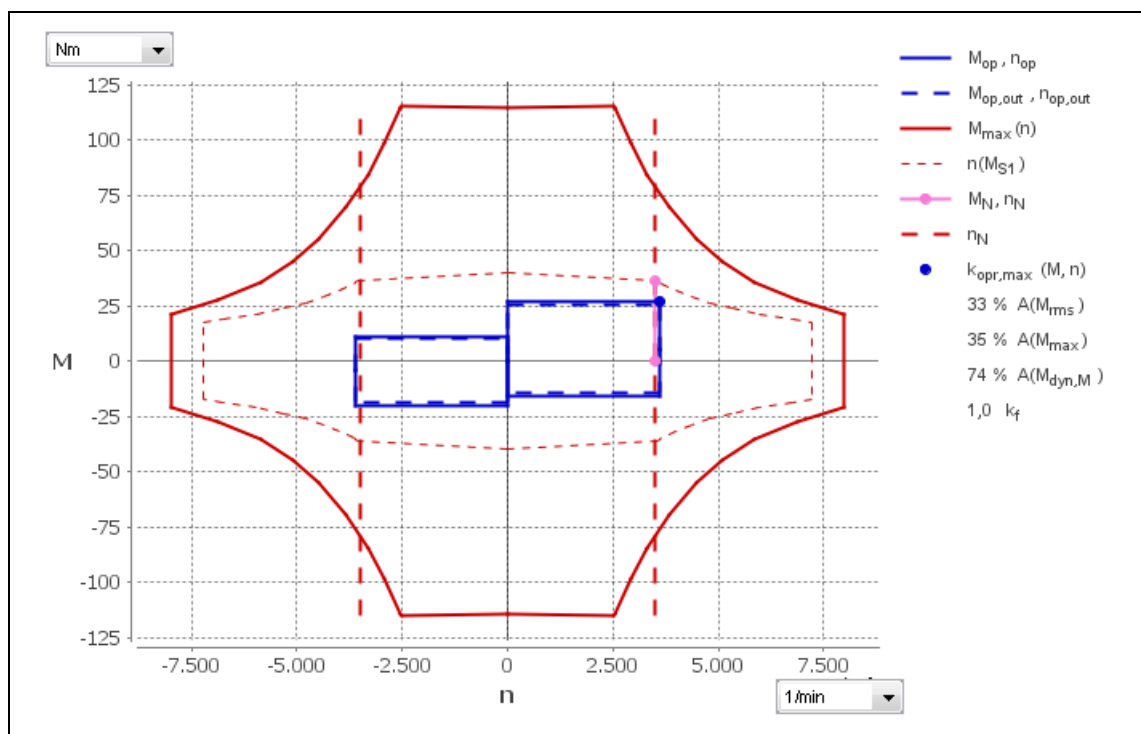
If the actual times are lower than the deceleration times, a control-related system consideration on the basis of empirical checks (e. g. on a test configuration) or by an appropriate simulation has to be carried out in addition to the drive dimensioning with the DSD.

8.2.10.2 Linear motion profiles

Linear motion profiles have no jerk limitation, and the maximum values of torque and speed are reached simultaneously.



[8-3] Linear motion profile



[8-4] Speed/torque/speed characteristic of the motor with a linear motion profile

8.2.10.3 Non-linear motion profiles

For motion applications (highly dynamic motion drives) in the fields of robotics, mounting, handling, apart from linear profiles there are further motion profiles with a jerk limitation:

- [S-shaped motion profiles](#)
- [sin²-shaped motion profiles](#)
- CAM curve profiles
 - CAM curve profiles can be created with the »CAM Designer« in the »Engineer«. Data can be transferred to the DSD using the exchange format TXT or DPR.

In comparison to a linear motion profile, a motion profile with jerk limitation produces a greater torque acceleration and thus a higher dynamic torque. Since this only occurs in the medium speed range and the motor can usually be actuated at higher speeds than those for linear motion profiles, the additional torque requirement is compensated by the greater gearbox ratio.

Highly dynamic motions result in an increasingly high load of the gearbox. The S-ramp times determined in DSD must be complied with for the gearbox not to be overloaded.

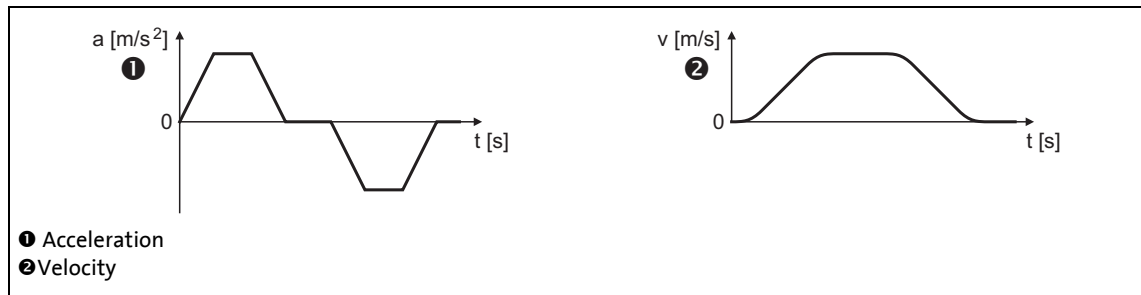
The following table shows advantages of a motion profile with jerk limitation:

Advantages for the application	Advantages for the motor/inverter
• Movement is effected with jerk limitation (s-shaped motion profile). • Movement is effected with a continuous jerk pattern (sinusoidal² motion profile, some CAM curve profiles). • Mechanical resonances are less active. • Mechanics are prevented from damage.	• The motor is clearly better utilised in the set of characteristic curves (maximum values of torque and speed do not arise at the same time, thus higher motor speeds and greater transmission ratios are possible). • Load-matching factor k_j can be reduced. • More stable control • Higher dynamic performance

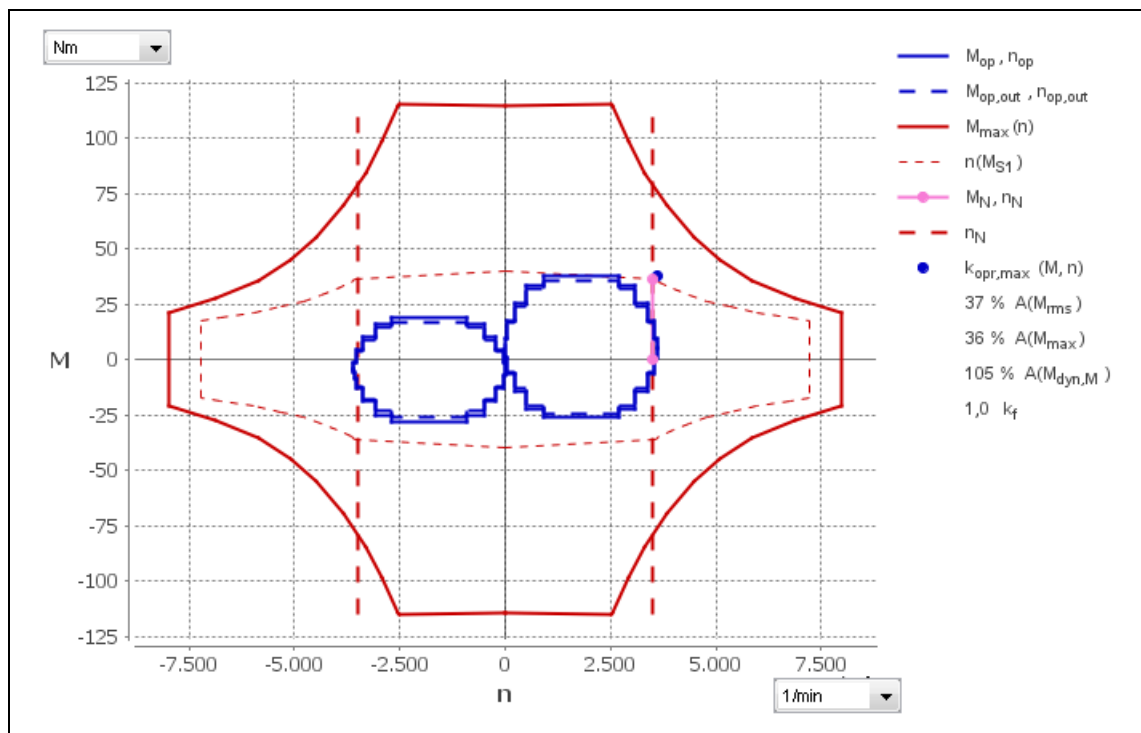
S-shaped motion profiles

In the case of the S-shaped motion profile the acceleration is shown and hidden linearly, by which the jerk is limited. Here the maximum values of torque and speed are not reached simultaneously. Like this, the motor can be better utilised in the set of characteristic curves for higher speeds.

- The max. attainable speed is higher than for the linear profile.
- Compared to the linear profile the Base process power is greater.
- Since the acceleration is shown and hidden linearly, the maximum acceleration is greater than in the case of the linear motion profile.



[8-5] S-shaped motion profile

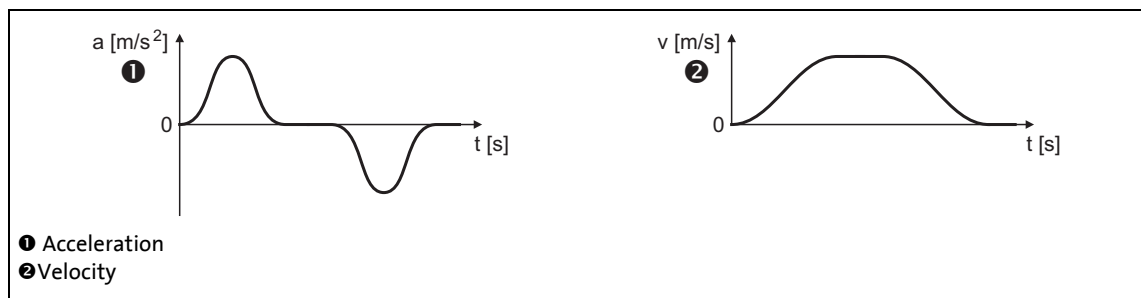


[8-6] Torque/speed characteristic of the motor with S-shaped motion profile

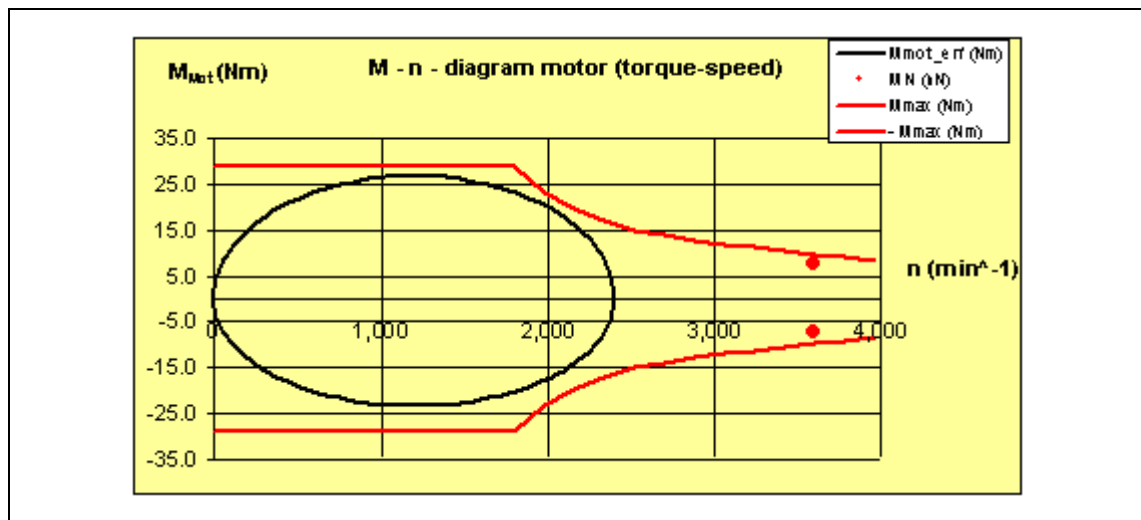
sin²-shaped motion profiles

In the case of the sin²-shaped motion profile, acceleration is effected in a sinusoidal manner. The jerk is also sinusoidal, i. e. continuously. The maximum values of torque and speed are not reached simultaneously; like this, the motor can be better utilised at higher speeds.

- The maximum speed that can be reached is higher than in the cases of the linear and S-shaped motion profiles.
- In comparison to the S-shaped motion profile, the Base process power is greater.
- Since the acceleration is effected in a sinusoidal manner, the maximum acceleration is greater than in the case of the linear motion profile (57 % of the acceleration of the linear motion profile).
- sin²-shaped motion profiles in the torque-speed diagram of the motor are represented in a circle of ellipsoidal manner.



[8-7] Sin²-shaped motion profile



[8-8] Speed-torque characteristics of the motor with Sin²-shaped motion profile

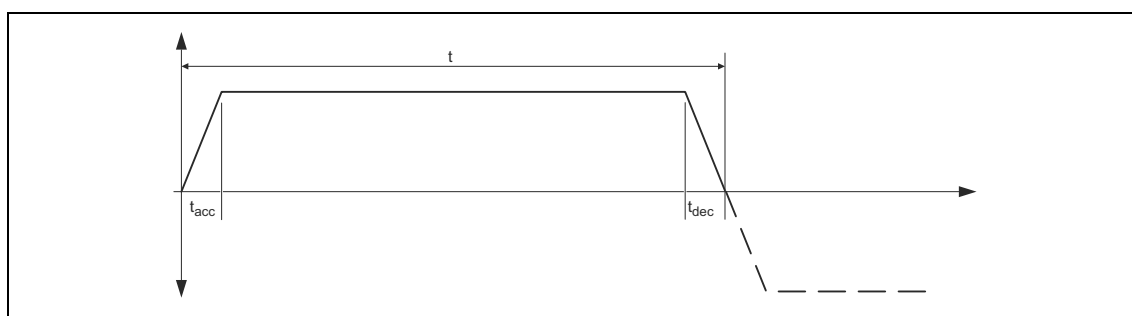
8.3 Predefined motion profile according to operating mode

For the selection of the motor, the operating mode is important. A motor, for instance, heats up less when loaded for a short time than when loaded continuously, and therefore it can be selected smaller.

- It is advisable to use the motion profile for steady-state operation. Acceleration processes can be taken into consideration. The motion profile is repeated in a cyclic manner.
- The predefined motion profiles are based on the operating modes in accordance with VDE 0530 or IEC 34-1.
- The DSD offers the selection of the operating modes S1, S2, S3 and S6.
- Operation of a motor in modes other than S1 may be run at a higher power level.

8.3.1 S1, continuous operation

Operation with a constant load that is available until the machine reaches the thermal steady state.

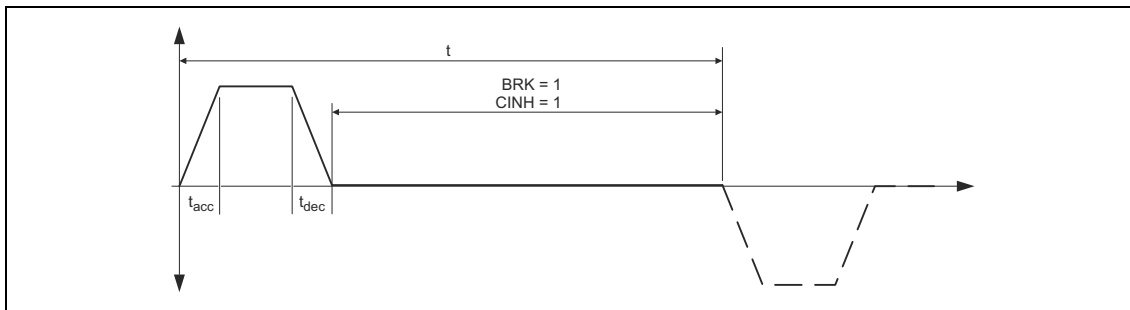


[8-9] Motion profile for operating mode S1

Description	
t	Cycle time, corresponds to the duration of the load phase.
t _{acc}	Acceleration time required by the drive until the constant load condition is reached.
t _{dec}	Deceleration time required by the drive until standstill.

8.3.2 S2, short-term operation

The operating time with constant load does not suffice to reach the thermal steady state. During the break that follows, the motor can cool down to the initial temperature.



[8-10] Motion profile for operating mode S2

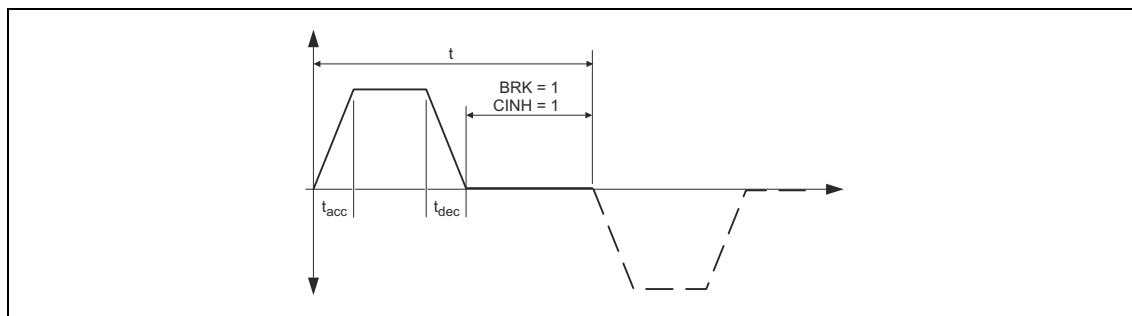
Description	
t	Cycle time, corresponds to the duration of the load phase.
t _{acc}	Acceleration time required by the drive until the constant load condition is reached.
t _{dec}	Deceleration time required by the drive until standstill.
BRK	Brake, BRK = 1: brake active
CINH	Controller inhibit, CINH = 1: controller inhibit active

8.3.3 Intermittent operation S3, S4, S5

The intermittent operation consists of a sequence of identical cycles, each of which including an operating time with constant load and a downtime.

Starting and braking times as well as inertias are characteristics of the respective operating mode:

- S3: The starting current is irrelevant for the motor heating.
- S4: The starting process is thermally relevant in addition.
- S5: The brake reaction and the starting performance are taken into consideration.

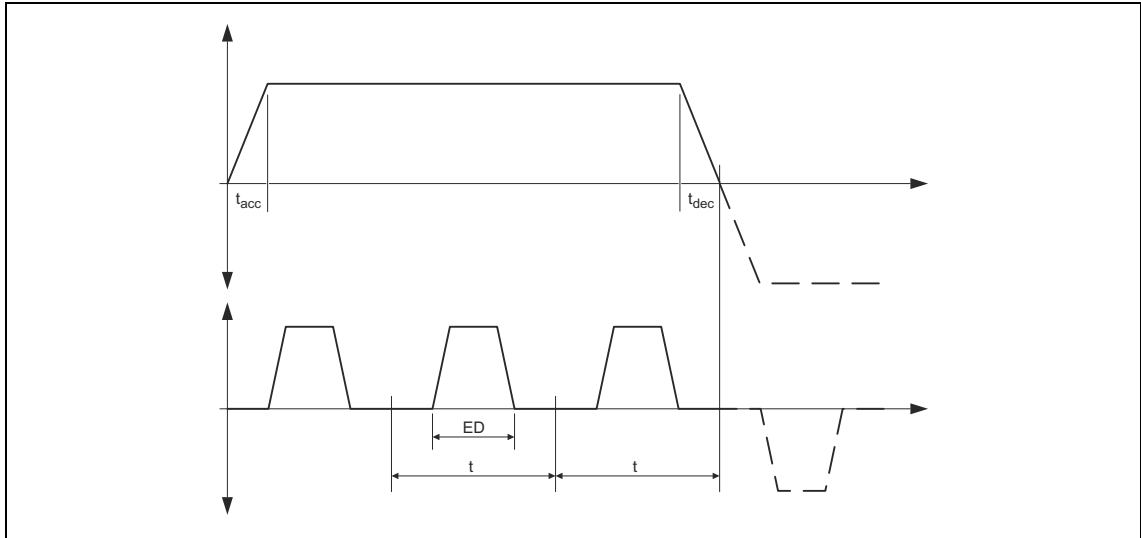


[8-11] Motion profile for operating mode S3

Description	
t	Cycle time, corresponds to the duration of the load phase.
t _{acc}	Acceleration time required by the drive until the constant load condition is reached.
t _{dec}	Deceleration time required by the drive until standstill.
BRK	Brake, BRK = 1: brake active
CINH	Controller inhibit, CINH = 1: controller inhibit active

8.3.4 Intermittent load S6, S7

Operation composed of a sequence of identical cycles each of which including an operating time with constant load and an idle time. There is no idle time.



[8-12] Motion profile for operating mode S6

Description	
t	Cycle time, complies with the load period.
t_{acc}	Acceleration time required by the drive until the constant load condition is reached.
t_{dec}	Deceleration time required by the drive until standstill.
OT	Relative operating time The relative operating time is the ratio of the load period to the cycle time.

8.3.5 Data for the entry

8.3.5.1 Max. velocity

Parameter	Description
$v_{\max}$	Max. velocity of the application.

See also:

- ▶ [Chain conveyor](#) (133) → [Speed](#) (138)
- ▶ [Roller conveyor](#) (139) → [Speed](#) (145)
- ▶ [Belt conveyor, unit load](#) (146) → [Speed](#) (150)
- ▶ [Belt conveyor, bulk material](#) (151) → [Speed](#) (157)
- ▶ [Synchronous drive - single roll](#) (158) → [Speed](#) (163)
- ▶ [Synchronous drive of squeegees](#) (164) → [Speed](#) (170)

8.3.5.2 Speed

Parameter	Description
n_{App}	Speed of application. • Speed required at the output shaft. • Please note: The speed of the application, not the rated speed of the motor is meant!

8.3.5.3 Variable payload mass

Parameter	Description
$m_{\text{var,L}}$	Changeable mass of the payload. • For the calculation in the DSD it is assumed that the payload is distributed evenly.

See also:

- ▶ [Rack drive](#) (94) → [Mass of the payload](#) (99)
- ▶ [Wheel drive](#) (106) → [Mass of the payload](#) (111)

8.3.5.4 Counter-torque

Parameter	Description
M_{vs}	Counter-torque that the drive must exert. • Required torque at the output shaft.

8.3.5.5 Variable force associated with the application

Parameter	Description
$F_{var,App}$	Required force of the application, changeable.

See also:

- ▶ [Belt drive, rotating \(□ 72\)](#) → [Tensile force at the slide \(counterforce\) \(□ 82\)](#)
- ▶ [Omega belt drive \(□ 83\)](#) → [Counterforce \(□ 93\)](#)
- ▶ [Rack drive \(□ 94\)](#) → [Counterforce \(□ 99\)](#)
- ▶ [Spindle drive \(□ 100\)](#) → [Counterforce \(□ 105\)](#)
- ▶ [Wheel drive \(□ 106\)](#) → [Counterforce \(□ 112\)](#)

8.3.5.6 Basic setting of motion profile

Parameter	Description
Use	The values of the basic settings are marked grey and cannot be altered.
Change	The values of the basic setting can be altered.

8.3.5.7 Relative operating time

Parameter	Description
OT	The relative operating time is the ratio of the load period to the cycle time. • The designation of the operating mode is supplemented by the relative operating time, e. g. "S3 -25 %".

8.3.5.8 Operating time

Parameter	Description
t_{on}	The operating time corresponds to the load time of the drive. • The designation of the operating mode is supplemented by the operating time, e. g. "S2-60 min".

8.3.5.9 Brake at standstill

Parameter	Description
Active	• Yes • The brake is active at standstill. If the brake is activated, the motor does not have to provide a torque. • No • The brake is not active at standstill.

8.3.5.10 Controller inhibit at standstill

Parameter	Description
Active	• Yes • The controller inhibit of the inverter is set. The thermal load of the inverter and motor is reduced by this. • No • The controller inhibit of the inverter is not set.

8.3.5.11 Acceleration time

Parameter	Description
t_{acc}	Acceleration time required by the drive until the constant load condition is reached.

8.3.5.12 Deceleration time

Parameter	Description
t_{dec}	Deceleration time required by the drive until standstill.

8.3.5.13 Cycle time

Parameter	Description
t	The cycle time corresponds to the duration of the load phase.

8.3.5.14 Direction of movement

Parameter	Description
Forward/back / Up/down	• Positive • The cycle is only positive. Accordingly, the drive only moves in positive direction. • Both • The cycle alternates between positive and negative. Accordingly, the drive first moves to the positive, then to the negative direction.

9 Mains and environment

9.1 Electrical supply system

9 Mains and environment

Mains voltage, power system, and ambient conditions are decisive for the operation of the drive system.

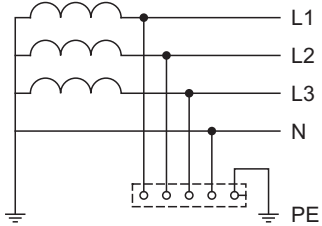
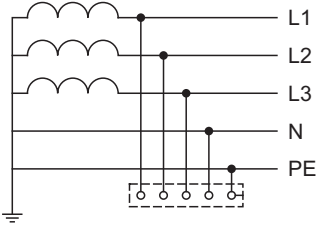
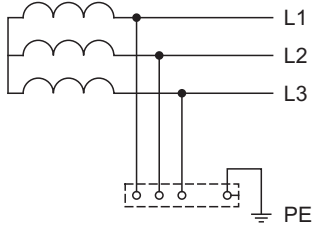
9.1 Electrical supply system

Select the supply system the drive system is to be connected to. For an inverter with DC supply, select the supply system of the energy supplier.

Supply system	Mains frequency	Power system	Note
1AC 230 V	50 Hz	TN/TT system IT mains	• Europe, Asia, Africa and Australia have a mains frequency of 50 Hz. • North America and parts of South America have a 60-Hz mains frequency. • Select a rated mains voltage of 400 V for 380-V systems.
3AC 230 V			
3AC 400 V			
3AC 415 V			
1AC 120 V	60 Hz		
1AC 240 V			
3AC 240 V			
3AC 480 V			

9.1.1 Power system

In the following the power systems which can be selected in the DSD and which are in use worldwide are described in detail.

Earthed power systems		Unearthed power systems
TT supply (with earthed star point)	TN supply (with earthed star point)	IT supply (with floating star point)
		

Earthed power systems

TT and TN systems are power systems with an earthed neutral. They are used in most countries. In some countries, power systems with earthed phase conductors are also used.

Unearthed power systems

IT systems are power systems with an isolated neutral. They are used in the following countries and industry sectors:

- In the public supply system in France and Belgium
- Chemical industry
- Mining
- Island power supplies (own generator)
- Hospitals
- Ship's mains
- Crane, conveyor, and hoist systems
- Paper and pulp industry

Advantages of the IT systems are the high fire and operator safety. Furthermore there is no disconnection during the first earth fault.

9.2 Ambient conditions

9.2.1 Max. ambient temperature, motor/gearbox

The permissible load capacity depends on the ambient temperature. The load capacity also depends on whether a geared motor or a motor without a gearbox is used.



Tip!

If a geared motor is used, the derating starts from a temperature of 30 °C, in the case of a motor without a gearbox it starts from 40 °C.

Depending on the site altitude, the following correction values k_θ result for geared motors:

ϑ_{opr}	k_θ			
	$\leq 1000 \text{ m}$	$\leq 2000 \text{ m}$	$\leq 3000 \text{ m}$	$\leq 4000 \text{ m}$
20 °C	1.15	1.04	0.92	0.81
30 °C	1	0.9	0.8	0.70
40 °C	0.8	0.72	0.64	0.56
50 °C	0.6	0.54	0.48	0.42
60 °C	0.4	0.36	0.32	0.28

For motors without a gearbox the following correction values k_{θ} result:

ϑ_{opr}	k_{θ}
0 ... 40 °C	1
≤ 45 °C	0.95
≤ 50 °C	0.9
≤ 55 °C	0.85
≤ 60 °C	0.8



Note!

- The DSD does not take sub-zero temperatures into consideration.
- For an ambient temperature < 0 °C you enter 0 °C.
- Make sure that the ambient conditions suit the motors. As a help, use the tables with the correction values.

9.2.2

Max. ambient temperature, inverter

DSD considers the drive-specific reduction factors and an ambient temperature range of 0 ... 60 °C.

- The ranges from -20 ... 0 °C have to be checked manually.
- In a temperature range of 0 ... 40 °C, operation of the components can be carried out without a power derating.
- For inverters the derating factor is stored in the DSD device-specifically.



Note!

The upper and lower limit values can vary for the different inverters.

In the chapter "[Inverter](#)" ([□ 382](#)) the characteristics of the different inverter types are listed.

9.2.3 Site altitude

The components can be operated up to a site altitude of 1000 m amsl without power reduction.

- From 1000 ... 4000 m amsl there is a power reduction.
- For inverters the derating factor is stored in the DSD device-specifically.
- The site altitude for geared motors is considered as a function of the temperature:

ϑ_{opr}	k_h			
	$\leq 1000 \text{ m}$	$\leq 2000 \text{ m}$	$\leq 3000 \text{ m}$	$\leq 4000 \text{ m}$
20 °C	1.15	1.04	0.92	0.81
30 °C	1	0.9	0.8	0.70
40 °C	0.8	0.72	0.64	0.56
50 °C	0.6	0.54	0.48	0.42
60 °C	0.4	0.36	0.32	0.28

- For motors without a gearbox, the following applies:

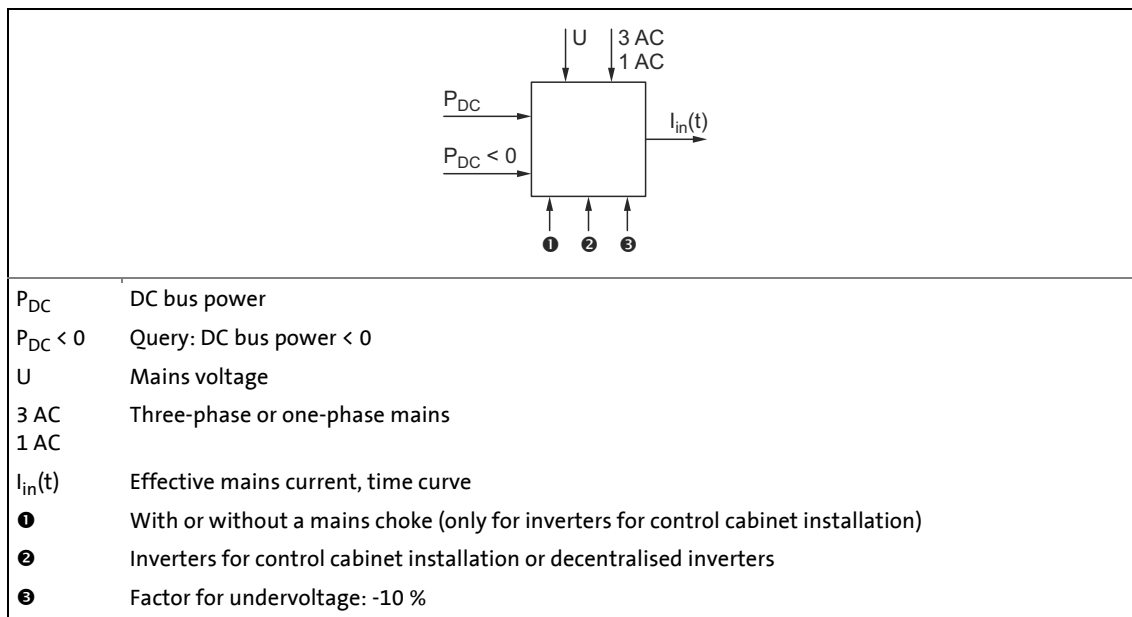
h	k_h
0 ... 1000 m	1
$\leq 2000 \text{ m}$	0.95
$\leq 3000 \text{ m}$	0.9
$\leq 4000 \text{ m}$	0.85

9.3 Calculation of the mains current

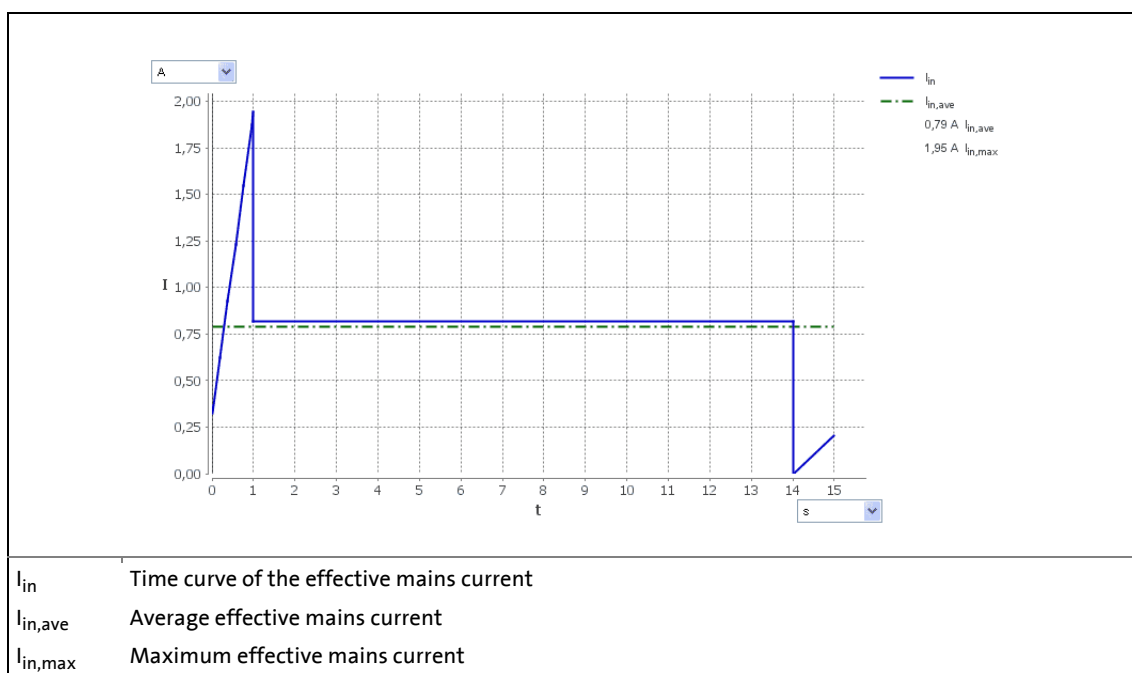
DSD calculates the effective mains current on the basis of the DC bus power for the following devices:

- Inverter for a single-axis application
- Power supply module or regenerative power supply module for a multi-axis system

The diagram shows variables which are of importance and which are taken into consideration for the calculation.



[9-1] Diagram: calculation of the mains current in DSD



[9-2] Diagram inverter/power supply module: mains current

10 Structure of the drive axis

The drive axis consists of a mechanical and an electrical part.

- The mechanical system comprises the mechanics of the application, the gearbox, possibly an additional drive element, the motor, the feedback system, and a possibly available mechanical brake.
- The electrical system (power transmission) includes the mains supply, mains chokes and filters, the inverter with an electrical brake unit, possibly motor chokes, and system cables.
 - Mains chokes, filters, motor chokes and cables are not an integral part of the DSD.
- The motor and feedback system provide the transition between the mechanical and electrical system of the drive axis.
- Apart from these two basic structures of power transmission you also have to consider the control system which can be divided into the areas functions, safety concept, and communication (bus system).
 - In the DSD the control system is only taken into consideration to a limited extent.

You carry out the following dimensioning steps:

- ▶ [Mechanical drive axis](#) (📖 301)
- ▶ [Electrical drive axis](#) (📖 303)
- ▶ [Drive concept](#) (📖 304)

10.1 Mechanical drive axis

The mechanical drive axis can consist of the mechanics of the application, a Lenze gearbox, an additional drive element, a feedback system, and an electromechanical brake.

10.1.1 Lenze gearbox

Make this selection if the application includes a gearbox.



- If you do not select a Lenze gearbox and additional drive element the motor is directly connected to the application.
 - Direct drive for winders
 - If the speeds of the winder and the motor are compatible, the motor is able to act directly on the reel shaft via a low-backlash clutch.
 - For low speeds, multi-pole three-phase AC motors with a rated speed of approx. 300 ... 500 min⁻¹ are used.
 - Gearboxes for winders
 - Generally, winding applications require the transformation of a high motor speed into a low winding speed. For this task, we recommend gearboxes with low backlash and low friction, especially if an indirect tension control via the drive torque is used.
 - The motor and the gearbox are selected in later dimensioning steps.
- [Motor selection](#) (📖 339)
- [Lenze gearbox selection](#) (📖 369)

10.1.2 Additional drive element

Make this selection if the application includes an additional drive element.



- If you do not select a Lenze gearbox and additional drive element the motor is directly connected to the application.
- DSD can simulate a user-definable mechanical ratio (additional drive component) with a toothed belt, flat belt, V-belt, chain, gear, or an individual gearbox.
- The additional drive element can be placed between the application and the motor or between the application and the Lenze gearbox.
- Additional drive element in winding applications.
 - Toothed belts as mechanical transmission elements between the drive and the winder are very well-suited because they have low friction and good damping characteristics.
 - Cardan shafts as axial coupling are suitable for big reels in center winding machines if the reels must be moved together with their pedestals for the winding process.
 - Axial couplings (e.g. cardan shafts) between the winding shaft and the motor or the gearbox output must be dimensioned in a low backlash manner.
- Data for the additional drive element is entered in a later dimensioning step. [Selection of an additional drive element](#) (□ 380)

10.1.3 Feedback

Make this selection if the application includes a feedback.



- For drives with a servo control a feedback system is required. A servo control without a feedback system cannot be dimensioned in the DSD.
- Make the selection if a user motor with feedback system is used. [Display of user motor](#) (□ 305)
- The feedback system is selected in a later dimensioning step. [Feedback selection](#) (□ 397)

10.1.4 Electromechanical brake

Make this selection if the application includes an electromechanical brake.

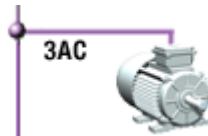


- The electromechanical brake is only checked if a parameter has been created for the brake in the motion profile. [Motion design](#) (□ 242)
- Make the selection if a user motor with electromechanical brake is used. [Display of user motor](#) (□ 305)
- The electromechanical brake is selected in a later dimensioning step. [Mechanical brake selection](#) (□ 362)

10.2 Electrical drive axis

10.2.1 Motor direct on line

Make this selection if you want to use the Lenze Smart Motor for the drive.



- The Lenze Smart Motor is directly connected to the AC system.
- There is no coupling via the DC bus.
- Suitable for single drive axes without energy-efficient use of the regenerative power.

The way to the Lenze Smart Motor

10.2.2 Inverter with mains supply (single-axis application)

Make this selection if the inverter is directly connected to the supply system.



- Operation of the inverter directly connected to the AC system (single axis drive).
- There is no coupling via the DC bus.
- Suitable for single drive axes without energy-efficient use of the regenerative power.
- DSD only offers inverters that combine supply (rectifiers) and inverters in one device and that are suitable for a direct connection to the AC system.

10.2.3 Inverter with DC supply (multi-axis application)

Make this selection if the drive axis is part of a multi-axis system or if it is supposed to feed back excessive energy back to the mains due to high regenerative power. This selection enables you to make efficient use of regenerative power in the drive system.



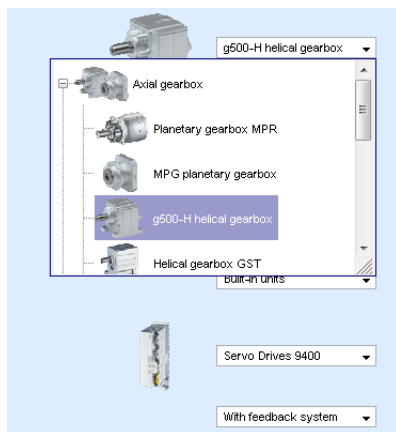
- The connection to the AC system is made via a central power supply unit (power supply module or regenerative power supply module). The inverter is connected to the supply unit via the DC bus.
- The supply via the supply system and the electrical braking system can be configured in the "dimension multi-axis system" application. For this purpose, the DSD projects of the drive axes are loaded into the application.
- DSD offers inverters
 - that combine supply (rectifiers) and inverters in one device and come with a DC-bus connection,
 - that do not have a supply (rectifiers) but only the inverter. They are only suitable for being connected to the DC-bus.

► [Size the multi-axis system](#) (186)

10.3 Drive concept

In the dimensioning step "Drive concept" you preselect the components for the drive axis:

- Gearbox
 - Gearbox / motor mounting
 - [Gearbox / motor mounting](#) (📖 309)
- Motor
- Inverter / motor mounting
 - Select built-in unit or decentralised inverter
- Inverter
- Traversing motor control
 - [Control system](#) (📖 383)



The DSD helps with the selection of the right products and checks the compatibility:

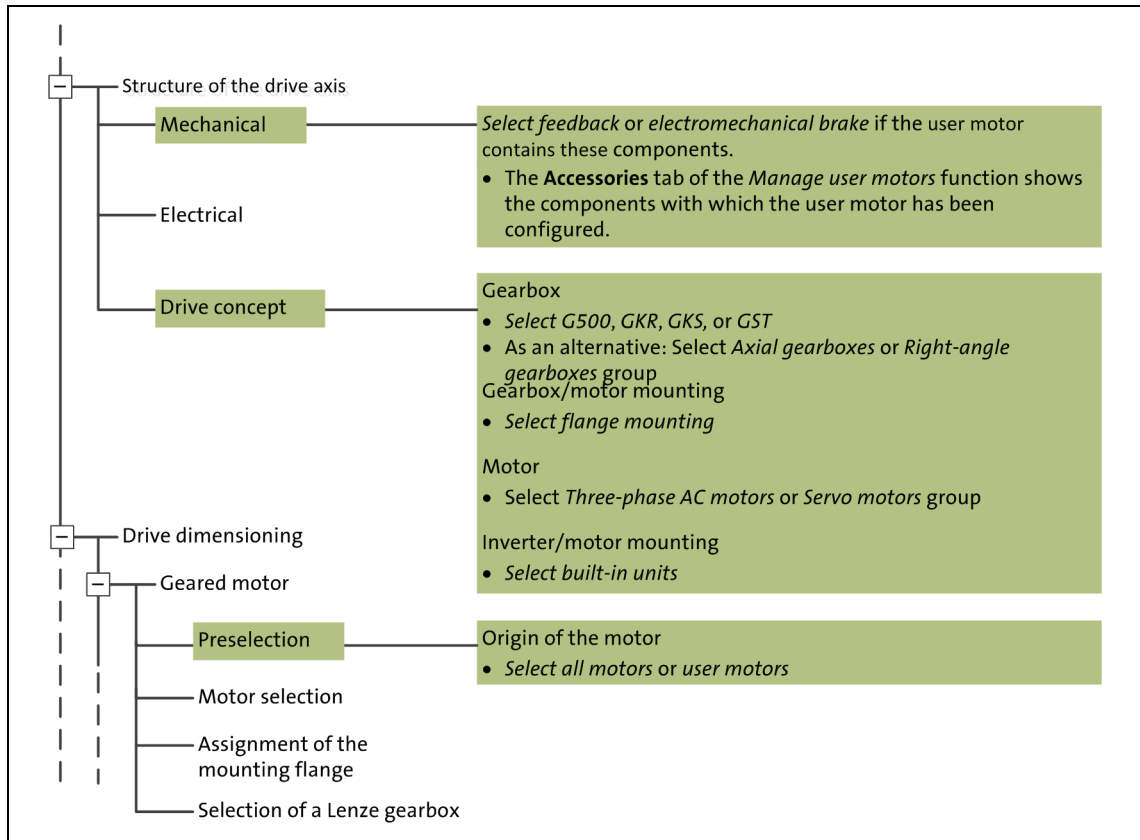
- Compatible components in the drop-down menus have a product name marked in black.
- Non-compatible components in the drop-down menus have a product name marked in grey or in italics.

If you select a component that is non-compatible, the DSD proposes a possible combination of components. You can either accept the proposition or discard it.

10.3.1 Display of user motor

By making specific settings in the *Mechanical* and *Drive concept* dimensioning steps, user motors are also shown for selection. In the *Geared motor* dimensioning step, you can select the motors which are to be shown in the *Motor selection* dimensioning step.

- Make the settings according to fig. [10-1] in order that user motors are displayed in the DSD project.



[10-1] Display of user motors: Settings for drive dimensioning



Note!

In an existing DSD project, newly created user motors will only be available after the data base has been updated.

- Re-execute the drive dimensioning in the DSD project starting from the *Drive concept* step in order that newly created user motors are displayed in the *Motor selection* dimensioning step.

10.3.2 Gearbox

The gearboxes available can be divided into two groups:

- Axial gearboxes
- Bevel gearbox

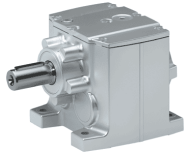
In the following subchapters, the gearboxes available in the DSD are described. The tabular representation makes it possible for you to easily compare the properties to each other.

The Lenze Smart Motor can only be combined with Lenze gearboxes of the g500 series.

See also

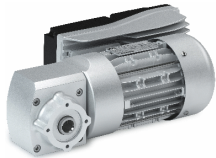
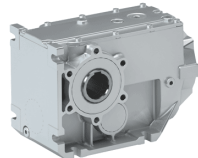
- ▶ [Selection help: Products for drive systems \(without winders\)](#) (📖 328)
- ▶ [Selection help: Products for winding drive systems](#) (📖 329)
- ▶ [Display of user motor](#) (📖 305)

10.3.2.1 Properties of the axial gearbox

	Helical gearbox g500-H	Shaft-mounted helical gearbox g500-S
Illustration		
Short description	Two-stage, three-stage or four-stage helical gearbox with a coaxial drive shaft and output shaft	Two-stage, three-stage or four-stage helical gearbox, flat design, drive shaft and output shaft in parallel
Torque density	Medium	Medium
Efficiency	High	High
Backlash	Low	Low
Number of frame sizes	13	11
Rated torque	45 ... 14000 Nm	130 ... 19000 Nm
Ratio	3.0 ... 3529	3.0 ... 5850
Shaft	Solid shaft	Solid/hollow shaft
Design	Base/flange	Base/flange
Motor mounting	Direct and standard mounting	Direct/standard mounting

The data correspond to the device version stored in DSD

10.3.2.2 Properties of the right-angle gearbox

	Bevel gearbox g350-B with m300 SmartMotor	Bevel gearbox g500-B
Illustration		
Short description	Single-stage bevel gearbox, drive shaft to driven shaft 90°	Two-stage, three-stage, or four-stage bevel gearbox, drive shaft 90° to driven shaft
Torque density	Medium	Medium
Efficiency	High	High
Backlash	Low	Low
Number of frame sizes	3	12
Rated torque	20 ... 55 Nm	45 ... 20000 Nm
Ratio	11.75	4.0 ... 2936
Shaft	Solid/hollow shaft	Solid/hollow shaft
Design	Flange	Base/flange
Motor mounting	Integrated	Direct/standard mounting

The data correspond to the device version stored in DSD

10.3.2.3 Lenze Smart motor

In the case of the Lenze Smart Motor, the parameter selection and settings are limited.

Gearbox



g500-H helical gearbox ▼

Gearbox / motor mounting

Direct mounting

Motor

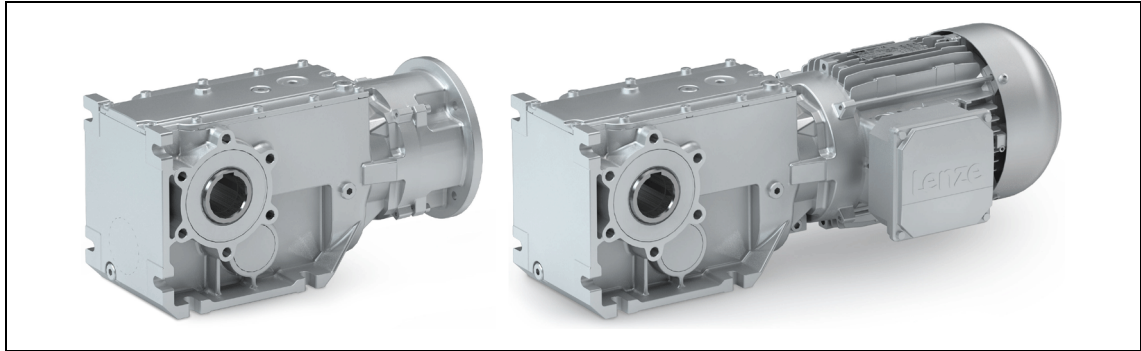
Lenze Smart Motor

Parameter	Description
Gearbox	Gearbox preselection • The Lenze Smart Motor can only be combined with the g500 gearbox.
Gearbox / motor mounting	Couple gearboxes to the motor via direct mounting or flange mounting. • The Lenze Smart Motor only allows for the direct mounting. • Read only.
Motor	Lenze Smart motor • Read only.

10.3.3 Gearbox / motor mounting

Many Lenze gearboxes are provided for direct mounting. The first pinion of the gearbox is directly mounted to the motor shaft. By this, coupling elements and possible torque limitations by clutches are not required, and the drive is provided with a higher mechanical stiffness.

Flange mounting means coupling the motor shaft with the gearbox shaft via a clutch. The coupling flanges of the motor and the gearbox are coupled via an adapter.



[10-2] Lenze gearbox with flange mounting (left) and direct mounting (right)



Tip!

Flange mounting allows for a larger variety of motor-gearbox combinations. In addition, the motor can be replaced more easily if necessary.

- Create an alternative DSD project and select flange mounting in the Drive concept dimensioning step if you cannot find a suitable solution with the direct mounting selection.
- Compare the differences, e.g. via the *Project comparison*.

User motor

A user motor can only be coupled using a gearbox with flange mounting.

- Select flange mounting so that user motors are shown in the *Drive dimensioning* dimensioning step. [Display of user motor](#) (305)

Lenze Smart motor

The Lenze Smart Motor is only intended for direct mounting. It is not possible to change the setting in the DSD.

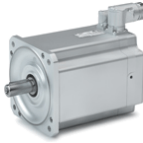
10.3.4 Motor

In the following subchapters, the motors available in the DSD are described. The tabular representation makes it possible for you to easily compare the properties to each other.

See also

- ▶ [Selection help: Products for drive systems \(without winders\)](#) (□ 328)
- ▶ [Selection help: Products for winding drive systems](#) (□ 329)
- ▶ [Display of user motor](#) (□ 305)

10.3.4.1 Features of synchronous servo motors

	MCS	m850
Illustration		
Short description	Highly dynamic synchronous servo motor, high power density	Synchronous servo motor
Enclosure	IP 54 / IP 65	IP 54
Dynamics	Very high	High
Mass inertia	Very low	Low
Overload capacity	Very high	High
Power density	Very high	High
Field weakening	Medium (only with 9400 servo inverter)	Medium
Detent torque (relating to M_0)	< 1 %	< 2 %
Total torque ripple for M_n	≤ 2.5 %	—
Number of frame sizes	5	3
Performance	0.25 ... 15.80 kW	2.0 ... 9.20 kW
Speed	1050 ... 6000 rpm	2500 ... 4000 min ⁻¹
Continuous torque	0.50 ... 72 Nm	4.8 ... 35 Nm
Square dimension/diameter	□ 6, 9, 12, 14, 19 cm	□ 12, 14, 19 cm
Shaft height	—	—
Fan/brake	Axial-flow blower, permanent magnet holding brake	No fan, spring-applied brake, permanent magnet holding brake
Feedback system	Resolver, SinCos absolute value encoder, incremental encoder with communication signal, One Cable Technology (depending on the power range and only with the i950 servo inverter)	Resolver, SinCos absolute value encoder, One Cable Technology (depending on the power range and only with the i950 servo inverter)
Gearbox mounting	Direct mounting or standard mounting	Direct mounting or standard mounting
Note	—	—

— Not possible / not available

The data correspond to the device version stored in DSD

10.3.4.2 Features of asynchronous servo motors

	MCA	MQA	SDSGA
Illustration			
Short description	Totally enclosed fan-cooled asynchronous servo motor	Enclosed-ventilated asynchronous servo motor, high dynamic performance and power density	Asynchronous servo motor, smooth housing, options for inverter operation
Enclosure	IP 23 / 54 / IP 65	IP 23	IP 54 / IP 55
Dynamics	High	Very high	Medium
Mass inertia	Low	Very low	High
Overload capacity	Very high	Very high	High
Power density	High	Very high	Medium
Field weakening	High	High	High
Detent torque (relating to M_0)	None	None	None
Total torque ripple for M_n	3.5 ... 4.5 %	3.5 ... 4.5 %	—
Number of frame sizes	9	3	3
Performance	0.80 ... 53.8 kW	10.60 ... 60.2 kW	0.075 ... 0.60 kW
Speed	550 ... 4160 min ⁻¹	550 ... 2935 min ⁻¹	2700 rpm
Continuous torque	2 ... 295 Nm	66.2 ... 296 Nm	0.27 ... 1.9 Nm
Square dimension/diameter	□ 10, 13, 14, 17, 19, 20, 21, 22, 26 cm	□ 20, 22, 26 cm	∅ 75, 85, 95 mm
Shaft height	—	100, 112, 132 mm	38, 43, 47 mm
Fan/brake	Axial-flow fan, spring-applied brake or permanent magnet holding brake	Radial-flow blower, spring-applied brake	No fan, spring-applied brake or permanent magnet holding brake
Feedback system	Resolver, incremental encoder, SinCos encoder, SinCos absolute value encoder	Resolver, incremental encoder, SinCos encoder, SinCos absolute value encoder	Resolver
Gearbox mounting	Direct mounting or standard mounting	Standard mounting	Direct mounting or standard mounting
Note	—	Cannot be combined with Lenze gearbox in DSD	—

— Not possible / not available

The data correspond to the device version stored in DSD

10.3.4.3 Features of three-phase AC motors

	MDXMA	MFxMA	MHxMA	m550-H	m540-P	m550-P	SmartMotor m300
Illustration							
Short description	Suitable for inverter operation, efficiency class IE1	Optimised for inverter operation, rated frequency of 120 Hz	Suitable for inverter operation, efficiency class IE2	Suitable for inverter operation, efficiency class IE2	Suitable for inverter operation, efficiency class IE3	Suitable for inverter operation, efficiency class IE3	Electronic motor with permanently adjustable speed, efficiency class IES2
Enclosure	IP 54 / IP 55	IP 54 / IP 55	IP 54 / IP 55	IP 54 / IP 55 / IP 65 / IP 66	IP 55 / IP 65	IP 54 / IP 55 / IP 65 / IP 66	IP 55 / IP 65
Dynamics	Medium	High	Medium	Medium	Medium	Medium	Medium
Mass inertia	Medium	Low	Medium	Medium	Medium	Medium	Medium
Overload capacity	Medium	Medium	Medium	Medium	Medium	Medium	High (4-fold)
Power density	Medium	High	Medium	Medium	Medium	Medium	Medium
Field weakening	Medium	Medium	Medium	Medium	Medium	Medium	–
Total torque ripple for M_n	3.5 ... 4.5 %	3.5 ... 4.5 %	3.5 ... 4.5 %	–	3.5 ... 4.5 %	–	–
Number of frame sizes	11	7	9	2	14	7	2
Performance	0.06 ... 53 kW	0.55 ... 22 kW	0.75 ... 78 kW	0.12 ... 0.55 kW	1.5 ... 87 kW	0.75 ... 22 kW	0.46 ... 1.36 kW
Speed	900, 1400, 2500, 2800 min ⁻¹	3500 min ⁻¹	1400, 2500 min ⁻¹	1400, 2500 min ⁻¹	1400, 2500 min ⁻¹	1400, 2500 min ⁻¹	500 ... 2600 rpm
Continuous torque	0.33 ... 290 Nm	1.5 ... 59 Nm	4.2 ... 290 Nm	0.81 ... 3.67 Nm	10 ... 354 Nm	4.92 ... 142 Nm	1.75 ... 5.0 Nm
Square dimension/diameter	–	–	–	–	–	–	–
Shaft height	63 ... 225 mm	63 ... 132 mm	80 ... 225 mm	63 ... 71 mm	90 ... 250 mm	80 ... 180 mm	63 ... 80 mm
Fan, brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow blower or axial integral fan, spring-applied brake	Axial-flow integral fan, spring-applied brake (optional)
Feedback system	Resolver, incremental encoder, SinCos absolute value encoder	Resolver, incremental encoder, SinCos absolute value encoder	Resolver, incremental encoder, SinCos absolute value encoder	Resolver, incremental encoder, SinCos absolute value encoder	Incremental encoder	Resolver, incremental encoder, SinCos absolute value encoder	–
Gearbox mounting	Direct mounting or standard mounting	Direct mounting or standard mounting	Direct mounting or standard mounting	Direct mounting or standard mounting	Direct mounting	Direct mounting or standard mounting	Direct mounting or standard mounting
Note	–	–	–	–	Only available in combination with a gearbox	–	–

– Not possible / not available

The data correspond to the device version stored in DSD

10.3.4.4 Motors for winding drives

Asynchronous motors

Three-phase asynchronous motors are the standard solution to most winding applications. They are cost-effective and can be operated in wide ranges of the field weakening without any difficulty. Due to their high inherent inertia, they are well-suited for handling the high mass inertias of the reel in the control system in a stable manner.

In combination with belt ratios, asynchronous motors with low rated speeds (higher-pole motors or 4-pole motors with 29-Hz technology) and optimally used field weakening are very well-suited for many winding applications.

Generally, blowers are required for cooling the motors since the smallest speeds result in the highest power loss. DSD checks the thermal motor utilisation.

Synchronous motors

Synchronous servo motors are used if the construction requires compact designs. Synchronous servo motors are only suitable to a limited extent for torque-controlled drives (indirect tension control) and for very accurate repeatability of the material tensile force. On the one hand the magnetisation is strongly temperature-dependent which can be hardly compensated for, and on the other hand the detent torques have an interfering impact. The achievable field weakening is considerably lower than with asynchronous motors. The characteristic curve of the motor shows the max. field weakening range.

Tandem motor systems

In case of greater motor powers or very big reels, every side of the winding shaft can be equipped with a motor. That way, the drive torque is symmetrically shared. Torsions in the winding material are minimised.

- Two asynchronous motors can be connected in parallel to an inverter without any difficulty and are hence a cost-effective solution.
- Concepts including two inverters are also possible. The torque division is carried out symmetrically via the control system.
- Synchronous servo motors require one inverter each. A parallel connection of the motors is not possible.

10.3.4.5 User motors

The motor technology is defined when a user motor is created. [Manage user motors](#) (450)

In order that the user motor is shown in the *Drive dimensioning* dimensioning step, you must select the desired motor technology instead of a motor in the *Drive concept* dimensioning step.

Selection of the motor technology	Defining the motor technology
The motor technology is selected in the <i>Drive concept</i> dimensioning step.	The motor technology is defined via the <i>Manage user motors</i> function. ▶ "Technology" tab (454)
	Possible selection: • Three-phase AC motor • Synchronous servo motor • Asynch. servo motor

10.3.5 Inverter

In the subchapters, the inverters available in DSD are described. The tabular representation makes it possible for you to easily compare the properties to each other.

See also [▶ Selection help: Products for drive systems \(without winders\) \(📖 328\)](#)
[▶ Selection help: Products for winding drive systems \(📖 329\)](#)

10.3.5.1 Features of frequency inverters

Frequency inverters are suitable for simple, speed-controlled drive tasks, and they are cost-effective. A speed feedback is not necessarily required.

	8400 BaseLine frequency inverters	8400 StateLine frequency inverters	8400 HighLine frequency inverters	i510 frequency inverters	i550 frequency inverters
Illustration					
Short description	Frequency inverters with integrated keypad, V/f control, sensorless vector control, overload capacity up to 200 %, pluggable memory chip for the parameter set	Scalable frequency inverter, V/f control with feedback, sensorless vector control, overload capacity up to 200 %, pluggable memory clip for parameter set, optionally with integrated safety functions, free function block interconnection, sensorless control for synchronous motors	Scalable frequency inverter, V/f control with feedback, sensorless vector control, overload capacity up to 200 %, pluggable memory clip for parameter set, optionally with integrated safety functions, free function block interconnection, point-to-point positioning, sensorless control for synchronous motors, servo control	Universal frequency inverter, V/f control, sensorless vector control, sensorless control for synchronous motors, overload capacity of up to 200 %, memory module	Scalable frequency inverter, V/f control with feedback, sensorless vector control, sensorless control for synchronous motors, torque control, overload capacity of up to 200 %, memory module, optional safety features
Voltage range/power range	1 AC 180 ... 264 V: 0.25 ... 2.2 kW 3 AC 320 ... 550 V: 0.37 ... 3.0 kW	1 AC 180 ... 264 V: 0.25 ... 2.2 kW 3 AC 320 ... 550 V: 0.37 ... 45 kW	1 AC 180 ... 264 V: 0.25 ... 2.2 kW 3 AC 320 ... 550 V: 0.37 ... 45 kW	Without an integrated EMC filter: 1/3 AC 170 ... 264 V: 0.25 ... 2.2 kW 3 AC 170 ... 264 V: 4.0 ... 5.5 kW With an integrated EMC filter: 1 AC 170 ... 264 V: 0.25 ... 2.2 kW 3 AC 340 ... 528 V: 0.37 ... 11 kW	Without an integrated EMC filter: 1/3 AC 170 ... 264 V: 0.25 ... 2.2 kW 1 AC 90 ... 132 V: 0.25 ... 1.1 kW 3 AC 170 ... 264 V: 4.0 ... 5.5 kW With an integrated EMC filter: 1 AC 170 ... 264 V: 0.25 ... 2.2 kW 3 AC 340 ... 528 V: 0.37 ... 110 kW
Approvals	CE, UL, GOST-R, RoHS	CE, UL, GOST-R, RoHS	CE, UL, GOST-R, RoHS	CE, UL, CSA, EAC, RoHS, IE2 in compliance with EN 50598-2	CE, UL, CSA, EAC, RoHS, IE2 in compliance with EN 50598-2
Permissible power systems	TN, TT	TN, TT, IT	TN, TT, IT	TN, TT, IT	TN, TT, IT
Switching frequencies	2, 4, 8, 16 kHz	2, 4, 8, 16 kHz	2, 4, 8, 16 kHz	2, 4, 8, 16 kHz	2, 4, 8, 16 kHz
Mechanical design					
Built-in unit	●	●	●	●	●
Push-through technique	–	● (up to 15 kW)	● (up to 15 kW)	–	–
Cold plate technique	–	● (up to 22 kW)	● (up to 22 kW)	–	–

	8400 BaseLine frequency inverters	8400 StateLine frequency inverters	8400 HighLine frequency inverters	i510 frequency inverters	i550 frequency inverters
Enclosure	IP 20	IP 20	IP 20	IP 20	IP 20
Operation in generator mode					
Integrated brake resistor	● (3 AC 400/500 V)	●	●	–	●
External brake transistor	● (1 AC 230/240 V)	–	–	–	–
DC-bus connection	–	●	●	–	● (3 AC 400/480 V)
Control types					
VFC plus (V/f control)	●	●	●	●	●
SLVC (sensorless vector control)	●	●	●	●	●
V/f control	–	●	●	●	●
VFC plus eco (V/f control, energetically optimised)	–	●	●	●	●
SLPSM (sensorless control for synchronous motors)	–	●	●	●	●
SC (servo control)	–	–	● (only for the asynchronous motor)	–	● (only for the asynchronous motor)
Drive function					
Voltage / frequency control	●	●	●	●	●
Torque control	–	●	●	●	●
closed-loop speed control	–	●	●	●	●
PID controller	●	●	●	●	●
Programmability					
Parameterisation	●	●	●	●	●
Function block programming	–	●	●	–	–
I/O					
Analog input / output	1/0	1/1	2/2	2/1	Standard I/O: 2/1 Application I/O: 2/2
Digital input / output	4/1	4/1	7/3	5/1	Standard I/O: 5/1 Application I/O: 7/2
Connection of motor holding brake	–	–	●	–	–
Relay output	1	1	1	1	1
Speed feedback	–	●	●	–	●
PTC	–	●	●	–	●
Linear motor temperature sensor (KTY/PT1000)	–	–	–	–	–
I×t monitoring	●	●	●	●	●

	8400 BaseLine frequency inverters	8400 StateLine frequency inverters	8400 HighLine frequency inverters	i510 frequency inverters	i550 frequency inverters
Fieldbus systems					
CAN bus	□	●	●	□	○
PROFIBUS	-	○	○	-	○
Interbus	-	○	○	-	-
Modbus RTU	-	-	-	□	○
Modbus TCP/IP	-	-	-	-	○
LECOM	-	-	-	-	-
AS interface	-	-	-	-	-
DeviceNet	-	-	-	-	-
Ethernet TCP/IP	-	○	○	-	○
PROFINET	-	○	○	-	○
EtherCAT	-	○	○	-	○
POWERLINK	-	○	○	-	○
Modbus TCP/IP	-	-	-	-	○
Safety functions					
Safe torque off	-	□	□	-	○
Diagnostics support					
LEDs	●	●	●	●	●
Integrated keypad	●	-	-	-	-
External keypad	-	○	○	○	○
PC interface	●	●	●	○	○
Memory module	●	●	●	●	●

● Standard

○ Option

□ Variant

- Not possible / not available

The data correspond to the device version stored in DSD

10.3.5.2 Servo inverter properties

Servo inverters are highly dynamic current-controlled systems for speed, torque, or position control. They are characterised by a high speed accuracy, a great torque setting range, and a high overload capability. A speed feedback is always required to operate them.

- Position-controlled systems are suitable for drive tasks as e.g. positioning, electronic gearbox or electronic cam.

	i950 servo inverters	9400 HighLine servo inverters	8400 TopLine frequency inverters	i700 servo inverters
Illustration				
Short description	Intelligent servo inverter for synchronous and asynchronous motors. Suitable for speed-controlled or position-controlled applications as well as positioning applications, modular fieldbus communication and encoder interfaces, pluggable SD card for parameter set and application data	Intelligent servo inverter for single-axis and multi-axis applications, function block structure that can be freely interconnected, activation via digital inputs/outputs and/or fieldbus, modular safety engineering, innovative rear panel system, pluggable memory chip for the parameter set	Servo inverter for synchronous and asynchronous servo motors, suitable for speed and position-controlled applications as well as positioning applications, multi encoder input, optionally with integrated safety engineering, fieldbus communication, pluggable memory chip for the parameter set	Servo inverter for single-axis and multi-axis applications, compact design and connection system, flexible motor control for synchronous and asynchronous motors, multi-axis system with central supply
Voltage range/power range	Single Drive: 3 AC 180 ... 528 V: 0.55 ... 110 kW DC 260 ... 775 V: 0.55 ... 110 kW	Single Drive: 3 AC 180 ... 550 V: 0.37 ... 370 kW DC 260 ... 775 V: 0.37 ... 315 kW Multi Drive: DC 260 ... 775 V: 0.37 ... 30 kW	1 AC 180 ... 264 V: 0.25 ... 2.2 kW 3 AC 320 ... 550 V: 0.37 ... 45 kW	Power supply module: 3 AC 320 ... 528 V DC 260 ... 775 V Axis module: DC 260 ... 775 V: 0.75 ... 15 kW
Approvals	CE, UL 61800-5-1, RoHS	CE, UL 61800-5-1, RoHS	CE, UL 508C, GOST-R, RoHS	CE, UL 508C, RoHS
Permissible power systems	TN, TT, IT	TN, TT, IT	TN, TT, IT, RoHS-compliant	TN, TT, IT
Switching frequencies	2, 4, 8, 16 kHz	1, 2, 4, 8, 16 kHz	2, 4, 8, 16 kHz	4, 8, 16 kHz
Mechanical design				
Built-in unit	●	●	●	●
Push-through technique	–	–	● (up to 15 kW)	●
Cold plate technique	–	–	● (up to 22 kW)	●
Installation backplane	–	● (SingleDrive up to 11 kW) ● (MultiDrive up to 15 kW)	–	–
Enclosure	IP 20	IP 20	IP 20	IP 20
Operation in generator mode				
Integrated brake resistor	●	● (SingleDrive, power supply modules)	●	●
External brake transistor	–	–	–	–
Regenerative	–	○	–	–
Control types				
VFC plus (V/f control)	●	●	●	●
SLVC (sensorless vector control)	–	●	●	–
SLPSM (sensorless control for synchronous motors)	–	–	●	–
SC (servo control)	●	●	●	●

	i950 servo inverters	9400 HighLine servo inverters	8400 TopLine frequency inverters	i700 servo inverters
Drive function				
Voltage / frequency control	●	●	●	●
Torque control	●	●	●	●
closed-loop speed control	●	●	●	●
PID controller	●	●	●	●
Motion Control	●	●	●	●
Programmability				
Parameterisation	●	●	●	●
Function block programming	–	●	●	–
IEC 61131-3	●	□	–	–
I/O				
Analog input / output	1/1	2/2	2/2	–
Digital input / output	4/1	9/4	7/3	2/0
Connection of motor holding brake	●	–	●	●
Relay output	–	–	1	1
Speed feedback	○	2 (3 ○)	3	1
Emulation of feedback output	–	○	1	–
PTC	●	●	●	●
Linear motor temperature sensor (KTY/PT1000)	○	●	●	●
I ² xT monitoring	●	●	●	●
Fieldbus systems				
CAN	–	●	●	–
PROFIBUS	–	○	○	–
Interbus	–	–	–	–
CANopen	–	○	●	–
Modbus RTU	–	–	–	–
Modbus TCP/IP	–	–	–	–
LECOM	–	–	–	–
AS interface	–	○	–	–
DeviceNet	–	○	–	–
Ethernet TCP/IP	–	○	–	–
PROFINET	○	○	○	–
EtherCAT	●	○	○	●
POWERLINK	–	○	○	–
EtherNet/IP	–	○	○	–
Safety functions				
Safe torque off	●	○	□	●
Further safety functions	●	○	–	□
Diagnostics support				
LEDs	●	●	●	●
Integrated keypad	–	–	–	–
External keypad	–	○	○	–
PC interface	●	●	●	●
Memory module	●	●	●	–

● Standard

○ Option

□ Variant

– Not possible / not available

The data correspond to the device version stored in DSD

10.3.5.3 Features of decentralised inverters

See also

► [8400 motec frequency inverters: motor mounting or single mounting \(322\)](#)

	8400 motec frequency inverters	8400 protec frequency inverters	i550 protec frequency inverters
Illustration			
Short description	Frequency inverters for motor and wall mounting, V/f control with/without encoder, vector control without speed feedback, optionally with integrated safety functions, fieldbus communication, pluggable memory chip for the parameter set	Frequency inverters for wall mounting, vector control with/without speed feedback, overload capacity up to 200 %, optionally with integrated safety functions, fieldbus communication, pluggable memory chip for the parameter set	Scalable frequency inverter, V/f control with/without feedback, sensorless vector control, sensorless control for synchronous motors, torque control, overload capacity of up to 200%, memory module, optional safety engineering
Voltage range/power range	3 AC 320 ... 528 V: 0.37 ... 7.5 kW	3 AC 320 ... 550 V: 0.75 ... 4.0 kW (1st version) 7.5 kW (2nd version)	Without an integrated EMC filter: 1/3 AC 170 ... 264 V: 0.37 ... 2.2 kW 3 AC 170 ... 264 V: 3.0 ... 11 kW 1 AC 90 ... 132 V: 0.37 ... 1.1 kW With an integrated EMC filter: 1 AC 170 ... 264 V: 0.37 ... 2.2 kW 3 AC 340 ... 528 V: 0.37 ... 11 kW
Approvals	CE, UL508C	CE, UL508C	CE, UL, CSA, EAC, RoHS, IE2 in compliance with EN 50598-2
Permissible power systems	TN, TT, IT	TN, TT	TN, TT, IT (□)
Switching frequencies	4, 8, 16 kHz	2, 4, 8, 16 kHz	2, 4, 8, 12, 16 kHz
Mechanical design			
Built-in unit	—	—	●
Push-through technique	—	—	—
Cold plate technique	—	—	□
Motor mounting	●	—	—
Wall mounting	●	●	●
Enclosure	IP 54 / IP 65	IP 65	IP 31, IP 65
Operation in generator mode			
Integrated brake resistor	●	●	●
External brake transistor	—	—	● (3 AC 400/480 V)
Regenerative	—	—	—
Control types			
VFC plus (V/f control)	●	●	●
SLVC (sensorless vector control)	●	●	●
SLPSM (sensorless control for synchronous motors)	●	●	●
V/f control	●	●	●
SC (servo control)	—	●	● (only with asynchronous motor)
Drive function			
Voltage / frequency control	●	●	●
Torque control	—	●	●
closed-loop speed control	●	●	● (only with asynchronous motor)
PID controller	●	●	●
Motion Control	—	—	—
Programmability			
Parameterisation	●	●	●
Function block programming	—	●	—
IEC 61131-3	—	—	—

	8400 motec frequency inverters	8400 protec frequency inverters	i550 protec frequency inverters
I/O			
Analog input / output	2, 1, 0 ¹⁾	1	Standard I/O: 2/1
Digital input / output	8/1, 5/1, 2/0 ¹⁾	6/2	Standard I/O: 5/1
Relay output	○	–	1
Speed feedback	●	●	●
PTC	●	●	●
Linear motor temperature sensor (KTY/PT1000)	–	–	–
Fieldbus systems			
CAN bus	□	□	□
Modbus RTU	–	–	□
PROFIBUS	□	□	–
Interbus	–	–	–
LECOM	–	–	–
AS interface	□	–	–
DeviceNet	–	–	–
PROFINET	□	□	□
POWERLINK	–	–	–
EtherCAT	□	–	□
EtherNet/IP	□	□	□
Modbus TCP/IP	–	–	–
Safety functions			
Safe torque off	□	□	□
Further safety functions	–	□	–
Diagnostics support			
LEDs	●	●	●
External keypad	○ (hand-held)	○ (hand-held)	○ (hand-held)
PC interface	●	●	●
Memory module	●	●	●

● Standard

○ Option

□ Variant

– Not possible / not available

¹⁾ Depending on the type of Communication Unit

The data correspond to the device version stored in DSD

10.3.5.4 8400 motec frequency inverters: motor mounting or single mounting

In the "drive concept" sizing step of the DSD, you can go to *Motor/inverter mounting* and select "Decentralised inverter - motor mounting" or "Decentralised inverter - single mounting".

- **Motor mounting:** In further drive sizing steps, there is a fixed correlation between motor power and inverter power for 8400 motec frequency inverters.
- **Single mounting:** In further drive sizing steps, there is no fixed correlation between motor power and inverter power for 8400 motec frequency inverters.
 - Sizing continues to be intended only for mounting on the motor. Sizing for a wall mounting is not possible.
 - The installation feasibility is not checked.
 - A product configuration is not possible in the DSD.



[10-3] 8400 motec frequency inverters: sizing examples for motor mounting and single mounting in the DSD

10.3.6 Overview of motor/inverter control types

		Control system	Encoders		Three-phase AC motor				Synchronous servo motor		Asynch. servo motor		
			Yes	No	m540-P/ m550-P (IE3)	MH (IE2)	MF (120 Hz)	MD (IE1)	MCS	m850	SDSGA	MCA	MQA
Frequency inverter (Control cabinet devices)	8400 frequency inverter	SC	✓		● ¹⁾	● ¹⁾	● ¹⁾	● ¹⁾	● ³⁾	● ³⁾	○ ¹⁾	● ¹⁾	● ¹⁾
		SLVC		✓	●	●	●	●	–	–	○	●	●
		VFC plus	✓ ²⁾	✓	●	●	●	●	–	–	○	●	●
		VFC plus eco		✓ ²⁾	●	●	●	●	–	–	○	●	●
		SLPSM		✓	–	–	–	–	○	○	–	–	–
	i510 frequency inverters	SLVC		✓	●	●	●	●	–	–	○	○	–
		VFC plus		✓	●	●	●	●	–	–	○	○	–
		VFC plus eco		✓	●	●	●	●	–	–	○	○	–
		SLPSM		✓	–	–	–	–	–	–	–	–	–
	i550 frequency inverters	SC	✓ ^{4) 5)}		●	●	●	●	–	–	○	○	○
		SLVC		✓	●	●	●	●	–	–	○	○	–
		VFC plus	✓ ⁴⁾	✓	●	●	●	●	–	–	○	○	–
		VFC plus eco		✓	●	●	●	●	–	–	○	○	–
		SLPSM		✓	–	–	–	–	–	–	–	–	–
Servo inverter (Control cabinet devices)	9400 HighLine servo inverters	SC	✓		●	●	●	●	●	●	○	●	●
		SLVC		✓	●	●	●	●	–	–	○	●	●
		VFC plus	✓	✓	●	●	●	●	–	–	○	●	●
	i950 servo inverters	SC	✓		●	●	●	●	●	●	○	●	●
		VFC plus	✓	✓	●	●	●	●	–	–	○	●	●
	i700 servo inverters	SC	✓		●	●	●	●	●	●	○	●	●
		VFC plus	✓		●	●	●	●	–	–	○	●	●

		Control system	Encoders		m540-P/ m550-P (IE3)	Three-phase AC motor			Synchronous servo motor		Asynch. servo motor		
			Yes	No		MH (IE2)	MF (120 Hz)	MD (IE1)	MCS	m850	SDSGA	MCA	MQA
Decentralised inverters	8400 motec frequency inverters	SLVC		✓	●	●	●	●	–	–	○	●	●
		VFC plus	✓		●	●	●	●	–	–	○	●	●
		VFC plus eco		✓	●	●	●	●	–	–	○	●	●
		SLPSM		✓	–	–	–	–	○	○	–	–	–
	8400 protec frequency inverters	SC	✓		●	●	●	●	–	–	○	●	●
		SLVC		✓	●	●	●	●	–	–	○	●	●
		VFC plus	✓	✓	●	●	●	●	–	–	○	●	●
		SLPSM		✓	–	–	–	–	○	○	–	–	–
	i550 protec frequency inverters	SC	✓ 4) 5)		●	●	●	●	–	–	○	○	○
		SLVC		✓	●	●	●	●	–	–	○	○	–
		VFC plus	✓ 4)	✓	●	●	●	●	–	–	○	○	–
		VFC plus eco		✓	●	●	●	●	–	–	○	○	–
		SLPSM		✓	–	–	–	–	–	–	–	–	–

SC Servo control
SLPSM Sensorless control for synchronous motors
SLVC Sensorless vector control
VFC plus V/f control
VFC plus eco V/f control, energetically optimised

- Operation possible
- Operation possible, cannot be selected in DSD
- Operation not possible
- 1) Not for 8400 BaseLine / StateLine frequency inverters
- 2) Not for 8400 BaseLine frequency inverters
- 3) Only for 8400 TopLine frequency inverters
- 4) With a 100 kHz HTL encoder via digital input
- 5) Without a linear motor temperature sensor (KTY/PT1000)

See also: [▶ Selection help: Control types for winding drive systems](#) (📖 331)

10.3.6.1 Encoderless motor control for vertical conveyors/hoists

An application is referred to as a vertical conveyor if the gravitational force has a significant effect on the motor torque. Applications recognised by the Drive Solution Designer as a vertical conveyor:

- Cable-guided hoists and linear applications with an angle of tilt of more than 45° (belt drives, rack drives, spindle drives, travelling drives).
- Slider-crank mechanism with an angle of tilt of 45° ... 135° or 235° ... 315°.
- Eccentric lift tables.

Drive systems for vertical conveyors must ensure a reliable and continuous operation of the application at all times. For this task, a special motor management is required.

Drive systems with feedback are very well-suited for vertical conveyors. For applications without feedback, the motor management must also ensure a continuous and safe operation of the drive, even without encoder, and for the transition phases lifting/lowering and lowering/lifting in particular. During this four-quadrant operation, the motor control must also ensure safe operation of the "Zero-Hertz field frequency" operating status.

DSD efficiently supports the user during the drive dimensioning phase and

- provides suitable control types and encoderless drive systems for certain power ranges,
- considers the operating behaviour of the drive system during the dimensioning phase,
- checks necessary overdimensioning of the drive components and the max. permissible motor utilisation,
- detects the utilisation of the selected drive components,
- signals exceedances of limit values by means of warning signals or notes.

Control types

All Lenze inverters are provided with the linear V/f control (VFC) which, however, requires an overdimensioning of the inverter with regard to the motor. Moreover, the motor may only be utilised to approx. 75 % of the rated torque.

9400 HighLine servo inverters are provided with a special Voltage Vector Control (VVC) motor management system. This is suitable for vertical conveyors with encoderless drive systems. This procedure ensures that motor excitation is coordinated for every operating status. For this purpose, the rated output current of the inverter must be at least 120% of the rated motor current.

Suitable control types

- VFC plus with VVC
V/f control with linear V/f characteristic
 - VVC: Voltage Vector Control
 - VVC is activated via parameters
 - Suitable for motor power ≤ 55 kW
 - Included in 9400 HighLine servo inverters
- VFC plus linear
V/f control with linear V/f characteristic
 - Suitable for motor power ≤ 7.5 kW (recommended limit value)
 - Contained in all Lenze inverters



Tip!

- Lenze 9400 HighLine servo inverters with VVC are recommended for vertical conveyors with encoderless drive systems ≤ 55 kW.
- Always execute drive systems > 55 kW with feedback.

Unsuitable control types

- VFC plus quadratic
V/f control with square-law V/f characteristic
- VFC plus eco
Energetically optimised V/F control
- SLVC
Sensorless vector control

Tests in DSD

DSD carries out all tests for a safe dimensioning. Here, the following product-specific and procedure-specific factors for utilisation and overdimensioning are assumed regarding application, motor and inverter.

- VFC plus with VVC (only possible with 9400 HighLine servo inverters)
 - The motor is only utilised to the rated torque.
 - The rated output current of the inverter is at least 120 % of the rated motor current.
- VFC plus (possible for all inverters)
 - The motor is maximally utilised to 75 % of the rated torque.
 - The rated output current of the inverter is at least 170 % of the rated motor current.
 - Compared to the requirement of the application, the inverter is overdimensioned with an overall factor of 2.27.

**Note!**

Observe the notes in the dimensioning protocol if

- limit values have been exceeded,
- Sizing has been carried out with 9400 HighLine servo inverters and the control mode VFC plus with VVC.
 - In order to activate VVC (Voltage Vector Control), you have to adapt parameters in the inverter.

See also

- ▶ [Hoist drive without counterweight \(113\)](#)
- ▶ [Hoist drive with counterweight \(122\)](#)

10.3.7 Selection help: Products for drive systems (without winders)

	Conveyor drives	Motion drives	Holst drives	Positioning drives	Coordinated drives for robots	Synchronous drives	Clock drives for cross cutters and flying saws	Drives for electronic cam drives	Drives for forming processes	Master and tool drives	Drives for pumps and fans
Servo inverter											
9400 HighLine servo inverters	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	○
i950 servo inverters	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	○
8400 TopLine frequency inverters	+++	+++	+++	+++	++	+++	+++	++	+++	+++	+++
i700 servo inverter ¹⁾	++	+++	+++	+++	+++	+++	+++	+++	++	+++	○
Frequency inverter											
i510 frequency inverters	++	++				○			++	○	+++
i550 frequency inverters	+++	+++	++	○		+			++	++	+++
8400 BaseLine frequency inverters	+++	++				○			++	○	+++
8400 StateLine frequency inverters	+++	+++	○	○		○			++	++	+++
8400 HighLine frequency inverters	+++	+++	++	+++		++			+++	+++	+++
8400 motec frequency inverters	+++	+++	○			○			++	++	+++
8400 protec frequency inverters	+++	+++	++	++		++			++	++	+++
i550 protec frequency inverters	+++	+++	++	○		+			++	++	+++
Servo motors											
MCA	○	+++	++	+++	+++	+++	+++	+++	+++	+++	○
MCS	○	++	++	+++	+++	++	+++	+++		○	
m850	++		++	+++	+++	++	+++	+++		○	
MQA	+++	+++	+++	+++	++	+++	+++	+++	+++	+++	++
Three-phase AC motors											
MDxMA, MHxMA, m550-H, m550-P, m540-P	+++	+++	+++	++	○	+++	++	++	+++	+++	+++
MFxMA	+++	+++	+++	+++	○	+++	++	++	+++	+++	+++
Axial gearboxes/ratios											
g500-H helical gearbox	+++	+++	+++	++	++	+++	+++	++	+++	+++	○
g500-S shaft-mounted helical gearbox	+++	+++	+++	++	++	+++	++	++	+++	+++	○
Traction drives, positive-fit ²⁾	+++	+++	+++	+++	+++	+++	+++	+++	+++	++	+++
Traction drives, friction-locked ³⁾	+++	+++	○						+++	+++	+++
Traction drives, chain	+++	○	++							○	
Bevel gearbox											
g500-B bevel gearbox	+++	+++	+++	++	++	+++	+++	++	+++	+++	○

+++ Very well suited

++ Well-suited

+ Suited

○ Suitable with restrictions

¹⁾ Operation with Lenze Motion Controller, e.g. P500 or C300²⁾ E. g. toothed belt, chain³⁾ E. g. V-belt, flat belt

10.3.8 Selection help: Products for winding drive systems

	Tension ctrl open loop (M)	Tension control closed loop (M) ¹⁾	Tension control closed loop (n) ¹⁾	Dancer position control (n)	Speed control (n)
Winder control mode					
Traversing motor control	Open-loop torque control	Open-loop torque control	closed-loop speed control	Closed-loop speed control/ open-loop speed control	Closed-loop speed control/ open-loop speed control
Axial gearboxes, ratios					
g500-H helical gearbox	++	++	++	+++	+++
g500-S shaft-mounted helical gearbox	++	++	++	+++	+++
Toothed belt	+++	+++	+++	+++	+++
Direct drive	+++	+++	+++	+++	+++
Bevel gearbox					
g500-B bevel gearbox	++	++	++	+++	+++
Servo motors					
MCA	+++	+++	+++	+++	+++
MCS	++	++	++	++	++
m850	++	++	++	++	++
MQA	+++	+++	+++	+++	+++
SDSGA	+++	+++	+++	+++	+++
Three-phase AC motors					
MDXMA	++	++	++	++	++
MFxMA	○	○	○	○	○
m550-P, m540-P	+++	+++	+++	+++	+++
MHxMA, m550-H	+++	+++	+++	+++	+++
Inverters (IP 20)					
i510 frequency inverters ⁴⁾	—	—	—	—	—
i550 frequency inverters	○ ³⁾ 6)	—	—	● ⁵⁾	● ⁵⁾

	Tension ctrl open loop (M)	Tension control closed loop (M) ¹⁾	Tension control closed loop (n) ¹⁾	Dancer position control (n)	Speed control (n)
8400 Baseline frequency inverters	–	–	–	–	–
8400 StateLine frequency inverters	–	–	–	● ⁵⁾	● ⁵⁾
8400 HighLine frequency inverters	● ³⁾	● ³⁾	●	●	●
8400 TopLine frequency inverters	●	●	●	●	●
9400 HighLine servo inverters	●	●	●	●	●
i950 servo inverters	●	●	●	●	●
i700 servo inverters	●	●	●	●	●
Decentralised inverters (IP 65)					
8400 motec frequency inverters ⁴⁾	–	–	–	● ⁵⁾	● ⁵⁾
8400 protec StateLine frequency inverters ⁴⁾	–	–	–	● ⁵⁾	● ⁵⁾
8400 protec HighLine frequency inverters ⁴⁾	●	–	●	●	●
i550 protec frequency inverters	○ ^{3) 6)}	–	–	● ⁵⁾	● ⁵⁾

- +++ Very well suited
- ++ Well-suited
- Suitable with restrictions
- Possible
- Not possible, not reasonable

- ²⁾ Diameter measurement, e.g. with an ultrasonic sensor (optional)
- ³⁾ Linear motor temperature sensor (KTY/PT1000) is not evaluated
- ⁴⁾ DC-bus connection not possible
- ⁵⁾ Diameter feedforward control not possible
- ⁶⁾ With an external diameter compensation function

10.3.9 Selection help: Control types for winding drive systems

	Tension control (M)	Tension control (M) ¹⁾	Tension control (n) ¹⁾	Dancer position control (n)	Speed control (n)
Winder control mode					
Traversing motor control	Open-loop torque control	Closed-loop torque control	closed-loop speed control	Closed-loop speed control/ open-loop speed control	Open-loop speed control/ closed-loop speed control
Control system					
SC					
Rewinder/unwinder	+	+	+	+	+
VFC plus without encoder					
Rewinder/unwinder	–	–	–	○	○
SLVC					
Rewinder	+	–	–	○	+
Unwinder	–	–	–	–	–
VFC plus with encoder					
Rewinder	○	–	–	○	○
Unwinder	–	–	–	○	○
VFC plus eco					
Rewinder/unwinder	–	–	–	–	–

+ Well-suited

○ Suitable with restrictions

– Not suitable

¹⁾ [Comparison of tension-controlled winder control modes \(217\)](#)

²⁾ Diameter measurement, e.g. with an ultrasonic sensor (optional)

SC Servo control

VFC plus V/f control

VFC plus eco V/f control with energetically optimised field injection in the partial load operational range

SLVC Sensorless vector control

11 Drive Dimensioning

Depending on the components selected, you carry out the following dimensioning steps:

- Geared motor
 - [Preselection of the geared motor](#) (📖 332)
 - [Motor selection](#) (📖 339)
 - [Selection of Lenze Smart Motor](#) (📖 345)
 - [Mechanical brake selection](#) (📖 362)
 - [Lenze gearbox selection](#) (📖 369)
 - [Selection of an additional drive element](#) (📖 380)
- Inverter
 - [Preselection](#) (📖 382)
 - [Selection table](#) (📖 384)
- Motor components
 - [Feedback selection](#) (📖 397)

11.1 Preselection of the geared motor

11.1.1 Origin of motor

Parameter	Description
	Limited selection in the <i>Motor selection</i> dimensioning step. • All motors • Selection of Lenze motors and user motors. • Lenze motors • Selection of Lenze motors. • User motors • Selection of user motors. ▶ Display of user motor (📖 305)

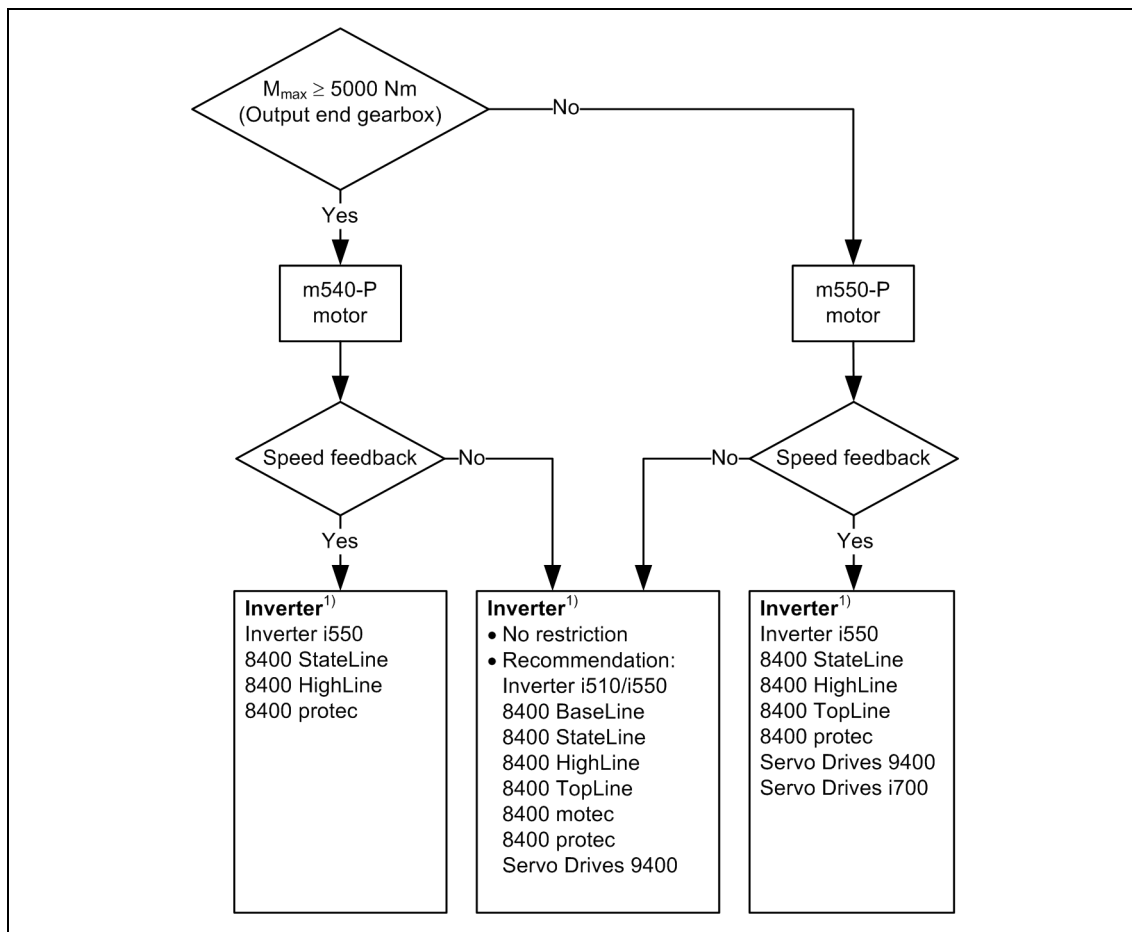
11.1.2 Motor group

Parameter	Description
Group	Selection of the IE3 motors of the m540-P or m550-P motor series for combination with a gearbox of the g500 series. • The DSD determines which series is suitable and sets it by default. • The parameter is only available if the m500-P motor series has been selected in the drive concept. Drive concept (📖 304)

Combinations of the g500 gearbox series with motors of the m550-P/m540-P series

... kW	Motor power with 3AC 400 V / 50 Hz
[...] kW	Motor power with 3AC 400 V / 87 Hz

Selection help for drive systems mit motors of the m550-P / m540-P series



[11-1] Selection help for IE3 motors of the m550-P / m540-P series

¹⁾ The assignment of the inverters depends on the feedback system.

11.1.3 Additional moment of inertia, motor shaft

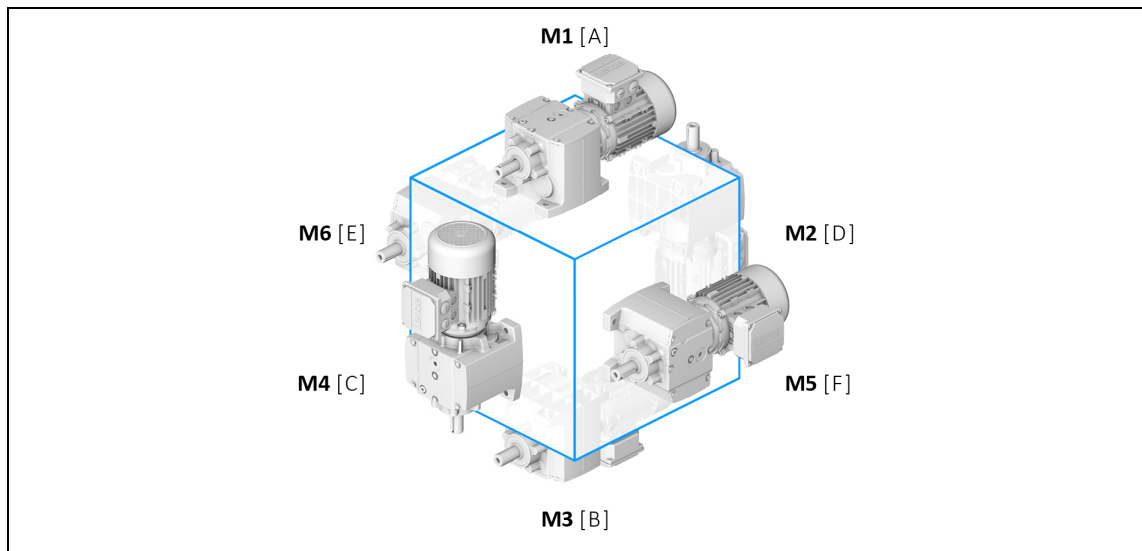
Parameter	Description
$J_{add,M}$	Additional moment of inertia on motor shaft. • For example flywheels/belt pulleys, and handwheels. • These centrifugal masses rotate at the same speed as the motor.

11.1.4 Mounting position

The Continuous rated curve of the gearbox is significantly affected by the mounting position.

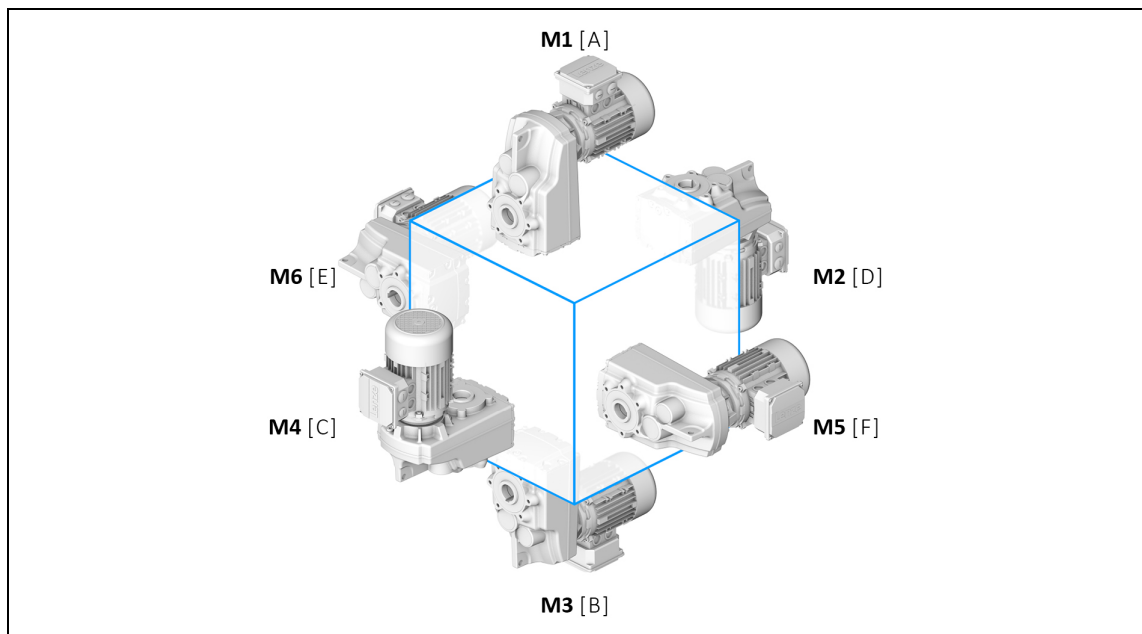
M1 ... M6 are the current designations for the mounting positions. The previously used designations [A] ... [F] are also shown.

g500-H



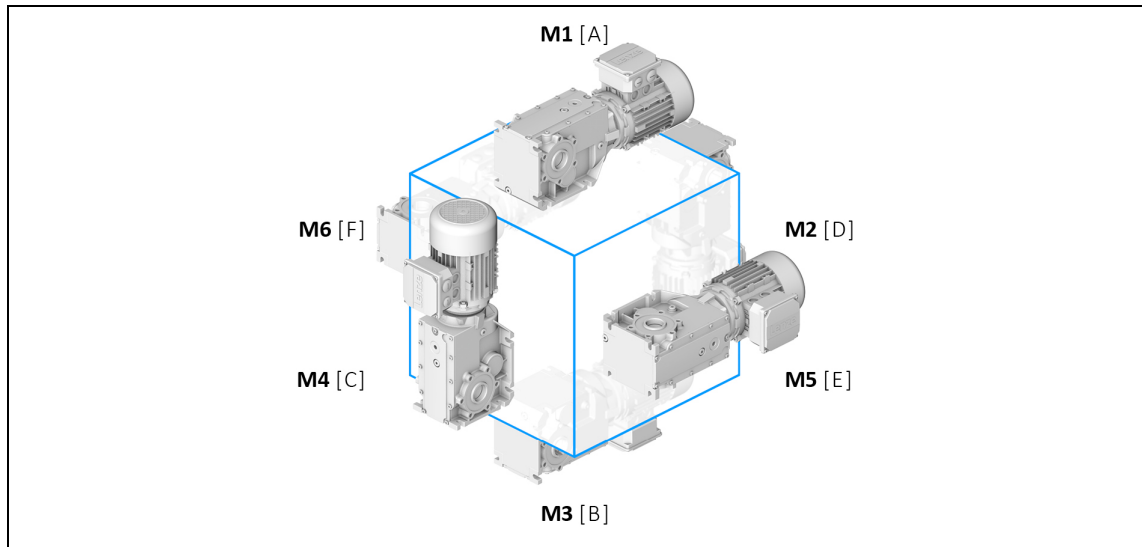
[11-2] g500-H helical gearbox mounting positions

g500-S



[11-3] g500-S shaft-mounted helical gearbox mounting positions

g500-B



[11-4] g500-B bevel gearbox mounting positions

11.1.5 Average daily operating time

The Continuous rated curve of the gearbox is influenced by the average daily operating time.

Parameter	Description
OT	Daily power-on time. • The operating time is required to determine the correction factors of the thermal speed for geared motors.

11.1.6 Additional drive element (K)

Parameter	Description
Type	The following designs are available: • Flat belt • V-belt • Chain • Dedicated gearbox • Gear wheel • Toothed belt



Note!

Whereas toothed belts, chain, and gears have a positive locking and thus present a low tendency for slip, in the case of a V-belt/flat belt there is a speed difference between the drive end and the output end (slip).

- This speed difference in general is low and is not considered by the DSD.



Stop!

If belt drives/chain drives are used, the radial stress of the Lenze gearbox by the pretension is not checked in the DSD. Carry this check out manually!

11.1.7 Energy-saving function

Parameter	Description
	Only Lenze Smart Motor
Off	Optimised for: • High dynamic performance • Maximum starting torque and torque • High speed accuracy
On	Reduced energy absorption in partial load operational range. • Approx. 50 % of the maximum starting torque is available.

11.1.8 Minimum ratio (K)

Parameter	Description
$i_{\min,K}$	Minimum setpoint ratio of the additional drive element. • If a ratio of $i_{\min,K}$ to $i_{\max,K}$ can be achieved, this value presents the lower limit. • Value can be directly entered or calculated using the gearbox calculator.  Gearbox calculator



Note!

If the ratio of the additional drive element is already known before the Lenze gearbox is selected, the minimum ratio and the maximum ratio are identical ($i_{\min,K} = i_{\max,K}$).

11.1.9 Maximum ratio (K)

Parameter	Description
$i_{\max,K}$	Maximum setpoint ratio of the additional drive element. • If a ratio of $i_{\min,K}$ to $i_{\max,K}$ can be achieved, this value presents the upper limit. • Value can be directly entered or calculated using the gearbox calculator.  Gearbox calculator



Note!

If the ratio of the additional drive element is already known before the Lenze gearbox is selected, the minimum ratio and the maximum ratio are identical ($i_{\min,K} = i_{\max,K}$).

11 Drive Dimensioning

11.2 Motor selection

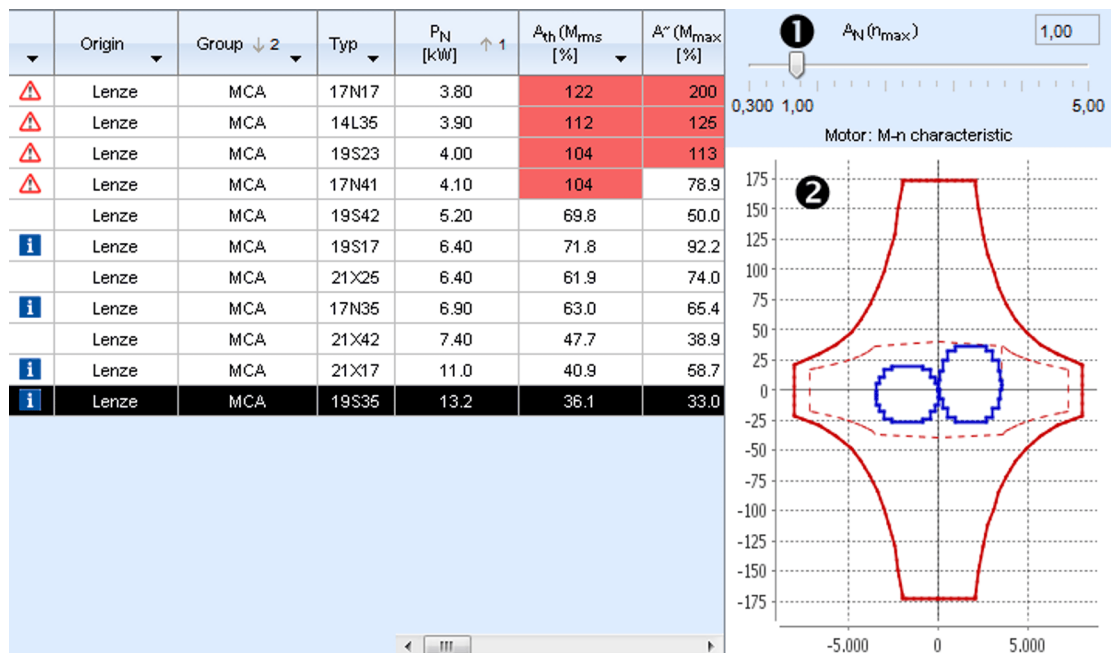
11.2 Motor selection

The Drive Solution Designer dimensions the motor for operation at the frequency inverter or servo inverter. The calculations for both combinations are based on the same model.

11.2.1 Selection table

The motor selection table lists the parameters of the motors provided for selection. In this context, a distinction between preliminary values and further parameters is to be made.

- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables](#) (35)
 - ▶ [Sorting and filtering results in selection tables](#) (36)



Description	
1	Slider for optimally utilising the rated speed • For the calculation of the required torque the motor inertia is taken into consideration. The gearbox ratio is calculated so that the rated speed (applicable to all applications except for winders) of the motor is assumed as the max. speed. • The sliders of winders with asynchronous or synchronous motors have a default setting of "2". • By means of the slider you can optimally adapt the motor: • Value = 1: rated speed • Values > 1: speed greater than rated speed (field weakening). • Values < 1: speed smaller than rated speed. • Lenze setting for winding applications: • Asynchronous motors: 2.0 • Synchronous motors: 1.0

Description	
②	Torque-speed characteristic of the motor. The represented characteristic refers to the motor-inverter combination. The inverter family selected in the <i>Drive concept</i> dimensioning step is used.
	Characteristic curve of the motor.
	Calculated characteristic curve of the motor. For most motors, measured characteristic curves are stored in DSD.
	S1 characteristic of the motor. Vertical characteristic: rated motor speed.
	Torque-speed characteristic of the application requirement. By means of the slider ① you can adapt the characteristic.

Description of the parameters

Parameter	Unit		Description
	Metric	Imperial	
k_f			Field weakening factor With the slider you can adapt the max. speed in advance.
$A_{rated} \sim (n_{max})$			Previously calculated utilisation of the motor - The utilisation is calculated from the ratio of the max. motor speed to its rated speed. Possible messages: ► Utilisation >100 %, regarding the max. torque (□ 512)
$A \sim (M_{max})$			Utilisation of the motor calculated in advance with reference to the max. torque in the M-n characteristic.
$A_{th,M} \sim (M_{rms})$	%	%	Thermal utilisation of the motor with regard to the effective torque Relevant topics: ► Continuous rated curves (S1 characteristics) (□ 344) Possible messages: ► Utilisation >100 %, regarding the effective torque (□ 522)
Type			Motor type Display of the type code.
P_{rated}	kW	kW	Rated power of the motor
M_{rated}	Nm	lbfft	Rated torque of the motor
M_0'	Nm	lbfft	Standstill point of the synchronous motor
$M_{dyn,M}$	Nm	lbfft	Maximum torque in air gap
f_{rated}	Hz	Hz	Rated frequency
I_{rated}	A	A	Rated current
n_{rated}	rpm	rpm	Rated speed
$P_{th,av,M}$	kW	kW	Medium power loss of the motor
$I_{max} \sim$	A	A	Previously determined max. required application current
$k_j \sim$			Previously calculated load matching - Mismatch of the moment of inertia Relevant topics: ► Load-matching factor (□ 353) Possible message: ► Max. mismatch is higher than permissible mismatch (□ 523)
$\cos \varphi$			Power factor

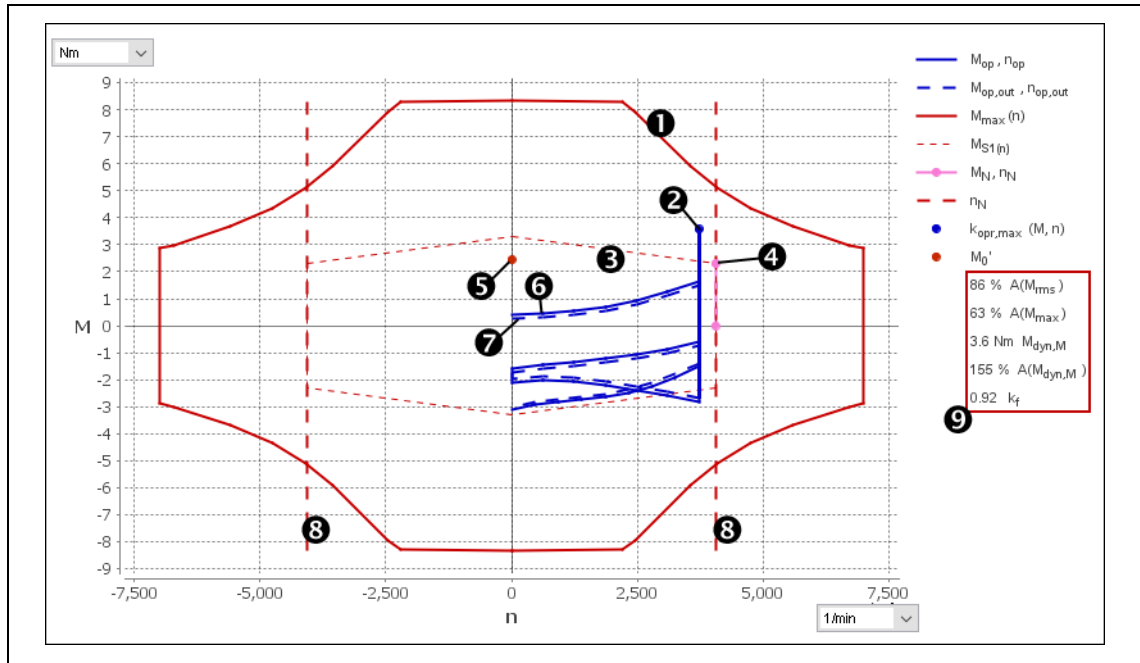
Parameter	Unit		Description
	Metric	Imperial	
IP			Protection type of the motor
Cooling			Type of motor cooling
			S Naturally ventilated (surface-ventilated)
			E Self-ventilated (integral fan)
			F Forced ventilated
V_{rated}	V	V	Rated voltage
Y/ Δ			Connection method
			S Y-connection
			D Δ connection

Related topics:

- ▶ [Torque/speed characteristic](#) (📖 342)
- ▶ [Motors for 87-Hz operation](#) (📖 349)
- ▶ [Motors for 120-Hz operation](#) (📖 349)
- ▶ [Dimensioning guidelines and dimensioning information](#) (📖 350)
- ▶ [Load-matching factor](#) (📖 353)
- ▶ [Radial forces/axial forces](#) (📖 359)

11.2.2 Torque/speed characteristic

The M-n characteristic indicates the torque to be reached with the selected inverter and the thermal state of the motor.



[11-5] M-n characteristic of the motor

Description	
1	Limit characteristic - For most motor-inverter combinations characteristic curves are stored in the DSD. - If no limit characteristic curve is saved, an equivalent characteristic is shown. It is represented as a red dotted line (.....).
2	Maximum operating point
3	Continuous rated curve Limit characteristic curve for the torque which the motor can provide continuously (S1 operation) without overheating.
4	Rated point of the motor
5	Standstill point of the synchronous motor
6	Torque-speed characteristic of the requirement of the application (M_{op}, n_{op}) - Air gap torque of the motor (internal torque M_{op} that is transmitted from the stator to the rotor). - For checking the motor-inverter combination the characteristic always has to be below the characteristic curve.
7	Torque-speed characteristic of the shaft torque ($M_{out,op}$) - Outer torque that is provided to the application by the motor shaft. - The torque required for accelerating the rotor results from the difference of the torque-speed characteristics 6 and 7.
8	Rated motor speed
9	Performance features The performance features can also be found in the selection table. Selection table (339)

11.2.2.1 Characteristic curves

Generally, DSD uses characteristic curves which apply to the respective selected rated voltage of the supply system and to the standard configuration of the inverter.

The characteristic curves are represented in two classes:

- Characteristic curves in the *Motor selection* and *Gearbox selection* dimensioning step:
 - Display what the motor is able to max. provide with the selected inverter family.
- Characteristic curves in the *Inverter selection* and *Protocol* dimensioning step:
 - Display what the motor-inverter combination is able to max. provide in the selected operating mode (switching frequency, overload behaviour, control mode, mains choke).

For the calculation in DSD, the quadrant for operation in motor mode is reflected to the quadrant for operation in generator mode and adapted if required. That way, it is ensured that the required torque is provided independent of the selected electrical braking circuit.

If there is no characteristic available for the motor-inverter combination or the selected control mode, DSD calculates a characteristic which is represented as a red dotted line.



Note!

If the standard configuration of the drive system has changed (e.g. use of a mains choke, motor choke, long motor cables, or a "smooth" network), the actual characteristic can differ considerably from the displayed one.

By means of the motor characteristic the required torque of the application can be checked on the basis of the max. available motor torque.

The following has to apply to each operating point $M_M = f(n)$:

$$M_{\max,M}(n) > M_{\max,App}(n)$$

[11-6] Check of the required application torque

The torque-speed limit characteristics of the motor-inverter combination presented in the Drive Solution Designer are static characteristics. In the case of acceleration times ≤ 50 ms for servo inverters and ≤ 100 ms for frequency inverters, the actual torque-speed behaviour may deviate considerably.

Representation of the limit characteristics at a torque $>400\% M_{\max,M}$

In case of very high overload factors, the course of the limit characteristics in the catalog (in tabular form) and in the DSD or »EASY Product Finder« may, in individual cases, be represented differently.

The data in the catalog are usually verified by measurements. In the DSD or »EASY Product Finder«, the characteristics are simulated and the torque is reduced to $400\% M_{\max,M}$ even if the inverter could offer a higher performance. Reason: At a torque $>400\% M_{\max,M}$, the simulation results get less accurate due to nonlinearity and saturation effects.

In case of drive sizing for an application with a torque requirement $M_{\max,App} > 400\% M_{\max,M}$, the required torque/speed behaviour must be ensured by single measurements or empirical tests.

11.2.2.2 Continuous rated curves (S1 characteristics)

The continuous rated curve of a motor is affected by winding losses and core losses. Due to the core losses increasing with the frequency, every motor has a continuous rated curve that decreases with increasing speed.

- The winding losses are quadratically proportional to the current. Very high overloads therefore result in a high increase of the losses. In order to consider both types of losses, the DSD uses a thermal model of the machine.

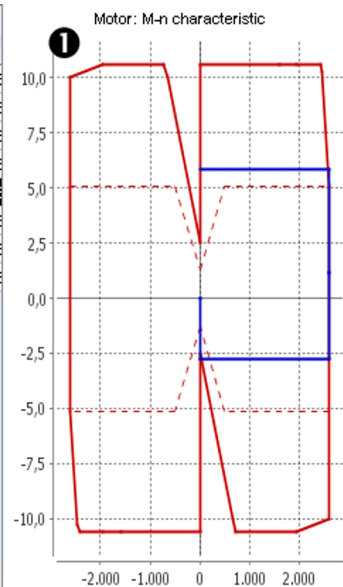
11.3 Selection of Lenze Smart Motor

11.3.1 Selection table

The motor selection table presents the parameters of the motors available. Here, it is distinguished between preview values and further parameters.

- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables \(35\)](#)
 - ▶ [Sorting and filtering results in selection tables \(36\)](#)

	Gearbox	N _i	i _{act} ↓ 3	M _{pe} ↑ 1 [Nm]	A _r ([%]	Motor	P _N ↑ [kW]
	g500-H320	2	16.923	281.30	25	MSEMA 080-32	1.36
⚠	g500-H320	2	14.898	283.50	25	MSEMA 080-32	1.36
	g500-H320	2	20.731	299.10	24	MSEMA 080-32	1.36
	g500-H320	2	18.250	309.70	23	MSEMA 080-32	1.36
	g500-H320	3	47.276	320.00	22	MSEMA 080-32	1.36
	g500-H320	2	23.754	320.00	22	MSEMA 080-32	1.36
	g500-H450	2	15.714	320.50	22	MSEMA 080-32	1.36
	g500-H450	2	22.170	376.20	19	MSEMA 080-32	1.36



Description	
①	Torque-speed characteristic of the motor.
—	Measured or simulated limit characteristic of the motor.
.....	Alternative for the characteristic curve of the motor. • Not for all motors measured or simulated characteristics are available.
- - -	S1 characteristic of the motor. • Vertical characteristic: rated motor speed.
—	Torque-speed characteristic of the application requirement.

Description of the parameters

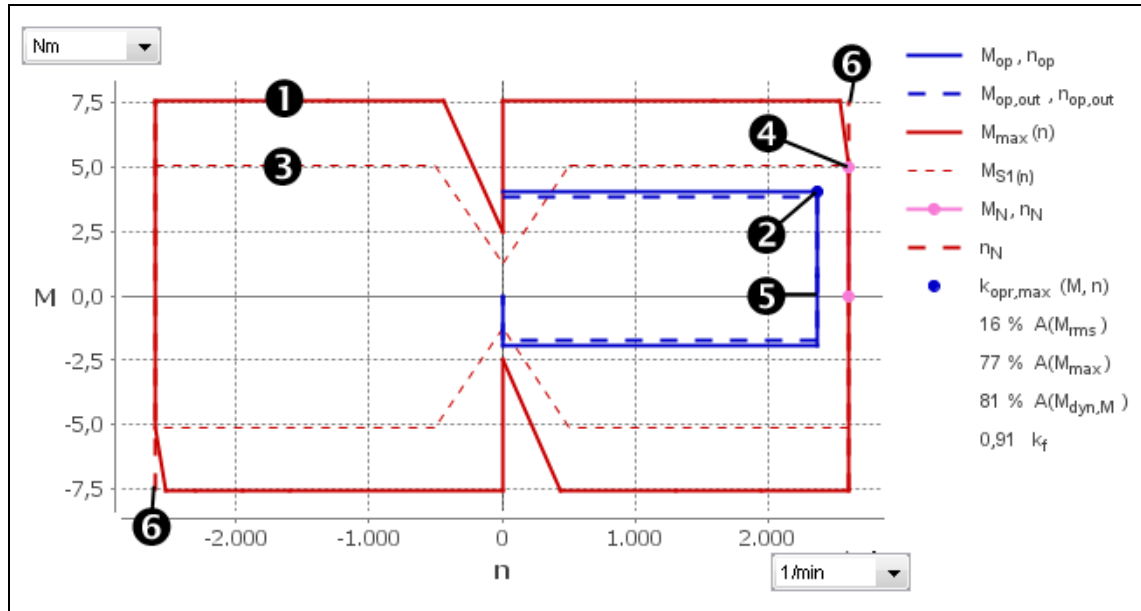
Parameter	Unit		Description
	Metric	Imperial	
Gearbox			Gearbox type • Display of one part of the type code, consisting of gearbox type and version.
rated_G			Number of gearbox stages
i_{act}			Actual ratio of the gearbox
$M_{\text{per,out}}$	Nm	lbfft	Rated torque of the gearbox at the output end
$\tilde{A}(M_{\text{eq}})$	%	%	Utilisation calculated in advance, with reference to the equivalent torque • Provides an indication for the endurance strength of the gearbox. Relevant topics: ▶ Check of the torque load (□ 373) Possible messages: ▶ Utilisation >100 % regarding the equivalent torque (□ 517)
Motor			Motor type • Display of the type code.
P_{rated}	kW	kW	Rated power of the motor
$A_{\text{th,D}}$	%	%	Utilisation of the drive system • The sum of the thermal utilisation of the drive components results in the utilisation of the drive system.
$A_{\text{max,D}}$	%	%	Max. utilisation of the drive system with regard to the torque • The utilisation limit is determined by the drive components.
$P_{\text{th,D}}$	kW	kW	Power loss of the drive system • The sum of the power loss of the drive components results in the power loss of the drive system.

Related topics:

- ▶ [Dimensioning guidelines and dimensioning information](#) (□ 350)
- ▶ [Load-matching factor](#) (□ 353)
- ▶ [Radial forces/axial forces](#) (□ 359)

11.3.2 Torque/speed characteristic

The torque/speed characteristic indicated the torque to be reached and the thermal state of the motor.



[11-7] M-n characteristic of the motor

Description	
1	Limit characteristic - For most motor-inverter combinations characteristic curves are stored in the DSD. - If no limit characteristic curve is saved, an equivalent characteristic is shown. It is represented as a red dotted line (.....).
2	Maximum operating point
3	Continuous rated curve Limit characteristic curve for the torque which the motor can provide continuously in S1 operation without overheating.
4	Rated point of the motor
5	Torque-speed characteristic of the application requirement For checking the motor-inverter combination the characteristic always has to be below the characteristic curve.
6	Rated motor speed
7	Performance features The performance features can also be found in the selection table. Selection table (345)

11.3.2.1 Characteristic curves

Usually, the DSD uses limit characteristics. The curve of the limit characteristic depends on the selected electrical supply system and the energy saving function of the Lenze Smart Motor.

By means of the motor characteristic the required torque of the application can be checked on the basis of the max. available motor torque.

The following has to apply to each operating point $M_M = f(n)$:

$$M_{\max,M}(n) > M_{\max,App}(n)$$

[11-8] Check of the required application torque

The torque/speed characteristics shown in the DSD are static characteristics.

11.3.2.2 Continuous rated curves (S1 characteristics)

The continuous rated curve of a motor is affected by winding losses and core losses. Due to the core losses increasing with the frequency, every motor has a continuous rated curve that decreases with increasing speed.

- The winding losses are quadratically proportional to the current. Very high overloads therefore result in a high increase of the losses. In order to consider both types of losses, the DSD uses a thermal model of the machine.

11.4 Dimensioning criteria for the motor

11.4.1 Motors for 87-Hz operation

87 Hz operation of standard asynchronous motors is completely integrated in the DSD for all inverters. The advantage of this operating mode is that the motor speed in comparison to 50 Hz operation is increased by 73 % at the same torque. Therefore also the nominal motor power rating is increased by 73 %. Thus the motor utilisation is considerably better. For the inverter no savings result from this.

- The rated speed for 4-pole motors in 87 Hz operation is approx. 2,500 rpm.
- For geared motors it has to be observed that the max. permissible input speed is not exceeded.
- 87 Hz operation is only possible on an inverter, the motor being actuated with 400 V Y / 230 V Δ in delta connection. The rated V/f point is set to 400 V / 87 Hz.
- Motors which allow for 87-Hz operation are indicated in the motor selection table of DSD with correspondingly converted data.
- The efficiency of the motor in 87-Hz operation is higher. Thus, compared to 50 Hz, the operation is more efficient and a smaller frame size is required.



Tip!

11.4.2 Motors for 120-Hz operation

For applications with frequently alternating speed and low requirements to the dynamics, Lenze offers motors in standard housing optimised for inverter operation.

- Efficiencies as with comparable IE2 motors, partly IE3 motors as well, but with considerably smaller frame sizes.
- Often a more competitive alternative to servo motors.

11.4.3 Dimensioning guidelines and dimensioning information

The application range of a motor is defined by its max. mechanical/electrical limits and the thermal limits.

- Whereas the mechanical/electrical limits are defined by the max. load values (M, n, U, I), for the thermal dimensioning the load characteristic as a whole is relevant.
- The thermal model of the motor is based on the continuous characteristic (S1 characteristic).
- The DSD simulates the thermal utilisation by means of an approximate model and presents it in the characteristic field.
- During longer operation with low field frequencies in the SLVC or VFC plus control mode, and if deviations between the actual and optimum motor excitation occur, the motor may heat up more.
 - Remedy: Dimension the drive with greater reserves.
- During longer operation outside of the indicated S1 characteristic, higher inaccuracies may occur.
 - Remedy: Dimension the drive with greater reserves.



Note!

The thermal model for operation at the frequency inverter is derived from the same model as the one for operation at the servo inverter.

- Depending on the system and the control type used (SC, SLVC, VFCPLUS), this may cause deviations.

11.4.4 Field weakening in case of the winding drive

The field weakening serves to considerably reduce the rated power of the drive. The greater the field weakening factor the more reduced the required rated power.

In order to achieve high field weakening factors (for max. motor speeds which are not too high), select a motor with as low a rated speed as possible. Four-pole standard three-phase AC motors (e.g. in 29-Hz technology) from size 132 are suitable.

The field weakening reduces the magnetisation of the motor above the rated speed. Hence, if maximum voltage is provided, the motor is able to operate at a speed which is significantly above the rated speed.

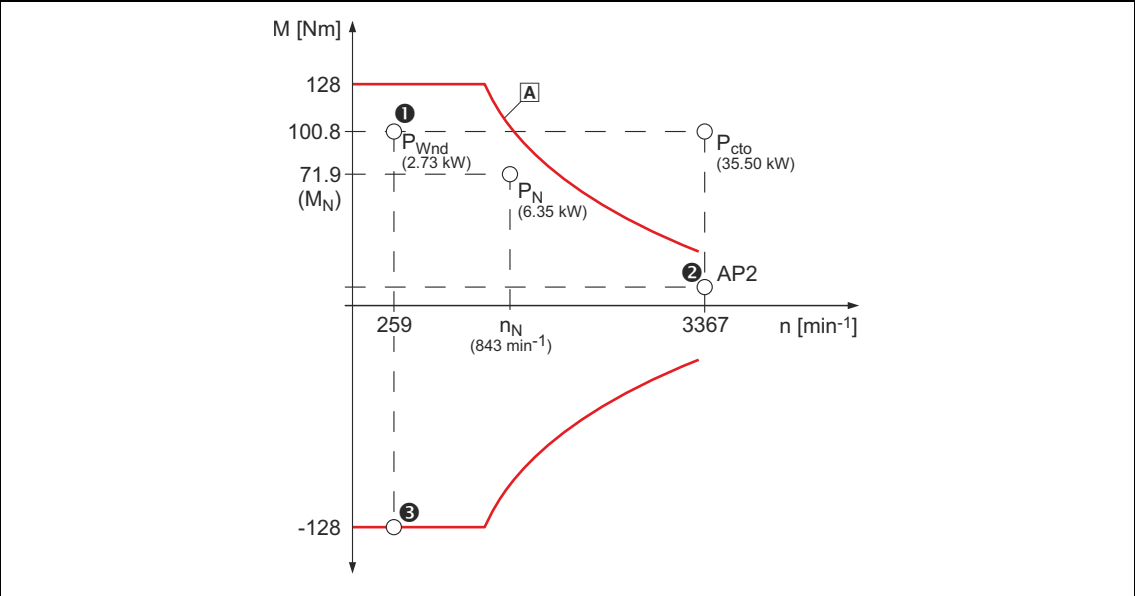
The power at the motor shaft remains almost constant up to a field weakening factor of approx. 1 : 1.5 to 1 : 2 (depending on the stalling torque). The power decreases with higher factors.

In practice, asynchronous motors for center winding machines are operated with field weakening factors of up to 1 : 4, in special cases even up to 1 : 5. Synchronous motors can be operated with a significantly reduced field weakening factor (max. 1 : 1.5). This can be seen from the motor characteristic.

In DSD a slider is used to adapt the field weakening factor in the motor table. Winders with asynchronous motors have a Lenze setting of $k_f = 2$. If the field weakening factor is changed, the torque-speed requirements (blue characteristic) and the utilisation values are automatically recalculated and displayed in the table. The optimal motor has been found if the characteristic curve (red characteristic) is not exceeded. [Dimensioning strategies](#) (211)

- Always select a field weakening factor k_f which is smaller than the winding ratio q :

$$k_f < q = \frac{d_{\max}}{d_{\min}}$$



[11-9] Characteristic of a winding drive with a field weakening factor $k_f = 4$

Description	
A	Characteristic curve of the motor
1	Operating point 1: max. diameter at max. speed
2	Operating point 2: min. diameter at max. speed
3	Operating point 3: emergency stop with max. diameter and max. speed
M_{rated}	Rated torque of the motor
N_{rated}	Rated speed of the motor
P_{rated}	Rated power of the motor
P_{wnd}	Required power of the winder
P_{cto}	Base process power of the motor

11.4.5 Thermal utilisation

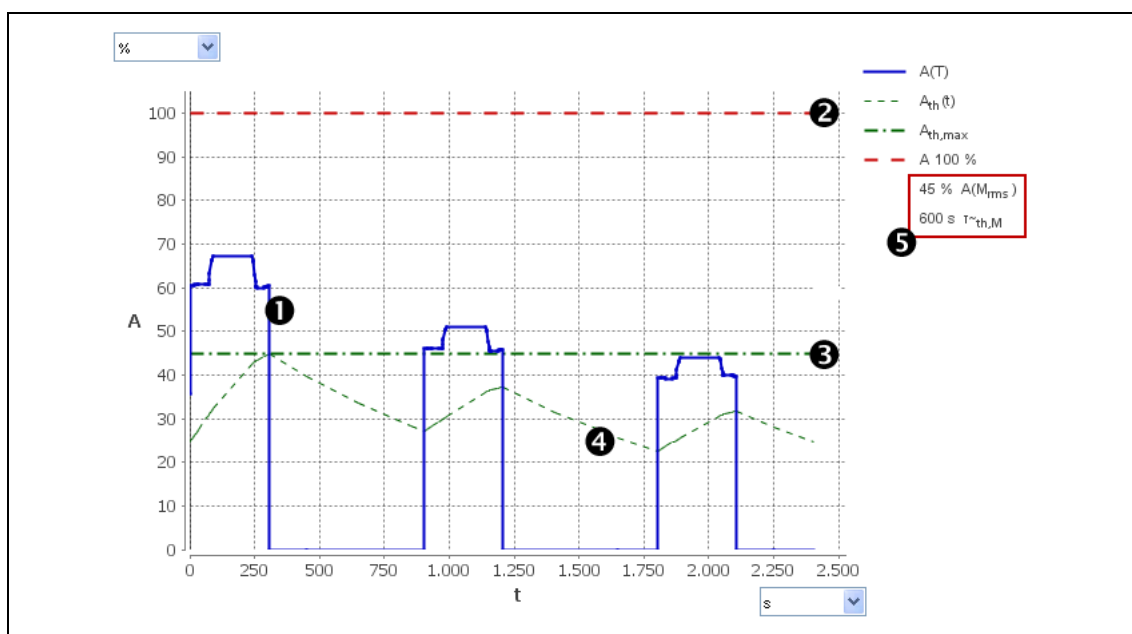
For the calculation of the thermal utilisation, the heating in the motor is simulated by a PT1 function.

Important quantities for the utilisation $A_{th}(t)$:

- Utilisation of the gearbox via a cycle.
 - The utilisation results from the ratio of the instantaneous torque value $M(n(t))$ and the corresponding value $M_{S1}(n(t))$ from the continuous characteristic
- Thermal time constant of the motor.

$$A_{th}(t) = \left(\frac{M(n(t))}{M_{S1}(n(t))} \right)^2$$

[11-10] Calculation of the thermal utilisation of the motor via a cycle



[11-11] Diagram of motor: Thermal utilisation

Description	
❶	Instantaneous utilisation
❷	100 % utilisation • If this limit is exceeded, the motor will be overheated.
❸	Max. value of the thermal utilisation
❹	Thermal utilisation • Simulated value, calculated with the time constant of the motor.
❺	Performance features • The performance features can also be found in the selection table. Selection table (339)

11.4.6 Load-matching factor

The load-matching factor is an important assessment criterion for speed- or angle controlled dynamic acceleration drives.

- The load-matching factor is the ratio of the load moment of inertia (reduced to the motor shaft) to the moment of inertia of the motor:

$$k_J = \frac{J_L}{i^2 \cdot J_M}$$

- The load-matching factor k_J is an important indicator for:
 - The acceleration capability
 - The control quality for speed- or angle-controlled drives
 - The stability limits of the control for speed- or angle-controlled drives
- A high k_J factor is uncritical for torque-controlled systems.
- With a low k_J factor, the load is not very dominant and the motor has a significant effect on the acceleration capability of the drive.
 - A bigger motor is no solution as the required dynamics will not be reached with it.
 - The solution for this is an increase of the gearbox ratio within the realms of possibility (observe the maximum speed for the motor and gearbox drive), or alternatively the use of low-inertia motors (e. g. synchronous motors, 120-Hz motors).

The DSD automatically calculates the occurring load-matching factors, i.e. the mismatch of the moments of inertia.

- The calculated values are displayed and logged as preview values in the different masks and after definition of the components also as actual values.
- Depending on the application, the load-matching factor k_J is fixedly determined in the DSD:
 - In the case of applications with a horizontal direction of movement, $k_J = 20$ is preset.
 - In the case of applications with a vertical direction of movement (angle of tilt $> 45^\circ$), $k_J = 50$ is preset.
 - The load-matching factor is only relevant for closed-loop speed-controlled/open-loop speed-controlled winder control modes, the following default limit values being set:
 $k_J = 500$ for a belt drive/direct drive.
 $k_J = 100$ for a tooth gearbox.
- If the load-matching factor $k_J < 0.5$, the drive is no longer optimally adjusted.
 - In this case, the motor and no longer the load is dominant (see diagram [\[11-12\]](#)).
 - For acceleration drives it is then favourable to select another ratio or a motor with low inertia.

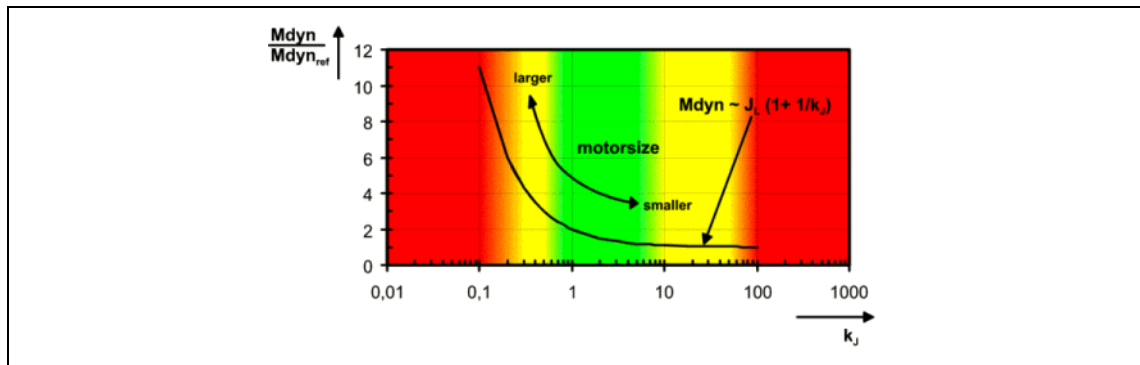


Note!

- For acceleration drives, load-matching factors $k_J < 0.5$ are unfavourable.
- For quasi-stationary drive (acceleration torques are not dominant here), load-matching factors $k_J < 0.5$ are non-critical.
 - For instance in case of drives in materials handling technology, the load-matching factor k_J can be clearly lower than 0.5.

11.4.6.1 Required acceleration torque

The following diagram shows the required relative acceleration torque as a function of the k_j factor, the coloured representation using traffic-light colours giving a rough guide value for optimum system properties of motion drives.



[11-12] Required acceleration torque as a function of k_j

- As the K_j factor becomes higher, the load becomes the increasingly dominant portion of the moments of inertia, and a larger motor will only slightly reduce the acceleration capability, but will simultaneously provide improved control-loop quality and system stability.
- A load-matching factor of $k_j = 1$ produces the minimum size of a drive.

11.4.6.2 Factors for the stability and quality of control

However, the control stability and quality not only depends on the k_j factor, but also on other factors, such as:

- Cyclic load alternation (sign reversal in the torque)
- Backlash in the mechanical transmission elements (e.g. gearbox, clutch, keyway, cardan shaft, chain)
- Elasticity in the mechanical transmission elements
- Triggering of the mechanical self-exciting frequency of the application
- Damping of the transmission elements

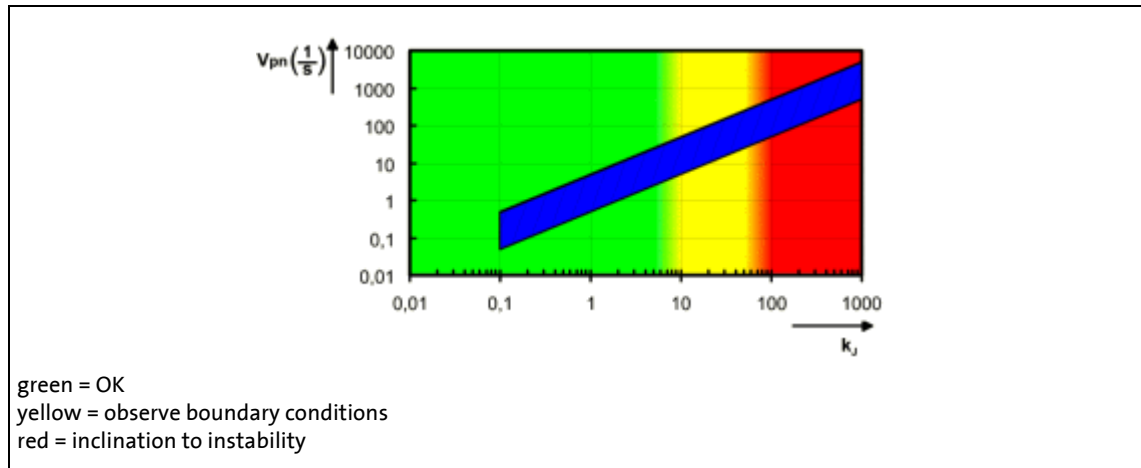


Note!

DSD creates a message if a k_j factor adjusted to the application is in the critical region.

11.4.6.3 Possible speed controller amplification factors

The following illustration shows the theoretically possible speed controller amplification factors for cyclic load alternation (rough guide values):



[11-13] Theoretically possible speed controller amplification factors as a function of K_J (guide values)

From a control-related perspective, a great moment of inertia, and therefore a great k_J factor requires a great amplification factor V_p in the speed controller.

- Because of backlash and elasticity in the gearbox, standard controller structures can only reach certain k_J factors in the practical control-loop implementations.
 - If these values are exceeded, they lead to a reduced control response or even instability, particularly with regard to cyclic load alternations.
 - If there are no load alternations, the stable control range moves up towards higher k_J factors.

11.4.6.4 Optimising drive with a high load-matching factor

In case of speed or phase-controlled applications with cyclic load alternation, high load-matching factors k_J often cannot be prevented. Typical applications are:

- Rotary indexing tables
- Pick-and-place applications
- Clocked winders
- Positioning applications

Mechanical measures for optimisation

- Use backlash-free or low backlash mechanical transmission. Toothed belts are very suitable as transmission element due to their damping features.
- Replace keyways by locking assemblies if possible.
- Use a toothed gearbox with as few steps as possible.

Electrical measures for optimisation

- Torque feedforward control for dynamic phases.
- Specific adaptation, e. g. of the amplification factor V_p within the speed controller, as a function of the moments of inertia which in turn can also be variable.
- Speed controller as a P controller.
- Adjustment of the actual speed value filter to load moment of inertia.
- Use of a low-jerk motion profile that do not exert any, or only a low incitation on the vibratory system.
- Do not incite mechanical natural frequencies.



Note!

The k_J factor pre-calculated in the DSD is only a guide value and serves as an indicator for a stable control.

- In case of unfavourable mechanical transmission elements, the k_J factor may be smaller.
- The exact value can either be detected by trying it on the machine or by a simulation of the application. A simulation needs the required parameters.

11.4.6.5 Load-matching factor in case of the winding drive

	Winder control mode: Tension control open loop (M) • Motor control: Open-loop torque control • Influence of k_j: No
	Winder control mode: Tension control closed loop (M) • Motor control: Closed-loop torque control • Influence of k_j: No
	Winder control mode: Tension control closed loop (n) • Motor control: closed-loop speed control • Influence of k_j: High
	Winder control mode: Dancer position control (n) • Motor control: Closed-loop speed control/open-loop speed control • Influence of k_j: High
	Winder control mode: Speed control (n) • Motor control: Open-loop speed control/closed-loop speed control • Influence of k_j: High

Special features of the closed-loop speed-controlled winding drive

The following requirements tend to cause unstable behaviour of the closed-loop speed-controlled winding drive:

- Winding drive with high acceleration component in the torque
- Intermittent winding operation (frequent change of torque) with the unwinder or un/rewinder. The critical value for k_j is significantly smaller than with a drive without change of torque.

The following measures support a stable control behaviour:

- Precise speed and torque feedforward control
- Keep the influence of the dancer weak
- Adapt the filter time constant for the actual speed value
- Adapt speed controller gain to variable winder mass
- Limit jerk of the line speed (S curve)
- Low-backlash mechanical transmission elements with good damping features between the motor shaft and the winding shaft (e.g. toothed belts or direct drive)



Note!

Use mechanical transmission elements with low backlash only to ensure a good winding performance.

- Mechanical transmission elements with backlash (e.g. toothed gearboxes, chains, cardan shafts, winding shaft intakes) may cause unstable behaviour of the control mode, even if the k_j factor is small.

Reels are able to take in very much material, they reach great masses and high moments of inertia. Hence, a load-matching factor k_j of up to 5000 may be the result for the drive system.

- For closed-loop speed-controlled/open-loop speed-controlled winding control modes, DSD generates a message if the load-matching factor k_j exceeds the limit value. The message is output in the dimensioning log. Default limit value:
 - $k_j = 500$ for a belt drive/direct drive.
 - $k_j = 100$ for a tooth gearbox.
- It is up to the user to assess the impact that a high load-matching factor has on the drive system and which measures are to be taken if necessary.

Impact of elastic winding materials on closed-loop speed-controlled winding systems

The control stability is determined by the material quality and material guiding of the winding material:

- A short and direct material guiding between the reel and material tension recognition (dancer, strain measuring unit) and to the fixed point of the winder improve the control stability.
- Very flexible, elastic winding materials impede the control stability, in particular in connection with greater distances between the reel and the fixed point.

11.4.7 Radial forces/axial forces

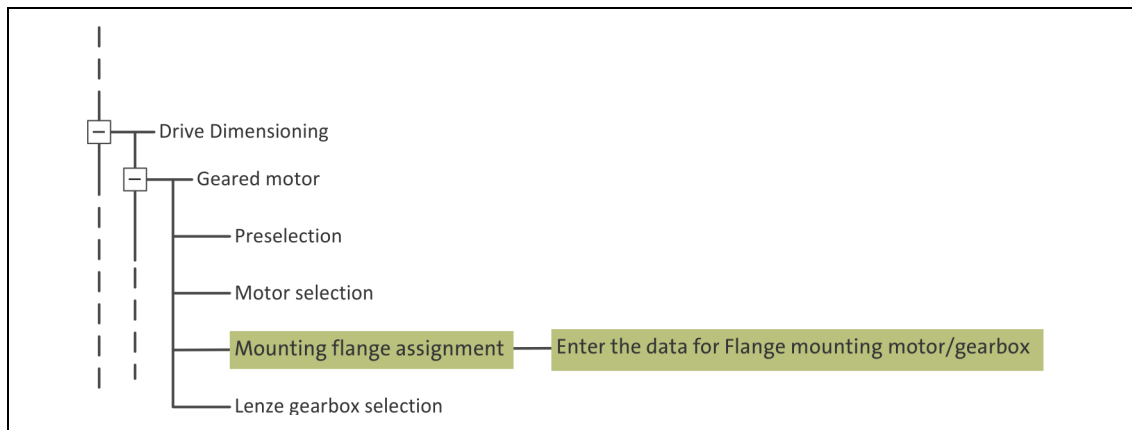
Dependent on the mechanical construction, radial and axial forces can act on the motor shaft or driven shaft of the gearbox. Loads due to these forces are not checked in DSD and must be checked manually.

See also: ▶ [Radial and axial loads of the motor or gearbox shaft](#) (□ 495)

11.5 Assigning the mounting flange to the user motor

Make the settings for the flange mounting to the gearbox in the *Mounting flange assignment* dimensioning step.

- The dimensioning step will only be displayed if a user motor has been selected.



[11-14] Settings for mounting to gearbox

The mounting flange of the user motor either corresponds to the standard IEC 72 / DIN 42948 or NEMA or no standard. Depending on this, the parameters differ in the *Assignment of mounting flange* dimensioning step.

Standard	Parameter	Symbol	Dimension unit
IEC 72 / DIN 42948	Motor size	–	–
	Motor flange size	–	–
	Motor design	–	–
NEMA	Motor size	–	–
No standard	Motor shaft diameter	d	mm
	Motor shaft: min. length	$l_{\min}$	mm
	Motor shaft: max. length	$l_{\max}$	mm
	Motor flange size	–	–

There are fixed assignments between the size, flange size, and the design, which the DSD takes into consideration in the drive dimensioning process.

- Make sure that the data entered comply with the real motor. By means of these parameters, the DSD checks whether the mounting flange matches the gearbox.

11.5.0.1 Motor size

Parameter	Description
	Selection of the size according to IEC 72 / DIN 42948 or NEMA Selection depends on the standard Manage user motors (450)

11.5.0.2 Motor flange size

Parameter	Description
	Selection of the flange size according to IEC 72 / DIN 42948 or no standard ▶ Manage user motors (450)

11.5.0.3 Motor design

Parameter	Description
	Selection of the size according to IEC 72 / DIN 42948 ▶ Manage user motors (450)

11.5.0.4 Motor shaft diameter

Parameter	Description
d	Motor shaft diameter

11.5.0.5 Motor shaft: min. length

Parameter	Description
$l_{\min}$	Minimum length of the motor shaft

11.5.0.6 Motor shaft: max. length

Parameter	Description
$l_{\max}$	Maximum length of the motor shaft

11.6 Mechanical brake selection

11.6.1 Selection table

The selection table presents the parameters of the brakes which can be selected.

- A distinction between preview values and further parameters is to be made.
- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables](#) (35)
 - ▶ [Sorting and filtering results in selection tables](#) (36)

Select a mechanical brake.

Brake version, mechanical: Application brake

Brake version, electrical: Spring-applied brake

Brake design: not adjustable

Reset table

Size	M _{N,B} [Nm]	k _s	t _{brk} (Ms)
08	3.6	10	1.1
08	8.0	10	0.54

Display all

Help Create note Protocol OK

Description of the parameters

Parameter	Unit		Description
	Metric	Imperial	
Brake design, mechanical			Two different mechanical brake designs are available as spring-applied brakes for three-phase AC motors: • Holding brake • Spring-applied brake without emergency stop features • Application brake • Spring-applied brake with emergency stop features
Brake design, electric			Spring pressure • Single-disk brakes with two friction surfaces. By several compression springs the braking torque in the deenergised state is generated by means of friction locking. The brake is released electromagnetically. Spring pressure, Cold Brake • Spring-applied brake as cold-brake variant. The power input of the open brake is reduced by decreasing the holding current. Since the brake heats up less, this variant is referred to as a cold brake. In this case, the integral fan is sufficient for cooling the brake even at low speeds. Spring pressure, overexcited • The brake coil is overexcited by activation with twice the rated voltage. • Advantages: The disengagement time is reduced, the brake releases much faster and the wear of the friction lining decreases. • Particularly suitable for hoist applications, hence only available in combination with a brake with an increased braking torque.
Brake design			Not adjustable • Design N, braking torque cannot be adjusted. Long-life • Stronger brake mechanics for applications with very high operating frequencies.
Type			Type designation of brake Relevant topics: ▶ Spring-applied brake (□ 366) ▶ Permanent magnet holding brake (□ 366)
Size			Size of the brake
$M_{N,B}$	Nm	lbfft	Rated braking torque of the brake

Parameter	Unit		Description
	Metric	Imperial	
k_S	%	%	Safety factor of the brake - The safety factor is calculated from the ratio of the rated braking torque and the braking torque required. - The result is limited to 10 and is displayed even if the value calculated is higher. - The DSD only checks the dimensioning as holding brake! Possible messages: ▶ Rated torque/dimensioning torque < safety factor of the brake (📘 535)
$t_{brk}^{\sim}(M_B)$	s	s	Theoretically calculated braking time For the calculation of the actual braking time this value must not be used.

Related topics:

- ▶ [Brake types](#) (📘 365)
- ▶ [Holding torque diagram](#) (📘 366)
- ▶ [Dimensioning criteria](#) (📘 368)

11.6.2 Brake types

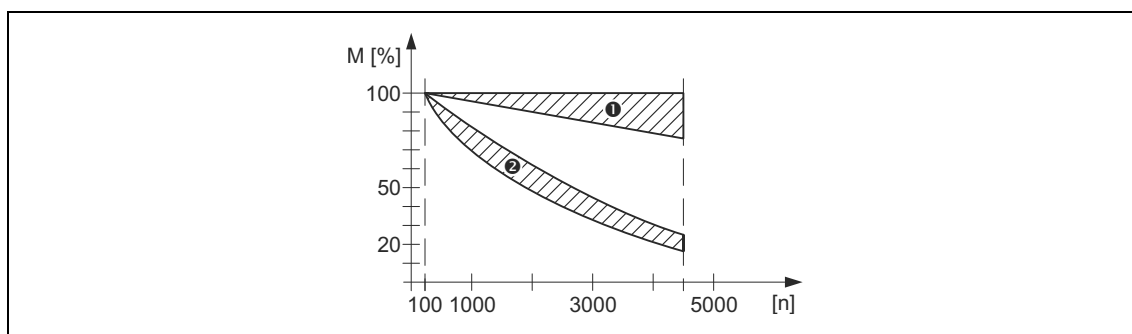
There are two types of brakes for Lenze motors:

- Spring-applied brakes for three-phase AC motors and servo motors.
- Permanent magnet holding brakes for servo motors.

According to their function, the brakes are distinguished as follows:

Function	Braking (standstill/operating speed)	Cyclically recurring braking
Holding brake without emergency stop features • Do not use for hoist drives!	$n = 0$	No
Holding brake with emergency stop features • Do not use permanent magnet holding brakes for hoist drives!	$n = n_{\max}$	No
Service brake • Dimensioning not possible in DSD.	$n = n_{\max}$	Yes

The diagram below shows the braking torques of spring-applied brakes and permanent magnet holding brakes as a function of the motor speed.



[11-15] Spring-applied brake and permanent magnet holding brake diagram: braking torque as a function of the motor speed

Description	
①	Spring-applied brake
②	Permanent magnet holding brake
M	Braking torque [%] • The rated torque (100 % = M_{rated}) is valid if $n = 100$ rpm
n	Motor speed

11.6.2.1 Spring-applied brake

Three-phase AC motors can be equipped with a spring-applied brake. After switching off the supply voltage, the spring-applied brake is activated (closed-circuit principle). For an ideal adaptation to the application, several braking torques and control variants are available for every motor frame size. Brakes in the long-life design are equipped with stronger brake mechanics and are suitable for applications with very high operating frequencies.

The very short operating times of the brake are realised through DC switching of the voltage. For interference suppression purposes, a spark suppressor is required which also increases the service life of the relay contacts.

- Asynchronous servo motors of the MQA series can be configured with a spring-applied brake.
 - For each motor frame size, two brakes of different frame sizes can be selected (this option is generally possible but not in every case).
- Three-phase AC motors can be configured with spring-applied brakes.
 - For each motor frame size, two brakes of different frame sizes can be selected (this option is generally possible but not in every case).

11.6.2.2 Permanent magnet holding brake

Permanent magnet holding brakes are backlash-free and can also hold the deenergised drive at a defined position. After switching off the supply voltage, the permanent magnet holding brake is activated (closed-circuit principle).

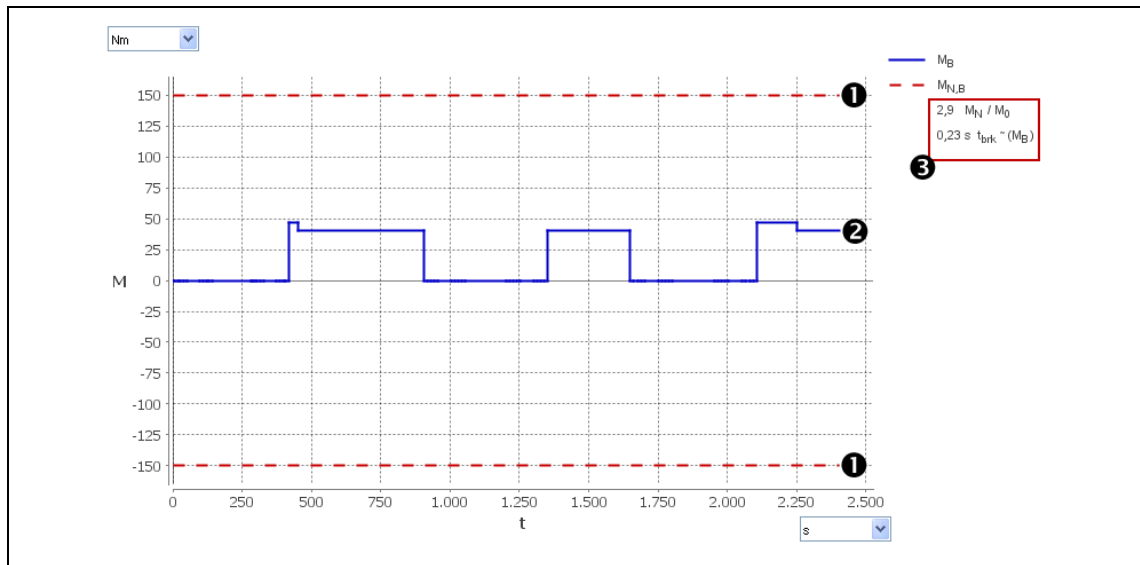
The very short operating times of the brake are realised through DC switching of the voltage. For interference suppression purposes, a spark suppressor is required which also increases the service life of the relay contacts.

Surface-ventilated servo motors (IP 54) are equipped with permanent magnet holding brakes.

- For motors of the MCS series two types of brakes (in the case of MCS 06/19 only one type) with different frame sizes are offered to be able to provide the required braking torque for different applications.
- For motors of the MCA series only one frame size per motor is offered.
- If the safety factor must be increased for e.g. a hoist drive, a bigger motor can be selected to be able to mount a bigger brake.

11.6.3 Holding torque diagram

Click on the button to call the diagrams in the drawing below the motor diagram. Click on the **M_{BRK}** button to show the diagram.



[11-16] Motor diagram: Holding torque mechanical brake

Description	
❶	Rated holding torque of the brake
❷	Instantaneous holding torque of the brake Requirement of the application
❸	Performance features The performance features can also be found in the selection table. Selection table (362)

11.6.4 Dimensioning criteria



Danger!

Falling loads in the case of vertical conveyors (angle > 45°) such as hoist drives.

In DSD you cannot dimension service brakes, but only holding brakes.

Protective measures:

- In order to ensure that the brake works safely, carry out all tests required manually.
- Dimension brakes for vertical conveyors with a safety factor ≥ 2 .
- Never use a permanent magnet holding brake for vertical conveyors. It cannot brake safely as the braking torque significantly decreases at higher speeds.
 - Either use an additional brake assembly outside of the motor or a motor with spring-applied brake in order to ensure the required safety.

For the dimensioning of the motor brake as holding brake, the following parameters are taken into consideration:

- Moment of inertia of the brake
- Holding torque
- Safety factor
- Electrical connection
- Installation feasibility with regard to the motor

The following is not taken into consideration:

- Double brakes
- Operating times
- Thermal dimensioning for cyclic braking processes
 - Service brake: wear calculation for braking during operation and emergency stop events.

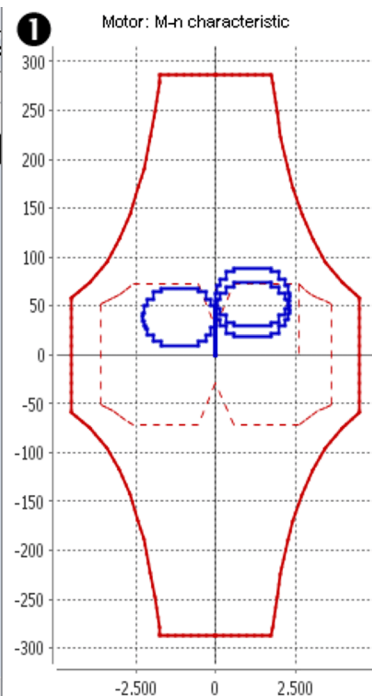
11.7 Lenze gearbox selection

11.7.1 Selection table

The gearbox selection table represents the parameters of the selected gearboxes, preview values, and some important parameters of the complete system.

- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables](#) (📖 35)
 - ▶ [Sorting and filtering results in selection tables](#) (📖 36)

	Gearbox	N _G	M _{per,0} [Nm]	A ⁺ (M _{max}) [%]	A ⁺ (M _{eq}) [%]	A ⁺ (n _r) [%]
⚠	GKS07	3	470	141	100	
	GKS07	3	725	92	65	
	GKS07	3	800	83	59	



Description	
①	Torque-speed characteristic of the motor.
—	Measured or simulated limit characteristic of the motor.
.....	Alternative for the characteristic curve of the motor. • Not for all motors measured or simulated characteristics are available.
- - -	S1 characteristic of the motor. • Vertical characteristic: rated motor speed.
—	Torque-speed characteristic of the application requirement.

Description of the parameters

Parameter	Unit		Description
	Metric	Imperial	
$\tilde{A}(M_{\max})$	%	%	Utilisation calculated in advance with reference to the max. drive torque. • Check with regard to the short-time strength of the gearbox. • If this value exceeds 100 %, this can lead to the destruction of the gearbox! Relevant topics: ► Check of the torque load (□ 373) Possible messages: ► Utilisation > yyy %, regarding the max. torque (□ 517)
$\tilde{A}(M_{\text{eq}})$	%	%	Utilisation calculated in advance, with reference to the equivalent torque • Provides an indication for the endurance strength of the gearbox. Relevant topics: ► Check of the torque load (□ 373) Possible messages: ► Utilisation >100 % regarding the equivalent torque (□ 517)
$\tilde{A}(n_{\max})$	%	%	Utilisation calculated in advance, with reference to the maximum speed. • Utilisation of the gearbox with regard to the short-time maximum possible speed. • If this value exceeds 100 %, operation is not possible (destruction). Relevant topics: ► Check of the torque load (□ 373) Possible messages: ► Utilisation >100 % regarding the max. speed (□ 518)
$A_{\text{th,G}}(\tilde{n}_{\text{av}})$	%	%	Utilisation of the gearbox calculated in advance with reference to the average speed. Relevant topics: ► Thermal utilisation (□ 377) Possible messages: ► Utilisation >100 % regarding the thermal speed (□ 518)
k_f			Field weakening factor of the motor • Specifies to which extent the motor is driven into field weakening by the selection of the ratio. • $k_f < 1$: the motor is only operated in the basic setting range. Relevant topics: ► Motor selection (□ 339)
Gearbox			Gearbox type • Display of one part of the type code, consisting of gearbox type and version.
SZ			Size
rated _G			Number of gearbox stages
i _{act,G}			Actual ratio of the gearbox
M _{per,out}	Nm	lbfft	Rated torque of the gearbox at the output end

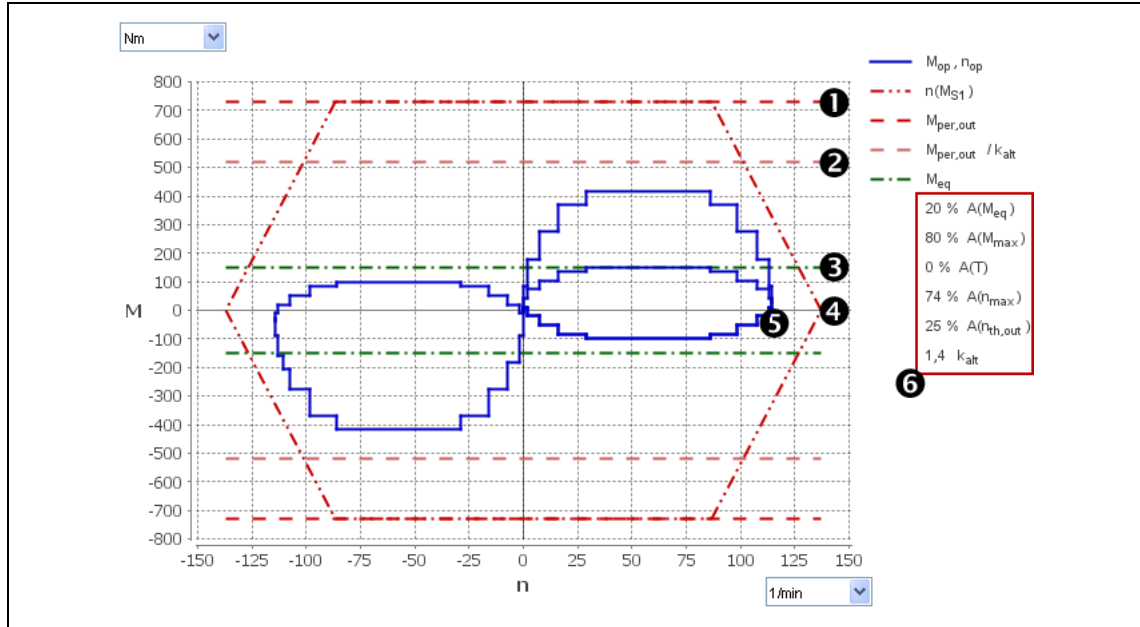
Parameter	Unit		Description
	Metric	Imperial	
$c_{\sim}$			Load capacity Ratio of the permissible rated torque of the gearbox to the supplied rated torque of the motor-gearbox combination.
$A_{th,M}(\tilde{M}_{rms})$	%	%	Thermal utilisation of the motor calculated in advance with reference to the effective torque Specifies to which extent the motor is thermally loaded by the selection of the transmission ratio. Relevant topics: ▶ Motor selection (□ 339)
			Possible messages: ▶ Utilisation >100 %, regarding the effective torque (□ 522)
k_j			Load-matching factor of the motor calculated in advance. Load-matching factor resulting from the selected ratio. Relevant topics: ▶ Load-matching factor (□ 353)
			Possible messages: ▶ Max. mismatch is higher than permissible mismatch (□ 523)
$P_{th,av,M}$	kW	kW	Medium power loss of the motor
$i_{req,K}$			Setpoint ratio of the additional drive element
$i_{\sim}$			Precalculated total ratio of the Lenze gearbox (G) and the additional drive element (K)

Related topics:

- ▶ [Check of the torque load](#) (□ 373)
- ▶ [Check of the speed load](#) (□ 377)
- ▶ [Radial and axial forces](#) (□ 377)
- ▶ [Thermal utilisation](#) (□ 377)

11.7.2 Torque/speed characteristic

The characteristic shows the required speed and torque at the output end of the gearbox and the corresponding limit values:



[11-17] Gearbox: M-n characteristic (output)

Description	
❶	Max. permissible torque This torque must not be exceeded in any case, even for a short time. The service life here is only $< 10^3$ load cycles.
❷	Permissible torque at alternating load - The permissible torque depends on the alternating load of the entered load. - In case of planetary gearboxes, the alternating load factor k_{alt} is always 1.0. ► Alternating load and repeated load cycle with regard to toothed gearboxes (375)
❸	Equivalent torque The equivalent torque presents an equivalent variable for sporadically occurring processes with respect to the strength of the gearbox. This variable is subordinate for cyclic processes.
❹	Continuous rated curve - Characteristic curve for the speed which the gearbox can transmit continuously (in the case of a defined torque) without overheating. - The continuous characteristic is affected by the ambient conditions, the mounting position and the average daily operating time. The definition of the continuous characteristic corresponds to the operating mode S1 and is based on the IEC 60034-1.
❺	Requirement of the application - The range of the entire characteristic has to be within $2 \times M_{per,out}$ which is defined from the static strength and the short-time permissible max. speed. - Torques above the continuous torque $M_{per,out}$ are only permissible sporadically and not for continuous cyclic operation.
❻	Performance features - The performance features can also be found in the selection table. ► Selection table (369)

11.8 Dimensioning criteria for the Lenze gearbox

11.8.1 Check of the torque load

The torque load considerably influences the service life of the gearbox. The load is considered in the dimensioning phase.

- DSD calculates the fatigue strength according to the Wöhler curve.
[Load test according to the Wöhler curve](#) (📖 373)
- DSD calculates alternating loads which occur at torque reversals.
[Alternating load and repeated load cycle with regard to toothed gearboxes](#) (📖 375)

11.8.1.1 Load test according to the Wöhler curve

The Wöhler characteristic describes the "static strength", the "fatigue strength", and the "endurance strength" of toothed gearboxes.

Static strength

- If the number of duty cycles is below 1000, the torque of the static strength can be utilised.
- Limits of the static strength defined in the DSD:
 - $2 \times M_{\text{per,out}}$ (rated torque in case of helical gearbox, shaft-mounted helical gearbox, bevel gearbox, helical-bevel gearbox, helical-worm gearbox.
 - $1.6 \times M_{\text{per,out}}$ (rated torque) in case of planetary gearbox.

Endurance strength

- The torque does not exceed $M_{\text{per,out}}$.
- The service life is not limited by the number of duty cycles.

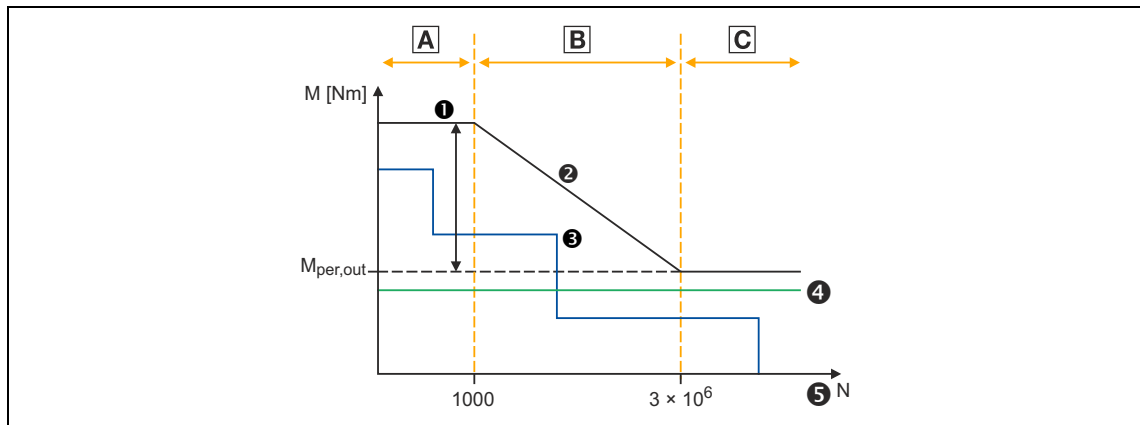
Fatigue strength

- The torque may be $> M_{\text{per,out}}$, however it must not occur too frequently.
- According to the load, the service is between 10^3 and 3×10^6 load cycles.
- Every operation in the range of static strength and fatigue strength affects the gearbox. If an accordingly great number of load cycles is reached, massive damage (e. g. fractures of the teeth or shaft) can occur.
- DSD carries out a fatigue strength calculation based on the Wöhler curve.
 - The approached points of the motion profile serve to calculate a theoretical damage of the gear toothing. Then, the theoretical damage after five years is determined, considering a daily operating time.
 - This test is simplified but safe.



Note!

Contact your Lenze sales partner if the result of the fatigue strength calculation is too negative. Based on the DSD project, the Lenze experts can carry out a detailed test.



[11-18] Wöhler characteristic (load over number of stress cycles)

Description	
A	Static strength
B	Fatigue strength
C	Endurance strength
1	Torque for calculating the short-time strength • 2 x torque in case of helical gearbox, shaft-mounted helical gearbox, bevel gearbox, helical-bevel gearbox, helical-worm gearbox. • 1.6 x torque in case of planetary gearbox.
2	Wöhler characteristic: characteristic curve for the evaluation of the load
3	Torque load collective
4	Equivalent torque
5	Number of duty cycles
$M_{per,out}$	Rated torque at the output end

The static strength and endurance strength are calculated differently depending on the characteristics of the motion profile in the DSD.

- In case of the freely defined motion profile, the current torque profile is checked against the max. torque ($2 \times M_{per,out}$ or $1.6 \times M_{per,out}$) and against the rated torque $M_{per,out}$.
- The equivalent torque is calculated on the basis of the motion profile.
 - The equivalent torque refers to the rated torque $M_{per,out}$ and expresses the stress of the gearbox bearings even if the gearbox is operated in the range rated for endurance strength regarding the toothings.
- The fatigue strength is only calculated if the gear toothing is operated in the fatigue strength range (i.e.. above the permissible output torque).
 - If the value is $< 100\%$, the wear is within a permissible range. The gearbox withstands the loads for at least five years.
 - If the value is $> 100\%$, the wear is probably out of range. The gearbox does probably not withstand the loads for five years.
- An alternating torque at the toothing is referred to as an alternating load and stresses the gearbox more than a non-alternating torque (for instance as that of a hoist drive).
 - For a drive dimensioning with freely defined motion profile, an alternating load factor is automatically calculated. When the static strength is tested and the fatigue strength is calculated, this factor is taken into consideration. Here, the required torque is multiplied by a value of 1 ... 1.4.

11.8.1.2 Alternating load and repeated load cycle with regard to toothed gearboxes

In case of a torque reversal (sign reversal), the gearbox is operated with alternating load. In case of a periodic alternating load (frequently, regularly), the max. permissible torque $M_{\max, \text{out}}$ is evaluated with the alternating load factor k_{alt} .

Alternating loads are calculated in the DSD and considered in the drive dimensioning phase.

If the alternating load was not considered, the gearbox would be operated in the fatigue strength range. For a highly dynamic application with a cycle time of 1 s, the gearbox would have reached the end of the fatigue strength after an operating time of less than 1000 h.

In case of planetary gearboxes, an alternating load is insignificant due to the system and does not need to be considered in the drive dimensioning.

Calculation of the alternating load

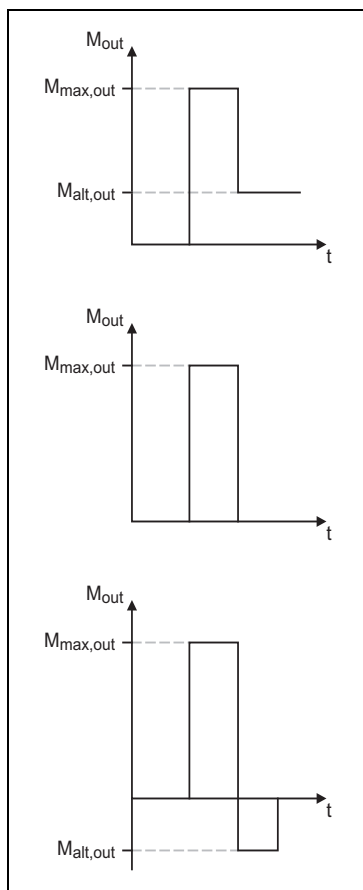
$M_{\max, \text{out}} \leq \frac{M_{\text{per, out}}}{k_{\text{alt}}}$ $k_{\text{alt}} = 1 + 0.4 \cdot \frac{ M_{\text{alt, out}} }{ M_{\max, \text{out}} }$	
$M_{\max, \text{out}}$	Max. permissible torque at the output end
$M_{\text{alt, out}}$	Max. torque at the output end in opposite direction to $M_{\max, \text{out}}$ ($ M_{\text{alt, out}} \leq M_{\max, \text{out}} $)
$M_{\text{per, out}}$	Rated torque at the output end
k_{alt}	Alternating load factor

[11-19] Calculation of the alternating load

Alternating load or pulsating load?

According to the intensity of the periodically occurring alternating load, the alternating load factor k_{alt} is in the range of 1 ... 1.4.

- In the case of a symmetrical alternating load $M_{alt,out} = M_{max,out}$, the alternating load factor k_{alt} is 1.4.
- An alternating load without sign reversal (no torque reversal) is a pulsating load. The alternating load factor for pulsating loads is $k_{alt} = 1$.



- Pulsating load
 - The torque alternates between two values without sign reversal
 - Alternating load factor $k_{alt} = 1$
- Pulsating load
 - The torque changes from 0 to the max. value without sign reversal
 - Alternating load factor $k_{alt} = 1$
- Alternating load
 - Torque reversal with sign reversal
 - Alternating load factor $k_{alt} > 1$ (here approx. 1.13)

[11-20] Different torque characteristics at the output end of the gearbox

Typical applications with alternating load

All applications are affected for which a torque reversal with a sign reversal can be generated via the motion profile. In practice, however, these applications can be narrowed down fairly well.

The applications given in the table can be dimensioned with the DSD.

Application	Information
Motion applications:	Basically, all motion applications (wheel drive, belt drive, rack drive, spindle drive, rotary table drive, hoist drive with counterweight, general rotary drive with motion profile) are affected, irrespective of whether they are actuated by means of frequency inverters or servo inverters. • Usually there is always a sign reversal in the case of the torque at the output end.

Typical applications without alternating load

For the following applications, an operation with alternating load is improbable.

Application	Information
Hoist drive without counterweight	For cable-guided hoists without counterweight no periodic alternating load occurs. Only a repeated load cycle can occur.
Continuous conveyor	For continuous conveyors, no periodic alternating load occurs. Only a repeated load cycle can occur.
Pump, fan	For pumps and fans, no periodic alternating load occurs. Only a repeated load cycle can occur.
Synchronous drive	Synchronous drives generally are quasi-stationary drives. There is no periodic alternating load. Usually there is only a repeated load cycle, unless these drives are traversed in intermittent operation.

11.8.2 Check of the speed load

DSD checks the gearbox with regard to its speed load.

- For all gearboxes or gearbox-motor combinations the max. input speed and the average output speed are checked.
- The best way to assess the dimensioning of the gearbox is by using the speed/torque diagram.
- For dynamic requirements with regard to geared motors, additional specific checks are required for these combinations. Taking the thermal load into consideration, a gearbox can be operated at high speeds for a short time.

DSD carries out these tests with regard to the thermal load.

11.8.3 Radial and axial forces

Dependent on the mechanical construction, radial and axial forces can act on the motor shaft or driven shaft of the gearbox. Loads due to these forces are not checked in the DSD.

See also: [▶ Radial and axial loads of the motor or gearbox shaft \(□ 495\)](#)

11.8.4 Thermal utilisation

The heating of the gearbox depends on speed, torque, site altitude, ambient temperature, mounting position and lubricant.

- The thermal utilisation of the gearbox via a cycle results from the ratio of the instantaneous speed value $n(t)$ and the corresponding value $n(M_{S1}(t))$ from the M-n characteristic. [Torque/speed characteristic](#) (372)
- A PT1 element (thermal time constant $\tau = 15 \text{ min}$) determines the max. value of utilisation.

$$A_{th}(t) = \frac{n(M(t))}{n(M_{S1}(t))}$$

[11-21] Calculation of the thermal gearbox utilisation via a cycle

11.8.4.1 Lubricant

The thermal load of the gearbox also depends on the lubricant used. DSD considers the lubricant when detecting the thermal load.

- Planetary gearboxes have a grease lubrication.
- In case of helical gearboxes, shaft-mounted helical gearboxes, bevel gearboxes, helical-bevel gearboxes, helical-worm gearboxes, gearbox oil is used.

Gearbox oil

In contrast to mineral oils, synthetic oil is more temperature-stable, more powerful and has a larger viscosity range. A gearbox with synthetic oil can be thermally loaded higher than a gearbox with mineral oil.

DSD detects the thermal gearbox utilisation in two steps:

1. Utilisation when mineral oil is used.
 - If the limit values are exceeded, DSD reports that the gearbox can continued to be operated using synthetic oil.
2. Utilisation when synthetic oil is used.
 - If the limit values are exceeded, DSD reports that the gearbox is overloaded.

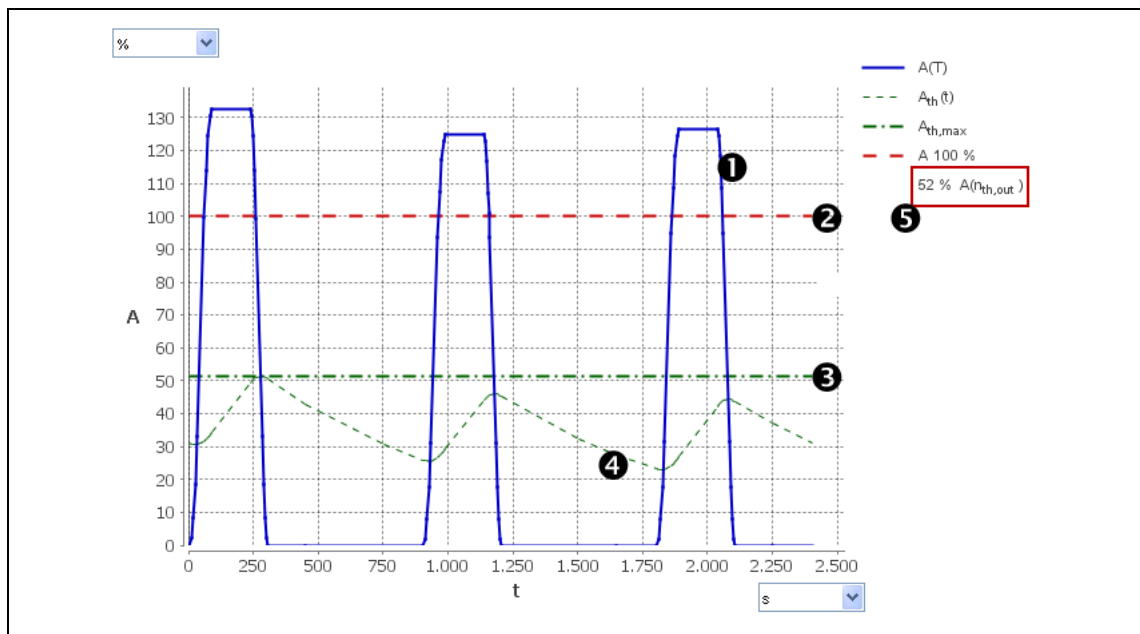
Shaft sealing ring

A gearbox contains a shaft sealing ring if gearbox oil is used as lubricant. Speed, oil temperature and duration of stress of the gearbox determine the wear of the shaft sealing ring.

Select a suitable shaft sealing ring:

- Standard shaft sealing ring when mineral gearbox oil is used.
- Viton shaft sealing ring when synthetic gearbox oil with high oil temperatures is used.

11.8.4.2 Diagram of thermal utilisation



[11-22] Diagram of gearbox: Thermal utilisation

Description	
❶	Instantaneous utilisation as a function of the speed Requirement of the application
❷	100 % limit If this limit is exceeded, the gearbox will be overheated.
❸	Max. value of the thermal utilisation
❹	Thermal utilisation Simulated value, calculated with the time constant of the motor.
❺	Performance features The performance features can also be found in the selection table. Selection table (369)

11.9 Selection of an additional drive element

The selection of the general ratio defines the final parameters. For the different gearbox types, different parameters are required.



Note!

The DSD does not check the load of the additional drive element!
This check is to be effected manually, if required.

11.9.1 Type identifier

Parameter	Description
–	Designation for the additional drive element. • Information is optional.

11.9.2 Ratio

Parameter	Description
$i_{act,K}$	Actually selected ratio of the additional drive element. • Value can be entered directly or calculated using the gearbox calculator. Gearbox calculator (475)

11.9.3 Efficiency

Parameter	Description
η_K	Efficiency of the additional drive element with regard to the rated variable (rated torque; rated speed) • The value can be entered directly or selected from the table of values. Value table for efficiencies

11.9.4 Moment of inertia

Parameter	Description
$J_{out,K}$	Mass moment of inertia • Relative to the Output end of the gearbox, including further moments of inertia (e. g. of clutches). • If only the moment of inertia $J_{in,K}$ for the Drive end is available, the following applies: $J_{out,K} = i_{act,K}^2 \cdot J_{in,K}$ • Value can be entered directly or calculated using the inertial calculator. Inertial calculator (472)

11.9.5 Permissible torque

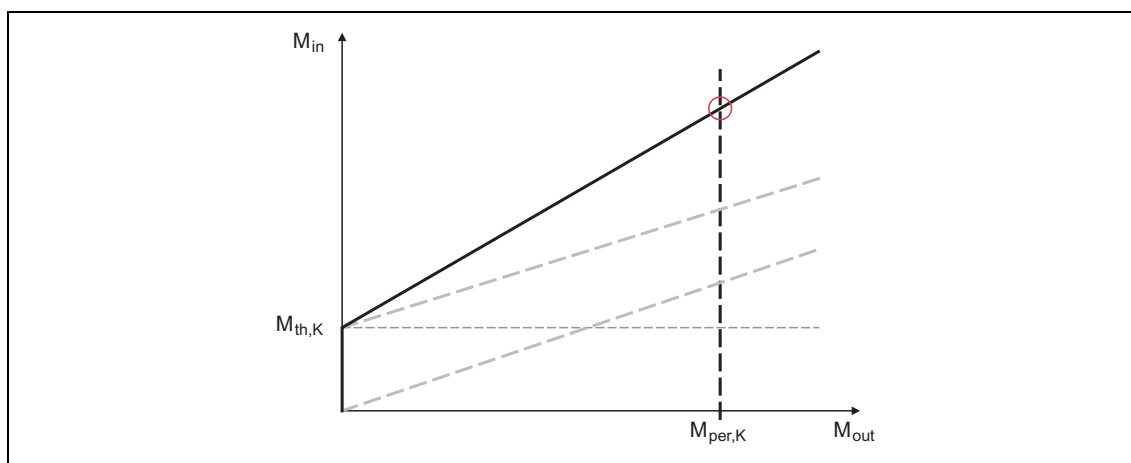
Parameter	Description
$M_{\text{per,out,K}}$	Permissible torque at the output end of the additional drive element • This torque is used for the determination of the maximum constant loss from the efficiency. • Due to the high pretension, belt drives have constant friction losses. • The friction torque depends on the parameters of the belt (e.g. width, material, tensile member used). These parameters also have an impact on the permissible transmittable torque. ► Constant torque loss (□ 381)

11.9.6 Constant torque loss

Parameter	Description
$M_{\text{th,K}}$	Constant torque portion resulting from the losses of the prestressed belt. • Relative to the output end. • The following applies: $M_{\text{th,K}} \leq \left(\frac{1}{\eta_K} - 1 \right) \cdot M_{\text{per,K}}$

For applications actuated via belts or chain, torque-dependent, speed-dependent, and constant losses occur:

- In comparison to the other losses, the speed-dependent losses are small and are thus are combined with the constant losses.
- Partly there is a high pretension which causes great bearing forces and friction losses between the belt or chain and the pinion.
 - These losses in the DSD are combined as constant, load-independent losses.
 - The proportion of these losses with regard to the total losses is entered under $M_{\text{th,K}}$.



[11-23] Definition of the constant, load-independent losses ($M_{\text{th,K}}$) for $i_{\text{act,K}} = 1$

11.10 Inverter

11.10.1 Preselection

In the following subchapters the parameters for the preselection of the inverter are described.

11.10.1.1 Motor output

Parameter	Description
	• Single axis • Double axis

11.10.1.2 Type

Parameter	Description
	• BaseLine • StateLine • HighLine • TopLine

11.10.1.3 Switching frequency

Parameter	Description
$f_{ch,set}$	Switching frequency of the inverter • At higher switching frequencies, acoustic motor noises and controller output currents are reduced. With a decreasing switching frequency, the losses in the motor increase. • The preselection in the DSD corresponds to the Lenze setting of the inverter selected. • Select the switching frequency at which the inverter is to be actuated. • According to the selection, the respective rated data is displayed in the selection table. • If the drive is to be actuated with a variable switching frequency, the max. possible output current can only be reached with the lowest switching frequency. • For inverters with a variable switching frequency in the Lenze setting, the lowest switching frequency is to be selected.

According to the inverter, different settings of the switching frequency can be carried out. The switching frequency can be selected between "variable" or "fixed".

- If a variable switching frequency is used, the respective maximum available switching frequency is specified. However, this switching frequency is not reached if the inverter is subjected to higher loads.
- Depending on the modulation mode of the switching frequency, a power-optimised or loss-optimised operation of the inverter can be carried out.



Note!

Derating for the motor

- If the selected switching frequency is too low for the motor, a derating must be carried out.

11.10.1.4 Motor control

Parameter	Description
Motor control	Type of motor control • Some frequency inverters provide the possibility of using a speed feedback (with or without feedback system). • A speed feedback (with feedback system) always has to be available for servo inverters.

11.10.1.5 Control system

Parameter	Description
Control system	SC Servo control Field-oriented control with current model. • Division of the motor current into field current and torque generating current. • Feedback required!
	VFC plus V/f control Simple voltage activation with linear characteristic. • Not suitable for hoist drives >7.5 kW! • An optimal torque utilisation is achieved with feedback.
	SLVC Sensorless vector control Voltage implanting motor control via motor model. • No feedback required. • Features a high overload capacity.
	VFC plus eco V/f control with energetically optimised field injection in partial load operational range.



Note!

For applications on an inclined plane with a max. required power > 7.5 kW, operation with VFC plus is not recommended because of the increased required power within lowering operation (high motor excitation)!

11.10.1.6 EMC filter integrated

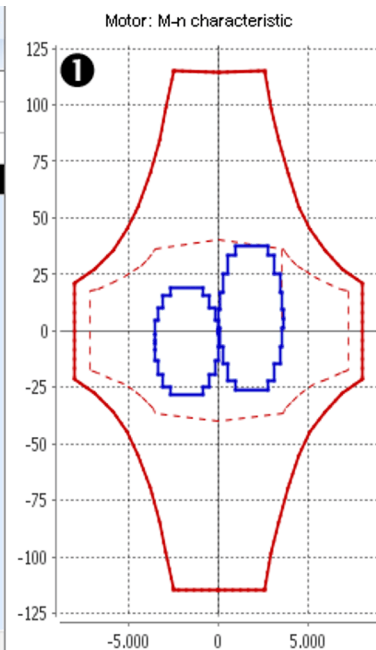
Parameter	Description
EMC filter integrated	Selection of whether an inverter with or without an integrated EMC filter is to be used. • Selection only available for i500 frequency inverters. • Selection only possible with an electrical 1AC 230 V network. • In the case of an electrical three-phase network, the configuration is predefined. It is not possible to make a selection.

11.10.2 Selection table

The selection table shows the parameters of the possible inverters and some of the motor parameters which are important for the selection.

- A distinction between preview values and further parameters is to be made.
- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables](#) (□ 35)
 - ▶ [Sorting and filtering results in selection tables](#) (□ 36)

	Type	P _N [kW]	K _{ol}	f _{ch}	M-n	A _{th} [%]	A _n
⚠	E94ASHE0134	5.50	None	8-2	-	102	
	E94ASHE0174	7.50	None	8-2	-	86	
	E94ASHE0244	11.0	None	8-2	✓	82	
	E94ASHE0324	15.0	None	8-2	✓	61	



Description	
①	Torque-speed characteristic of the motor.
	Measured characteristic curve of the motor.
	Alternative for the characteristic curve of the motor. • Not for all motors measured characteristics are available.
	S1 characteristic of the motor. • Vertical characteristic: rated motor speed.
	Torque-speed characteristic of the application requirement.

Description of the parameters

In the table the possible parameters are described. The parameters actually shown in the selection table depend on the inverter which you have selected in the drive concept.

Parameter	Unit		Description
	Metric	Imperial	
Type			Code designation of the inverter selected
P _{rated}	kW	kW	Rated output power of the inverter • Typical motor power of a 4-pole standard asynchronous motor. • Only serves as an indication for the power assignment of the inverter and motor.

Parameter	Unit		Description
	Metric	Imperial	
k_{ol}			Set inverter operation with increased continuous power. Frequency inverters can be operated with rated power (100% = "Heavy Duty") and increased rated power (120% = "Light Duty"). An increased permanent power but only a few overload reserves are provided during operation with an increased rated power (120% = "Light Duty"). Possible restrictions for this operation: limited temperature range, use of a mains choke, lower switching frequency.
f_{ch}	kHz	kHz	Switching frequency range
M-n			M-n characteristic of the motor ✓: saved characteristic -: equivalent characteristic
A_{th}	%	%	Previously calculated thermal utilisation of the inverter Monitoring of the continuous current Relevant topics: ▶ Thermal utilisation (txt) (□ 388)
			Possible messages: ▶ Max. thermal utilisation >100 % (□ 542)
$A_{(I_{max})}$	%	%	Previously calculated utilisation of the inverter relative to the max. output current Ratio of the required current to the max. output current of the inverter. Relevant topics: ▶ Determination of the utilisation values of the inverter (□ 386)
			Possible messages: ▶ Max. output current exceeded (□ 541)
$A_{(I_{max,I}/I_{N,M})}$			Utilisation of the inverter calculated in advance with reference to the ratio of the rated output current of the inverter and the rated motor current An overdimensioning that is too high, due to an unfavourable current resolution will possibly result in control-oriented problems and an insufficient behaviour with regard to smooth running. Relevant topics: ▶ Determination of the utilisation values of the inverter (□ 386)
			Possible messages: ▶ Current resolution is not adapted to the motor (□ 543)
I_{rated}	A	A	Rated output current of the inverter
I_{max}	A	A	Max. output current of the inverter The maximum output current depends on the mains voltage and the heatsink temperature and is reduced at low output frequencies. Relevant topics: ▶ Current derating for inverters (□ 396)
			Possible messages: ▶ Max. output current exceeded (□ 541)

11.10.3 Dimensioning criteria

Inverters are dimensioned according to the maximum current and the mean value of the output current. Depending on the operating conditions, individual components can only be subjected to a lower load, however, others to a higher load.

- For lower field frequencies, individual inverters have a Derating with regard to the maximum currents provided.



Note!

The DSD calculates an angle of tilt of the application (a gradient) of 45° with the standstill currents resulting from a possible Derating .

11.10.3.1 Determination of the utilisation values of the inverter

For the calculation of the required utilisation values, the motor current is calculated in DSD. Here, DSD considers torques of up to 400 % of the rated torque and, in the case of three-phase AC motors/ servo motors, speeds of up to 500 % / 200 % of the rated speed. Outside of these limits, the calculation of the current may be inaccurate.

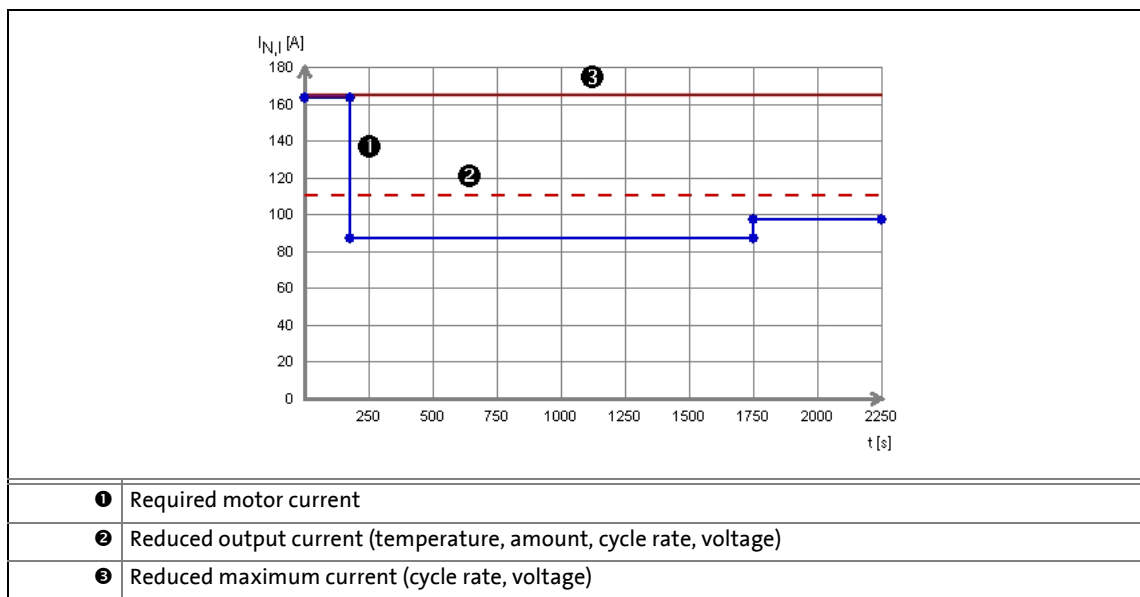
- In order to achieve an optimum coordination of motor and inverter with regard to the control performance, the DSD only proposes inverters which are not too oversized for the respective control type:

$$A \sim = \frac{I_{\max,U}}{I_{N,M}}$$

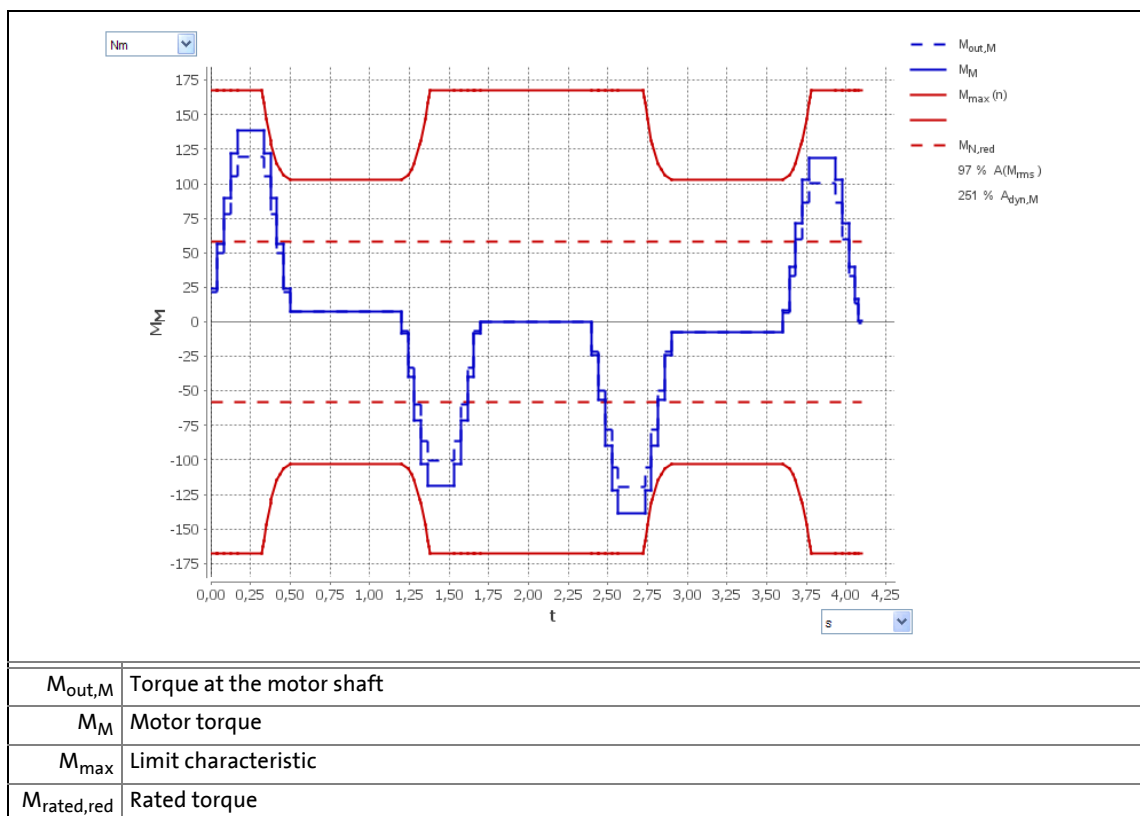
- Inverters that do not meet this condition are highlighted in the selection table. An overdimensioning of the inverter which is too great is problematic for field-oriented controls with regard to the control quality. In the case of the V/f control there are no limit values for this.
- In specific situations also an inverter with a lower rated output current than the rated motor current can be selected. This is verified via the thermal check in the DSD.
- For the selection table and with the inverter that is selected later on, the following checks are carried out and shown in the diagram:
 - Maximum utilisation
 - Thermal utilisation (Ixt)

11 Drive Dimensioning

11.10 Inverter



[11-24] Diagram concerning the output current of the inverter



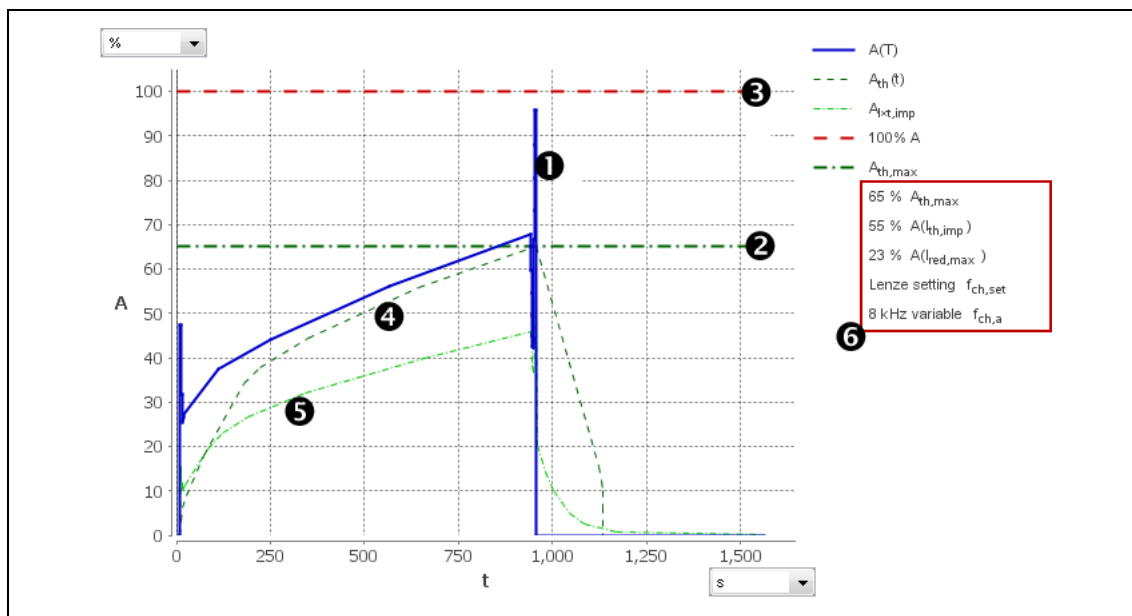
[11-25] Motor torque characteristics

In the diagram the characteristic curve is transformed to the time period. Additionally the rated torque that is reduced due to the temperature and the site altitude is presented. The different characteristics of the motor torque and the torque at the motor shaft render the proportion of the motor moment of inertia clearly visible.

11.10.3.2 Thermal utilisation (Ixt)

For determining the thermal utilisation the required current is evaluated via a device-internal monitoring function. It is simulated for the steady state.

- The momentary current utilisation of the inverter is calculated from the ratio of the required motor current to the inverter output current available. The inverter output current is reduced according to the applicable basic conditions.
- The maximum value of the thermal utilisation reflects the monitoring function of the inverter.



[11-26] Inverter diagram: Thermal utilisation

Description	
❶	Instantaneous utilisation
❷	Max. value of the thermal utilisation
❸	100 % utilisation • 100 % corresponds the rated threshold.
❹	Thermal utilisation • Simulated value, calculated with the time constant of the motor.
❺	Ixt pulse utilisation
❻	Performance features • The performance features can also be found in the selection table. Selection table (□ 384)

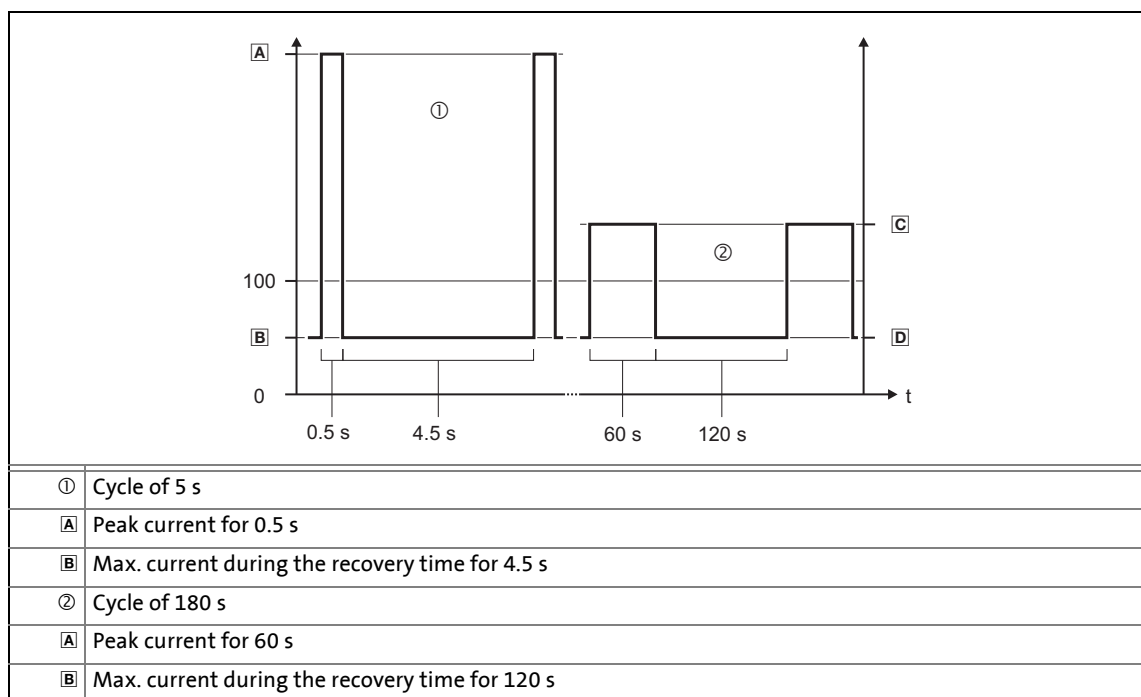
11.10.3.3 Overcurrent operation for 9400 HighLine servo inverters

The inverters are designed for two overcurrent modes:

- Cycle of 5 s
 - Load period of 0.5 s with peak current **A**
 - Recovery time of 4.5 s with limited current **B**
- Cycle of 3 min
 - Load period of 1 min with peak current **C**
 - Recovery time of 2 min with limited current **D**

After a load period with a peak current a recovery time has to follow. During the recovery time the current may not exceed the value specified.

The values specified refer to the rated output current $I_{N,out}$.



[11-27] Overcurrent capability for 9400 HighLine servo inverters at 45 °C

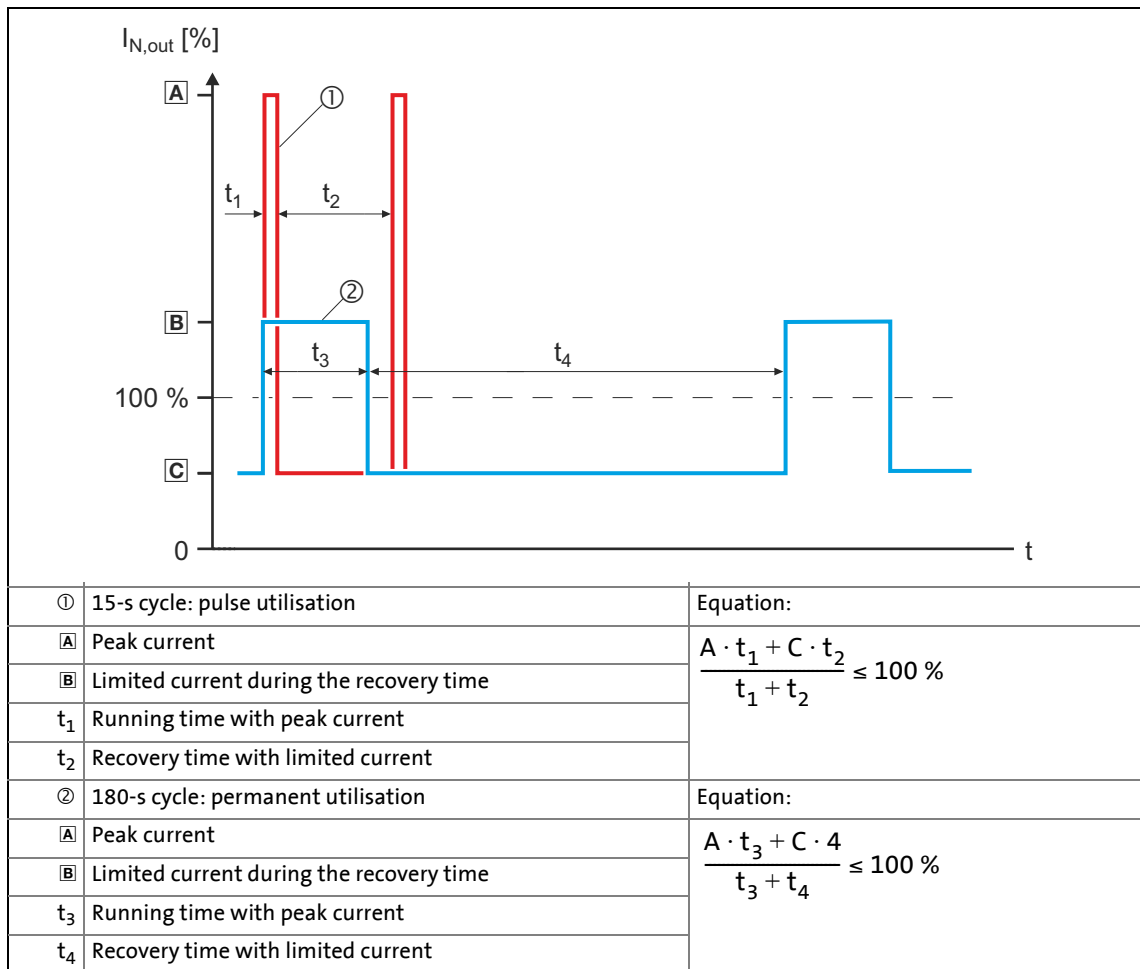
11.10.3.4 Overcurrent operation for i700 servo inverters

Temporarily, the power supply modules and axis modules can be operated with output currents higher than the rated current.

Two utilisation cycles are specified, each with a running time and a recovery time. A running time must be followed by a recovery time. The current must not exceed the indicated value in the recovery time. All values refer to the rated output current.

- 15-s cycle: pulse utilisation
 - 3 s running time with peak current (200 %)
 - 12 s recovery time with limited current (66 %)
- 180-s cycle: permanent utilisation
 - 60 s running time with peak current (150 %)
 - 120 s recovery time with limited current (75 %)

The illustration below shows typical curves of utilisation cycles:



[11-28] Overcurrent capability for i700 servo inverters at 40 °C

11.10.3.5 Overcurrent operation for i950 servo inverters

The inverters can be operated with a higher current exceeding the rated current if the duration of this overcurrent operation is limited in time.

Two utilisation cycles of a duration of 15 s and 180 s are defined. Within these utilisation cycles, the excess current may flow for a specific length of time in each case if they are followed by a recovery phase of a corresponding length.

15 s cycle

In this operation, the inverter may be loaded with up to 200 % of the rated current for 3 s if afterwards a recovery period of 12 s with max. 75 % of the rated current is observed. One cycle corresponds to 15 s.

180 s cycle

In this operation, the inverter may be loaded with up to 150 % of the rated current for 60 s if afterwards a recovery period of 120 s with max. 75 % of the rated current is observed. One cycle corresponds to 180 s.

Monitoring of the device utilisation ($I \times t$) activates the error response set if one of the two utilisation values exceeds the threshold of 100 %.

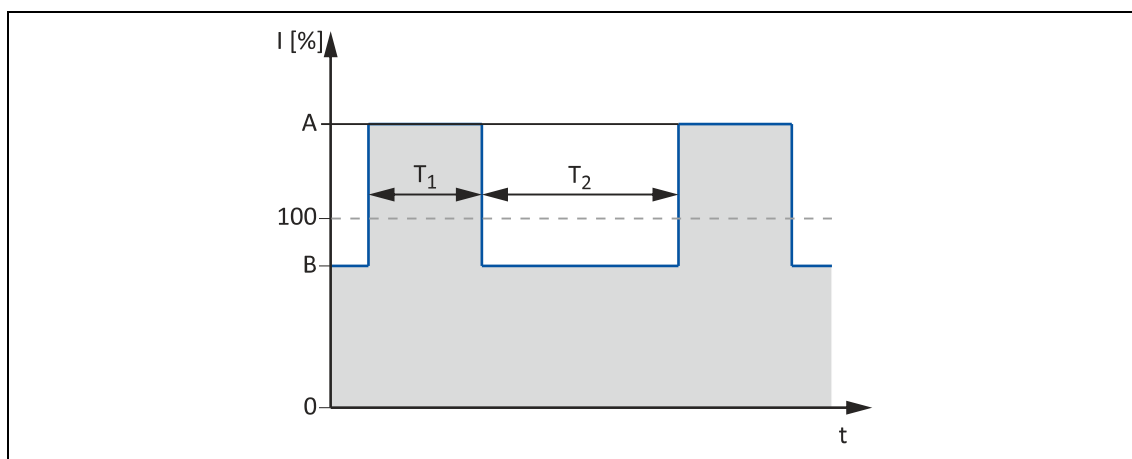


Note!

The maximum output currents comply with the switching frequencies, and the overload behaviour of the inverters is specified in the rated data.

In the case of rotating field frequencies < 10 Hz, the temporal overload behaviour may be reduced.

The diagram shows one cycle. The basic conditions from the table (area in the diagram highlighted in grey) must be complied with, so that the inverter is not overloaded. Both cycles can be combined with each other.



[11-29] Overcurrent capability for i950 servo inverters

	Max. output current A [%]	Max. overload time T1 [s]	Max. output current during recovery time B [%]	Min. recovery time T2 [s]
15 s cycle	200	3	75	12
180 s cycle	150	60	75	120

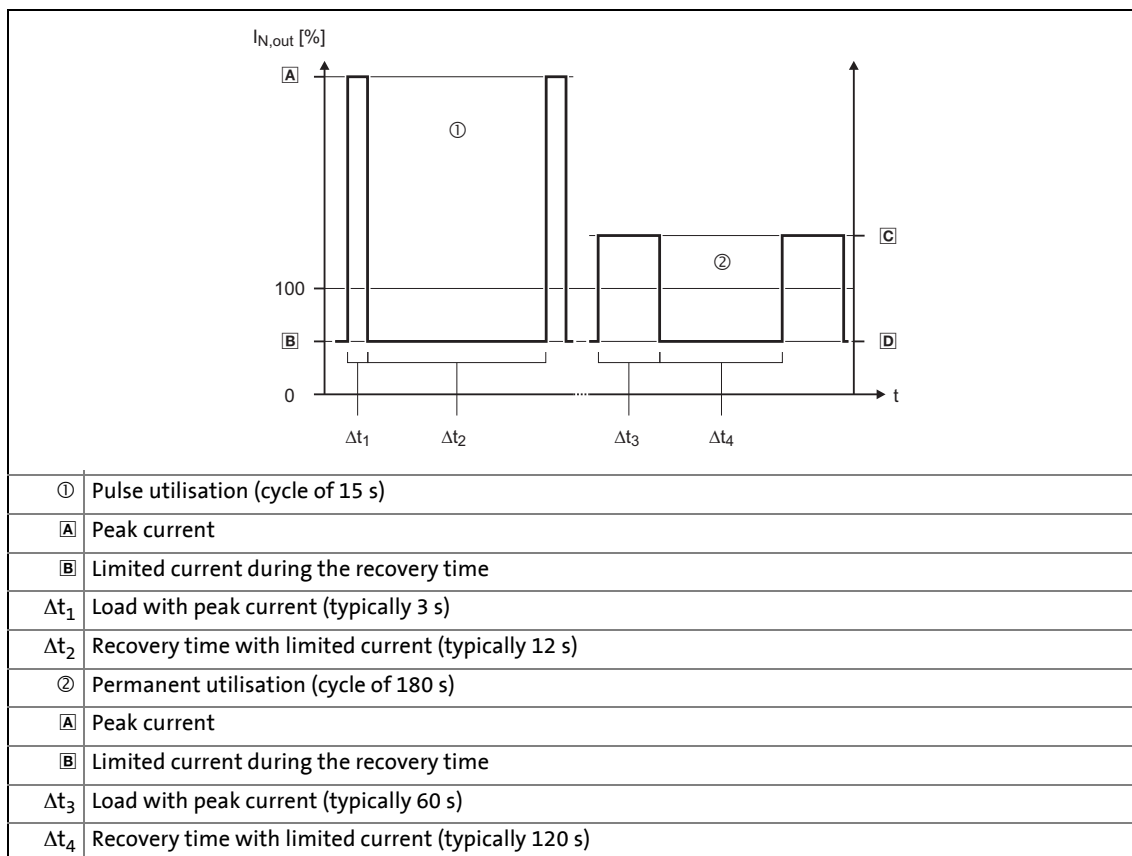
11.10.3.6 Overcurrent operation for 8400 frequency inverter drives

The inverters are designed for a temporary overcurrent. The utilisation by a defined, cyclic operation is determined via the I_{xt} monitoring function. The I_{xt} function consists of two moving averages which are checked in parallel:

- A short-time moving average of the apparent motor current for a pulse utilisation.
- A continuous moving average of the apparent motor current for a continuous utilisation.

Type of utilisation	Utilisation cycle	Condition for the monitoring function
Pulse utilisation	15 s	$I_{rated,out} > 160 \%$
Permanent utilisation	180 s	The monitoring function is switched on continuously.

The characteristics of typical load functions and the simulation of the I_{xt} function are shown in the following illustration:



[11-30] Overcurrent capability for 8400 frequency inverters at 45 °C

11.10.3.7 Overcurrent operation with i510 and i550 frequency inverters

The inverters can be operated with a higher current exceeding the rated current if the duration of this overcurrent operation is limited in time.

Two utilisation cycles of a duration of 15 s and 180 s are defined. Within these utilisation cycles, the excess current may flow for a specific length of time in each case if they are followed by a recovery phase of a corresponding length.

15 s cycle

In this operation, the inverter may be loaded with up to 200 % of the rated current for 3 s if afterwards a recovery period of 12 s with max. 75 % of the rated current is observed. One cycle corresponds to 15 s.

180 s cycle

In this operation, the inverter may be loaded with up to 150 % of the rated current for 60 s if afterwards a recovery period of 120 s with max. 75 % of the rated current is observed. One cycle corresponds to 180 s.

Monitoring of the device utilisation ($I \times t$) activates the error response set if one of the two utilisation values exceeds the threshold of 100 %.

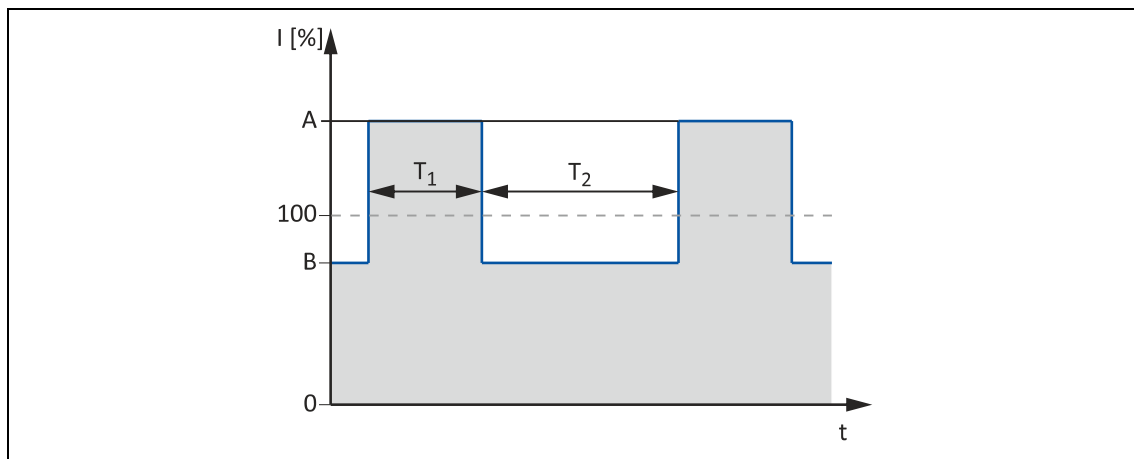


Note!

The maximum output currents comply with the switching frequencies, and the overload behaviour of the inverters is specified in the rated data.

In the case of rotating field frequencies < 10 Hz, the temporal overload behaviour may be reduced.

The diagram shows one cycle. The basic conditions from the table (area in the diagram highlighted in grey) must be complied with, so that the inverter is not overloaded. Both cycles can be combined with each other.



[11-31] Overcurrent capability of i510 and i550 frequency inverters

	Max. output current A [%]	Max. overload time T1 [s]	Max. output current during recovery time B [%]	Min. recovery time T2 [s]
15 s cycle	200	3	75	12
180 s cycle	150	60	75	120

11.10.3.8 Current derating for inverters

If low field frequencies occur, the max. output current is limited for some inverters. The torque calculated is no longer reached.



Note!

The specific restrictions due to the current derating can be found in the respective documentation for the inverter.

Effects

- [Applications with low field frequencies](#) (503)
- The current derating has a more serious impact on synchronous machines than on asynchronous machines. Due to the slip frequency, in the case of asynchronous machines the threshold for low rotating field frequencies is not exceeded so quickly.
- During operation in generator mode the current derating is more distinct than during operation in motor mode.
- If an output current above the standstill current is required for horizontal drives:
 - Acceleration movements: The acceleration distance or time will be slightly longer.
 - Braking processes: The braking distance slightly increases.
 - DC-injection braking: The braking current is reduced, and thus the braking torque provided by the inverter is reduced.
 - Extruder drives which are accelerated to the target speed during a "cold start" have no noticeable torque reduction within the first minutes during the acceleration phase and following constant speed phase. The pinch effect with regard to the current, which might possibly occur should be taken into consideration during the dimensioning. This applies in particular to great drive powers, since the slip frequency usually decreases with an increasing rated motor power.
- Slip frequencies of 4-pole asynchronous machines (example):

P_n	n_n	Slip speed $n_s (n_0 - n_n)$	Resulting slip frequency f_s
90 kW	1480 rpm	$(1500 - 1480) \text{ rpm} = 20 \text{ rpm}$	0.67 Hz
22 kW	1456 rpm	$(1500 - 1456) \text{ rpm} = 44 \text{ rpm}$	1.47 Hz
4 kW	1435 rpm	$(1500 - 1435) \text{ rpm} = 65 \text{ rpm}$	2.17 Hz



Note!

The DSD takes the output currents specified in the documentation of the inverter ($f_d > |5 \text{ Hz}|$) as a basis for calculation, and not the standstill currents.

- For passive loads a torque reduction only has a small effect on a greater following error, and it has no interfering effects on most applications.

11 Drive Dimensioning

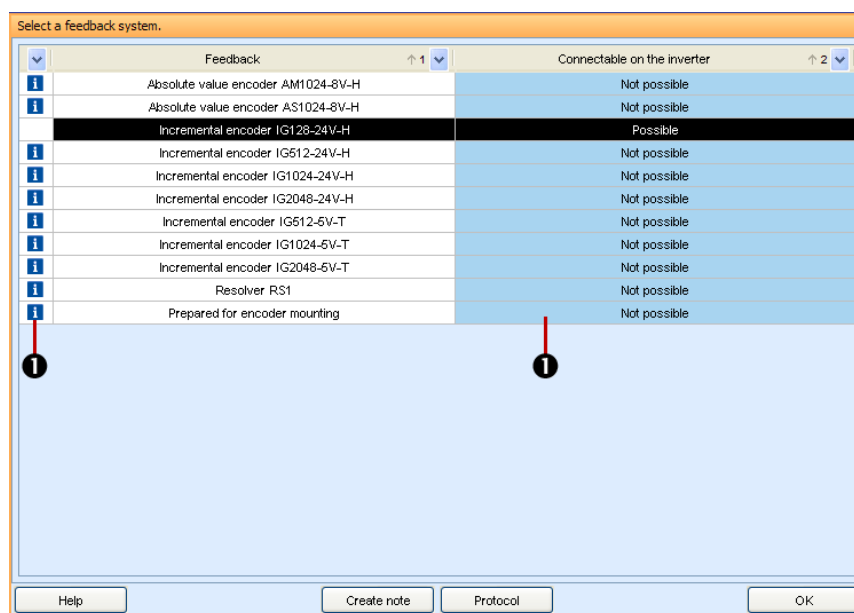
11.11 Feedback selection

11.11 Feedback selection

11.11.1 Selection table

The selection table presents the parameters of the feedback systems which can be selected.

- A distinction between preview values and further parameters is to be made.
- A basic description of the selection table and tools for a quick selection of suitable components can be found here:
 - ▶ [Structure of the selection tables](#) (📖 35)
 - ▶ [Sorting and filtering results in selection tables](#) (📖 36)



Description	
❗	Drive dimensioning messages. • The feedback system does not match the inverter.
i	Note • Important information has to be observed for a correct function of the component. A blue background indicates the corresponding value.

Description of the parameters

Parameter	Description
Feedback	Type of feedback system ▶ Feedback selection (📖 397)
Connectable on the inverter	Combinability of the feedback system with the inverter and motor ▶ Inverter/feedback combination not possible (📖 538)

11.11.2 Dimensioning criteria

When the selection is made, DSD checks whether

- the design of the feedback system is compatible with the selected motor,
- the function of the feedback system is compatible with the selected inverter,
- the inverter may be operated without feedback.



Tip!

You can also configure feedback systems for motors which act on slave drives. They therefore do not have to be compatible to the inverter that controls the motor.

The following criteria must be checked manually:

- Accuracies, resolutions, limit frequencies, max. permissible speeds etc.
- The limit frequency at the inverter input can be exceeded if the feedback system outputs a too high pulse frequency due to the combination of number of increments and max. speed.

The following table shows which feedback systems can be combined with the motor and inverter series:

	Feedback system						SSI absolute value encoder
	Resolver	No feedback	Encoder		SinCos encoder		
			HTL	TTL	Singleturn	Multiturn	
Servo motors							
MCA	✓	(✓)*	(✓)*	✓	✓	✓	
MCS	✓				✓	✓	
MQA	✓	(✓)*	(✓)*	✓	✓	✓	
SDSGA	✓	✓	✓	✓			
SDSGS	✓				✓	✓	
Three-phase AC motors							
MDXMA	✓	✓	✓	✓			
MFxMA	✓	✓	✓	✓			
MHxMA, m550-H	✓	✓	✓	✓			
Servo inverter							
9400 HighLine servo inverters	✓	✓		✓	✓	✓	✓
i700 servo inverters	✓	✓			✓	✓	
8400 TopLine frequency inverters	✓	✓	✓	✓	✓	✓	
Frequency inverter							
8400 BaseLine frequency inverters		✓					
8400 StateLine frequency inverters		✓					
8400 HighLine frequency inverters		✓	✓				
8400 protec frequency inverters		✓	✓				
8400 motec frequency inverters		✓					

* technically feasible, however, not a preferred combination

Features of feedback systems

The feedback systems listed in the table differ from each other with regard to the position recognition after the supply voltage is switched off.

- For synchronous motors the rotor position information is required for switch-on. For this, the rotor position within a motor revolution has to be given. This can be implemented with the following feedback systems:
 - Resolver
 - Sin/cos encoders (singleturn and multiturn)
- If the current position has to be known for positioning purposes after connecting the drive system, the following is suitable:
 - Resolvers, sin/cos encoders and SSI absolute value encoders (singleturn) for motors without gearbox for representing a revolution.
 - Sin/cos encoders and SSI absolute value encoders (multiturn) for representing several motor revolutions.
- TTL encoders and HTL encoders do not contain any position information and thus are a reasonably priced solution for asynchronous machines.

**Note!**

Please observe that some inverters require certain additional components.

If required, also the limit frequency of the frequency input has to be taken into consideration.

The dimensioning criterion for the feedback systems is their accuracy. This is not taken into consideration by the DSD.

- Accuracy improves in the order: resolver, incremental encoder, SinCos encoder.
- A higher pulse rate of the incremental encoders also produces a higher accuracy.

12 Components in the DC bus

The energy flow of a drive system in motor and in generator mode can be controlled via the DC bus if the inverter is provided with terminals on the DC-bus level. DSD offers components for the operation in the DC bus:

- Power supply modules for energy supply into the drive system.
- Regenerative power supply modules for energy supply into the drive system and energy feedback to the AC system.
- Brake resistors

12.1 Supply concept

Select in the "Select supply concept" dimensioning step a power supply module or a regenerative power supply module.

- The dimensioning step is only available in the "Dimensioning multi-axis system" application.



Power supply module 9400

- Central AC mains connection for a Multi Drive axis interconnection.
- Integrated brake chopper and connection to DC bus busbar system.
- Filters and a brake resistor are to be provided externally if required.
- By the collective use of the mains supply, the mains filter, the brake chopper and the DC-bus busbar system, the expenses for material and installation within a Multi Drive axis interconnection are considerably reduced.



9400 regenerative power supply module

- Optimally suitable for clock drives as the module is able to provide a multiple of the rated power for a short time.
- For increasing the supply power, the supply modules can be connected in parallel.
- For increasing the regenerative power, several regenerative power supply modules can be connected in parallel.
- Easy mounting and installation through separation of installation backplane and electronic module.
- Mains filters can be simply added and connected to the installation backplane via the available connecting cables.



i700 power supply module

- Internal brake chopper and brake resistor.
- If required, an external brake resistor can be connected.
- 5-fold overload is permissible for a short time.
- A power supply module can supply up to 10 axis modules.

12.2 Power supply module 9400

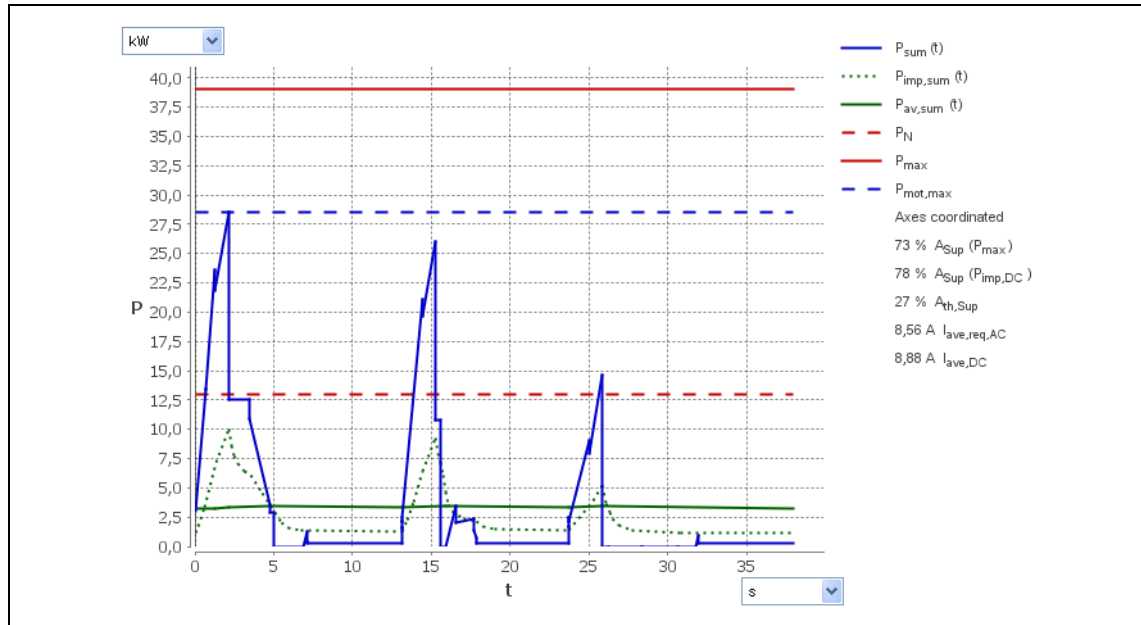
12.2.1 Selection table

Description of the parameters

Parameter	Unit		Description
	Metric	Imperial	
$A_{\text{Sup}}(P_{\text{imp,DC}})$	%	%	Utilisation with regard to the pulse power in the DC bus
$A(P_{\text{DC}})$	%	%	Utilisation with regard to the power in the DC bus
$A_{\text{Sup}}(P_{\text{max,DC}})$	%	%	Utilisation with regard to the max. power in the DC bus
Type			Type of the power supply module selected
Ind			Mains choke • Yes: operation only permissible with a mains choke. • No: operation permissible without a mains choke.
P_{rated}	kW	kW	Rated output power • Depending on the mains choke and mains voltage.
$P_{\text{max}}(\tau_2)$	kW	kW	Max. permissible power, relative to the 3-s cycle • 60 s overload / 120 s load removal with 75 % of the continuous rated quantity
$P_{\text{max}}(\tau_1)$	kW	kW	Max. permissible power, relative to the 5-s cycle • 0.5 s overload / 4.5 s load removal with 75 % of the continuous rated quantity
$I_{\text{N,DC}}$	A	A	Rated current in the DC bus during operation in motor mode
$I_{\text{max,DC}}$	A	A	Max. output current
S_{N}	kVA	kVA	Apparent mains power

12.2.2 Utilisation

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the power supply module.



[12-1] Power supply module 9400 diagram: utilisation

Description	
$P_{sum}(t)$	Total power in the DC bus over time
$P_{imp,sum}(t)$	Pulse power in motor mode in the DC bus • Relevant for the short-time thermal utilisation of the power supply module
$P_{av,sum}(t)$	Average power in the DC bus
P_{rated}	Permissible DC continuous power in supply mode
P_{max}	Max. permissible power in regenerative feedback mode
$P_{mot,max}$	Demand of the max. DC bus power in motor mode
Axes coordinated	Movement of drive axes • Axes can be coordinated or uncoordinated
$A_{th,Sup}$	Thermal utilisation of the power supply module
$A(P_{imp,DC})$	Short-time thermal utilisation of the power supply module
$A_{Sup}(P_{max})$	Utilisation of the power supply module, relative to the max. power in the DC bus
$I_{ave,req,AC}$	Average AC power demand of the device (for cable dimensioning)
$I_{ave,DC}$	Average DC power demand of the device (for cable dimensioning)

12.3 9400 regenerative power supply module

12.3.1 Selection table

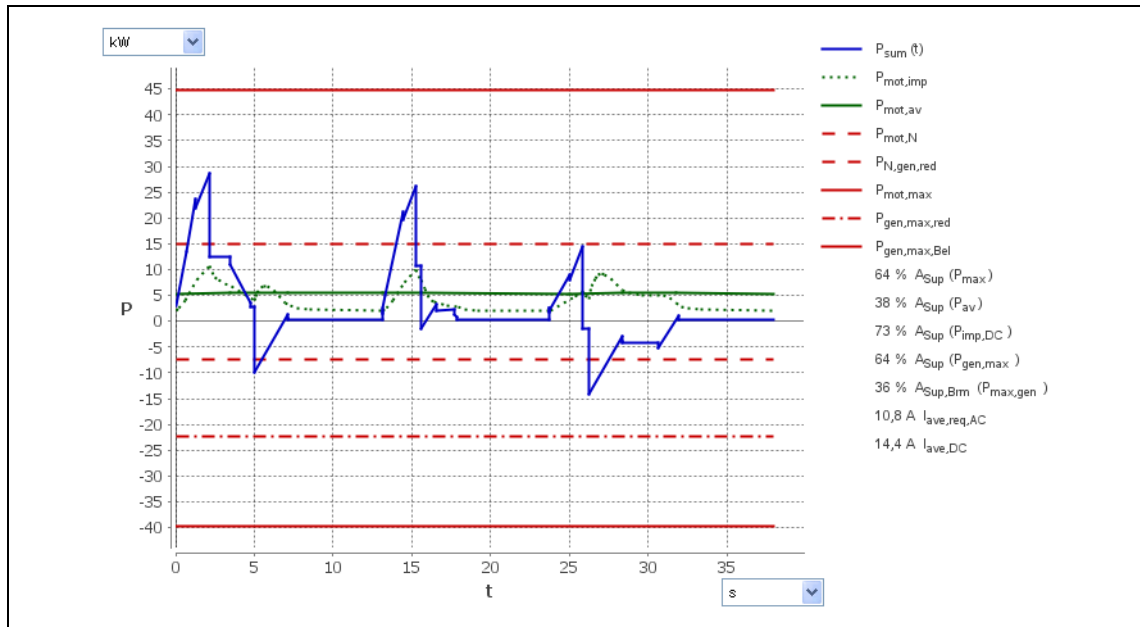
Description of the parameters

Parameter	Unit		Description
	Met	Imp	
$A(P_{\text{mot,max,DC}})$	%	%	Utilisation with regard to the max. DC-bus power in motor mode
$A(P_{\text{gen,max,DC}})$	%	%	Utilisation with regard to the max. DC-bus power in generator mode
$A(P_{\text{imp,DC}})$	%	%	Utilisation with regard to the pulse power in the DC bus
$A(P_{\text{DC}})$	%	%	Utilisation with regard to the average DC-bus power Possible warnings: ► Utilisation relative to the permissible continuous power exceeded (□ 553)
Type			Type of regenerative power supply module
Ind			Mains choke • Operation is permissible with mains choke only.
$P_{\text{max}}(\tau_1)$	kW	kW	Max. permissible power, relative to the 5-s cycle • 0.5 s overload / 4.5 s load removal with 75 % of the continuous rated quantity
$P_{\text{gen,max}}$	kW	kW	Max. permissible regenerative power
P_N	kW	kW	Rated horsepower • Depending on the mains choke and mains voltage.
$P_{\text{gen,N}}$	kW	kW	Rated power during operation in generator mode • Depending on the mains choke and mains voltage.
$I_{\text{N,AC}}$	A	A	Rated mains current
$I_{\text{gen,N,AC}}$	A	A	Rated mains current in generator mode
S_N	kVA	kVA	Apparent mains power
$S_{\text{gen,AC}}$	kVA	kVA	Apparent mains power in generator mode

12.3.2 Utilisation

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the power supply module.

Regenerative power supply modules 9400 can be connected in parallel. The diagram shows the values for all the devices connected in parallel.



[12-2] Regenerative power supply module 9400 diagram: utilisation

Description	
$P_{sum}(t)$	Total power in the DC bus over time
$P_{mot,imp}$	DC pulse power in motor mode, relevant for the short-time thermal utilisation of the power supply module
$P_{mot,av}$	Average DC power at the power supply module
$P_{mot,N}$	Permissible DC continuous power in supply mode, dependent on the mains choke and mains voltage
$P_{N,gen,red}$	Permissible DC continuous power in regenerative feedback mode, dependent on the mains choke and mains voltage
$P_{mot,max}$	Max. permissible power in regenerative feedback mode
$P_{gen,max,red}$	Max. permissible DC power in regenerative feedback mode without support of brake transistor
$P_{gen,max,Brm}$	Max. permissible DC power in regenerative feedback with support of brake transistor
$A_{Sup}(P_{max})$	Utilisation of the regenerative power supply module, relative to the max. power in the DC bus
$A_{Sup}(P_{av})$	Utilisation of the regenerative power supply module, relative to the continuous power in the DC bus
$A_{Sup}(P_{imp})$	Utilisation of the regenerative power supply module, relative to the pulse power in the DC bus
$A_{Sup}(P_{gen,max})$	Utilisation of the regenerative power supply module without brake chopper, relative to the max. regenerative power
$A_{Sup,Brm}(P_{gen,max})$	Utilisation of the regenerative power supply module with brake chopper, relative to the max. regenerative power

12.4 i700 power supply module

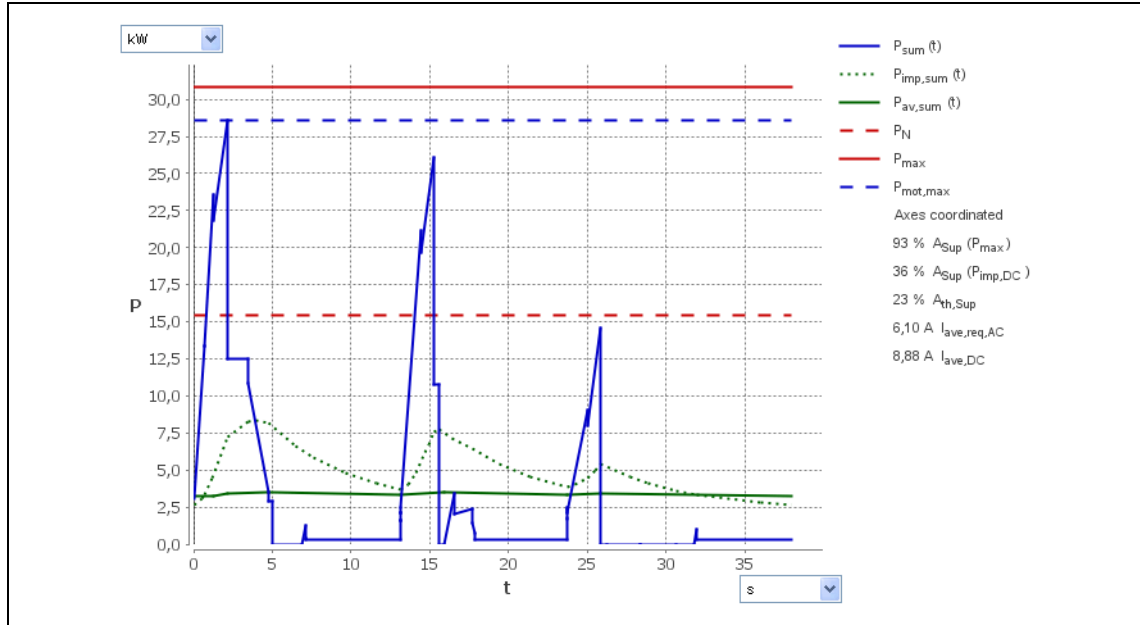
12.4.1 Selection table

Description of the parameters

Parameter	Unit		Description
	Metric	Imperial	
$A(I_{rms,AC})$	%	%	Utilisation relative to the effective mains current
$A(I_{max,AC})$	%	%	Utilisation relative to the max. mains current
Type			Type of the power supply module selected
Ind			Mains choke selection • Decision as to whether a mains choke is to be used for the power supply module. • By selecting a mains choke, possibly a smaller power supply module can be used. • By using a mains choke, the use of a capacitor module is possibly rendered unnecessary. • The use of a mains choke is basically determined by the utilisation of the power supply module. The use of a mains choke for increasing the available continuous power of the grouping mostly is not profitable.
$I_{N,DC}$	A	A	Rated current at the output of the power supply module
$I_{max,DC}$	A	A	Maximum permissible output current
$I_{N,AC}$	A	A	Rated value of the effective mains current
$I_{max,AC}$	A	A	Max. permissible effective mains current

12.4.2 Utilisation

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the power supply module.



[12-3] Power supply module i700 diagram: utilisation

Description	
$P_{sum}(t)$	Total power in the DC bus over time
$P_{imp,sum}(t)$	Pulse power in motor mode in the DC bus • Relevant for the short-time thermal utilisation of the power supply module
$P_{av,sum}(t)$	Average power in the DC bus
P_{rated}	Permissible DC continuous power in supply mode
P_{max}	Max. permissible power in regenerative feedback mode
$P_{mot,max}$	Demand of the max. DC bus power in motor mode
Axes coordinated	Movement of drive axes • Axes can be coordinated or uncoordinated
$A_{th,Sup}$	Thermal utilisation of the power supply module
$A(P_{imp,DC})$	Short-time thermal utilisation of the power supply module
$A_{sup}(P_{max})$	Utilisation of the power supply module, relative to the max. power in the DC bus
$I_{ave,req,AC}$	Average AC power demand of the device (for cable dimensioning)
$I_{ave,DC}$	Average DC power demand of the device (for cable dimensioning)

12.5

Selection of components



DSD detects automatically whether an electrical braking system is required.

If the "Components selection" dimensioning step is displayed, the application does not need an electrical braking system. The selection is optional.

- If this selection is activated, a brake resistor can be selected in the next dimensioning step. [Brake resistor selection](#) (📖 407)

12.6

Brake resistor selection

**Danger!**

Brake resistors may become very hot. Hence, the function of the brake resistor needs to be monitored.

- In the event of an error, a mains contactor must separate the inverter or the DC bus from the feeding supply system!
- Due to fire hazard, keep a sufficiently high safety distance between the brake resistor and its adjacent components!

The conversion of excess energy from the DC bus into thermal energy is required in order to prevent the DC bus voltage from rising into the overvoltage range during the braking phase and thus inhibiting electrical braking.

- Options to dissipate or convert excessive energy:
 - Feedback into the supply network via a regenerative power supply module.
 - Conversion into heat via a brake resistor.
 - Storage of the energy within an energy store (e. g. capacitor bank; use is rather uncommon).
- Even if there is no regenerative power, excessive energy must be dissipated, if any. In the event of an emergency stop, for instance, the deceleration time must be longer than during normal operation.

The following Lenze components have an integrated brake transistor which can be connected to the brake resistor. For these components, brake resistors can be selected in DSD.

- 9400 HighLine servo inverters
- Power supply module 9400
- 9400 regenerative power supply module
- i700 power supply module
- 8400 frequency inverter
- 8400 protec frequency inverters
- 8400 motec frequency inverters

12.6.1 Number of integrated brake transistors

In the "Dimensioning multi-axis system" application, multiple power supply systems or regenerative power supply systems connected in parallel can be selected. The number of brake transistors is displayed for information purposes.

Parameter	Unit		Description
	Met	Imp	
N			Number of the regenerative power supply modules connected in parallel with one integrated brake transistor each. • The selected brake resistor or the interconnection of multiple brake resistors must be considered for every module. • Read only.

12.6.2 Interconnection of brake resistors

The resistance value of the brake resistor selected is required to assess in which way the series or parallel connection has to be selected, so that the total resistance R_{sum} is between the minimum and the maximum resistance value.

- The minimum resistance results from the max. permissible current load of the brake transistor.
 - The minimum resistance is part of the technical data of the brake resistor.
 - The minimum resistance must not be undershot.
- The maximum resistance results from the max. regenerative power and the switching voltage U_{ch} .
 - The maximum resistance must not be exceeded.



Note!

- In the case of a series connection the total resistance increases, by which the peak power that can be maximally dissipated decreases.
- Expanding it with a parallel connection increases the peak power again, but the total resistance also decreases.
- In any case, the number of connected resistors leads to a proportional increase of available continuous power and brake energy.

- Calculation of the total resistance R_{sum} for a group of resistors that are connected in parallel and in series:

$R_{\text{sum}} = \frac{n_1 \cdot R_B}{n_2}$	
R_{sum}	Value of the total resistance
R_B	Value of the resistance selected
n_1	Number of the resistors connected in series
n_2	Number of the resistors connected in parallel

- Calculation of the max. power which the resistor can dissipate:

$$P_{\max} = \frac{U_{\text{ch}}^2}{R_{\text{sum}}}$$

12.6.3 Selection table

Parameter	Unit		Description
	Met	Imp	
A(P _{rated})	%	%	Utilisation of the brake resistor relative to the rated power Possible messages: ▶ Permanent utilisation of the brake chopper > 100 % (📖 557)
A(P _{max})	%	%	Utilisation of the brake resistor relative to the max. braking power Possible messages: ▶ Utilisation >100 %, regarding the peak braking power (📖 558)
Type			Type of the brake resistor selected
R _B	Ohm	Ohm	Resistance value Possible messages: ▶ Resulting brake resistance too low (📖 559)
r _{res}	Ohm	Ohm	Resulting resistance from wiring the individual resistors
P _{rated}	W	W	Rated power of the resistor
W	kWs	kWs	Thermal capacity of the brake resistor • The thermal capacity describes the overload capacity of a cooled brake resistor. • The thermal capacity is provided with the technical data of the brake resistor. • Since the braking processes are generally very short, the brake resistor must be able to thermally store the energy without being damaged due to overheating. Due to the short braking processes, it is only able to dissipate little energy to the environment through heat radiation or convection.
τ _{th,Rb}	s	s	Thermal time constant for checking the brake resistor
Enclosure			Enclosure of the brake resistor selected ▶ IP enclosure (📖 410)
Thermostat			Thermostat • Information on whether the brake resistor is equipped with a thermostat.

12.6.4 IP enclosure

The brake resistor can be jeopardised by the ingress of objects, dust, and liquids.

- Select an enclosure which ensures that the brake resistor is sufficiently protected against the ingress of objects, dust, and liquids.

Excerpt from DIN 40050

Protection against accidental contact/protection against ingress of solid foreign bodies

Enclosure	Function
IP 2x	Protection against ingress of solid foreign bodies with a diameter greater than 12 mm (medium-sized foreign bodies). Keeping away fingers or similar objects.
IP 5x	Protection against harmful dust deposits. • The ingress of dust is not prevented, but the dust shall not enter in such quantities that the operation of the apparatus is affected (dust-protected). Complete protection against contact.
IP 6x	Protection against the ingress of dust (dust-proof). Complete protection against contact.

Protection against water

Enclosure	Function
IP x3	Protection against water falling at any angle up to 60° from the vertical (splashing water).
IP x4	Protection against water splashing against the apparatus enclosure from any direction (splashing water).
IP x5	Protection against a water jet directed against the enclosure from any direction (water jet).

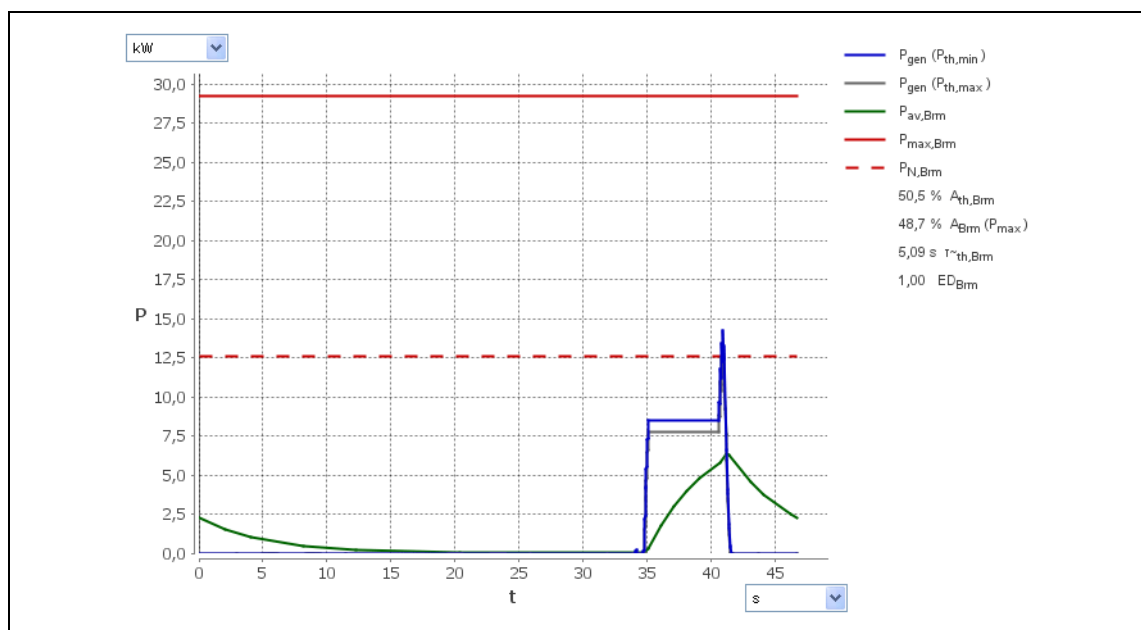
12.6.5 Integrated brake transistor utilisation

12.6.5.1 Brake transistor in the inverter

The following inverters have an integrated brake transistor to which brake resistors can be connected to.

- 9400 HighLine servo inverters
- 8400 frequency inverter
- 8400 protec frequency inverters
- 8400 motec frequency inverters

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the brake transistor.



[12-4] Inverter diagram: utilisation of the integrated brake transistor

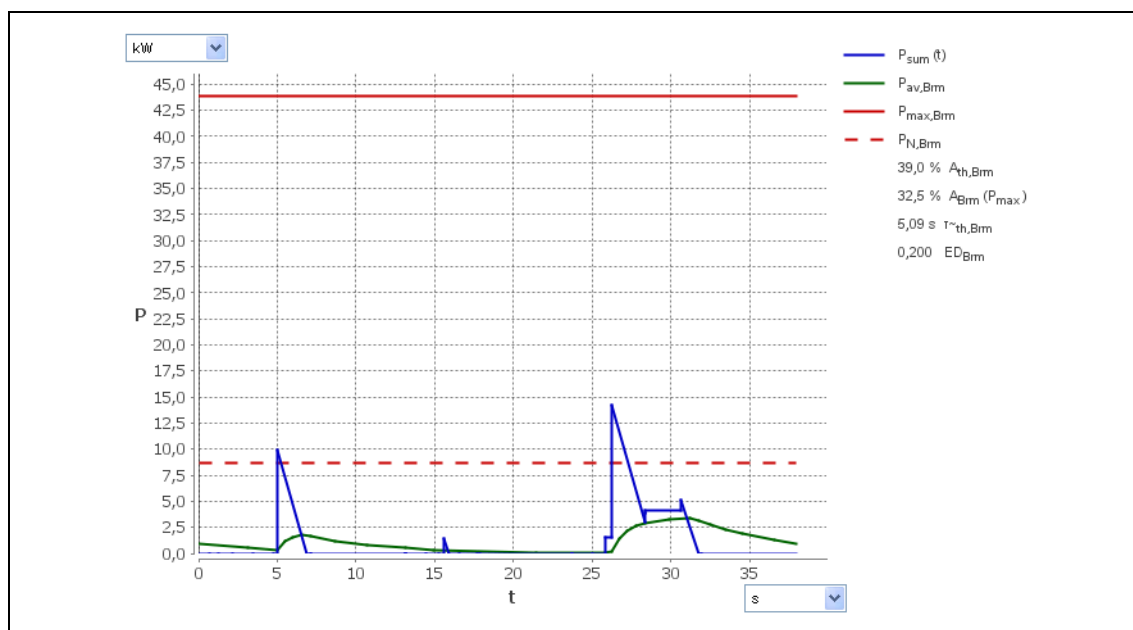
Description	
$P_{\text{gen}}(P_{\text{th,min}})$	DC power in generator mode on the brake transistor, assuming ideal efficiency of motor, gearbox, and inverter.
$P_{\text{gen}}(P_{\text{th,max}})$	DC power in generator mode on the brake transistor, assuming worst efficiency of motor, gearbox, and inverter.
$P_{\text{av,Brm}}$	Average braking power on the brake transistor, considering the thermal time constant ($\tau_{\text{th,Brm}}$)
$P_{\text{max,Brm}}$	Peak braking power of the brake transistor
$P_{\text{N,Brm}}$	Continuous braking power of the brake transistor
$A_{\text{th,Brm}}$	Thermal utilisation of the brake transistor. • Possible message: The permanent utilisation of the brake transistor is xxx %. Thus the limit value of 100 % is exceeded.
$A_{\text{Brm}}(P_{\text{max}})$	Utilisation of the brake transistor relative to the peak braking power • Possible message: The max. utilisation of the brake chopper is xxx %. Thus the limit value of 100 % is exceeded.
$\tau_{\text{th,Brm}}$	Thermal time constant for checking the brake transistor
ED_{Brm}	Relative operating time of the brake resistor (pulse-pause ratio)

12.6.5.2 Brake transistor in the power supply module or regenerative power supply module

The following power supply modules and regenerative power supply modules have an integrated brake transistor to which brake resistors can be connected to.

- Power supply module 9400
- 9400 regenerative power supply module
- i700 power supply module

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the power supply module or regenerative power supply module.



[12-5] Power supply module or regenerative power supply module diagram: integrated brake transistor utilisation

Description	
$P_{\text{sum}}(t)$	Total power in generator mode in the DC bus over time
$P_{\text{av,Brm}}$	Average braking power on the brake transistor, considering the thermal time constant ($\tau_{\text{th,Brm}}$)
$P_{\text{max,Brm}}$	Peak braking power of the brake transistor
$P_{\text{N,Brm}}$	Continuous braking power of the brake transistor
$A_{\text{th,Brm}}$	Thermal utilisation of the brake transistor. • Possible message: The permanent utilisation of the brake transistor is xxx %. Thus the limit value of 100 % is exceeded.
$A_{\text{Brm}}(P_{\text{max}})$	Utilisation of the brake transistor relative to the peak braking power • Possible message: The max. utilisation of the brake chopper is xxx %. Thus the limit value of 100 % is exceeded.
$\tau_{\text{th,Brm}}$	Thermal time constant for checking the brake transistor
ED_{Brm}	Relative operating time of the brake resistor (pulse-pause ratio)

12.6.6 Brake resistor utilisation

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the brake resistor.

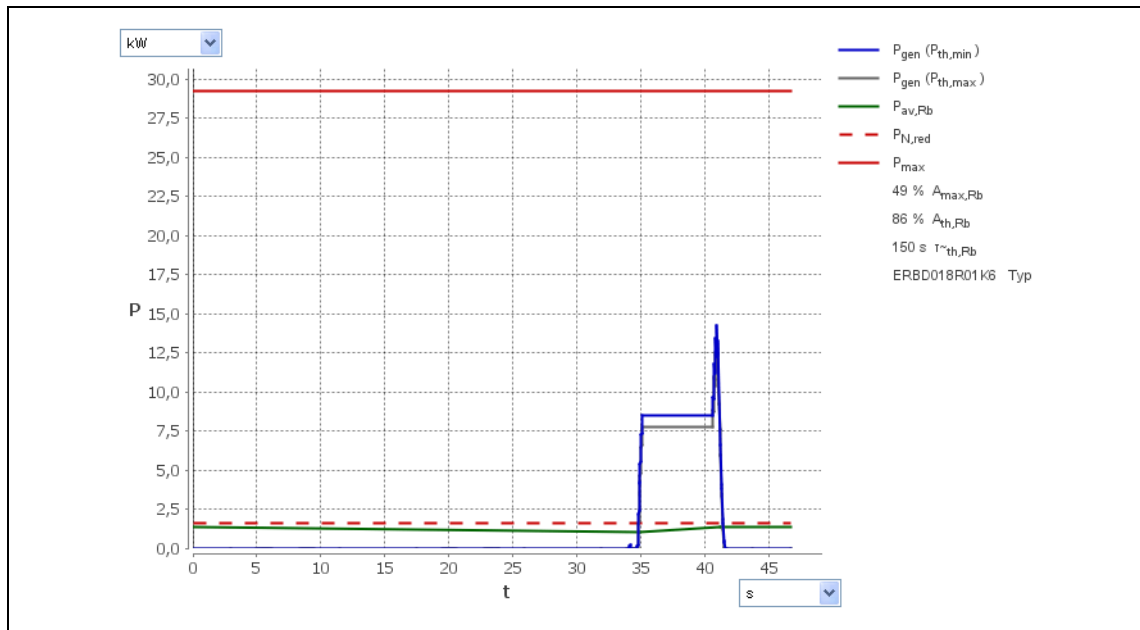
- Use brake resistors with a monitoring function (e.g. thermal contacts) to ensure that the mains contactor is switched off in the event of an overload.

12.6.6.1 Brake resistor on the inverter

The following inverters have an integrated brake transistor to which brake resistors can be connected to.

- 9400 HighLine servo inverters
- 8400 frequency inverter
- 8400 protec frequency inverters
- 8400 motec frequency inverters

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the brake resistor.



[12-6] Inverter diagram: brake resistor utilisation

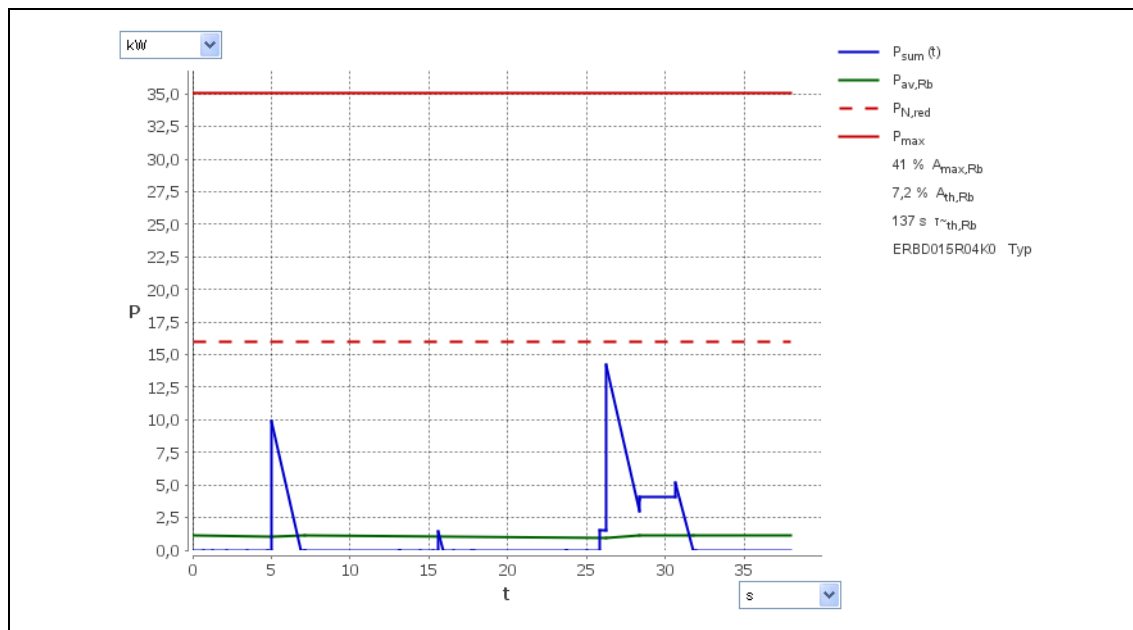
Description	
$P_{\text{gen}}(P_{\text{th,min}})$	DC power in generator mode on the brake resistor, assuming ideal efficiency of motor, inverter, and gearbox.
$P_{\text{gen}}(P_{\text{th,max}})$	DC power in generator mode on the brake resistor, assuming worst efficiency of motor, inverter, and gearbox.
$P_{\text{av,Rb}}$	Average braking power on the brake resistor, considering the thermal time constant ($\tau_{\text{th,Brm}}$)
$P_{\text{N,red}}$	Continuous power of the brake resistor
P_{max}	Peak power of the brake resistor
$A_{\text{max,Rb}}$	Max. utilisation of the brake resistor Possible message: The max. utilisation of the equivalent resistance is xxx %. Thus the limit value of 100 % is exceeded.
$A_{\text{th,Rb}}$	Thermal utilisation of the brake resistor Possible message: The permanent utilisation of the equivalent resistance is xxx %. Thus the limit value of 100 % is exceeded.
$\tau_{\text{th,Rb}}$	Thermal time constant for checking the brake resistor
Type	Brake resistor type

12.6.6.2 Brake resistor on the power supply module or regenerative power supply module

The following power supply modules and regenerative power supply modules have an integrated brake transistor to which brake resistors can be connected to.

- Power supply module 9400
- 9400 regenerative power supply module
- i700 power supply module

The simulation of device-internal monitoring functions serves for the evaluation of the power demand by DSD and the determination of the utilisation of the brake resistor.



[12-7] Power supply module or regenerative power supply module diagram: brake resistor utilisation

Description	
$P_{sum}(t)$	Total power in generator mode in the DC bus over time
$P_{av,Rb}$	Average braking power on the brake resistor, considering the thermal time constant ($\tau_{th,Brm}$)
$P_{N,red}$	Continuous power of the brake resistor
P_{max}	Peak power of the brake resistor
$A_{max,Rb}$	Max. utilisation of the brake resistor Possible message: The max. utilisation of the equivalent resistance is xxx %. Thus the limit value of 100 % is exceeded.
$A_{th,Rb}$	Thermal utilisation of the brake resistor Possible message: The permanent utilisation of the equivalent resistance is xxx %. Thus the limit value of 100 % is exceeded.
$\tau_{th,Rb}$	Thermal time constant for checking the brake resistor
Type	Brake resistor type

13 Product options

After drive dimensioning has been executed, you can select and configure in detail product options for the motor, gearbox and inverter. These product options are required if an order is to be generated from the dimensioning result.

- Features selected during the drive dimensioning process are permanently set in the product options and can only be changed in the corresponding dimensioning steps.
- In the case of non-configurable products (e.g. brake resistors), the product options shown are for information purposes only.

The “EASY Product Finder” product configuration is used as the central service for the product options so the Drive Solution Designer always uses the current product models. This means that new product options are available directly, for example, without having to update the Drive Solution Designer.

Configured product options are also saved if the Drive Solution Designer project is saved with the product configuration. After the Drive Solution Designer project is opened, the configured project options are thus once again available. The configured product options can be overwritten if the Drive Solution Designer project is configured anew.



Tip!

Create an alternative project to retain the saved version of the product options. You can then configure the Drive Solution Designer project and product options anew in the alternative.

Interaction between the Drive Solution Designer and the “EASY Product Finder”

After defining the product options in the Drive Solution Designer, save the shopping cart in a file. This file is now loaded to the “EASY Product Finder” shopping cart. You can now select further products for your project, store them in the shopping cart, and immediately send a request to Lenze Sales, for example, to enquire price information and create CAD data.



Tip!

A wildcard is created in the shopping cart file for products that cannot be configured in the Drive Solution Designer. You can manually assign suitable products to the wildcards in the “EASY Product Finder”.

Configuration of the product options impossible

There may be a variety of reasons why the configuration is impossible.

Cause	Possible remedies
Error transferring parameter values for the product configuration.	Contact Lenze sales partner.
No Internet connection.	Check the Internet connection.
The “EASY Product Finder” server is not available at the moment due to maintenance work.	You may have to set the Internet address of a different server. ▶ "Network connections" register (43)

14 Energy efficiency

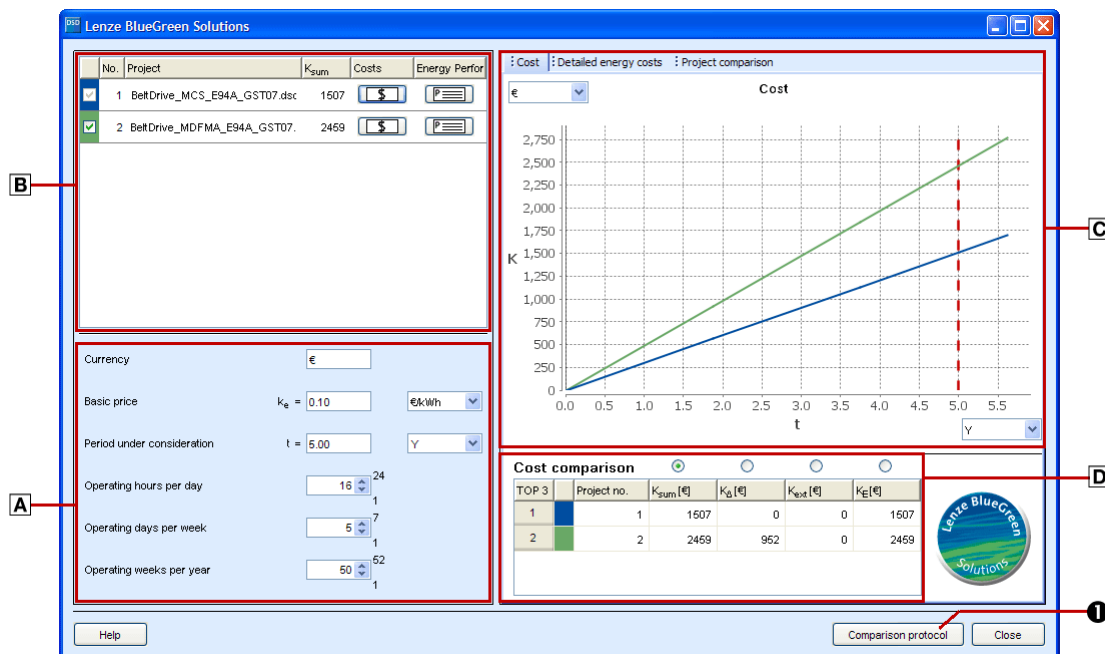
Lenze BlueGreen solutions serve to execute energy efficiency calculations for dimensioned drives.

- A project comparison serves to compare and optimise the different mechanical concepts and drive components with regard to their energy required.
- You can calculate the share of energy in the production costs and the energy emissions for CO₂ certificates of the European Union for the entire production line.
- Calculate the investment costs, cost schedules, cost rankings and the overall costs of the drive system.
- The results of the energy efficiency calculation are approximate values.
 - Contact the Lenze sales if you want to calculate the energy efficiency of the drive system under real operating conditions.
- The energy efficiency calculation considers the most important losses in the drive system.
 - Considered loss sources: Application, gearbox, additional drive element, motor, inverter, regenerative power supply module, brake chopper and brake resistors, DC-bus operation.
 - Losses of the following components are excepted: Engine fans, Motor fans, motor brakes, filters, mains chokes, cables, additional modules of the inverter, automation components.
 - The losses of the application are based on the efficiency of the application entered in the DSD.

14.1

Lenze BlueGreen Solutions

- Go to the "Protocol" dimensioning step and click the button  to open the *Lenze BlueGreen Solutions* dialog box.



A [Basic data for the calculation of energy costs](#) (418)

B [Project data](#) (419)

C [Diagrams and project comparison](#) (419)

D [Cost comparison TOP 3](#) (420)

- Open the comparison protocol
 - Comparison of data and costs of the drive systems considered in the comparison.
 - The output format is adjustable. [Output settings](#) (441)

14.1.1

Basic data for the calculation of energy costs

Name	Description
Currency	Definition of the currency unit The currency is used for all calculations of energy costs.
Energy rate k_e	Price per energy unit
Period under consideration T	The energy costs are calculated for the given period. - The period under consideration can be, for instance, the time of amortisation. - In the "Cost" diagram, the period under consideration is selected. - Possible time units: - D: Day - M: Month - Y: Year
Operating hours per day	Operating time of the drive system: Average hours per day
Operating days per week	Operating time of the drive system: Average days per week
Operating weeks per year	Operating time of the drive system: Average weeks per year

14.1.2 Project data

Name	Description
	Selection of the projects to be compared to each other. • Display of all projects that are currently opened in the DSD. • The project from which you have opened the Lenze BlueGreen Solutions, is a reference project. It ranks first and cannot be deselected. • Remove the checkmark if you do not want to include the projects into the comparison. • Each project is assigned to a colour. This makes it easy for you to detect it in the cost diagram and while comparing costs.
No.	Project number that are automatically assigned to the project. • DSD assigns the project number according to the sequence of the opened projects.
Project	Name of the project. • Indicates the file name of the DSD project.
K_{sum}	Sum consists of energy costs K_E (variable costs and investment costs K_{ext} (fixed costs).
Costs	 Entering the investment costs K_{ext}. • Press button to open the <i>Price entry</i> dialog box. • You can enter prices and possible discounts for components and applications. • Accept the values. The K_{sum} column indicates the summarised costs. ► Investment costs of the drive components (422)
Energy Performance Certificate	 Energy Performance Certificate of the drive system. • Press button to open the Energy Performance Certificate. • The output format is adjustable. Output settings (441) ► The Energy Performance Certificate (422)

14.1.3 Diagrams and project comparison

Name	Description
Cost	Cost schedules as line diagram. • The amortisation date of the investment can be detected easily when all fixed costs have been entered. • Note: • The calculation is based on a constant utilisation of the machine. • Changes of the basic price are not taken into consideration.
Detailed energy costs	Energy costs shown as bar diagram. • The energy costs of the drive system are shown as bars. • The energy costs of the components have different colours. This makes it easy for you to detect the cost differentials.
Project comparison	Representation of the data in tabular form. • Energy values and costs of the application and components can be compared easily.

Tabular project comparison

In addition to the graphic display, the tabular representation provides exact numerical values.

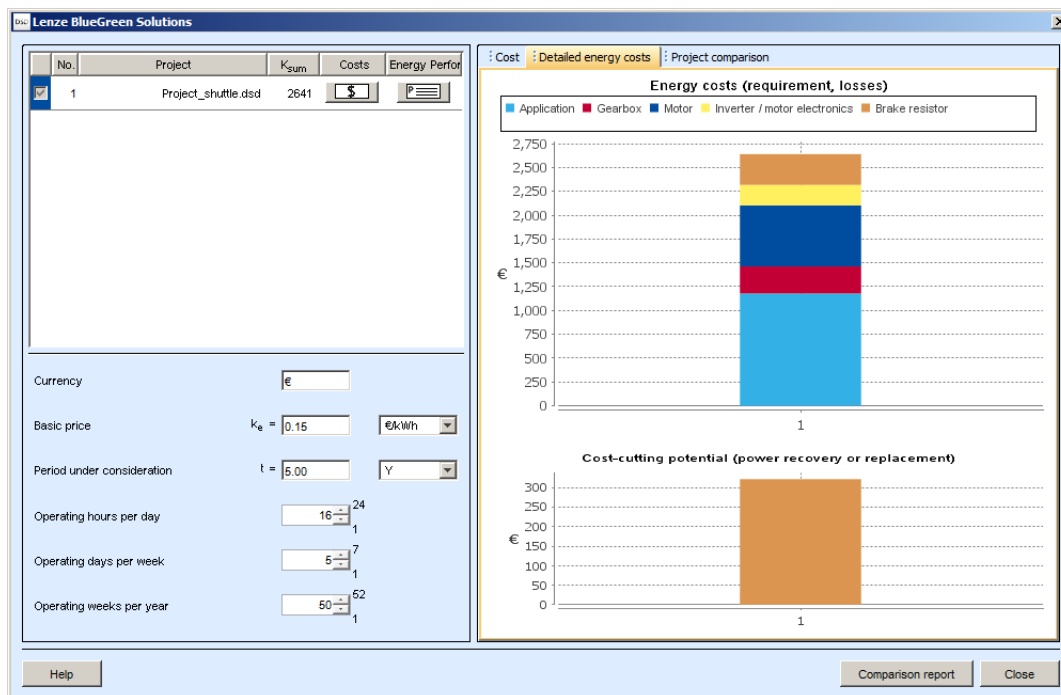
Paramètre	1	2
Analysis of energy efficiency		
Average machine operating time	46 %	46 %
Energy requirement in the period under consideration	38975 kWh	49560 kWh
Energy costs in the period under consideration	5846 €	7434 €
Energy savings with power recovery	1251 €	3091 €
Total investment costs	0 €	0 €
Application		
Application model	Travelling drive	Hoist drive without c
Max. application power	9.38 kW	13.6 kW
Max. required torque	416 Nm	647 Nm
Max. application speed	263 1/min	226 1/min
Losses	7385 kWh	3172 kWh
Energy costs	1108 €	476 €
Lenze gearbox		
Gearbox	g500-B820	g500-B1500
Number of stages	3	3
Losses	5156 kWh	7552 kWh
Energy costs	773 €	1133 €
Motor		
Motor group	MCA	MHXMA
Type designation	19S35-	132-22
Losses	13118 kWh	10820 kWh
Energy costs	1968 €	1638 €
Inverter / motor electronics		
Inverter type	E84AVTCx1534	E94ASHE0324
Losses	4955 kWh	7310 kWh
Energy costs	743 €	1096 €
Electrical brake unit		
Integrated brake transistor type		E84ASxE0324
Brake resistor type	ERBS018R01K2	ERBS018R02K3
Losses	8339 kWh	20606 kWh
Energy costs brake resistor	1251 €	3091 €

14.1.4 Cost comparison TOP 3

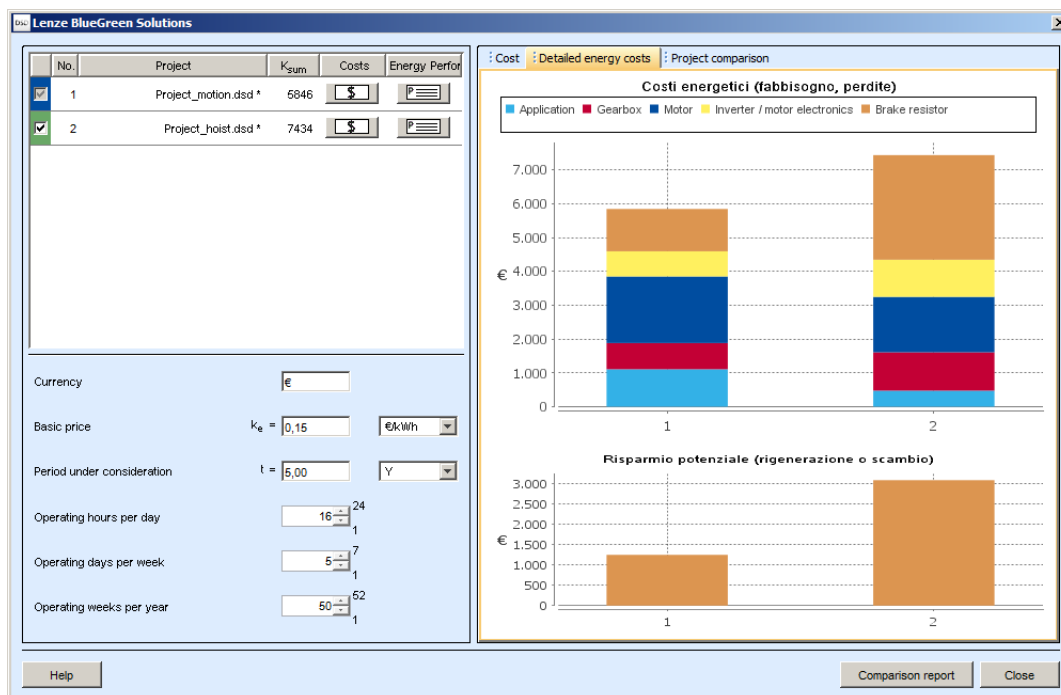
Name	Description
TOP 3	Ranking of the drive systems according to different cost criteria. The three projects that are shown in the list, depend on the selected cost criterion.
Project no.	Project number that are automatically assigned to the project. DSD assigns the project number according to the sequence of the opened projects. ► Project data (419)
K_{sum}	Sum consists of energy costs K_E (variable costs and investment costs K_{ext} (fixed costs). ► Project data (419)
K_{Δ}	Difference of the total costs K_{sum} of the projects. The difference to the highest value in the list is displayed.
K_{ext}	Investment costs (fixed costs). ► Project data (419)
K_E	Energy costs (variable costs) ► Project data (419)
	Sorting of the table according to a cost criterion. - Select the column with the costs you want to consider. - The sorting is ascending, starting with the lowest costs.

14.1.4.1 Detailed energy costs

The diagrams show the proportionate energy costs (losses) of the drive components available (gearbox, motor, inverter) and the application on the basis of the operating data entered and the energy price. In this way, several drive solutions of different applications or alternative drive solutions for identical applications can be graphically compared to each other.



[14-1] Proportionate energy costs of the drive components of one drive



[14-2] Comparison of the proportionate energy costs of the drive components of two drives

14.1.4.2 Investment costs of the drive components

Use this dialog to optionally enter prices and discounts of the drive components. The prices are shown as investment costs in the "Cost schedule" diagram and provide some key decision criteria with regard to amortisation.

Component	List price	Discount	Final price
Geared motor / motor	0.0	0.0 %	0
Inverter	0.0	0.0 %	0
DC-bus components	0.0	0.0 %	0
Electrical brake circuit	0.0	0.0 %	0
Application	0.0	0.0 %	0

[14-3] Entry of the investment costs of the drive components

14.1.5 The Energy Performance Certificate

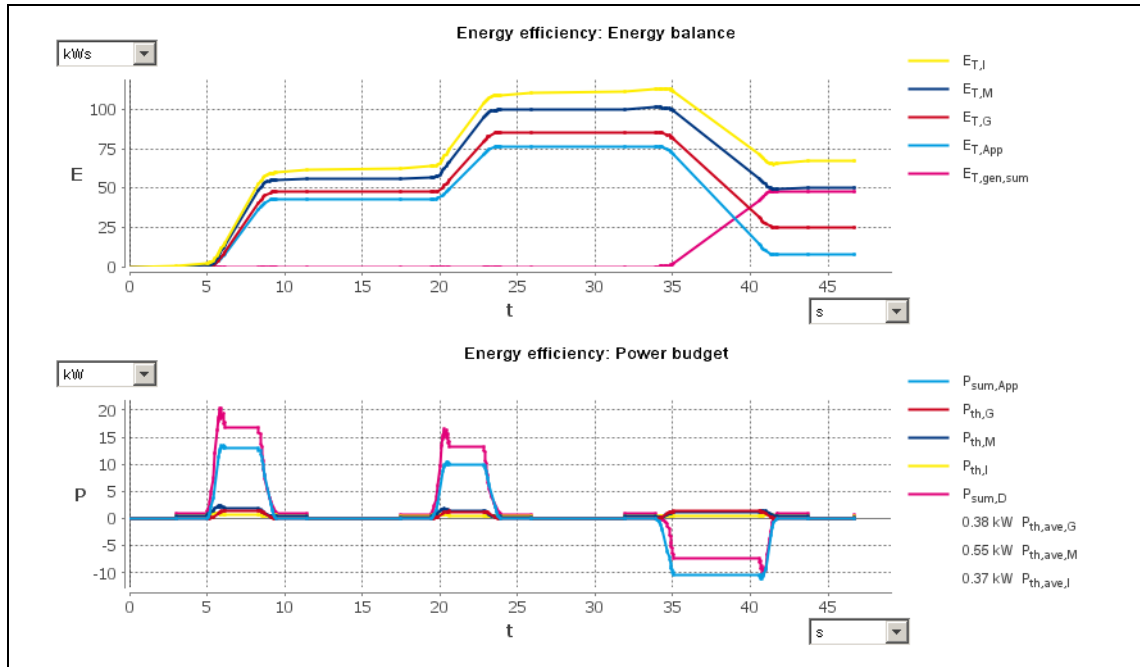
The results of the energy efficiency calculation are documented in the Energy Performance Certificate:

- The Energy Performance Certificate contains detailed information on the required energy of the application, the different drive components, and of the drive system as a whole.
- The energy costs are displayed transparently and clearly.
- In addition, the recoverable energy is shown, which can be exchanged via the DC-bus or fed back into the supply system by means of a regenerative module.
- The CO₂ emission according to the CO₂ equivalent 550 g/kWh (source VDI) for the energy requirement and the recoverable energy is shown for the drive system as a whole.
- All results for the machine cycle (cycle time of the motion profile) and for the selected period under consideration (e. g. 5 years) are summed for the drive system as a whole.
- The energy requirement and the costs for the whole period under consideration are determined for the drive components and the application.

14.1.6 Energy and power flows

The diagrams show the energy and loss characteristics of the drive components as a function of time for one operating cycle. This example refers to a hoist drive.

- The energy efficiency diagrams can be found in the result tree under *All diagrams*.



[14-4] Energy and power characteristics of a hoist drive with acceleration and braking phases

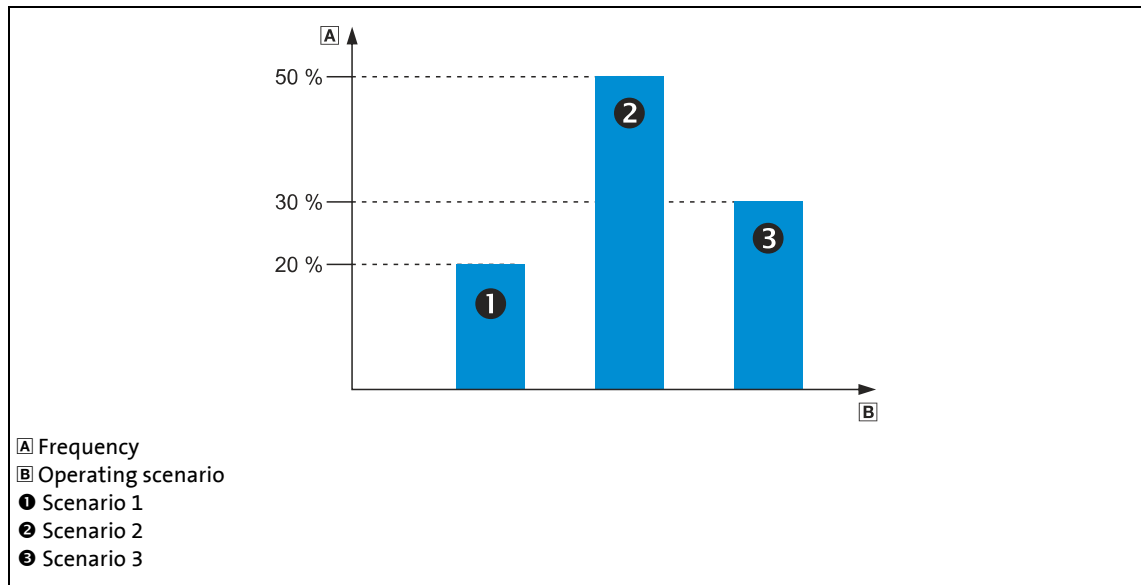
Description	
$E_{T,I}$	Energy characteristic at the inverter input (electrical energy)
$E_{T,M}$	Energy characteristic at the motor terminals (electrical energy)
$E_{T,G}$	Energy characteristic at the gearbox input (mechanical energy)
$E_{T,App}$	Energy characteristic at the application (mechanical energy)
$E_{T,gen,sum}$	Regenerative energy characteristic at the DC bus (electrical energy)
$P_{sum,App}$	Power loss characteristic of the application (mechanical power)
$P_{th,G}$	Power loss characteristic of the gearbox (mechanical power)
$P_{th,M}$	Power loss characteristic of the motor (electrical power)
$P_{th,I}$	Power loss characteristic of the inverter (electrical power)
$P_{sum,D}$	Total power loss characteristic of the drive system
$P_{th,ave,G}$	Average power loss of the gearbox (mechanical power)
$P_{th,ave,M}$	Average power loss of the motor (electrical power)
$P_{th,ave,I}$	Average power loss of the inverter (electrical power)

14.1.7 Energy efficiency analysis with different load cycles

The DSD Energy Performance Certificate is based on repetitive operating cycles with identical load profiles. In practice, however, different scenarios and operating cycles (e.g. different motion profiles and variable payloads) are often executed at specific frequencies.

This chapter describes how an overall Energy Performance Certificate is compiled for different scenarios.

If necessary, the total energy demand can be recorded later on by monitoring whilst the system is being operated and compared with the dimensioning in the DSD.



[14-5] Example: Operation with different load cycles

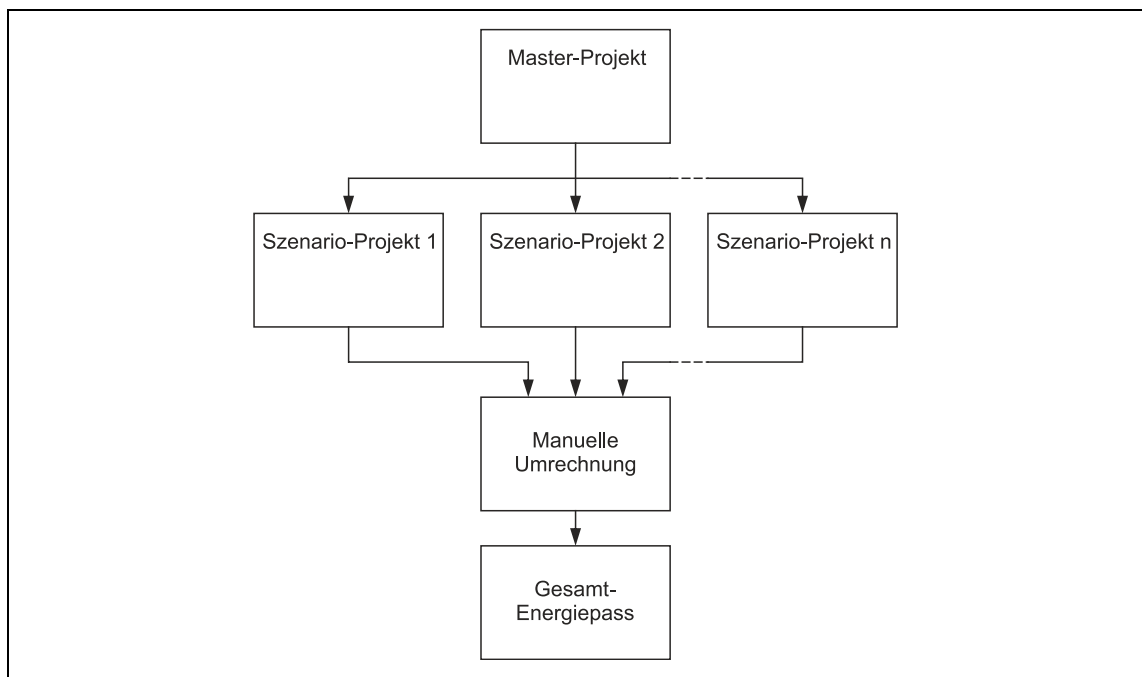
Example of an application with three different load cycles:

DSD	Fixed mass [kg]	Payload [kg]	Speed [m/s]	Service life [weeks/year]
Scenario project 1	500	300	1,2	10
Scenario project 2	500	210	0,8	15
Scenario project 3	500	100	0,5	25



How to carry out the energy efficiency analysis:

1. Create a master project for the whole drive train and for all applicable operating modes.
2. Derive the scenario projects (1 ... n) from the master project in each case for the different operating scenarios.
 - The [Application Tuner](#) is a comfortable tool for carrying out the derivations.
 - The master project can also be used as scenario project.
3. In a last step, add the energy balances of all scenario projects manually.
 - For other analysis periods, the results must be converted proportionally.
 - [Basic data for the calculation of energy costs](#) (418)



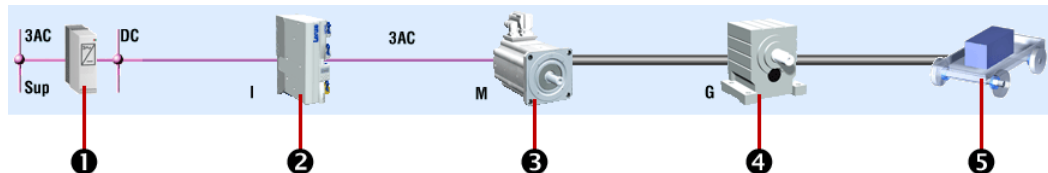
[14-6] Procedure for compiling an Energy Performance Certificate with different load cycles

14.2 Tips for optimising the drive systems

Generally the following applies:

- Avoid overdimensioning without extremely overloading the components.
- The longer the operating time of the drive, the greater are the saving effects.

Further possibilities for an energy-efficient dimensioning of the drive system can be found in the following table.



Legend	Possible dimensioning
①	Supply / feed • In DC-bus connection, • with power recovery into the mains.
②	Inverter with • servo control • low switching frequency, • 2-switch modulation (e.g. 8400 frequency inverters), • Control mode VFC plus eco.
③	Motor • Use synchronous motor, IE2 motor or 120-Hz motor • Utilise speed setting range, e. g. 87 Hz operation for standard motors
④	Gearbox with • a high efficiency, • a low number of stages, • a low input speed.
⑤	Application with • low friction, • low inertia.

14.2.1 Cost-cutting potentials in applications

Improved energy efficiency thanks to	1. Using electrical energy intelligently			2. Converting energy with high efficiency				3. Using braking energy		
	Exact dimensioning	Closed-loop controlled operation (inverter)	Energy-efficient control	Asynchronous motor with high efficiency	Synchronous motor	Gearbox with high efficiency	Electrical drive instead of fluid drive	DC-bus connection for energy exchange	Buffering the braking energy (capacitor)	Power recovery into the mains
Conveyor drive	●	●	●	●		●				
Travelling drive	●	□	●	●		●		○		
Hoist drive	●	●	●	●		●	●	○		●
Positioning drive	○	●	●		●		●	●		○
Coordinated drive for robots	○	□	●		●			●		
Synchronous drive	●	□		●		●		○		
Winding drive	●	□	□	●		●		●		●
Clock drive	○	□	●		●		●	●	●	○
Drive for electronic cam	○	□	●		●		●	●	●	
Drive for forming process	●	●		●	●	●	●			○
Main or tool drive	●	●	●	●	●					○
Drive for pump or fan	●	●	●	●	○	●				
Slider-crank mechanism, eccentric lift table	●	○		●	●	●		○		○

- ☐ State of the technology
 ● Great potential
 ○ Partial potential

14.2.2 Optimising the single-axis application

1. Dimension a drive axis in DSD.
2. Create an alternative of the DSD project and carry out the dimensioning with alternative drive components. ▶ [Creating an alternative](#) (📖 55)
3. Compare both projects regarding the energy efficiency.
 - If required, check if changes of the motion profile have a positive effect on the energy balance. ▶ [Motion design](#) (📖 242)

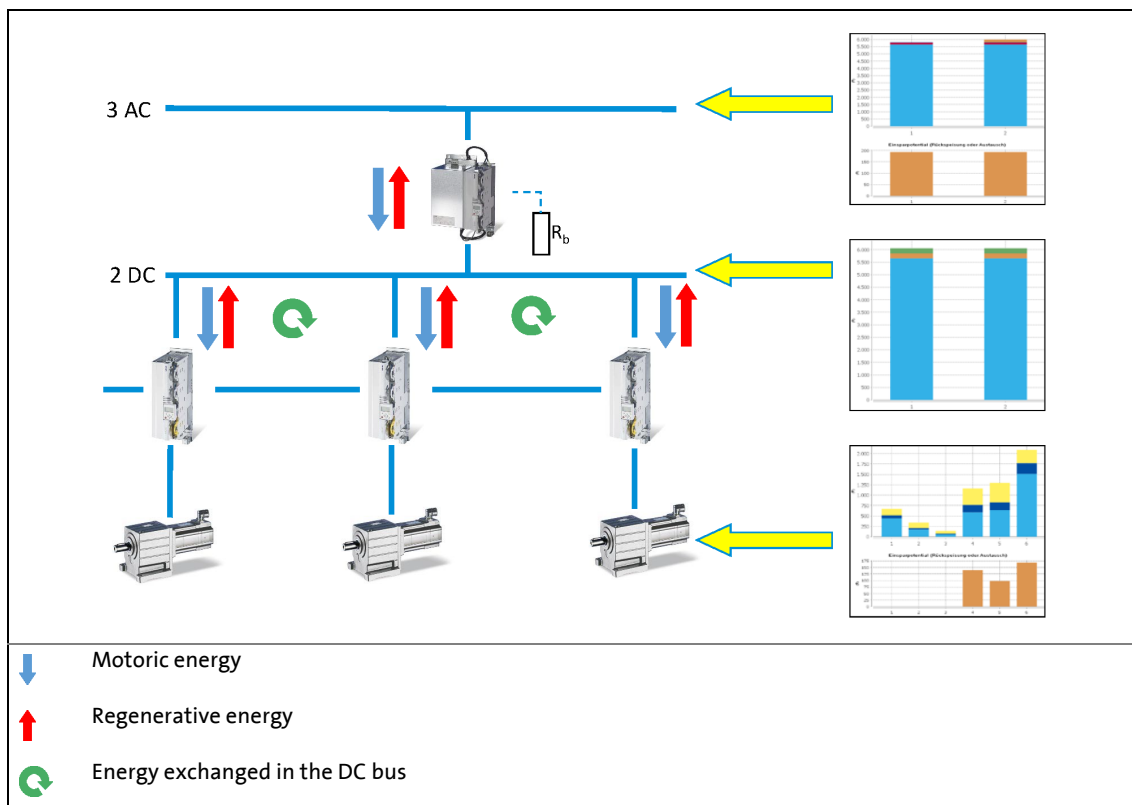
14.2.3 Optimising the multi-axis application

4. Create the motion profiles for the drive axes in the independent *MotionDesigner* and optimise them with regard to realistic conditions so that as much energy as possible will be exchanged in the DC-bus connection. ▶ [MotionDesigner](#) (📖 243)
5. Dimensioning drive axes in DSD.
6. Create one alternative each of the DSD projects and execute the dimensioning with alternative drive components. ▶ [Creating an alternative](#) (📖 55)
7. Compare the projects regarding the energy efficiency.
8. Load the optimised DSD projects of the drive axes into the application "Dimensioning the multi-axis system" and configure the multi-axis system. ▶ [Size the multi-axis system](#) (📖 186)

14.2.4 Energy efficiency in a multi-axis system

In the multi-axis system, several inverters are actuated on the same DC bus. If this process involves temporary or continuous regenerative actuation of some inverters, they directly exchange energies in the DC bus without making any detours via the supply system. Regenerative operating phases can for instance be generated by reducing a load (potential energy), by braking a drive to a standstill (kinetic energy), or by permanent braking of an unwinder (process energy). DC bus operation is a very efficient method to save electrical energy.

If some operating phases mainly involve regenerative energy, the use of a common brake chopper or a power supply module/regenerative module is additionally required. Without this measure, the drives would become deenergised and therefore uncontrolled when there is excess regenerative energy.

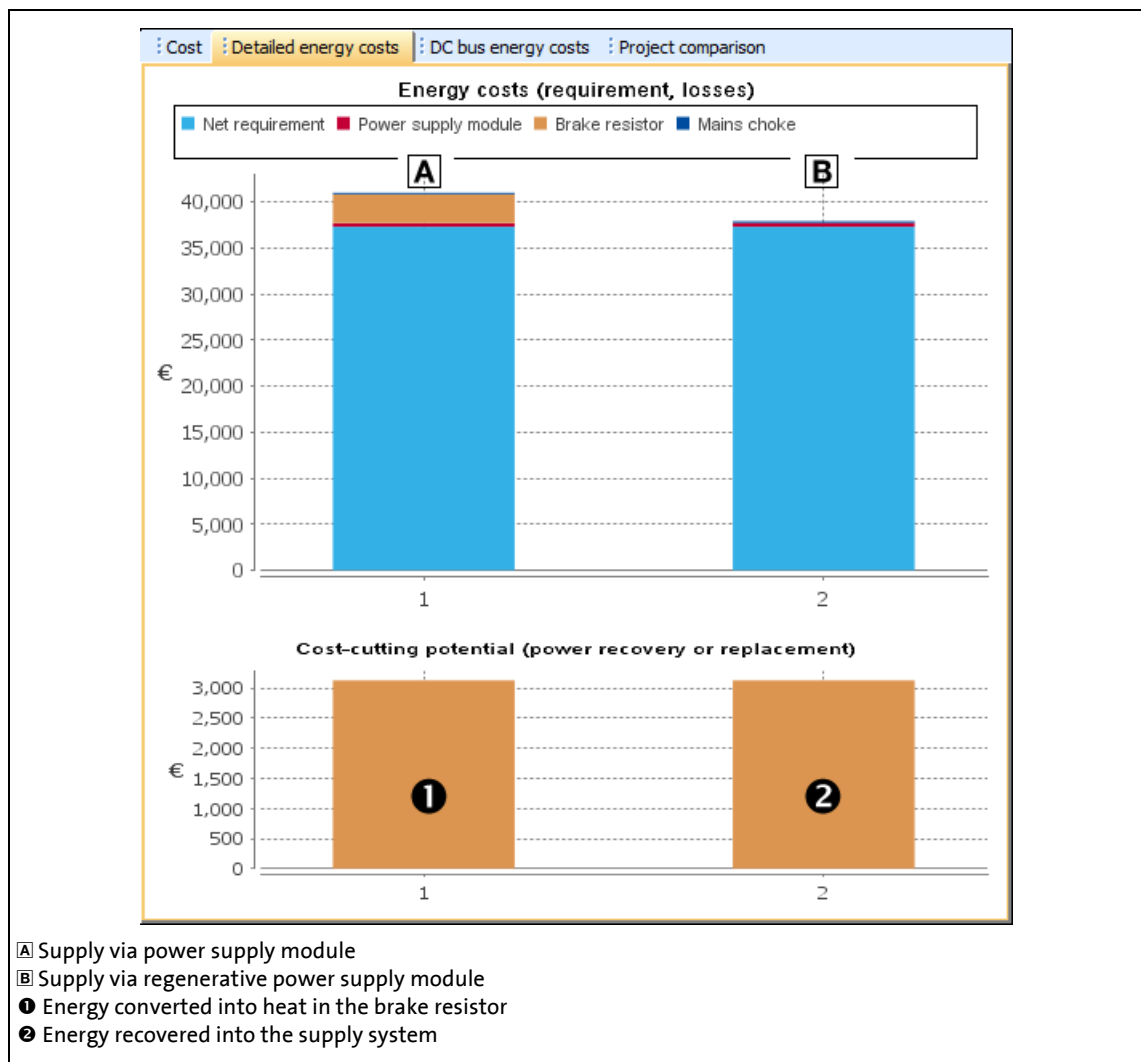


[14-7] Energy flow in DC-bus operation

For a DC-bus connection, basically three electrical operating principles are provided to absorb regenerative energy and to therefore ensure continuous control of the drives:

- ▶ [Power supply module with brake chopper](#) (430)
- ▶ [Power supply module/regenerative module without brake chopper](#) (430)
- ▶ [Power supply module/regenerative module with brake chopper](#) (431)

For the DC-bus connection, the DSD creates an Energy Performance Certificate for each drive axis and an Energy Performance Certificate for the power supply module.



[14-8] Energy costs in a DC-bus connection

14.2.4.1 Power supply module with brake chopper

If only a small amount of regenerative energy is produced, or if power recovery is not desired, a common power supply module with an integrated brake chopper is used for all drives actuated in the DC-bus connection. During the braking phases of the drive system, the excess regenerative energy is converted into thermal energy in a brake resistor.

14.2.4.2 Power supply module/regenerative module without brake chopper

If the whole regenerative energy is to be recovered by the supply system, a common regenerative power supply module is used for all drives actuated in the DC-bus connection. During the braking phases of the drive system, the excess regenerative energy is recovered by the supply system, and in this way the overall energy balance of the system is improved.

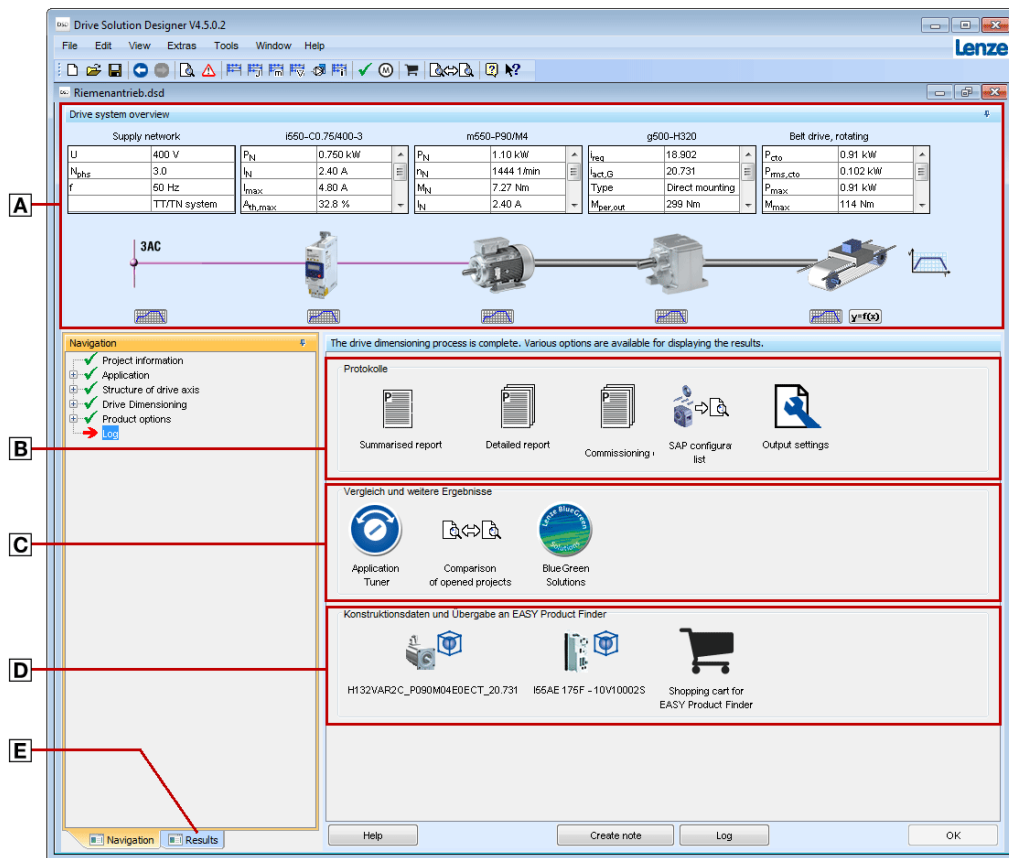
14.2.4.3 Power supply module/regenerative module with brake chopper

If the excess regenerative energy is to be recovered by the supply system and energy peaks are converted into thermal energy in a brake resistor, a common regenerative power supply module with a brake resistor is used for all drives in the DC-bus connection. During the braking phases of the drive system, the excess regenerative energy is recovered by the supply system first. If the regenerative module reaches the current limitation, the remaining regenerative energy is converted in the brake resistor. This reduces the overall energy balance of a system.

Such hybrid concepts are applied if high, short-time, regenerative power peaks with a low energy content occur, requiring a cost-effective concept. Also, a redundancy in the recovery concept for the event of a mains failure may be desired.

15 Results: comparing, optimising, logging

The DSD provides a variety of representations for evaluating results.

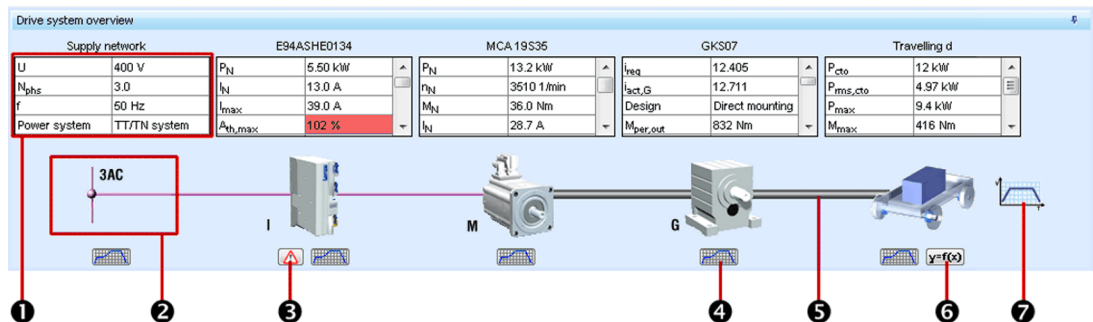


- A [Drawing](#) (📄 433)
- B [Reports](#) (📄 438)
- C [Comparison and additional results](#) (📄 442)
- D [Design data and transfer to the »EASY Product Finder«](#) (📄 443)
- E [Results](#) (📄 437)

15.1

Drawing

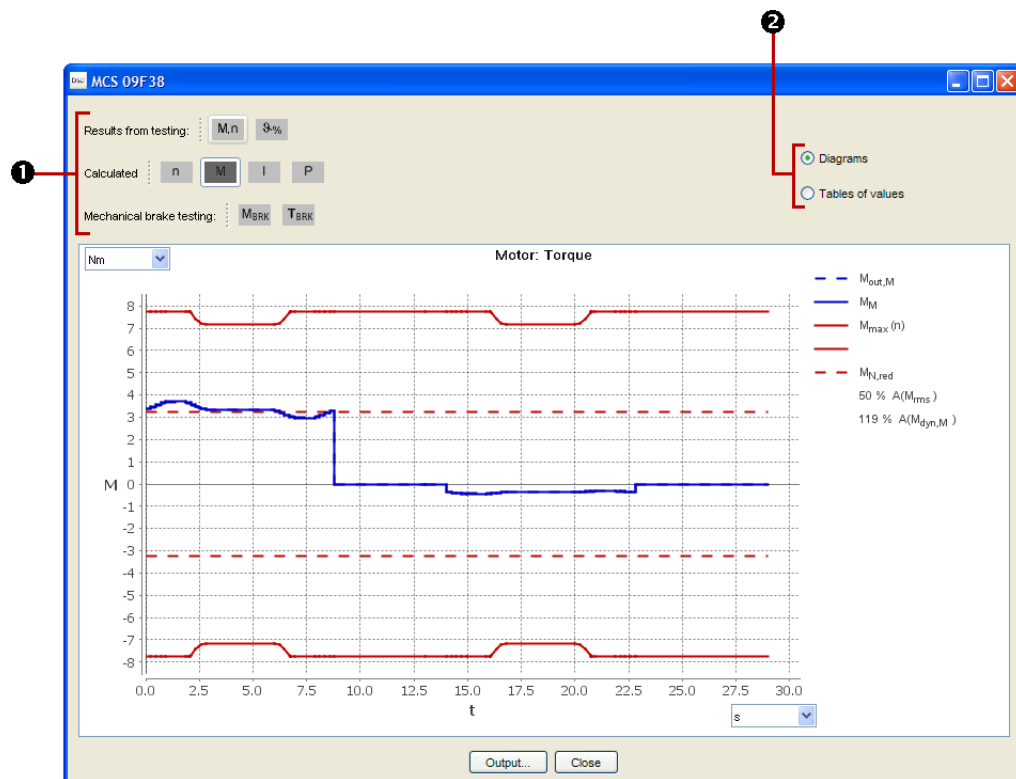
The drawing visualises the current state of the drive dimensioning.



Legend	Description
1	Short overview of the drive system with the data entered, rated data of the selected drive components and their utilisation degrees, and display of notes and tips.
2	Illustration of the component (at the same time button). By clicking on the illustration you directly reach the selection table for the corresponding component where a variety of data is provided.
3	Button for calling messages for drive dimensioning of the corresponding component.
4	Button for calling the diagrams for the corresponding component. - Graphical representation of the speed, torque, and utilisation behaviour. Diagrams for the components (434)
5	Representation of the drive train used.
6	Button for calling the description of the application in the online help.
7	Button for calling the motion profile. Motion design (242)

Diagrams for the components

In the *Diagrams* dialog box the speed, torque, and utilisation of the application or of a component are shown in diagrams or value tables.



Legend	Description
①	Buttons for switching the corresponding diagrams or value tables on/off.
②	Selection for the representation as diagrams or value tables. • The representation as diagram is a convenient help to assess the application or the component and to identify reserves and possible risks. • The value table represents all values of a characteristic in the form of a table and thus facilitates the determination of correct values (e. g. limit values) of the application or the component. • Where required, the limits for the respective components are also provided in the diagrams displayed.

Legend for the representation of the characteristics:

Graphics element	Colour	Kind	Meaning
Point	Blue		Maximum operating point
	Red		Standstill point of the synchronous motor
Line	Blue		Requirement of the application
	Red		Maximum permissible values
			Reduced rated values (temperature, height, etc.)
			Max. continuous characteristics
	Green		Instantaneous PT1 function
			Calculated equivalent values

Buttons

Depending on the component, different quantities which can be individually shown or masked out by means of the following buttons on the upper edge of the profile dialog are shown in the profile dialog:

Button	Information
a	Acceleration
α	Angular acceleration
BRK	Setting the brake
CINH	Setting the controller inhibit
f_{ch}	Switching frequency of the inverter
f_{out}	Output frequency of the inverter
F	Counterforce
F 	Tensile force at the belt
I	Current within the motor, inverter
J	Characteristic of mass inertia
m	Characteristic of the payload mass
s	Translatory traverse path
j	Rotary traverse path
M	Motor, gearbox, application torque
M, n	Speed-torque characteristic of motor/gearbox
M_{BRK}	Torque curve of the holding brake
M_{dyn}	Dynamic torque
M_{out,G}	Output torque of the Lenze gearbox
M_{out,K}	Output torque of the additional drive element
M_{sds}	Stationary torque
n	Speed
n_{in,G}	Drive speed of the Lenze gearbox
n_{in,K}	Drive speed of the general ratio

Button	Information
$n_{out,G}$	Output speed of the Lenze gearbox
$n_{out,K}$	Output speed of the additional drive element
ω	Angular velocity
P	Power, application, motor
P_{DC}	Required power in the DC bus
P_{req}	Required power
$\vartheta\%$	Thermal utilisation
T_{BRK}	Theoretical braking time of the mechanical brake • The time from the respective operating point until standstill is calculated
v	Speed
$W_{l/t}$	Characteristic of the gearbox fatigue strength
E94APx	Requirement calculation of the drive axis when the 9400 power supply module is used
E94ARx	Requirement calculation of the drive axis when the 9400 regenerative power supply module is used
R	Brake resistor
int.Chp	Brake chopper integrated in the inverter
int.Chp 94	Brake chopper integrated in the 9400 power supply module or 9400 regenerative power supply module

Editing functions

Function	Description
Zooming	• Zooming in: • Draw up a rectangle across the area to be zoomed in by keeping the left mouse button pressed. • Zooming out: • Open the context menu with the right mouse button. There are three commands for zooming out under Automatic adjustment.
Copy	Open the context menu with the right mouse button. Execute the Merge command to copy the diagram to clipboard.
Save as...	Open the context menu with the right mouse button. Execute the Save as... command to save the diagram as PNG graphic (Portable Network Graphic).
Print...	Open the context menu with the right mouse button. Execute the Print... command to open a dialog box which serves to print the diagram.

15.2

Results

The *Result* has a hierarchical tree structure and shows all results contained in the DSD:

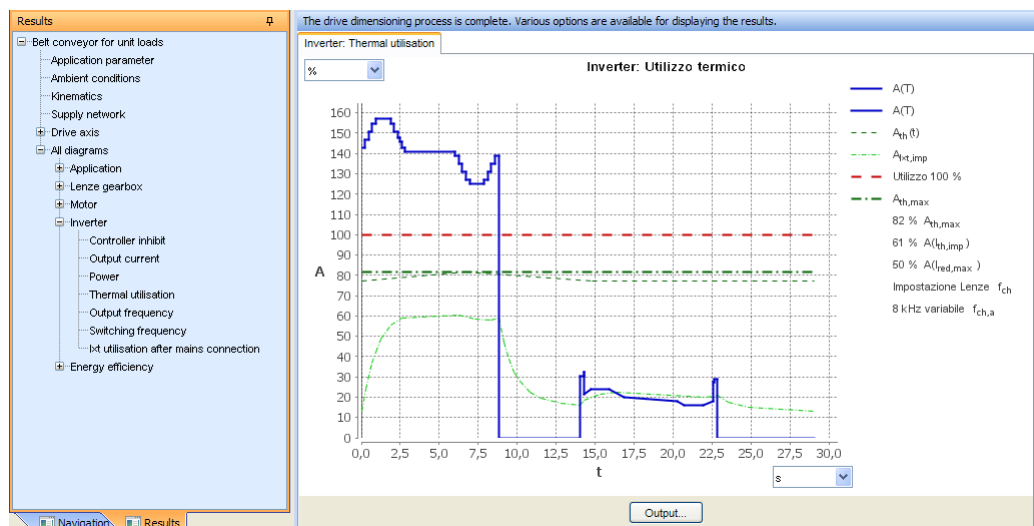
- Diagrams of the application and the components
- Rated values and calculated values of the components
- Options of the components

Example: Representation of the rated values

Parameter	Value
Inverter type	E94AMHE0024
Inverter technology variant	Servo inverter
Typical motor power	0.370 kW
Output current	1.50 A
Max. output current	6.00 A
Max. standstill current	6.00 A
Overload capacity	0...∞ %
Overload capacity, inverter setting	None
Switching frequency	Lenze setting
Mains voltage	400 V
Number of phases	3
Power system	TT/TN system
Motor control	With feedback
Control system	SC: servo control
Power reduction with regard to ambient temperature	0.0250
Power reduction with regard to site altitude	0.0500
Inverter design	{Standard mounting; Cold plate technology; Push-through technique; Without

- A $\oplus$ in front of an element in the *Result tree* signals that subelements are available.
 - If you click on $\oplus$, the subelements are shown.
 - If you click on $\ominus$, the subelements are hidden.
- Different tabs in the result view show rated values, calculated values, or product options.

Example: Representation of a diagram (thermal inverter utilisation)



15.3

Reports

**Note!**

- The calculation results presented in the report are based on your default setting and the data you have entered.
 - Check whether these data are correct and complete. Lenze can not accept any liability for incorrect, unusable, or incomplete drive solutions resulting from incorrect or incomplete data.
- The DSD carries out a physical drive dimensioning process. The specific properties and the operational performance of a drive cannot be taken into consideration.
- Since every application is individually integrated into an overall concept, we recommend having a system integration check performed by a Lenze specialist in addition to the drive dimensioning.
- Observe the [Restrictions of the drive dimensioning](#) section and the release notes in the "Application Knowledge Base" (AKB) at <http://AKB.Lenze.de>.

At the end of a dimensioning there are various possibilities of evaluating and documenting the drive solution. You can create different protocols, compare several open projects to each other, and carry out a drive analysis. Protocols, analyses and project comparisons can either be opened in Microsoft Word or Adobe Reader and be opened in addition.

**Tip!**

You can also log the current state of the dimensioning, compare open projects to each other, or carry out a drive analysis anytime during the dimensioning process.

For this purpose, click the **protocol** button in the input area to open the *protocol* dialog box.

15.3.1

Summarised report



The summarised protocol is a summary of the most important data of the drive dimensioning and serves as an overview. The length of the protocol is one page.

- Click the icon to open the protocol.
- You can set the output format: [Output settings](#) (📖 441)

15.3.2 Detailed report



- The detailed protocol is the complete documentation of the drive dimensioning:
 - User and customer data
 - Notes
 - Application data
 - Rated data, utilisation values and options of the components selected
 - Warning signals
 - Dimensioning notes
 - A great number of diagrams and tables of values
- Click the icon to open the protocol.
- You can set the output format and information scope: [Output settings](#) (□ 441)

15.3.3 Commissioning data



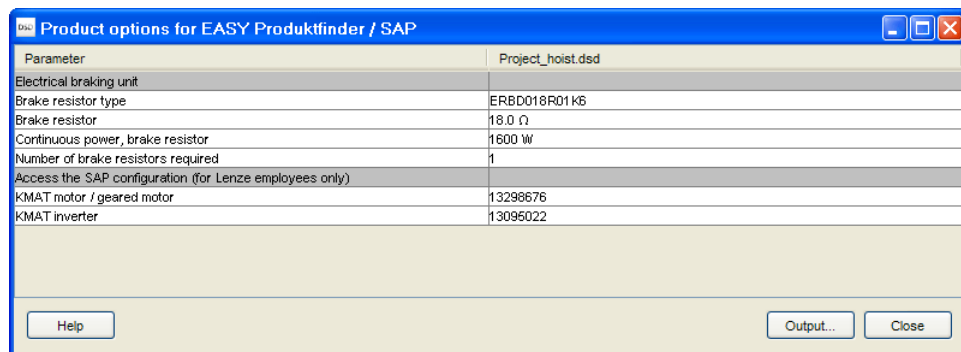
- The commissioning data contain some specific information for the commissioning of the application:
 - User and customer data
 - Notes
 - Application data
 - Rated data, utilisation values and options of the components selected
 - Warning signals
 - Dimensioning notes
 - A great number of diagrams and tables of values
- Click the icon to open the protocol.
- You can set the output format and information scope: [Output settings](#) (□ 441)

15.3.4 SAP list of the configuration



The list shows the features of the Lenze products used, which are required for a transfer to the »EASY Product Finder«.

- Click the icon to open the SAP list.
 - The dialog box can also be opened using the **View→Product options for EASY Product Finder / SAP** command.



Parameter	Project_hoist.dsd
Electrical braking unit	
Brake resistor type	ERBD018R01 K6
Brake resistor	18.0 Ω
Continuous power, brake resistor	1600 W
Number of brake resistors required	1
Access the SAP configuration (for Lenze employees only)	
KMAT motor / geared motor	13298676
KMAT inverter	13095022

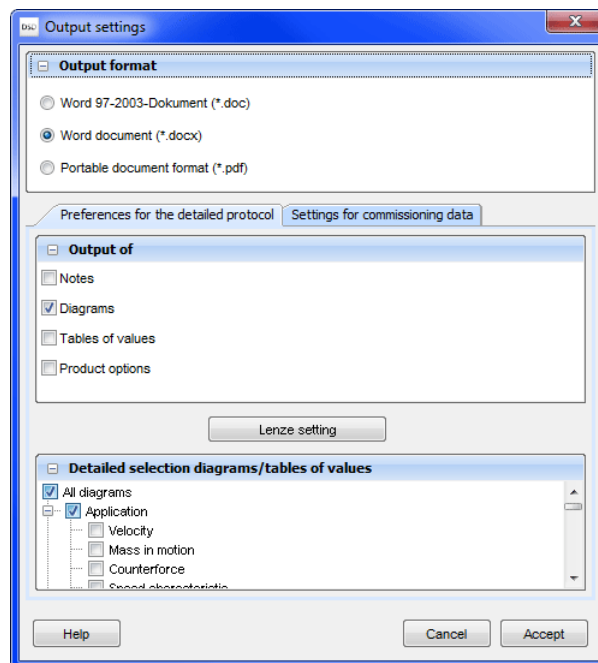
Help Output... Close

15.3.5 Output settings



In the settings for the protocol you define the format and the length.

- Click the icon to open the dialog box.
 - The dialog box can also be opened via **Tools→Settings, Protocol** tab.
 - [Settings](#) (42)
- Available formats for all versions:
 - Doc (from Microsoft Word 2002)
 - WordML (from Microsoft Word 2003, Service Pack 2)
 - PDF (Adobe Reader)
- Details for the detailed protocol and the commissioning data
 - Detailed selection of diagrams and value tables.



15.4

Comparison and additional results

15.4.1

Application Tuner



The *Application Tuner* serves to

- change the data of the application and the motion data as well as to observe and optimise the impacts on the drive,
- integrate further possible operating statuses and material recipes into the dimensioning for the reference scenario,
- create your own DSD project based on an optimised drive solution or to output a protocol.

Click the icon to open the *Application Tuner* dialog box.

► [Application Tuner](#) (📖 57)

15.4.2

Comparison of the open projects



If several projects are open at the same time, they can be compared with respect to the application and the utilisation of the components.

- Click the icon to open the project comparison.
 - The dialog box can also be opened with the command **View→Project comparison**.
- [Project comparison](#) (📖 59)

Project comparison		
Parameter	Project_motion(1).dsd	Project_motion.dsd
Lenze gearbox		
Gearbox	GKS07	GKS07
Number of stages	3	3
Design	Direct mounting	Direct mounting
Actual gearbox ratio	12.71	12.71
Thermal utilisation of the gearbox with mineral oil	66 %	66 %
Gearbox utilisation	90 %	90 %
Utilisation, with reference to the equivalent torque	27 %	27 %
Gearbox utilisation	66 %	66 %
Utilisation, fatigue strength	0 %	0 %
Motor		
Motor group	MCA	MCA
Type designation	19S17	19S35
Rated motor power	6.40 kW	13.2 kW
Rated motor torque	36.3 Nm	36.0 Nm
Rated motor speed	1700 1/min	3510 1/min
Rated motor current	13.9 A	28.7 A
Rated motor voltage	390 V	390 V
Moment of inertia	72.0 kgcm²	72.0 kgcm²
Field weakening factor	2.1	1.0
Utilisation with reference to the effective torque	50 %	37 %
Utilisation, maximum torque (motor, inverter)	144 %	36 %
Short-time overload	104 %	105 %
Max. load-matching factor	14	14
Electromechanical brake		
Brake type	PMB	PMB
Brake size	14	14
Braking torque	40.0 Nm	40.0 Nm
Rated braking torque / dimensioned braking torque	10.0	10.0
Theoretical braking time	1.48 s	1.48 s
Feedback:		
Help Output... Close		

15.4.3

BlueGreen

Solutions



The different mechanical concepts and drive components can be compared and optimised with regard to the energy required.

- Click the icon to open the *Lenze BlueGreen Solutions* dialog box.

► [Energy efficiency](#) (📖 417)

15.5

Design data and transfer to the »EASY Product Finder«

15.5.1

CAD data in the geared motor



If product characteristics have been defined in the *Details regarding Lenze products* dimensioning step, you can generate the engineering data of the geared motor.

- This function requires an Internet connection.
- CAD data are not available for all components.
- Click the icon to generate the construction data.

15.5.2

CAD data inverter



If product characteristics have been defined in the *Details regarding Lenze products* dimensioning step, you can generate the engineering data of the inverter.

- This function requires an Internet connection.
- CAD data are not available for all components.
- Click the icon to generate the construction data.

15.5.3 Shopping cart for »EASY Product Finder«



Projects can be stored in a shopping cart and then loaded to the shopping cart of the »EASY Product Finder«. This requires the configuration of the product options.

► [Product options](#) (□ 416)

- In addition to the products used in the project, also project information items are stored:
 - File name of the project
 - DSD version
 - Project
 - Date of creation
 - Date of the last change
 - Drive axis
- The *Shopping cart for »EASY Product Finder«* function requires a connection with the Internet. If necessary, the URL can be set under **Extras→Settings** in the *Network connections* area in the *URL for product configuration* field.
 - ["Network connections" register](#) (□ 43)
- Storing the current DSD project in a shopping cart file:
 - Click on the shopping cart item.
- Storing all projects opened in the DSD in a shopping cart file:
 - Execute the **Save all DSD projects in the shopping cart...** command in the **Tools** menu, or
 - click on the  icon in the toolbar.
- Loading the shopping cart file in the »EASY Product Finder«:
 - Execute the **Load shopping cart file** command in the shopping cart of the »EASY Product Finder«, select the shopping cart file of the DSD saved locally and load it.



Note!

For products that cannot be configured in the DSD, a wildcard is created in the shopping cart file. In the »EASY Product Finder« you can manually assign suitable products to the wildcards. If you have any questions regarding the product selection, please refer to your Lenze sales partner.

15.6 Reserves with regard to the drive dimensioning

In order to avoid a multiple consideration of reserves, no reserves whatsoever are allowed for in the DSD (exception: DC bus power in the multi-axis grouping).



Note!

Generally, sufficient reserves are to be provided for with regard to drive dimensionings, so that:

- the application is always under control (inverter may not run in current limitation), and the drive does not become uncontrollable if there are slight changes with regard to the load or to sluggishness.
- the drive is not operated above its rated data thermally and with regard to its service life (this particularly applies to gearboxes).

Of course, on the other hand, the reserves should not be too big, because after all this is a competitive factor possibly resulting in unacceptable price/performance ratios.

With regard to the amount of the reserves, note the comments in the following subchapters!

- The DSD supports the decision-making with regard to the reserves by displaying all utilisation degrees. However, you have to decide for yourself whether a smaller component (inverter, motor, or gearbox) still suffices.
- In order to avoid a selection of reserves that are too big, it usually is assumed that the system planner has also already provided for reserves without explicitly mentioning this.

15.6.1 Dynamic reserves

These are reserves of the inverter-motor combination with regard to the torque.

- The dynamic reserves should at least be 15 ... 25 %, so that the drive can always be controlled in a safe manner.

15.6.2 Stationary reserves

These are reserves for the rated point of the drive component, i. e. usually thermal reserves.

- The stationary reserves can turn out slightly smaller than the dynamic reserves. There are applications which can be operated with a thermal reserve of the motor of 0 %.
- Recommended values: 5 ... 15 %, depending on the application and safety relevance.

15.6.3 Speed reserves

If unlimited performance of the application is also required in the case of undervoltages, voltage drops due to long motor cables, or filters, corresponding speed reserves must be considered in the drive dimensioning.

15.6.4 Torque reserves of the motor

Dynamic torque reserves can only be accurately planned by using the M-n characteristics of the motor.

- In the selection table of the motor the requirement of the application is represented in the M-n characteristic. ▶ [Selection table](#) (📖 339)

15.6.5 Reserves for inverters, power supply modules, regenerative power supply modules

These are reserves for the maximum current $I_{\max}$ and the thermal utilisation "ixt" of the inverter.

- The $I_{\max}$ reserves should at least be 15 ... 25 %, so that the drive can always be controlled in a safe manner.
- The ixt reserves should at least be 15 ... 25 %, so that the drive works reliably and does not switch off.



Note!

Note that the dimensioning of this drive component defines the braking ability of the drive train and should not be dimensioned too tightly.

With regard to the determined DC power, the DSD already allows for 10 % of reserves, and also represents it as a requirement (incl. reserves).

15.6.6 Reserves for brake resistors and brake choppers

Brake resistors are non-critical components, so that they don't immediately fail or are switched off if the rated power is exceeded.

- If the rated power of the resistor is exceeded continuously, the temperature monitoring of the resistor can be activated and switch off the system.



Danger!

Without a temperature monitoring on the resistor, the surface temperature can reach impermissible values and possibly present an ignition source for combustible materials close-by!

The brake choppers do not feature a current monitoring.

- The maximum permissible current can be exceeded by an incorrect assignment of the brake resistor, which, however, is checked by the DSD.
- The continuous load limit of the brake chopper is also checked by the DSD.



Note!

Note that the dimensioning of this drive component defines the braking ability of the drive train and should not be dimensioned too tightly.

With regard to the determined DC power, the DSD already allows for 10 % of reserves, and also represents it as a requirement (incl. reserves).

The reserves for brake resistors/brake choppers should be at least 15 ... 25 %.

15.6.7 Reserves for gearboxes

Rated torque $M_{per,out}$ at the gearbox output end

An occasional and short-time exceeding of the rated torque $M_{per,out}$ is initially non-critical if the maximum value $< 2 \times M_{per,out}$ (planetary gearbox: $< 1.6 \times M_{per,out}$).

- However, if this happens repeatedly, the gearbox is operated in fatigue strength and the service life of the gearbox is reduced.
- In case of a gearbox, except for planetary gearboxes, the alternating load factor k_{alt} has to be considered. [Alternating load and repeated load cycle with regard to toothed gearboxes](#) (□ 375)
- The maximum value of $2 \times M_{per,out}$ (planetary gearbox: $1.6 \times M_{per,out}$) should by no means be exceeded (even if it only occurs occasionally) as the service life of the gearbox will be reduced considerably.



Stop!

Any operation in the range of the fatigue strength affects the gearbox!

If accordingly high load cycle numbers are reached, massive damage, for example tooth or shaft breaks is possible!

► [Check of the torque load](#) (□ 373)

Average input speed (thermal limit)

Exceeding the thermal limit leads to increased stress of gaskets and lubricant, which results in a reduction of the useful life.

Maximum drive speed

This value is above the average input speed. Exceeding the max. permissible input speed leads to an extremely high and damaging stress of gaskets and lubricant, which causes a significant reduction of the useful life.

15.6.8 Reserves for drive systems with an active load

The value to be set with regard to the dynamic reserves for drive systems with an active load (e. g. hoists or vertical conveyors) must not be too small, because for example hoists in the range of current limitation move downwards.



Note!

With regard to a hoist, at least 100 % of reserve should be provided for the dimensioning of the motor brake!

In DSD, motor brakes are only dimensioned as holding brakes, not as service brakes. Additional checks must be carried out manually. Notes with regard to this subject are included in the DSD protocol. The use of PM brakes must also be checked in the case of winding applications.

In the case of hoist drives (e.g. cable-guided hoists, vertical lifters via toothed belts, racks and pinions), please observe that permanent magnet holding brakes

- have a significant speed-dependent torque drop which may vary from 100 % of the characteristic braking torque at zero speed to 20 % of the characteristic braking torque.
- Cannot safely brake the drive in the lowering phase if electrical braking by means of the inverter fails. Hence, these brakes are not suitable for emergency braking. Use an additional (redundant) brake outside of the motor or a spring-applied brake.

15.6.9 Reserves for drive systems with a passive load

These applications are not so critical with regard to dynamic reserves like those for hoists or vertical conveyors.

- In order to continuously operate motion applications with a low positioning error, the dynamic reserves here also are to be at least 15 ... 25 %.
- Motor brakes do not have to have greater reserves for these applications, actually they may even be smaller than the rated motor torque.

16 Manage user motors

User motors are required for drive dimensioning if

- motors required are not available in the Lenze product range (e.g. in the power range from 90 kW to 315 kW),
- Lenze motors are to be actuated with other type data, e.g. 29-Hz motors (some 29-Hz motors are already included in the user motor database in the DSD),
- new Lenze motors are not yet included in the DSD,
- special motors are required for solving the application.

The *Manage user motors* function serves to work with user-defined motors in the DSD.

Features of user motors in the DSD

- Three-phase AC motors, asynchronous servo motors and synchronous servo motors can be created individually.
- During drive dimensioning, user motors can be selected the same way as Lenze motors.
- The coupling with Lenze gearboxes is made via flange mounting.
- Drive dimensioning with feedback system and electromechanical brake is possible. The user motor can be defined with these components.
- Some Lenze motors have already been created in 29-Hz technology by default. These motors are preferably used for winding drives.
- User motors in DSD projects of other users can be imported to DSD when the project is opened.

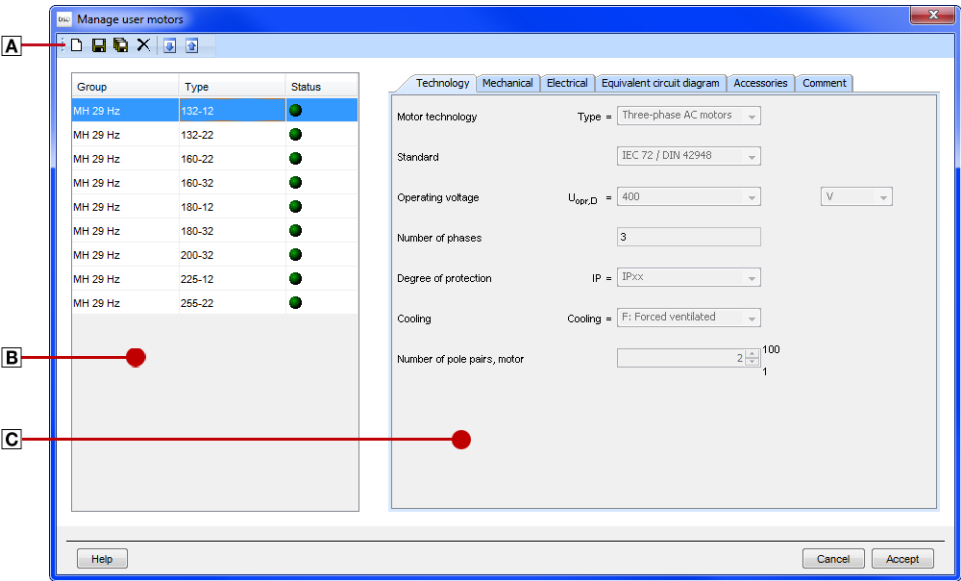


Click the  icon in the toolbar of the DSD or select the **Tools → Manage user motors...** command to open the *Manage user motors* dialog box.

16 Manage user motors

16.1 User interface

16.1 User interface



Legend	
A	Toolbar (452)
B	Management area (452)
C	Input area (453)

16.2

Toolbar

Click on an icon to carry out the respective function.

Symbol	Function
	Create a new user motor. • Creates a new data set.
	Save data set of the marked user motor.
	Save data sets of all user motors.
	Delete marked user motor.
	Export all data sets of the self-created user motors. • The data sets can be transmitted to other DSD installations. • The data sets of the supplied user motors cannot be exported. • The data sets have the file format *.mdb (Microsoft Access).
	Import data sets of self-created user motors that have been created in a different DSD installation. • The data sets have the file format *.mdb (Microsoft Access).

16.3

Management area

Display

Display	Meaning
Group	Motor designation • The designation serves the purpose of documentation and has no impact on the tests performed by the DSD. • The motor designation is shown in the selection table of the motor in the <i>Group</i> column. Selection table (📖 339)
Type	Motor type • The designation serves the purpose of documentation and has no impact on the tests performed by the DSD. • The motor type is shown in the selection table of the motor in the <i>Type</i> column. Selection table (📖 339)
Status	 The data set of the user motor contains changes that have not been saved yet. • Save data set via the command in the toolbar or in the context menu. •
	 All data of the user motor are saved in the data set.
	 The data of the user motor is not complete. • The imported data of the user motor comes from an elder DSD version where less data was required for creating a user motor. • Complete data in order that the display goes off.

Commands in the context menu

- Hold the mouse pointer over the desired user motor and press the right mouse button to open the context menu.

Menu command	Keyboard command	Function
Copy the selected data set.	<Ctrl>+<C>	Copy the data set into the clipboard.
Paste	<Ctrl>+<V>	Paste the data set from the clipboard. • The data set is always entered at the end of the motor list.
Delete the selected data set	–	Delete data set.
Save the selected data set	–	Save data set.

Change designations



How to change the designations in the fields Group and Type.

1. Hold the mouse pointer over the desired input field and double-click it.
2. Edit the designation in the input field.
3. Press the <Enter> key to accept the changes.
4. If required, press the <Esc> key to discard the changes.

16.4

Input area



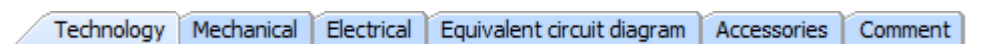
Danger!

Quality and consistency of the motor data are important for the exact calculation of the user motor.

- Have the motor manufacturer confirm the motor data and check these data thoroughly.
- Check the resulting limit characteristics, currents, voltages and frequencies for plausibility. In case of questions, contact the motor manufacturer.
- Lenze shall not be liable for any defective drive dimensioning caused by using the *Manage user motors* function.

The motor data is sorted thematically via the tabs.

- Click the tab to enter or change the respective motor data.



16.4.1 "Technology" tab

Parameter	Symbol	Description	Dimension unit
Motor technology	Type	Motor type selection: - Asynch. servo motor - Synchronous servo motor - Three-phase AC motor	
Standard	—	Standard for mounting the motor to the gearbox: - IEC 72, DIN 42948 - NEMA - No standard	
Operating voltage	$U_{opr,D}$	Supply system voltage Input voltage of the inverter	V
Number of phases	—	Only user motors for 3-phase mains connection can be created. Read only.	
Enclosure	IP	Protection type of the motor	
		IP 23 Protection against solid particles with $\varnothing 12.5$ mm and falling spraying water up to 60° against the vertical	
		IP 54 Protection against a damaging amount of dust and splash water from all sides	
		IP XX To be selected if the motor does not fulfil IP 23 or IP 54	
Cooling	—	Select cooling mode of the motor	
		S Naturally ventilated, no fan Preferred values for derating: $n_{11} = 0$, $M_{11} = M_0$	
		E, G Self-ventilated, the fan is mounted on the motor shaft (G: Cast iron fan for increased inertia) - The cooling effect decreases at low speeds - Give values for derating the torque under n_{11} and M_{11}	
		F Forced ventilated, the fan is mounted on the motor Preferred values for derating: $n_{11} = 0$, $M_{11} = M_0$	
		M_0 , M_{11} , n_{11} : "Mechanical" tab (□ 455)	
Number of pole pairs, motor	—	Number of motor pole pairs: 2-pole motor: $p = 1$ 4-pole motor: $p = 2$ 6-pole motor: $p = 3$	

Relationship between the operating voltage and the mains voltage

The table shows the assignment of the motor's operating voltage to the mains voltage which is set in the *Mains and environment* navigation step.

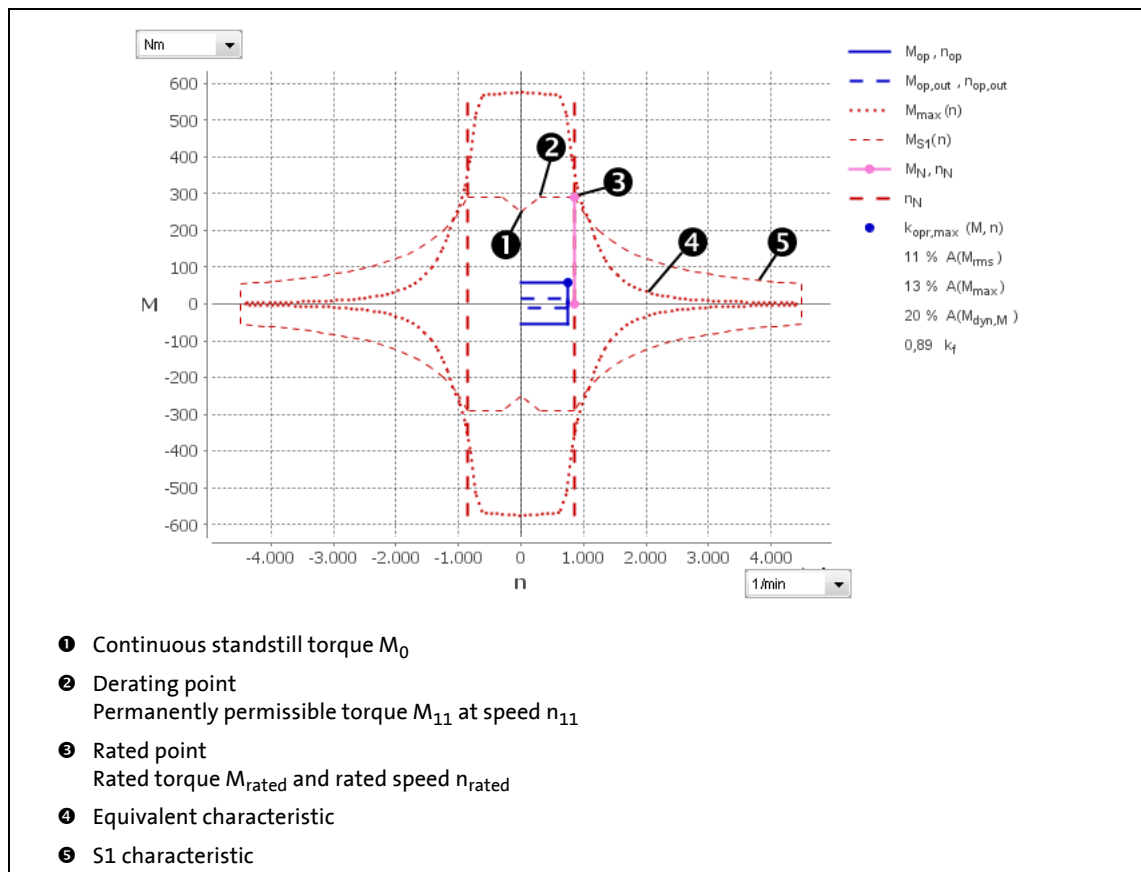
"Mains and environment" navigation step	"Technology" tab	"Electrical" tab
Electrical supply system	Operating voltage	Rated voltage
1AC 230 V 3AC 230 V	230 V	Irrelevant to the relationship between the operating voltage and the mains voltage
3AC 400 V 3AC 415 V	400 V	
3AC 480 V	460 V	

16.4.2 "Mechanical" tab

Parameter	Symbol	Description	Dimension unit
Rated speed	n_{rated}	Rated speed of the motor	rpm
Rated torque	M_{rated}	Rated torque of the motor	Nm
Rated horsepower	P_{rated}	Rated power of the motor	kW
Efficiency	η	Efficiency of the motor in its rated point	
Moment of inertia	J_M	Moment of inertia of the motor • If self-ventilated, consider moment of inertia of the fan	kgcm ²
Continuous static torque	M_0	Torque which the motor can make thermally available permanently at standstill	Nm
		Asynchronous servo motor, three-phase AC motor	
		If M_0 is missing: When $M_0 = M_{\text{rated}}$ (cooling F, S) $M_0 = 0.7 \cdot M_{\text{rated}}$ (cooling E, G)	
		Synchronous servo motor	
S1- derating (torque)	M_{11}	If M_0 is missing: When $M_0 = M_{\text{rated}}$ (cooling F, S)	Nm
		Permanently permissible torque on the derating point at speed n_{11}	
S1- derating (speed)	n_{11}	Speed on the derating point at torque M_{11}	rpm
Max. permissible speed	n_{max}	Maximum permissible motor speed • If the speed is exceeded, the motor will be destroyed	rpm
		Asynchronous servo motor, three-phase AC motor, synchronous servo motor	
		If n_{max} is missing: $n_{\text{max}} = 2.5 \cdot n_{\text{rated}}$	
Max. permissible torque	M_{max}	Magnetically and mechanically permissible motor torque	Nm
		Asynchronous servo motor, three-phase AC motor	
		If M_{max} is missing: $M_{\text{max}} = 4 \cdot M_{\text{rated}}$	
		Synchronous servo motor	
		If M_{max} is missing: $M_{\text{max}} = \frac{I_{\text{max}}}{I_N} \cdot M_N$	

Torque/speed characteristic

DSD calculates the M/n characteristic on the basis of the entered motor data and the selected inverter.



[16-1] Plausible M/n characteristic of a user motor (asynchronous motor)

16.4.3 "Electrical" tab

Parameter	Symbol	Description	Dimension unit
Rated current	I_{rated}	Current of the motor in its rated point	A
Standstill current	I_0	Permanently permissible motor current at standstill • The value is not checked	A
		Asynchronous servo motor, three-phase AC motor, synchronous servo motor	
		If I_0 is missing: $I_0 = I_{rated}$	
Max. permissible current	I_{max}	Max. permissible motor current	A
		Only asynchronous servo motor, three-phase AC motor	
		If I_{max} is missing: $I_{max} = 4 \cdot I_{rated}$	
Rated voltage	U_{rated}	Rated voltage of the motor • When the motor is connected to the inverter, the motor voltage may be lower than the rated voltage. This might cause a change of the motor performance data.	V
Wiring	—	Selection of the wiring of the motor windings	
		Y Star connection	
		Δ Delta connection	
Rated frequency	f_{rated}	Field frequency for the respective rated point	Hz
Power factor	$\cos \varphi$	Power factor in the rated operation	

16.4.4 "Equivalent circuit diagram" tab

16.4.4.1 Asynchronous servo motor, three-phase AC motor

Parameter	Symbol	Description	Dimension unit
Stator resistance	R_1	Resistance value of the stator winding • Give value for an operating temperature of 20 °C	Ω
Rotor resistance	$R_{2'}$	Resistance value of the rotor winding, with regard to the stator end • Give value for an operating temperature of 20 °C	Ω
Mutual inductance	L_h	Mutual inductance at rated operation	mH
Stator leakage inductance	L_{1s}	Leakage inductance of the stator	mH
Rotor leakage inductance	$L_{2s'}$	Leakage inductance of the rotor with regard to the stator end	mH
Iron loss resistance (optional)	R_{FE}	Resistance which represents the iron losses in the rated operation	Ω

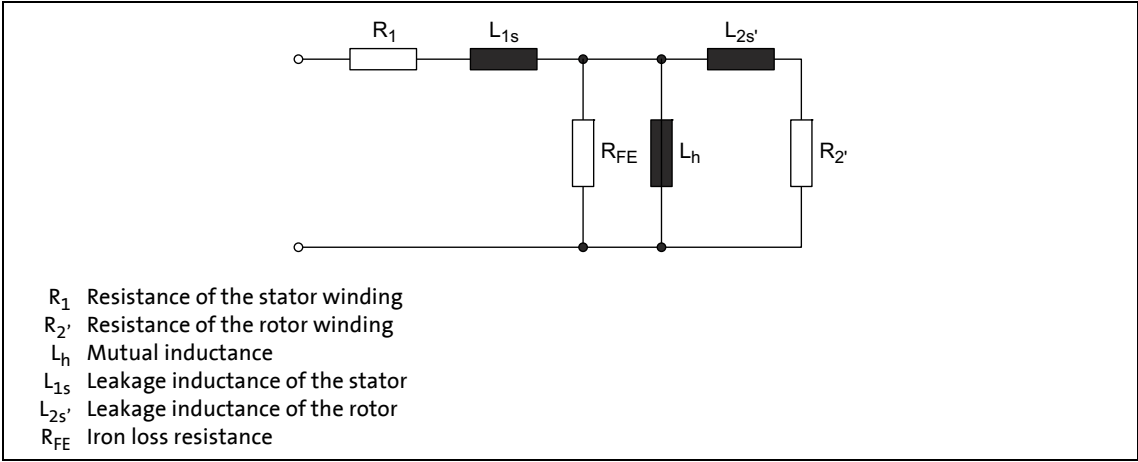
- Enter the value for a motor phase. DSD calculates with the equivalent circuit diagram of a motor phase.
- If Lenze three-phase AC motors (MD, MH, MF) and Lenze asynchronous servo motors (MCA, MQA) are listed in the Lenze parameter C00086, you can use the values from the motor table in the »Engineer«.
- The value for the iron loss resistance R_{FE} is not contained in C00086. The data is optional.
 - If no checked value is provided, always enter zero. Otherwise, a wrong characteristic occurs.
- Provide the resistance values R_1 and $R_{2'}$ for an operating temperature of 20 °C.

If operating temperatures are specified according to EN 60085 in classes of insulation, the resistance values have to be converted for an operating temperature of 20 °C. Guide values for classes of insulation are: Class B = 120 °C, class F = 150 °C. Ask the motor manufacturer for the exact values.

Calculation of R_1 (stator winding made of CU)		Calculation of $R_{2'}$ (rotor winding made of AL)
$R_1 = \frac{R_{1,iso}}{(1 + 0.0039 \cdot (\vartheta_{iso} - 20))}$		$R_{2'} = \frac{R_{2',iso}}{(1 + 0.004 \cdot (\vartheta_{iso} - 20))}$
Symbol	Description	Dimension unit
R_1	Resistance value of the stator winding at an operating temperature of 20 °C	Ω
$R_{1,iso}$	Resistance value of the stator winding at an operating temperature according to EN 60085	Ω
$R_{2'}$	Resistance value of the rotor winding at an operating temperature of 20 °C	Ω
$R_{2',iso}$	Resistance value of the rotor winding at an operating temperature according to EN 60085	Ω
ϑ_{iso}	Operating temperature according to class of insulation	°C

- If only the reactance is given for an inductance in Ohms, you have to convert the value for the entry in mH. For this purpose, the rated frequency f is required.

Calculation of inductances		
$L = \frac{X}{2 \cdot \pi \cdot f \cdot 1000}$		
Symbol	Description	Dimension unit
L	Inductance	mH
X	Reactance	Ω
f	Rated frequency	Hz



[16-2] Equivalent circuit diagram of asynchronous motor (representation for one phase)

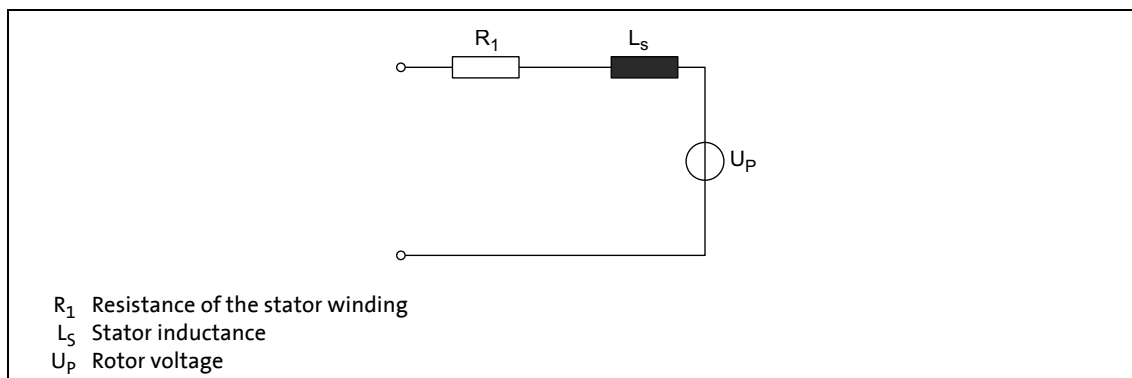
16.4.4.2 Synchronous servo motor

Parameter	Symbol	Description	Dimension unit
Stator resistance	R_1	Resistance value of the stator winding • Give value for an operating temperature of 20 °C	Ω
Stator inductance (rating)	$L_S(I_{rated})$	Stator inductance when operating at rated current	mh
Stator inductance (idle state)	$L_S(I_0)$	Stator inductance while the motor is idling and at rated speed	mh
Stator inductance (max. current)	$L_S(I_{max})$	Stator inductance when operating at max. motor current	mh

- Enter the value for a motor phase. DSD calculates with the equivalent circuit diagram of a motor phase.
- If Lenze synchronous servo motors (MCS, MDSKS) are listed in the Lenze parameter C00086, you can use the values from the motor table in the »Engineer«.
- If the two values for the stator inductance (motor in idle state, operation at max. motor current) are not given, you can enter the rated value. Then, however, saturation impacts are not taken into consideration.
- Provide the resistance value R_1 for an operating temperature of 20 °C.

If operating temperatures are specified according to EN 60085 in classes of insulation, the resistance value has to be converted for an operating temperature of 20 °C. Guide values for classes of insulation are: Class B = 120 °C, class F = 150 °C. Ask the motor manufacturer for the exact value.

Calculation of R_1 (stator winding made of CU)		
$R_1 = \frac{R_{1,iso}}{(1 + 0.0039 \cdot (\vartheta_{iso} - 20))}$		
Symbol	Description	Dimension unit
R_1	Resistance value of the stator winding at an operating temperature of 20 °C	Ω
$R_{1,iso}$	Resistance value of the stator winding at an operating temperature according to EN 60085	Ω
ϑ_{iso}	Operating temperature according to class of insulation	°C



[16-3] Equivalent circuit diagram of synchronous motor (representation for one phase)

16.4.5 "Accessories" tab

Parameter	Symbol	Description	Dimension unit
Electromechanical brake	—	Selection: • with: Motor with electromechanical brake • without: Motor without electromechanical brake	
Braking torque	$M_{N,B}$	Braking torque of the electromechanical brake • Motor without electromechanical brake: The parameter is masked out.	Nm
Moment of inertia	J_B	Moment of inertia of the electromechanical brake • Motor without electromechanical brake: The parameter is masked out.	kgcm ²
Feedback system	—	Selection: • with: Motor with feedback system • without: Motor without feedback system	

16.4.6 "Comment" tab

The input field serves to enter comments and notes regarding the user motor.

16.5 Checklist for the asynchronous motor

1. Technology

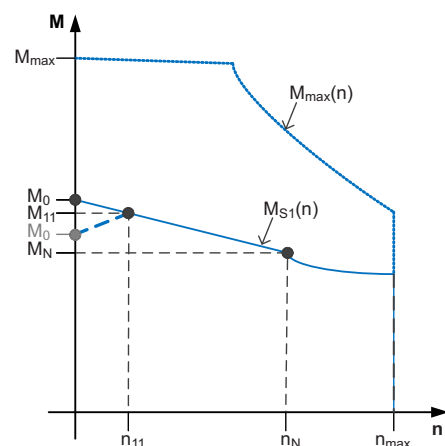
- | | | |
|--------------------------------------|---|---|
| a. Motor technology | ☐ Asynch. servo motor | ☐ Three-phase AC motor |
| b. Standard (mounted to the gearbox) | ☐ IEC 72 / DIN 42984 | ☐ NEMA ☐ No standard |
| c. Enclosure | ☐ IP23 | ☐ IP54 ☐ IP__ |
| d. Cooling | ☐ Self-ventilated ☐ Self-ventilated | ☐ Forced ventilated ☐ Grey iron fan |
| e. Operating voltage (inverter) | ☐ 1AC 230 V ☐ 3AC 415 V | ☐ 3AC 230 V ☐ 3AC 400 V |
| f. Number of pole pairs, motor | P _____ | |

Example: 4-pole motor, rated frequency $f_{\text{rated}} = 50 \text{ Hz}$

$$n_N = \frac{f_N}{2p} = 1500 \text{ }^1/\text{min}$$

2. Mechanical

- | | |
|----------------------------------|--|
| a. Rated speed | n_{rated} _____ $^1/\text{min}$ |
| b. Rated torque | M_n _____ Nm |
| c. Rated horsepower | P_{rated} _____ kW |
| d. Efficiency in the rated point | η _____ |
| e. Moment of inertia | J_M _____ kgcm^2 |
| f. Continuous static torque | M_0 * _____ Nm |
| g. S1- derating (torque) | M_{11} * _____ Nm |
| h. S1- derating (speed) | n_{11} * _____ $^1/\text{min}$ |
| i. Max. permissible speed | n_{max} _____ $^1/\text{min}$ |
| j. Max. permissible torque | M_{max} _____ Nm |



M_{11}/n_{11} : self-ventilated motor with reduced cooling at a low speed; therefore M_0 is reduced.

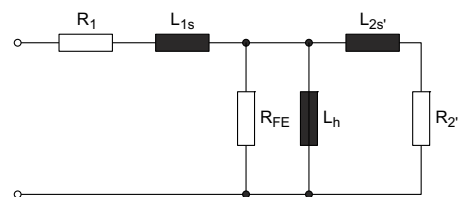
* If no information is available, set $M_0 = M_{11} = M_N$ and $n_{11} = 0$

3. Electrical

- | | |
|--------------------------------------|--|
| a. Rated current | I_{rated} _____ A |
| b. Standstill current | I_0 _____ A |
| c. Max. permissible current | I_{max} _____ A |
| d. Rated voltage | U_{rated} _____ V |
| e. Wiring | ☐ Delta ☐ Star |
| f. Rated frequency | f_{rated} _____ Hz |
| g. Power factor (in rated operation) | $\cos \varphi$ _____ |

4. Equivalent circuit diagram

- | | | |
|------------------------------------|-----------|----------------|
| a. Stator resistance | R_1 | _____ Ω |
| b. Rotor resistance | R_2' | _____ Ω |
| c. Mutual inductance | L_h | _____ mH |
| d. Stator leakage inductance | L_{1s} | _____ mH |
| e. Rotor leakage inductance | L_{2s}' | _____ mH |
| f. Iron loss resistance (optional) | R_{FE} | _____ Ω |



R_1 Resistance of the stator winding
 R_2' Resistance of the rotor winding
 L_h Mutual inductance
 L_{1s} Leakage inductance of the stator
 L_{2s}' Leakage inductance of the rotor
 R_{FE} Iron loss resistance

5. Accessories

- | | | |
|----------------------------|-------------------------------|----------------------------------|
| a. Electromechanical brake | ☐ With | ☐ Without |
| b. Feedback system | ☐ With | ☐ Without |



Note!

Specify moments of inertia of built-on accessories at the motor rotor (brakes, encoders, pulleys, etc.) separately.

6. Comment

16.6 Checklist for the synchronous motor

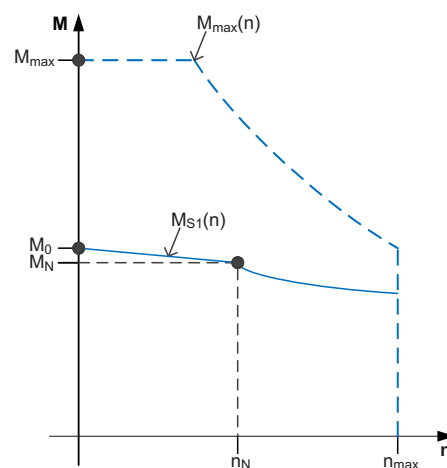
1. Technology

- | | | | |
|--------------------------------------|--|---|--|
| a. Motor technology | ☐ Synchronous servo motor | | |
| b. Standard (mounted to the gearbox) | ☐ IEC 72 / DIN 42984 | ☐ NEMA | ☐ No standard |
| c. Enclosure | ☐ IP23 | ☐ IP54 | ☐ IP__ |
| d. Cooling | ☐ Self-ventilated
☐ Self-ventilated | ☐ Forced ventilated | ☐ Grey iron fan |
| e. Operating voltage (inverter) | ☐ 1AC 230 V
☐ 3AC 415 V | ☐ 3AC 230 V
☐ 3AC 480 V | ☐ 3AC 400 V |
| f. Number of pole pairs, motor | P _____ | Example: 4-pole motor, rated frequency $f_{\text{rated}} = 50 \text{ Hz}$ | |

$$n_N = \frac{f_N}{2p} = 1500 \text{ }^1/\text{min}$$

2. Mechanical

- | | |
|----------------------------------|--|
| a. Rated speed | n_{rated} _____ $^1/\text{min}$ |
| b. Rated torque | M_n _____ Nm |
| c. Rated horsepower | P_{rated} _____ kW |
| d. Efficiency in the rated point | η _____ |
| e. Moment of inertia | J_M _____ kgcm^2 |
| f. Continuous static torque | M_0 * _____ Nm |
| g. S1- derating (torque) | M_{11} ** _____ Nm |
| h. S1- derating (speed) | n_{11} ** _____ $^1/\text{min}$ |
| i. Max. permissible speed | n_{max} _____ $^1/\text{min}$ |
| j. Max. permissible torque | M_{max} _____ Nm |



* If no information is available, set $M_0 = M_{\text{rated}}$

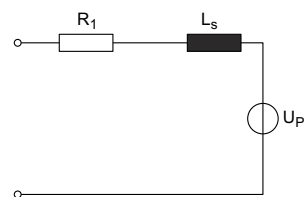
** No S1 derating for the synchronous servo motor
Set $M_{11} = M_0$ and $n_{11} = 0$

3. Electrical

- | | |
|--------------------------------------|--|
| a. Rated current | I_{rated} _____ A |
| b. Standstill current | I_0 _____ A |
| c. Max. permissible current | I_{max} _____ A |
| d. Rated voltage | U_{rated} _____ V |
| e. Wiring | ☐ Delta ☐ Star |
| f. Rated frequency | f_{rated} _____ Hz |
| g. Power factor (in rated operation) | $\cos \varphi$ _____ |

4. Equivalent circuit diagram

- | | | |
|-------------------------------------|------------------|----------------|
| a. Stator resistance | R_1 | _____ Ω |
| b. Stator inductance (rating) | $L_S(I_{rated})$ | _____ mH |
| c. Stator inductance (idle state) | $L_S(I_0)$ | _____ mH |
| d. Stator inductance (max. current) | $L_S(I_{max})$ | _____ mH |



R_1 Resistance of the stator winding
 L_S Stator inductance
 U_p Rotor voltage



Note!

If no values for the stator inductance (idle state) and stator inductance (max. current) are available, the rated value can be applied, the impact of saturation not being taken into consideration.

5. Accessories

- | | | |
|----------------------------|-------------------------------|----------------------------------|
| a. Electromechanical brake | ☐ With | ☐ Without |
| b. Feedback system | ☐ With | ☐ Without |



Note!

Specify moments of inertia of built-on accessories at the motor rotor (brakes, encoders, pulleys, etc.) separately.

6. Comment

17 Auxiliary means

With regard to the selection of the correct components, the DSD supports you by the following integrated auxiliary means:

- ▶ [Auxiliary calculator](#) (📖 467)
- ▶ [Physical coefficients](#) (📖 488)
- ▶ [MotionDesigner](#) (📖 489)
- ▶ [Lenze intranet](#) (📖 489)
- ▶ [Lenze Internet](#) (📖 490)
- ▶ [Lenze «EASY Product Finder»](#) (📖 490)

Online documentation

Further support is provided by the online documentation which is not only a mere program description, but additionally contains cross-references to the following information sources:

- Application information sheets
- Auxiliary tools (Microsoft® Excel worksheets)
- Project planning information

Print media

The following auxiliary means are also available in printed form

- Lenze formulary



Tip!

If you require personal help for the DSD, please address your responsible Lenze sales department.

17.1 Auxiliary calculator

The DSD contains different auxiliary calculators that are to support you with the determination of input values. They can be called via the **Tools** menu.

- The auxiliary calculators can also be called via buttons behind the respective input field of a parameter in the *Input area* (here encircled in red):

- A quantity determined by means of the auxiliary calculator is automatically accepted in the respective input field of the parameter.

General auxiliary calculators

The general auxiliary calculators can be called via the **Tools** menu, or directly via the icons in the *Toolbar*:

Symbol	Menu command	Description
	Tools	
	→Calculator...	► Calculator (Microsoft® calculator) (📖 469)
	→Mass calculator...	► Mass calculator (📖 470)
	→Inertial calculator...	► Inertial calculator (📖 472)
	→Gearbox calculator...	► Gearbox calculator (📖 475)

Special host computers

- The special auxiliary calculators are provided via the *Input area* for specific parameters of an application. Furthermore they can be called via the menu **Tools→Special auxiliary calculators**.

Symbol	Menu command	Description
	Tools→Special auxiliary calculators	
	→Travelling resistance	▶ "Travelling resistance" calculator (484) The calculator is also provided in the input area of the following applications: ▶ Wheel drive (106) ▶ Belt drive, rotating (72)
	→Pinion diameter	▶ "Pinion diameter" calculator (484) The calculator is also provided in the input area of the following application: ▶ Rack drive (94) ▶ Belt drive, rotating (72) ▶ Omega belt drive (83)
	→Leadscrew efficiency	▶ "Leadscrew efficiency" calculator (487) The calculator is also provided in the input area of the following application: ▶ Spindle drive (100)
	→Mass of belt	▶ "Mass of belt" calculator (482) The calculator is also provided in the input area of the following application: ▶ Belt drive, rotating (72)
	→Mass of delivery volume	▶ "Mass of delivery volume (material handling technology)" calculator (481) The calculator is also provided in the input area of the following application: ▶ Belt conveyor, bulk material (151)
	→Uniform load mass	▶ "Uniform load mass (material handling technology)" calculator (480) The calculator is also provided in the input area of the following applications: ▶ Roller conveyor (139) ▶ Chain conveyor (133) ▶ Belt conveyor, unit load (146) ▶ Belt conveyor, bulk material (151)
	→Backing force	▶ "Backing force (material handling technology)" calculator (483) The calculator is also provided in the input area of the following applications: ▶ Roller conveyor (139) ▶ Chain conveyor (133) ▶ Belt conveyor, unit load (146) ▶ Belt conveyor, bulk material (151)
	→Mass of counterweight	▶ "Mass of counterweight (hoist drive)" calculator (478) The calculator is also provided in the input area of the following application: ▶ Hoist drive with counterweight (122)
	→Mass of rope/cable	▶ "Mass of rope/cable (hoist drive)" calculator (479) The calculator is also provided in the input area of the following applications: ▶ Hoist drive without counterweight (113) ▶ Hoist drive with counterweight (122)

17.1.1 Calculator (Microsoft® calculator)**How to call the calculator:**

- Via the **Tools→Calculator...** command
- Via the  icon in the *toolbar* or in the *input area*.
- By means of the calculator, you can edit all standard operations which you carry out by using a conventional pocket calculator. The calculator carries out basic arithmetic operations, like for example addition or subtraction, as well as scientific functions, like for instance logarithms and factorials.
- The calculator is provided with an individual online help, explaining the use of the calculator to you.

17.1.2 Mass calculator

**How to call the calculator:**

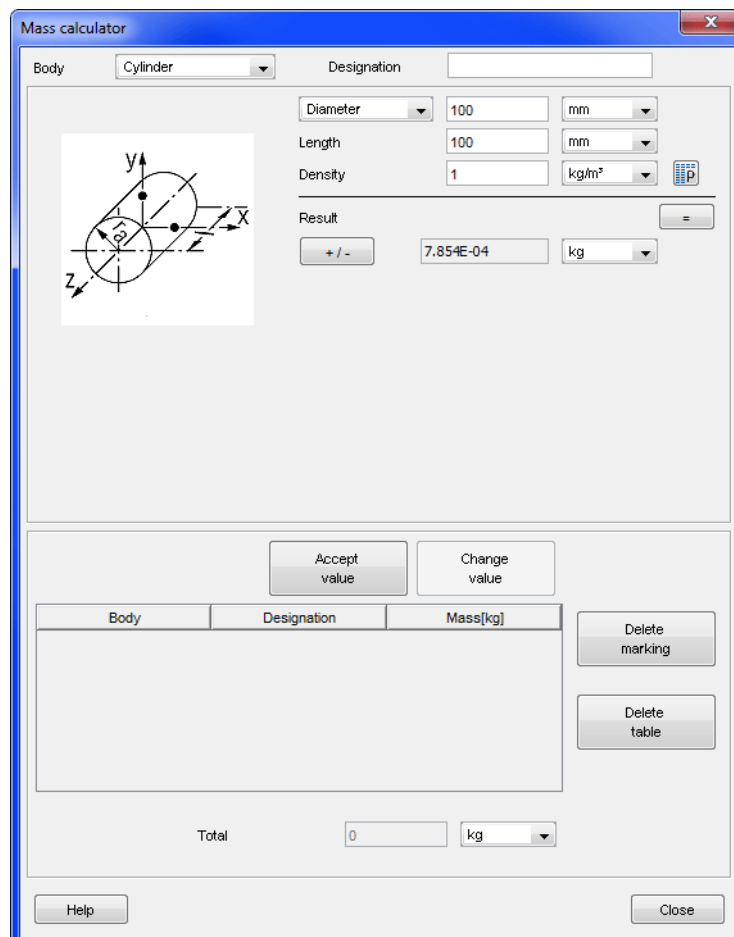
- Via the **Tools→Mass calculator...** command
- Via the  icon in the *toolbar* or in the *input area*.

By means of this mass calculator, the mass of different fields can be calculated or assessed.

- The individual values are automatically added in the table.
- By means of subtraction (negative mass value), hollow spaces or holes can be subtracted from the total field again.

**Tip!**

A glass, for instance, can be composed of the glass bottom (cylinder) and the glass wall (thick-walled cylinder), or of the outer cylinder minus the inner cylinder.



Button	Function
+/-	Switch over between negative and positive mass. • A negative mass can, for instance, be a bore that has to be subtracted from the field.
=	Display result.
	Call up density table. • In the density table, the specific weight of the most important materials is specified.
Accept value	Add the calculated value of the field to the table.
Change value	Apply changes to the field selected from the table.
Delete marking	Delete the field selected from the table.
Delete table	Delete all fields in the table
Close	Close dialog box. • Only available if the calculator is called via the <i>toolbar</i> or the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

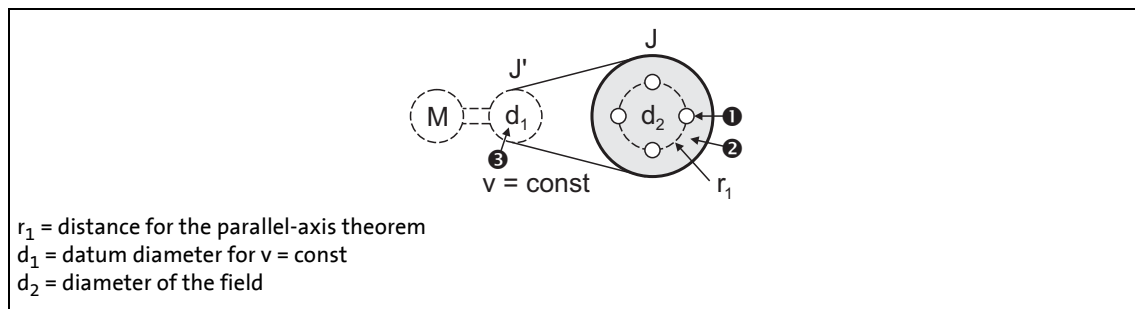
Input field	Meaning
Field	Selection of the field to be calculated. • If "Direct entry" is selected, the mass value of the field is entered directly.
Name	Name of the field • Optional input for easier identification of the individual fields.
Diameter, length, density, radius, etc.	Input parameters for the calculation • The input parameters depend on the field selected.

17.1.3 Inertial calculator

**How to call the calculator:**

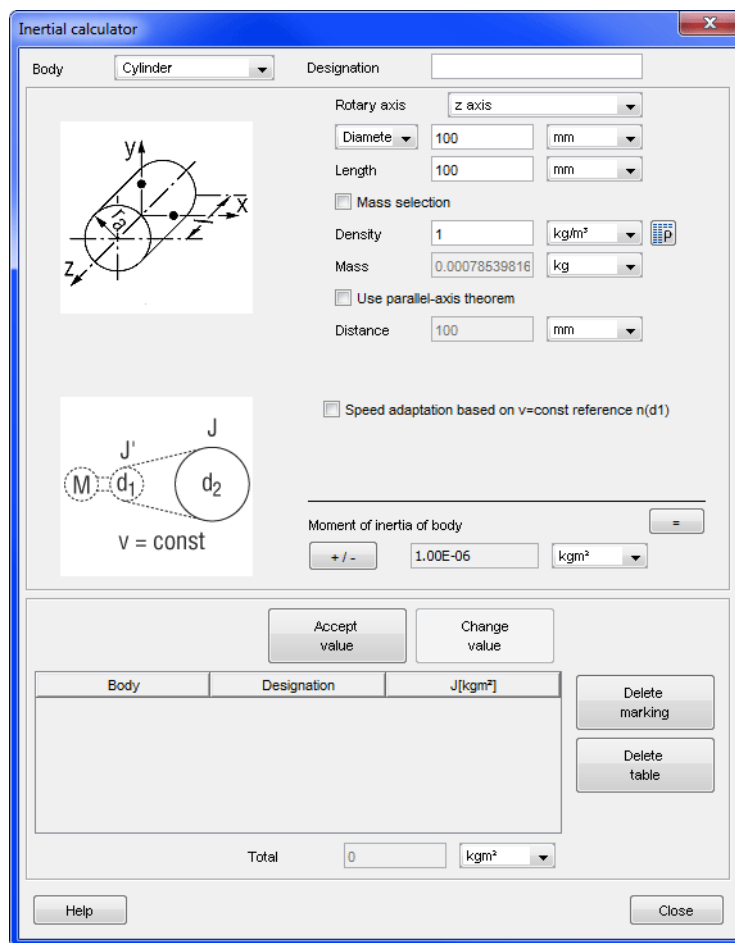
- Via the **Tools→Inertial calculator...** command
- Via the  icon in the *toolbar* or in the *input area*.

By means of the inertial calculator, the inertia of complex geometric fields can be calculated:



[17-1] Example for the calculation of a the total inertia of a belt transmission

- Fields can contain hollow spaces ❶, which in the inertial calculator are entered as fields with a negative inertia.
- If a mass is not rotated around the axis defined in the inertial calculator – as shown with regard to the hollow spaces ❶ –, but is shifted by a distance from the centre, the "parallel-axis theorem" can be used.
- Fields (e. g. belt pulley with bore ❷), rotating with a different reference speed than that of the drive speed of the motor ❸, however, featuring the same circumferential speed, can be apportioned to the motor side by means of the inertial calculator, selecting " $v=\text{const}$ ".



Button	Function
+/-	Switch over between negative and positive inertia. Required with regard to a negative mass (e. g. bore) which has to be subtracted from the field.
=	Display result.
	Call up density table. In the density table, the specific weight of the most important materials is specified.
Accept value	Add calculated inertia of the subfield to the table (to the total inertia).
Change value	Apply changes to the subfield selected from the table.
Delete marking	Delete the subfield selected from the table.
Delete table	Delete all subfields in the table.
Close	Close dialog box. Only available if the calculator is called via the <i>toolbar</i> or the <i>menu bar</i>.
Accept	Accept calculated value for the parameter and close dialog box. Only available if the calculator is called via the <i>input area</i>.
Cancel	Discard calculated value and close dialog box. Only available if the calculator is called via the <i>input area</i>.

Input field	Meaning
Field	Selection of the field to be calculated. • If "Direct entry" is selected, the mass value of the field is entered directly.
Name	Name of the field • Optional input for easier identification of the different fields.
Rotary axis, diameter, length, etc.	Input parameters for the calculation • The input parameters depend on the field selected.
Mass	When selecting the option Mass default , the mass, instead of the further input parameters, can be directly preselected for the calculation.
Distance	When selecting the option Use parallel-axis theorem , here the distance for the parallel displacement of the axes can be preselected.
d1/r1 d2/r2	When selecting the option Speed adaptation to v=const reference n(d1) , a conversion to another reference diameter/radius can be effected. • In this connection, the circumferential speed remains constant at a changing speed. • Example 1: The mass inertia of a deflection pulley/roller is to be apportioned to the driving pulley. The driving pulley and deflection pulley both feature different diameters. • Example 2: The carrying rollers of a conveyor belt are to be summed up with the drive roll and the deflection roller of the conveying belt to a combined inertia. • Example 3: As shown in fig. [17-1] , the total inertia of a belt transmission is to be calculated with regard to the output end (general ratio).

17.1.4 Gearbox calculator



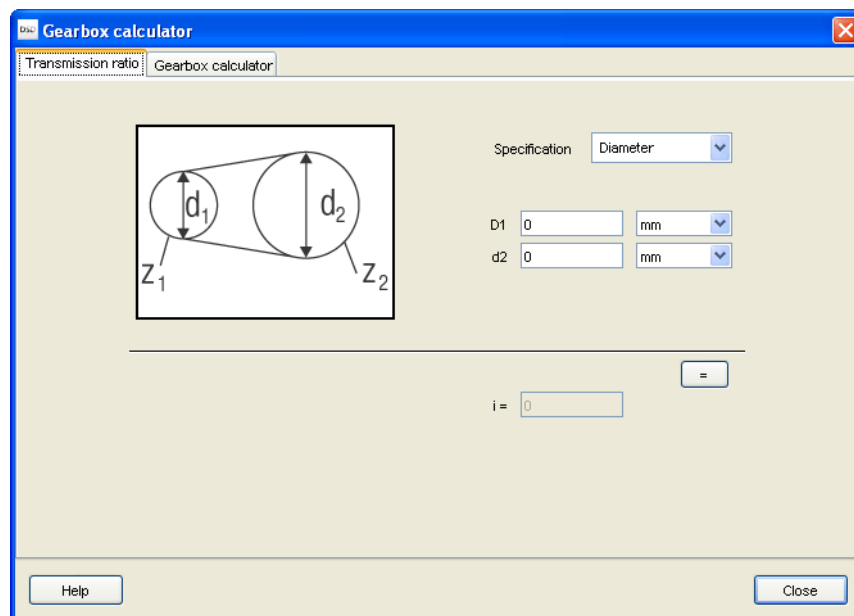
How to call the calculator:

- Via the **Tools→Gearbox calculator...** command
- Via the  icon in the *toolbar* or in the *input area*.

The calculator has two tabs.

Transmission ratio tab

On the **Transmission ratio** tab, the transmission ratio is calculated:



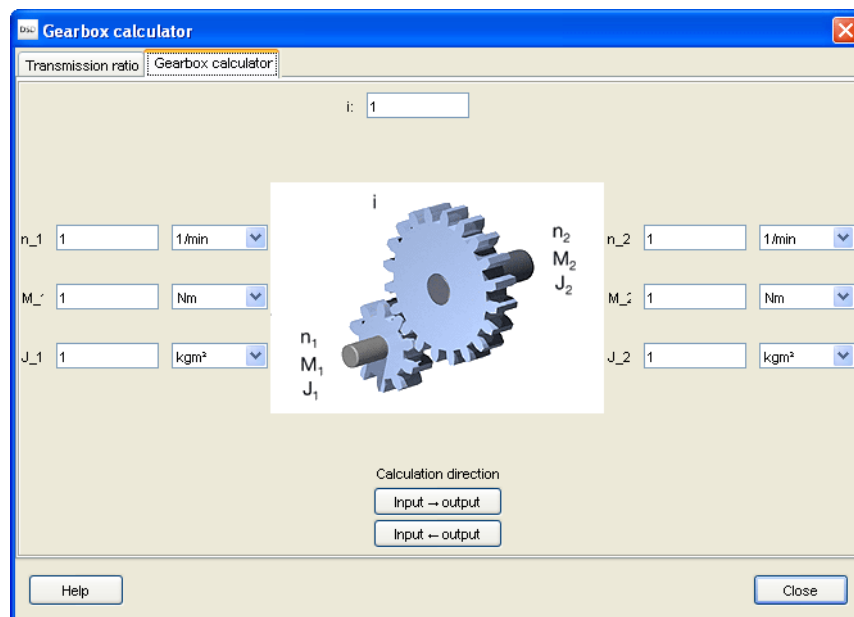
Button	Function
=	Display result.
Close	Close dialog box. • Only available if the calculator is called via the <i>toolbar</i> or the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Specification	Selection of the input (diameter or number of teeth).
d_1, d_2	Diameter presetting for the calculation • For "Diameter" presetting selection only.
Z_1, Z_2	Default with regard to the number of teeth for the calculation. • For presetting selection "Number of teeth" only.

Gearbox calculator tab

On the **Gearbox calculator** tab, torques, speeds and mass inertias are transformed from one side of the gearbox to the other.

- In order to allow for a transformation from the output end to the drive end, the desired direction of the transformation can be changed by means of two buttons. Both calculation directions, however, are only available via the toolbar when the gearbox calculator is called up. If an application is carried out, only one direction is active.



Button	Function
Drive end --> output end	Calculate result: drive end on output end. • Button only available by direct call-up via <i>Toolbar</i> .
Drive end <-- output end	Calculate result: output end on drive end.
Close	Close dialog box. • Only available if the calculator is called via the <i>toolbar</i> or the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

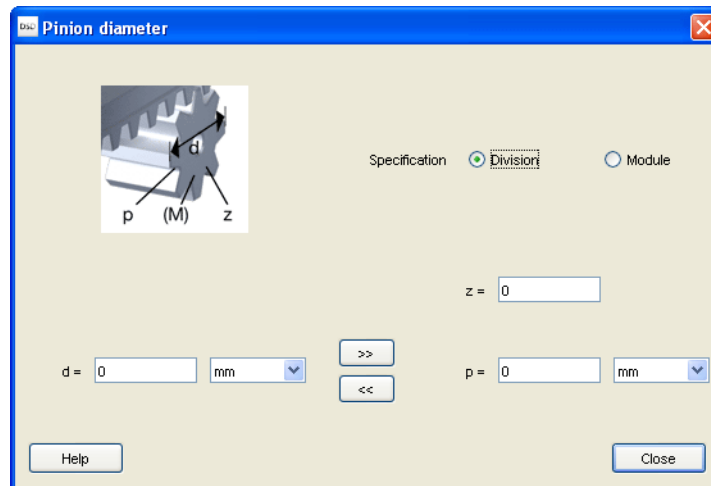
Input field	Meaning
i	Transmission ratio for the calculation
n₁	Speed at the drive end
M₁	Torque at the drive end
J₁	Moment of inertia at the drive end
n₂	Speed at the output end
M₂	Torque at the output end
J₂	Moment of inertia at the output end

17.1.5 "Pinion diameter" calculator

**How to call the calculator:**

- Via the **Tools→Special auxiliary calculators→Pinion diameter...** command
- Via the  icon in the *input area*.

The calculator serves to calculate the drive diameter of rack and pinions from the module and of belt applications from the division.



Button	Function
>>	Calculate pitch/module from the diameter and the number of teeth. • Button only available by direct call-up via <i>Toolbar</i> .
<<	Calculate diameter from the pitch/module and the number of teeth.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Specification	Selection of the calculation basis. • "Module" (toothed racks) or "Pitch" (toothed belts) are available for selection.
Z	Number of teeth of the driving pinion
P	Division
M	Module

17.1.6 "Mass of counterweight (hoist drive)" calculator



How to call the calculator:

- Via the **Tools→Special auxiliary calculators→Mass of counterweight (hoist drive)...** command
- Via the  icon in the *input area*.

With regard to hoisting applications with counterweight, the required drive power can be minimised by selecting the optimum counterweight.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Mass of the payload	Input parameters for the calculation
Mass of hoisting cage	
Reeving, counterweight	
Reeving, payload	



Note!

The DSD does not transfer values from the input area to the auxiliary calculator.

- Ensure that the values for the reeving in the auxiliary calculator correspond to the values entered in DSD to avoid incorrect calculations.

17.1.7 "Mass of rope/cable (hoist drive)" calculator



How to call the calculator:

- Via the **Tools**→**Special auxiliary calculators**→**Mass of rope/cable (hoist drive)...** command
- Via the  icon in the *input area*.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Cable density	Input parameters for the calculation
Cable length	
Cable diameter	

17.1.8 "Uniform load mass (material handling technology)" calculator



How to call the calculator:

- Via the **Tools→Special auxiliary calculators→Uniform load mass (material handling technology)...** command
- Via the  icon in the *input area*.

The calculator serves to calculate the length of expanded loads.



Tip!

For belt applications, the ["Mass of belt" calculator](#) is provided. (482)

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Weight per length	Input parameters for the calculation
Conveying length	



Note!

The DSD does not transfer values from the input area to the auxiliary calculator.

- Ensure that the value for the conveying length in the auxiliary calculator corresponds to the value entered in DSD to avoid incorrect calculations.

17.1.9 "Mass of delivery volume (material handling technology)" calculator



How to call the calculator:

- Via the **Tools**→**Special auxiliary calculators**→**Mass of delivery volume (material handling technology)**... command
- Via the  icon in the *input area*.

The calculator serves to calculate the payload of a belt conveyor based on the delivery volume.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Max. delivery rate	Input parameters for the calculation
Max. velocity	
Conveying length	

17.1.10 "Mass of belt" calculator



How to call the calculator:

- Via the **Tools→Special auxiliary calculators→Belt mass...** command
- Via the  icon in the *input area*.



Note!

For calculating the mass of the belt of an application, manufacturer data regarding the belt used are required.

Belts can be specified by using a weight standardised with regard to specific width. Relating to a width of 10 mm, e. g. the mass is given in g/m. For this type of specification, the presetting "Mass with reference width" is to be selected.

If the mass is specified for fixed belt widths relative to the length, the presetting "Mass with length reference" is to be selected instead.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Specification	Selection of the reference (width reference or length reference).
Reference width	Input parameters for the calculation • When selecting the length reference, the input parameters Reference width and Belt width are inapplicable.
Specific mass of belt	
Length of the belt	
Mass of belt	
Number of belts (parallel)	Number of the parallel running belts with the same data.

17.1.11 "Backing force (material handling technology)" calculator



How to call the calculator:

- Via the **Tools→Special auxiliary calculators→Backing force (material handling technology)...** command
- Via the  icon in the *input area*.

The calculator serves to calculate the force acting on a continuous conveyor, exerted by transported material driven against a limit stop.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Mass at limit stop	The masses driven against a limit stop
Friction factor of load on track	Friction coefficient between load and support
Angle of tilt	Angle to the horizontal β
Force through further types of friction	Force through further types of friction



Note!

The DSD does not transfer values from the input area to the auxiliary calculator.

- Ensure that the angle β in the auxiliary calculator corresponds to the angle entered in DSD to avoid incorrect calculations.

17.1.12 "Travelling resistance" calculator



How to call the calculator:

- Via the **Tools→Special auxiliary calculators→Travelling resistance...** command
- Via the  icon in the *input area*.

The calculator has two tabs.

Travelling drive tab

The calculator determines the travelling resistance of vehicles on tracks or on the road.

- The Travelling resistance is a typical quantity for a vehicle and is calculated as follows:

$F' = g \cdot \left(\frac{2 \cdot f \cdot \cos \beta}{d_{Whl}} + \frac{d_{Brg} \cdot \mu}{d_{Whl}} + c \right)$	
g	Gravitational acceleration
f	Lever arm of the rolling friction
β	Angle of tilt
d _{Whl}	Wheel diameter
d _{Brg}	Bearing diameter
μ	Coefficient of friction
c	Side friction

Travelling resistance

Wheel drive | Linear guide

Leverage of rolling friction: 0 mm

Bearing friction: 0

Wheel flange friction: 0

Wheel diameter: 0 mm

Angle of tilt: 0 °

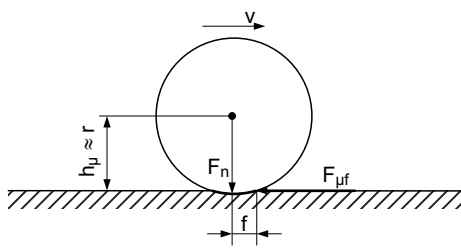
Bearing diameter: 0 mm

Specific travelling resistance: 0 N/A

Buttons: Help, Close

Button	Function
=	Calculate result.
Standard values	Resets all values in the input fields to the Lenze setting. • Button only available by direct call-up via <i>Toolbar</i> .
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Lever arm of the rolling friction	Lever arm of the rolling friction
Bearing friction	Bearing friction (coefficient)
Wheel flange friction	Lateral friction (coefficient)
Wheel diameter	Wheel diameter • For the motion drive has to be identical to the values in the input mask.
Angle of tilt	Angle to the horizontal β
Bearing diameter	Bearing diameter

	
f	Lever arm of the rolling friction
$F_{\mu f}$	Rolling friction (absolute value)
F_n	Pinch pressure of rollers
v	Speed

[17-2] Principle of the rolling friction



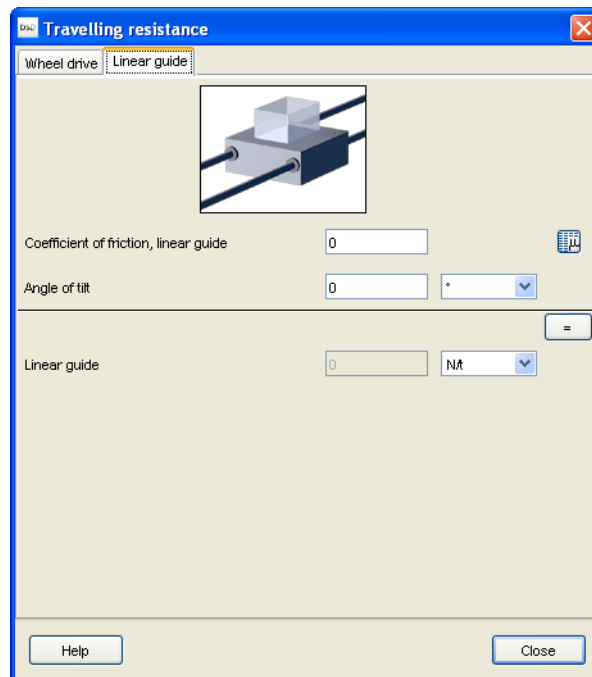
Note!

The DSD does not transfer values from the input area to the auxiliary calculator.

- Ensure that the angle β in the auxiliary calculator corresponds to the angle entered in DSD to avoid incorrect calculations.

the **Linear guide** tab

The calculator determines the travelling resistance for applications with linear guides.



Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Coefficient of friction of the guide	Coefficient of friction of the guide
Angle of tilt	Angle to the horizontal β



Note!

- The travelling resistance only contains the parts of the friction force, which depend on the mass of the application. Constant forces that are independent of the load in the motion design must be entered as counterforces!
- The DSD does not transfer values from the input area to the auxiliary calculator.
 - Ensure that the angle β in the auxiliary calculator corresponds to the angle entered in DSD to avoid incorrect calculations.

17.1.13 "Leadscrew efficiency" calculator

**How to call the calculator:**

- Via the **Tools→Special auxiliary calculators→Leadscrew efficiency...** command
- Via the  icon in the *input area*.

The calculator serves to calculate the efficiency of the spindle of a spindle drive.

Button	Function
=	Calculate result.
Close	Close dialog box. • Only available if the calculator is called via the <i>menu bar</i> .
Accept	Accept calculated value for the parameter and close dialog box. • Only available if the calculator is called via the <i>input area</i> .
Cancel	Discard calculated value and close dialog box. • Only available if the calculator is called via the <i>input area</i> .

Input field	Meaning
Leadscrew pitch	Input parameters for the calculation
Effective (frictional) leadscrew diameter	
Coefficient of friction of the leadscrew	

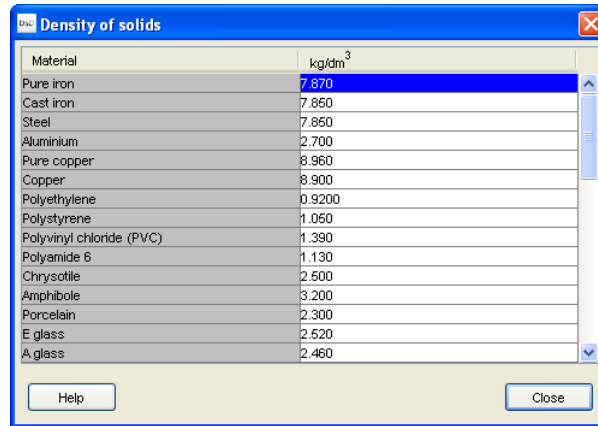
**Note!**

The DSD does not transfer values from the *input area* to the auxiliary calculator.

17.2 Physical coefficients

The DSD contains extensive value tables with physical coefficients. They are helpful when entering the values.

The following illustration shows the example of a value table.



Material	kg/dm ³
Pure iron	7.870
Cast iron	7.850
Steel	7.850
Aluminium	2.700
Pure copper	8.960
Copper	8.900
Polyethylene	0.9200
Polystyrene	1.050
Polyvinyl chloride (PVC)	1.390
Polyamide 6	1.130
Chrysotile	2.500
Amphibole	3.200
Porcelain	2.300
E glass	2.520
A glass	2.460

- You can call the value tables via the menu bar or via buttons in the corresponding position of the *Input area* and in the auxiliary calculators:

Symbol	Value table	Use in the following applications
	Density of solids	Auxiliary calculator
	Density of winding material	Winding drives
	Density of liquids	Pump
	Static friction coefficient	Line drive with simple roller Line drive with pinch roller
	Coefficient of sliding friction	Rack drive Spindle drive Slider-crank mechanism
	Coefficient of friction for rolls	Chain conveyor Belt conveyor for unit loads
	Bearing and leadscrew friction	Roller conveyor
	Wheel flange and lateral friction	
	Lever arm of the rolling friction	Roller conveyor Line drive with pinch roller
	Shunt-force factor for belt conveyors	Belt conveyor for bulk material
	Filling factor for belt conveyors	Belt conveyor for bulk material
	Efficiency of drive elements	Belt applications

**Tip!**

You miss a coefficient in the value tables? Inform your responsible Lenze sales department, so that the missing coefficient can be included in future DSD versions.

17.3**MotionDesigner**

Via the  icon in the *toolbar* or the **Tools→MotionDesigner** command, the *MotionDesigner* dialog box is called which serves to create and save translatory and rotary profiles.

- The *MotionDesigner* dialog box is also provided if no application is opened yet.
- Detailed information on the entry of a motion profile via the *MotionDesigner* dialog box can be found in the chapter "[Motion design](#)". ( 242)

17.4**Lenze intranet**

The intranet can only be accessed by Lenze employees with an access authorisation. When an intranet connection has been established you can call the following pages on the Lenze website via the **Help** menu:

- Support on the intranet (AKB)
- Version information (AKB)
- Subscribe to the AKB newsletter
 - Subscribe to the DSD newsletter to regularly receive current information on the DSD via e-mail!
- Software download
- Information on drive sizing

17.5 Lenze Internet

When an internet connection has been established, you can call the following pages on the Lenze website via the **Help** menu:

- Support on the Web (AKB)
- Search in AKB
- Version information (AKB)
- Subscribe to the AKB newsletter
 - Subscribe to the DSD newsletter to regularly receive current information on the DSD via e-mail!
- Software download
- Lenze on the Internet

17.6 Lenze «EASY Product Finder»



How to call the »EASY Product Finder«:

- Use the **Tools→Further tools (web links)→EASY Product Finder** command.
- On the Internet at <http://dsc.lenze.de/dsc>.

Advantages of the «EASY Product Finder»:

- Electronic catalog for the selection of products.
- Simple compilation of products and accessories by means of configuration.
- Comprehensive information concerning the products.
- CAD data and M-n characteristics for all established products.

18 Restrictions of the drive dimensioning

Many thousand dimensioning processes have been carried out with the DSD, during which the program has stood the test of time.

- **Important information, release notes on the DSD, and tips and tricks can be found:**
 - in the "Application Knowledge Base" (AKB) under <http://AKB.Lenze.de>
 - in the "Services & Downloads" area under <http://www.Lenze.com>.
- Also use the weblinks in the **Help** menu.
- The dimensioning includes the components gearbox, motor, inverter, encoder, electrical brake units, regenerative power supply modules, and electromechanical brakes.
- Further accessories (e. g. mains filters, automation modules, drive software) at present are not configured by the DSD yet and can for example be determined via the »EASY Product Finder«.
- Current data and features of the Lenze products can be gathered from the documentation for the respective product.

The following chapters describe restrictions with regard to the drive dimensioning by means of the DSD. In these cases the DSD does not carry out checks, or only to a limited extent. You have to carry out the checks manually.

18.1

Field weakening



Note!

Only relevant for drive systems which are to be operated above the rated speed ($n_{\max} > n_{\text{rated}}$).

- Typical applications for this are: winding, traverse and infeed drives with rapid feed under partial load!
- DSD outputs a message when the field weakening operation is reached:
 - Synchronous motors: $n_{\max} > 2.0 \cdot n_{\text{rated}}$
 - Asynchronous motors: $n_{\max} > 5.0 \cdot n_{\text{rated}}$

Changes in the dynamic behaviour of the motor in the field weakening operation are not checked in the DSD.

18.2 Worldwide mains voltages and supply forms

The DSD contains mains voltages and supply forms existing worldwide. Depending on the selection that has been made, the DSD automatically assigns the available solution space of inverters.



Note!

For inverters which are operated on mains with "3 AC, 415 V" < $U_{\text{mains_rated}} \leq$ "3 AC, 500 V" (e. g. Canada, Taiwan, or operating networks with special voltages):

The dimensioning can also be carried out with the setting "3 AC, 400 V", "3 AC, 415 V" or "3 AC, 480 V" in the DSD. However, if the voltage deviates, the application must be checked manually with reduced current values of the inverter in the end!

See also:

► [Mains and environment](#) (📖 295)

18.3 Undervoltages: Impact on operational performance

The effects of undervoltages (e. g. "3 AC, 400 V" - 10 %) on the available device output voltages and thus on the motor M-n characteristics is not yet automatically included by the DSD.

18.4 Highly dynamic applications with acceleration times < 50 ms



Note!

Only relevant for highly dynamic applications with acceleration times < 50 ms, e. g. Motion Control applications for which highly dynamic motion profiles with a low following error have to be traversed!

See also: [Minimum acceleration and deceleration times](#) (📖 281)

The rise time of the drive system (results of the reference input variable) is increasingly noticeable with regard to extremely short accelerations and is taken into consideration.

The rise time depends on the type of inverter that is used, on the motor, and on the control process. Often simulations of the process are required to check the feasibility of such applications, or data or experience is available.

- The DSD checks all relevant physical parameters, irrespective of the shortness of the acceleration time.
- The rise time of the inverters used are not checked by the DSD.
- Additionally, the response times of field buses and master controls are to be regarded.

18.5 Feedback systems

Selection criteria like for example accuracy, resolutions, limit frequencies, max. permissible speeds, are not taken into consideration by the DSD.

The limit frequency at the inverter input can be exceeded if the feedback system outputs a too high pulse frequency due to the combination of number of increments and max. speed. A check in the DSD does not take place.

- The compliance with these criteria must be checked manually.

18.6 Mechanical brakes for winding drives

Due to high moments of inertia and high material speeds, rotating reels may store high amounts of kinetic energy which must be dissipated quickly in the event of an emergency stop. Only effective and sufficiently dimensioned electrical, electromechanical brakes and sometimes also mechanical brakes are able to dissipate these energies. A combination and coordination of multiple braking systems is possible.

- Winding drives must be equipped with at least one brake assembly, either as motor brake or independent separate brake, which is able to safely brake the drive with a defined frequency and a defined braking distance in the event of an error.
- For very high moments of inertia and speeds, we recommend to additionally use e.g. disc brakes to unload the drive during the braking phase. The additional brake can act as redundant system at the same time.
- The brake control must be carried out on two channels.
- For a drive dimensioning with electromechanical motor brake, DSD calculates the brake as holding brake with a certain reserve. The reserve factor is indicated in the dimensioning protocol. In addition, the motor brake must be dimensioned as service brake, under consideration of the max. permissible friction energy of the brake.

Permanent magnet holding brake

Permanent magnet holding brakes have a reduced braking torque at higher speeds (speed-dependent torque drop). At zero speed, the torque may drop down from 100 % to 20 % of the characteristic braking torque.

If the brake features a safety-relevant function, you must not use a permanent magnet holding brake as a service brake.

- In case of an emergency (electrical braking by the inverter fails), the drive is not braked safely.
- Either use an additional brake assembly outside of the motor or a motor with spring-applied brake.
- A service brake must be dimensioned and checked manually. DSD only dimensions a motor brake as holding brake, not as service brake.

18.7

Saturation effects in the motor at $> 200\% M_{\text{rated}}$ **Note!**

Only occurs with regard to dynamic overcurrents $>$ approx. 200 ... 250 %.

If motors are operated above a rated current of approx. 200 ... 250 %, the torque for synchronous motors no longer increases proportionally to the current, or in the case of asynchronous motors no longer follows the equations stored in the DSD.

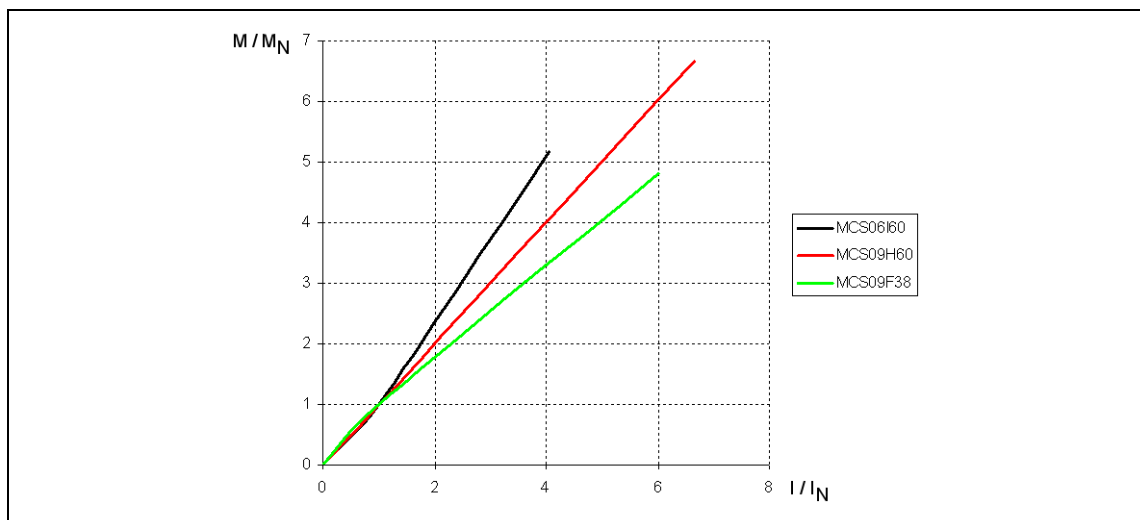
- This effect is considered in DSD.
- DSD generates a "note" if the value of 400 % is exceeded and indicates that the thermal utilisation of the motor and inverter and an increased current requirement of the inverter result from this.

Effect for synchronous machines (SM)

For SM, the ratio of torque to current (k_T) is an important parameter. However, this ratio is non-linear at high loads and strong speed variations.

Two different effects occur:

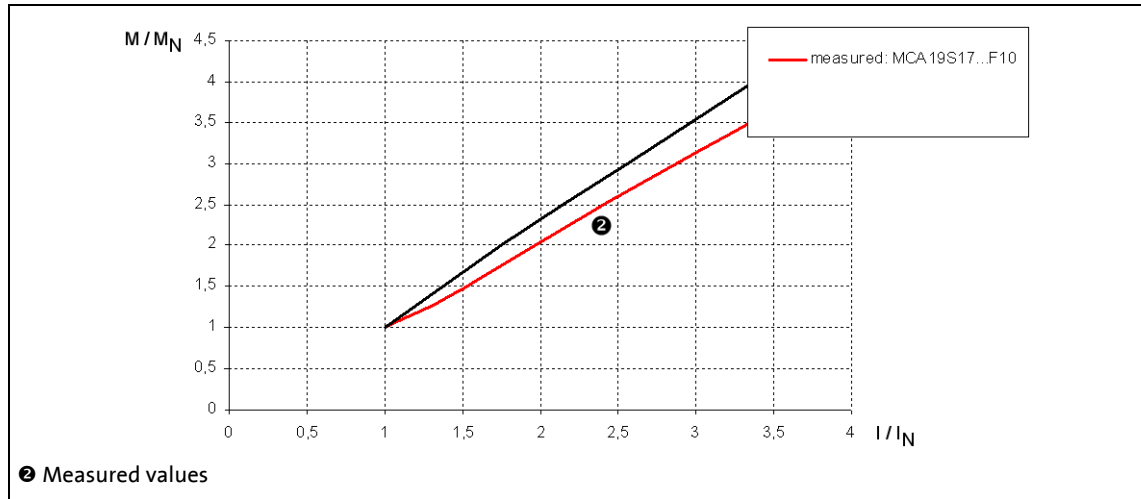
- Saturation of iron parts at high currents.
- Speed-dependent, inexact image of the real motor in the motor management of the inverter.



[18-1] Torque-current ratio by means of the example of MCS synchronous servo motors

Effect for asynchronous machines (ASM)

For asynchronous machines, the current is calculated from a complex current model. Here, both saturation effects and voltage drops in the inverter are considered. The calculations in DSD may be assumed adequately accurate up to a quadruple overload of the motor.



[18-2] Torque-current ratio by means of the example of an MCA asynchronous servo motor

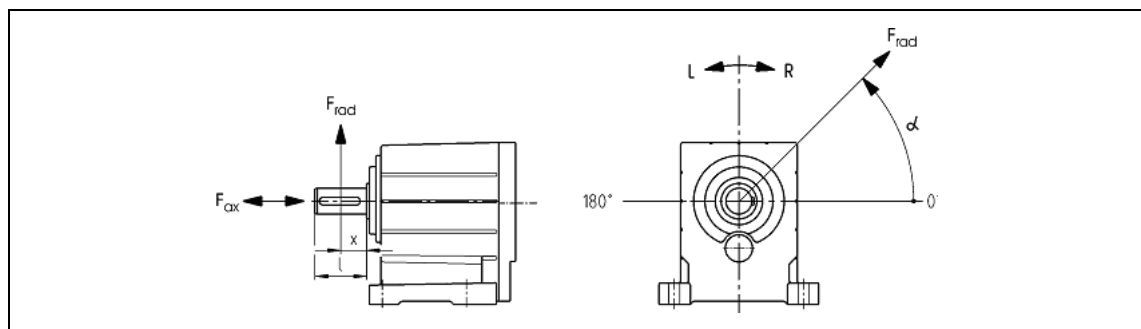
18.8

Radial and axial loads of the motor or gearbox shaft**Note!**

Only relevant for motor shafts or gearbox shafts that are connected to the load machine via belts or chains!

Dependent on the mechanical design, radial (e.g. for belt outputs) and axial forces can act on the motor or gearbox output shaft.

- The permissible limit values can be found in the catalogue of the component.



[18-3] Radial and axial loads in the case of a helical gearbox

18.9

Service brake, holding brake with safety function**Note!**

Only relevant for motors that are repeatedly stopped from full speed via the electromechanical motor brake!

As a general rule, these are motors directly connected to the mains in start-stop operation, or brakes in variable-speed drives for emergency-off processes, which are activated more frequently!

The dimensioning of the electromechanical brake on the motor shaft is carried out according to the required holding torque of the application as a pure "holding brake" at standstill.

- The function of the brake as "service brake", i. e. the cyclic stopping of the rotating motor shaft from full speed under normal operating conditions is not checked by the DSD.
- The requirement for a holding brake with safety function also recurrently used for emergency-off purposes for controlled and uncontrolled drives, is not checked by the DSD..
- For these functions, in addition to the torque check, further dimensioning steps are required additionally, which are to be gathered from the brake catalogues.

18.10

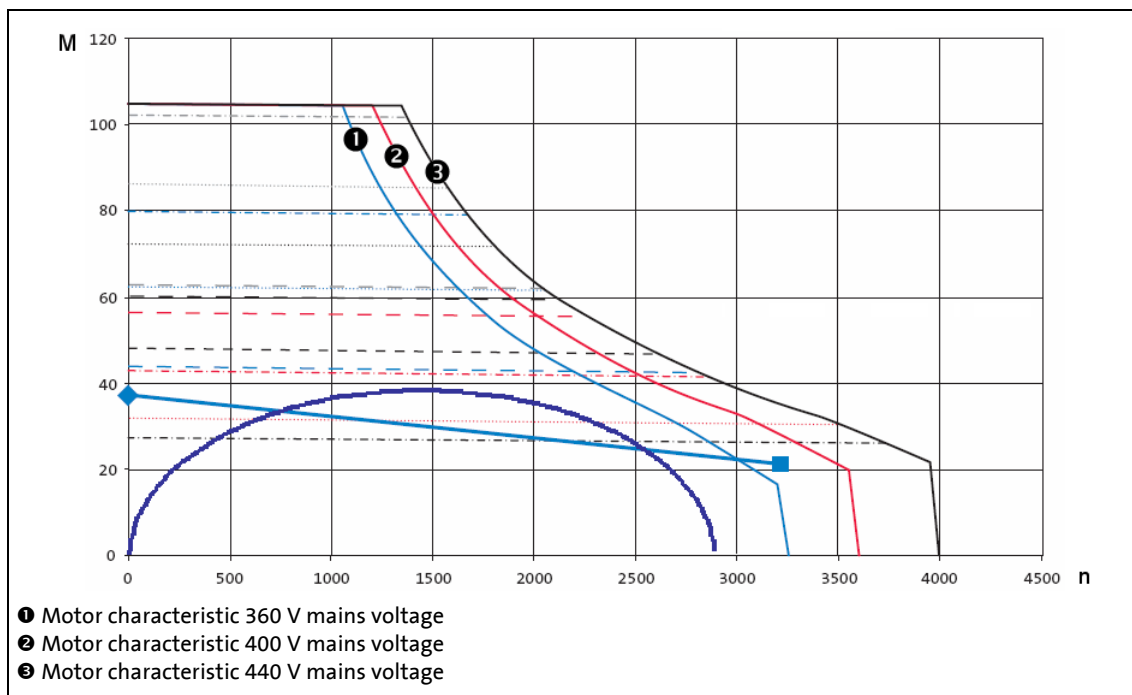
Displacement of the M-n characteristic

**Note!**

Only relevant for inverter-motor combinations which are not adjusted to each other as regards voltage (output voltage of inverter < motor voltage).

If the max. available output voltage on the inverter is lower than the rated motor voltage, field weakening already starts below the rated motor speed.

- The output voltage on the inverter depends on the mains voltage.
- Depending on the max. output voltage on the inverter, the available torque decreases.
- In overboost operation ($M > M_N$), this effect is particularly distinctive.
- Possible causes are:
 - Mains undervoltage
 - Voltage drop on filters, chokes. The components are only considered in DSD if they are mandatory for operation.
 - Voltage drop on long motor cables
 - The operating voltages of the inverter and motor ($U_{\text{mot}} > U_{\text{mains}}$) are not optimally assigned, e. g. 460 V motor on the inverter with 400 V mains supply.



[18-4] Maximum and continuous torques

18.11 Maximum permissible motor cable length



Note!

Only relevant for motors that are connected to the inverter by means of a long motor cable (> 50 m).

The length and type of the shielded motor cable that is used (PE/PVC cable, capacitance per unit length of the cable) has an impact on the value of the capacitive earth leakage currents to be expected. These leakage currents have to be additionally provided by the inverter. Therefore there is a maximum permissible motor cable length which can be found in the Operating Instructions of the inverters.

- The maximum permissible length also depends on the power of the respective inverter and is 50 m.
- The maximum possible motor cable length can be increased by means of filters in the motor cable (permissible for inverters only).
- Also the encoder system used can require limitations where the maximum permissible length is concerned.

18.12 Effects of low switching frequencies on the motor

DSD takes the impact of the switching frequencies on the inverter into consideration.

- DSD checks the effects of low switching frequencies on the motor assuming that the switching frequency only decreases below 4 kHz for a short time. The effects have to be checked manually.

Motor type	Operation on inverters with switching frequencies $f_{ch} < 8$ kHz
MDFQA 100, 112, 132, 160	Effects • If $f_{ch} = 4$ kHz, the motor only provides approx. 95 % of its rated torque continuously. • If $f_{ch} = 2$ kHz, the motor only provides approx. 85 % of its rated torque continuously. • Increased noise emission.
MQA 20, 22, 26	Effects • If $f_{ch} = 4$ kHz, the motor only provides approx. 95 % of its rated torque continuously. • If $f_{ch} = 2$ kHz, the motor only provides approx. 85 % of its rated torque continuously.
MCA 20, 22, 26	

18.13 Motor temperature monitoring acc. to UL 508C

UL 508C describes special requirements for the thermal protection of motors. Carry out one of the following measures to comply with these requirements:

- I^2t motor temperature monitoring. Here, the torque must be reduced for low motor speeds first (derating).
- Motor temperature encoder and evaluation in the inverter must be approved acc. to UL 508C.

 I^2t motor temperature monitoring

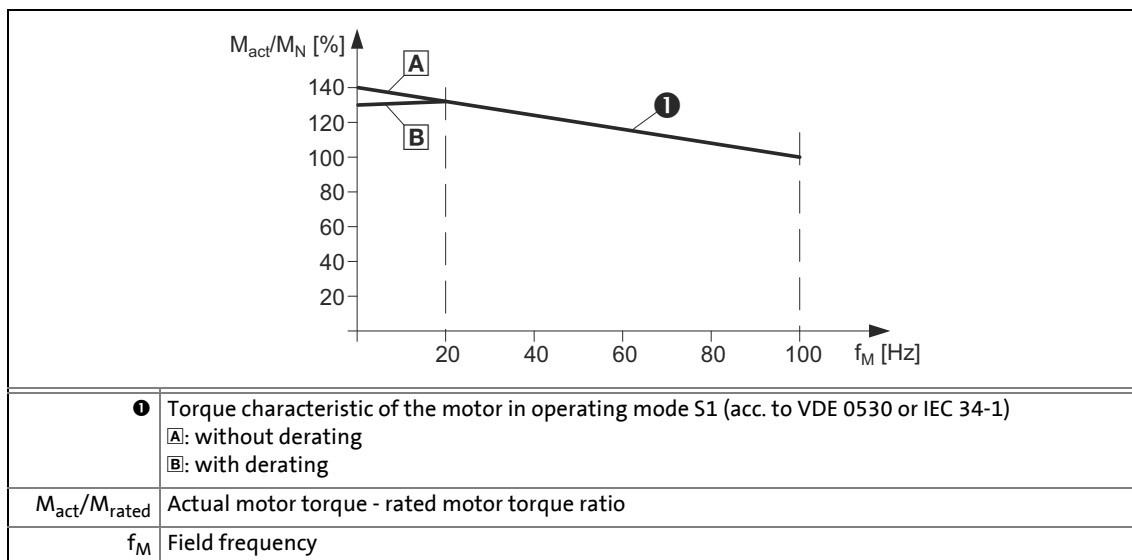
Independent of the type of ventilation (forced ventilated, self-ventilated or naturally ventilated), the following torque limitation must be complied with:

For $f_M = 0$ Hz (standstill): $M/M_{rated} < 100\%$

For $f_M = 20$ Hz: $M/M_N = 100\%$

The limitation means a derating of the motor torque. Depending on the type of ventilation of the motor, the following derating is required:

- Self-ventilated motor
 - No measures required. The available derating curves comply with the requirements.
- Forced ventilated motor
 - For $f_M = 0 \dots 20$ Hz: Limit actual torque M_{act} to $99\% M_{rated}$.
- Naturally ventilated motor
 - For $f_M = 0 \dots 20$ Hz: Limit actual torque M_{act} to $99\% M_{rated}$.
 - For $f_M > 20 \dots f_{rated}$: Limit actual torque M_{act} to $100\% M_{rated}$.



[18-5] Torque characteristic of the motor with/without derating

18.14 Operation of inverters on the earth-leakage circuit breaker**Note!**

Only relevant for inverters which are to be connected to an earth-leakage circuit breaker.

If an inverter is operated on an earth-leakage circuit breaker, a false tripping can occur due to capacitive earth leakage currents.

- This has to be observed in particular when earth-leakage circuit breakers with a fault current of 30 mA are used.
- In the case of earth-leakage circuit breakers with a fault current of 300 mA this is less critical, however, it should be checked.
- Universal-current sensitive residual current circuit breakers may be used only.
- Further information on this can be found in the *Application Knowledge Base*.

18.15 Qualitative requirements with regard to the application**Note!**

Is valid only if accuracies have to be quantified!

Currently the DSD does not check yet whether qualitative requirements with regard to the application, like for example speed, torque, angle, and positioning accuracy, and the concentricity factor and torque setting ranges can be implemented.

- This check is to be effected manually, if required.

18.16 System disturbances**Note!**

Relevant for all applications!

When inverters are operated on the mains, low- and high-frequency system perturbations occur.

- The low-frequency system perturbations are limited by upstream mains chokes.
- The high-frequency system perturbations (EMC) are limited by upstream RFI filters of class C2 for industrial purposes, or C1 for residential areas.
- The dimensioning of these upstream elements currently is not integrated in the DSD yet and has to be carried out in the »EASY Product Finder« or manually by means of the documentation for the respective device.

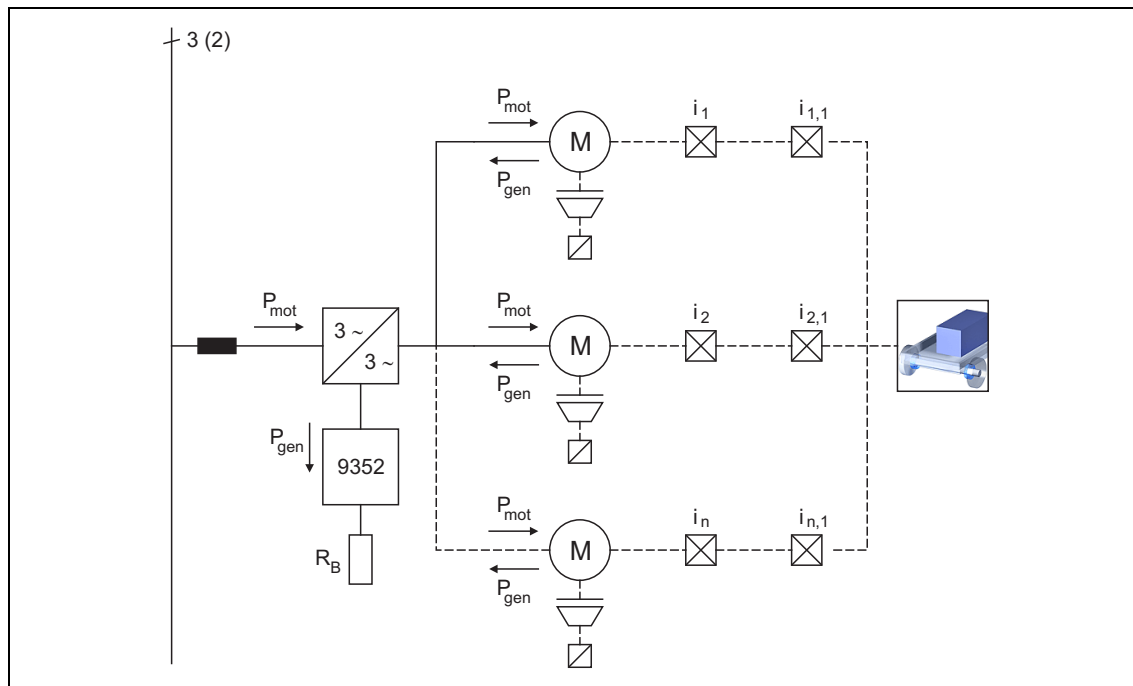
18.17

Parallel operation of several motors on one inverter (group drives)

**Note!**

Relevant only for specific applications, e. g. hoists, winders, caterpillar take-offs, pumps and power conveyors.

Such a dimensioning at present is not yet supported by the DSD.



[18-6] Group drives

Remedy

When entering the data in the DSD, divide the masses, moments of inertia, and tensile forces or counterforces by the number of motors involved in the application (applies to the motor and gearbox selection). The inverter in this case has to be selected manually, since it has to operate the sum of the motors.

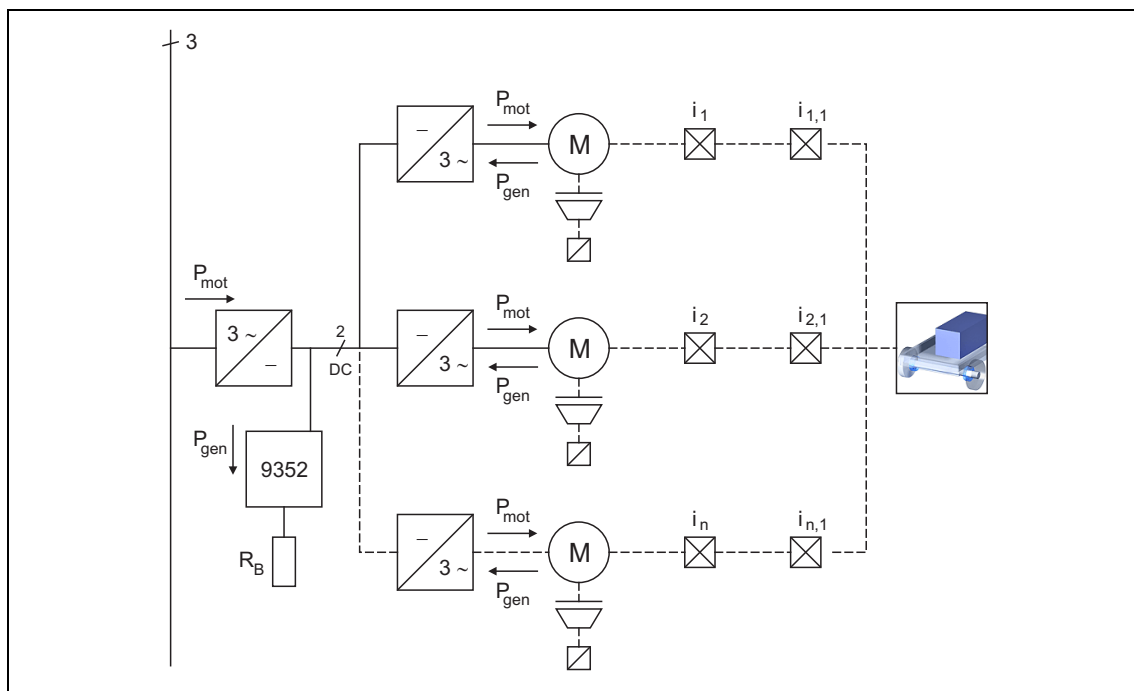
18.18 Parallel operation of several motors on several inverters



Note!

Only relevant for specific applications, e. g. caterpillars and omega belt drives.

At present this application cannot be dimensioned by the DSD.



[18-7] Parallel operation of several motors on several inverters

Remedy

When entering the data in the DSD, divide the masses, moments of inertia and tensile forces by the number of motors involved in the application (only if all drives are identical). Like this a train can be calculated completely.

18.19 ATEX for gearbox



Note!

Relevant only for use in potentially explosive atmosphere!

Such a dimensioning at present is not supported by the DSD.

Remedy

Configure ATEX gearbox with the »EASY Product Finder«.

18.20 Applications with low field frequencies

Low output frequencies are to be expected in particular if the motor is loaded at standstill or at very low speeds ($f_d < 1$ Hz).

- During longer operation in this range, inverter and motor may be thermally overloaded.

18.21 Emergency-off scenarios

For specific applications, information is required on how fast the drive can be stopped in emergency situations under defined conditions.

- This calculation currently is not yet integrated in the DSD.

**Tip!**

Emergency stop scenarios can be calculated with the *Application Tuner* by changing the motion profile with the emergency stop times. That way, you can check whether the drive will still be able to handle the emergency stop scenarios. [Application Tuner](#) (□ 57)

18.22 Switching in the motor cable

**Note!**

Relevant for all inverters, in particular for frequency inverters!

This check has to be carried out manually:

If several motors are operated parallel at the output of an inverter (group drives), and if they are switched via contactor while a current is applied, further checks have to be carried out.

18.23 Filter in the motor cable

**Note!**

Only relevant for frequency inverters, filters may not be used for servo inverters!

Reasons for the use of filters in the motor cable:

- An increase of the maximally permissible cable length.
- Avoiding the use of shielded motor cables.
- Protection of the motor winding against too high speeds for voltage rises.

The filters are to be dimensioned manually or using the »EASY Product Finder«.

18.24 Application of bearing current chokes**Note!**

Only relevant for inverters > 15 kW!

- Lenze servo motors of the MQA series are already equipped with insulated bearings and insulated encoders. In this way, bearing currents are completely avoided.
- For the m850, MCS and MCA servo motors, so far no necessity for insulated bearings or for the use of bearing current chokes has been established by field observation.
- The three-phase application motors imply the possibility of providing for insulated bearings and insulated encoders from frame size 200 for an additional charge on request. Below the frame size 200, up to now no necessity for insulated bearings or for the use of bearing current chokes has been established by field observation.

This check additionally is to be carried out manually:

Under specific conditions it may be required to use bearing current chokes from a specific motor output (approx. > 15 kW) for preventing premature bearing failures.

18.25 Improved motor control with temperature detection

If the SC control mode (servo control) is used, we recommend using motors with a linear motor temperature sensor (KTY/PT1000).

If the temperature is detected via a linear motor temperature sensor (KTY/PT1000), the motor control is able to evaluate the signal of the thermal sensor. In this way, the control properties are improved.

- The torque performance is independent of the motor temperature.
- The motor always provides the optimal torque.

18.26 Cooling servo motors without gearbox via mounting flange

If naturally ventilated motors of the MCS series are used, a most of the heat must be dissipated via the mounting flange. If this process is neglected, the motor becomes impermissibly hot if operated with rated data. If a geared motor is used, the heat is reliably dissipated via the housing of the gearbox.

A motor without gearbox must be mounted to a thermally conductive/isolating plate or chassis. The operation with rated data is permissible if a mounting plate is used which complies with at least the following requirements:

- The plate is made of steel and the heat of the steel plate is dissipated through free convection.
- The dimensions of the steel plate are
 - 270 × 270 mm for MCS06,
 - 330 × 330 mm for MCS09,
 - 450 × 450 mm for MCS12/14/19.

18.27 Permanent load at low motor speeds for applications acc. to UL

For machines and plants with UL approval, a special thermal protection for motors may be required. Advanced thermal protection acc. to UL 2111 (standard for overheating protection for motors) is achieved by two measures:

- A. Activated I^2t monitoring in the inverter.
- B. Thermal encoder with UL approval. In addition, the temperature evaluation in the inverter must comply with the requirements acc. to UL.

If the I^2t monitoring in the inverter is used, the permanent torque of the motor must be reduced at low speeds (derating).

- Naturally ventilated and forced ventilated motors:
 - Reduce the torque to 99 % of the rated torque in a frequency range of 0 ... 20 Hz.
- Self-ventilated motors:
 - For low frequencies, the torque must comply with the values provided by the characteristic curve (M-n characteristic) of the motor.

19 Drive sizing messages

The following chapter describe warning signals, notes and tips that are useful for drive dimensioning.

19.1 Application

19.1.1 Ratio of the tensile forces $F_{in} / F_{out} > \text{limit value}$



Note!

The ratio of the tensile forces F_{in} / F_{out} is xxx. Thus the limit value of yyy is exceeded.

Cause	Effects	Possible remedies
The Static friction on the interface of the roll to the material is not sufficient to transmit the difference of forces.	The roll slips.	• Increase tension on output side F_{out}. • Reduce tension on input side F_{in}. • Increase wrap angle. • Improve static friction.

19.1.2 Ratio of the tensile forces $F_{out} / F_{in} > \text{limit value}$



Note!

The ratio of the tensile forces F_{out} / F_{in} is xxx. Thus the limit value of yyy is exceeded.

Cause	Effects	Possible remedies
The Static friction on the interface of the roll to the material is not sufficient to transmit the difference of forces.	The roll slips.	• Increase tension on output side F_{out}. • Reduce tension on input side F_{in}. • Increase wrap angle. • Improve static friction.

19.1.3 Difference of the tensile forces $F_{in} - F_{out} > \text{limit value}$



Note!

The difference of the tensile forces $F_{in} - F_{out}$ is xxx. Thus the limit value of yyy is exceeded.

Cause	Effects	Possible remedies
The Static friction on the interface of the roll to the material is not sufficient to transmit the difference of forces.	The material slips through.	• Reduce the force difference between the input and the output ($F_{in} - F_{out}$). • Increase contact pressing force. • Improve static friction.

19.1.4 Speed of the application = 0 (standstill)


Stop!

The speed of the application is xxx min^{-1} .
With this value, dimensioning is not possible.

Cause	Effects	Possible remedies
The velocity or speed entered is 0. This is not a valid operating status for the dimensioning.	This leads to subsequent conflicts if a motor with a gearbox is selected, because the calculation of the transmission ratio will involve a division by zero. If a motor without a gearbox is used it is possible to continue, since only the holding moment has to be derived.	Enter a non-zero velocity value speed value.

19.1.5 Safety check of controller inhibit failed


Warning!

Controller inhibit was activated although a torque from the drive is available.

Cause	Effects	Possible remedies
Brake has not been activated.	- Drive is unguided with inhibited controller. - Drive moves in an uncontrolled way.	Deactivate controller inhibit, or activate brake.

19.1.6 No values available for the torque of the application


Stop!

The data imported or entered do not contain any values for the torque!
Without values, dimensioning is not possible.

Cause	Effects	Possible remedies
The application does not generate any torque. If no torques or forces are specified or imported and no frictions or accelerations are specified for masses or mass inertias, the calculation of the application torque results in 0 Nm.	For this drive dimensioning, the DSD needs the corresponding process parameters. Dimensioning without these parameters is not possible.	Check entered values or imported motion profile.

19.1.7 Parameter of the motion profile is not evaluated


Note!

The motion profile contains the parameter "xxx".

The parameter is not required for the application and thus not evaluated.

Cause	Effects	Possible remedies
The opened motion profile contains a parameter that does not appear in the selected application.	DSD ignores the parameter in the calculation of the motion profile.	• Select an application in which the parameter appears. • Correct the motion profile.

19.1.8 Utilisation of the DC busbar system is xxx %


Note!

In the worst case, the utilisation of the DC busbar system may be %.

Hence, the sum of the DC-bus currents of the axis modules may exceed the permissible limit value (120 A) of the DC busbar system.

Check the sequence of the axis modules for optimal current distribution in the DC busbar system.

See DSD protocol for the required power of the individual axis modules as an orientation guide.

Cause	Effects	Possible remedies
Due to an unfavourable arrangement (sequence) of the axis modules, the DC busbars may be overloaded.	Excessive heat generation damages the DC busbar system.	• Check topology to ensure that the current value in the DC busbar system, including sections, does not exceed 120 A. • Divide the DC-bus connection and supply via separate power supply modules or regenerative power supply modules.

19.1.9 Torque setting range > 50 for winding control mode xxx


Note!

The selected winding control mode xxx is not suitable for torque setting range yyy (limit value: 50).

Select a control mode with tensile force sensor in the web or a dancer control.

Cause	Effects	Possible remedies
The torque setting range results from the entered values for tensile force and diameter.	Minimum tensile forces cannot be reached or cannot be repeated.	• Carry out recommended measures.

19.1.10 Low-friction dancer required for tensile force setting range xxx**Note!**

The tensile force setting range xxx is defined by the dancer. For this purpose, select a low-friction dancer. Check whether this condition is complied with.

Cause	Effects	Possible remedies
The tensile force setting range results from the entered values for the tensile force.	Minimum tensile forces cannot be reached or cannot be repeated.	Carry out recommended measures.

19.1.11 Value range for the reel diameter not plausible**Stop!**

The value range entered for the reel diameter is not plausible. The minimum value is greater than the maximum value. With these values, dimensioning is not possible.

Cause	Effects	Possible remedies
Minimum value is greater than maximum value.	Calculations are not possible.	Enter values correctly.

19.1.12 Value range for the tensile force of the winder not plausible**Stop!**

The value range entered for the tensile force of the winder is not plausible. The minimum value is greater than the maximum value. With these values, dimensioning is not possible.

Cause	Effects	Possible remedies
Minimum value is greater than maximum value.	Calculations are not possible.	Enter values correctly.

19.1.13 High breakaway torque of chain conveyor**Note!**

In case of the chain conveyor, a high breakaway torque may occur depending on the mechanical operating principle of the chain up to 250 % greater than the steady-state torque. In the selected VFC operating mode, the drive cannot safely provide the required torque. Select another operating mode, e.g. SLVC. Deactivate the energy saving function.

Cause	Effects	Possible remedies
The max. starting torque of a drive with V/f control (VFC plus) is lower than that of a drive with sensorless vector control (SLVC).	The drive is not able to start.	Use sensorless vector control (SLVC) mode. SLVC requires a feedback system.

19.1.14 The data of the motion profile are inconsistent**Warning!**

The data entered for the motion profile are inconsistent.

Cause	Effects	Possible remedies
The elements of the motion profile do not constitute a closed curve.	The DSD is not able to calculate the motion profile with the data entered.	Correct entries for the motion profile.

19.1.15 The length of the crank is greater than the length of the connecting rod**Warning!**

The length l_{Cnk} of the crank is greater than the length l_{Crd} of the connecting rod. This geometry cannot be displayed.

Cause	Effects	Possible remedies
The crank length l_{Cnk} is greater than the connecting rod length l_{Crd} .	The geometrical variables entered do not produce a consistent solution.	• Correct the entries.

19.1.16 The length of the connecting rod is shorter than double the length of the crank**Tip!**

The length l_{Crd} of the connecting rod is shorter than double the length l_{Cnk} of the crank. This length ratio has an unfavourable effect on the resulting torque requirement of the slider-crank mechanism.

Cause	Effects	Possible remedies
The unfavourable angular relationships increase the power required and thus the torque required at the crank.	A bigger drive is required.	Consult the engineering department on whether the connecting rod can be extended.

19.1.17 Push axis offset too large**Warning!**

The offset ε (value) of the slider path is greater than the length l_{Crd} of the con-rod minus the length l_{Cnk} of the crank. This geometry is not mapped.

Cause	Effects	Possible remedies
The offset ε (value) of the slider path is greater than the length of the connecting rod minus the length of the crank. In the DSD, a reserve of 20 % is taken into consideration.	The geometrical variables entered do not produce a consistent solution.	Adapt the geometrical data. The following condition must be met: $ \varepsilon > (l_{Crd} - l_{Cnk}) \times 0.8$

19.1.18 Number of interpolation points in the motion profile is too large


Note!

The torque characteristic of the application in the motion profile has xxx interpolation points. With an increasing number of interpolation points, the computing time required by the DSD in the navigation steps also increases. From a number of 500 interpolation points onwards, the computing time increases noticeably.

Cause	Effects	Possible remedies
In the navigation steps for selecting the drive components, numerous characteristics of drive-typical parameters (e.g. torque, current) over time as well as utilisation values (e.g. thermal utilisation) are determined. - The computing time for executing the computing algorithms integrated in the DSD depends on the number of interpolation points. - Due to the non-linear relationship between the speed and torque, the number of data points is usually larger for a slider-crank mechanism or eccentric disk than for a linear application (e.g. travelling drive) featuring a motion profile of the same length.	The computing time required by the DSD for the selection of the drive components increases with an increasing number of interpolation points. - In the case of an extremely large number of interpolation points, the DSD requires several minutes until the next navigation step is reached. - The computing time is also influenced by the selection of drive components (e.g. i950 servo inverters, i550 frequency inverters). - The file size of the DSD project is increasing.	- Import of M-n operating points: - Reduce the number of interpolation points in the motion profile. - Slider-crank mechanism and/or eccentric lift table: - Reduce the number of revolutions at the crank or eccentric disk. In this process, the revolutions in positive and negative direction must be added. Depending on the actual motion profile, up to three revolutions at the crank or eccentric disk can usually be carried out without causing any significant restrictions. - Linear applications (e.g. travelling drive): - Shorten the motion profile. Please note: In order to prevent the thermal utilisation of the components from changing, the time ratio of movement and standstill must remain the same if the motion profile is shortened.

19.1.19 Regenerative energy for roller conveyors


Tip!

The DSD determines the requirement of an electric braking system while taking the defined motion profile into account.

In roller conveyors, small amounts of regenerative energy can occur, even at constant speeds, due merely to the properties of the employed mechanical transmission elements.

Therefore, Lenze recommends always using a brake resistor for roller conveyors with Lenze Smart Motors.

Cause	Effects	Possible remedies
Short-term regenerative energy flows can be caused by unsteady roll-off effects and slightly dampened vibrations in the pallet being transported due to elasticities and slack in chain transmissions between the gearbox and the transported goods.	The Lenze Smart Motor shuts down with an error message.	Use a brake resistor.

19.2 Drive system

19.2.1 Utilisation >100 %, regarding the max. torque


Warning!

The utilisation of the motor-inverter combination relative to the required max. torque of the application is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The max. torque required by the application is higher than the torque provided by the motor-inverter combination.	The drive cannot activate the application: • The acceleration capacity does not suffice. • The speed that is required is not achieved. • In the case of hoist drives, the load can drop.	Check the max. torque on the basis of the motor characteristic. ▶ Torque/speed characteristic (p. 342)

19.2.2 In the DC-bus connection, the braking circuit of the inverter is not checked


Note!

In the DSD, only one central braking circuit can be dimensioned.
In a DC-bus connection, the braking circuit of the inverter is ignored.

Cause	Effects	Possible remedies
In the DC-bus connection, the DSD does not check the brake choppers in the single drive axes. • In the DSD, you can only dimension one central brake chopper for the supply concept.	If the braking circuit of the single drive axis is dimensioned incorrectly, the brake chopper or brake resistor will be destroyed. Fire hazard!	• Only use the brake chopper when the regenerative energy is dissipated safely. • Check the brake chopper of the single drive axis manually. • Use results calculated by DSD.

19.2.3 In the DC-bus connection, the EMC protection of the device is ineffective


Note!

The EMC protection of the device is not effective in the DC-bus connection. Check whether EMC measures are required for the entire DC-bus connection or machine.

Cause	Effects	Possible remedies
In the DC-bus operation, the EMC protection integrated in the device is not effective or only partially effective.	EMC Directives may possibly not be observed.	Take EMC measures for the entire DC-bus connection or the entire machine.

19.2.4 Product has been discontinued


Note!

The distribution for product xxx will cease soon.

Recommendation: Select an alternative product or contact your Lenze distribution partner.

Cause	Effects	Possible remedies
The product has been discontinued and shall not be used anymore for drive dimensioning.	Maybe the product is not available anymore.	• Select current product. • Contact Lenze sales partner.

19.2.5 No effective starting current limitation available


Note!

No effective starting current limitation available.

For DC-bus capacity of the DC-bus connection, an external charging connection may be required.

Cause	Effects	Possible remedies
Without an effective starting current limitation, the devices must not be connected in parallel.	Devices will be destroyed.	Contact your Lenze sales partner.

19.2.6 Checking the drive system and the tensile force sensor


Note!

Check whether the drive system and the tensile force sensor are suitable for the torque setting range xxx and the tensile force setting range yyy.

Recommendation: Use low-friction mechanical transmission elements between the motor and the winding shaft as well as a linear motor temperature sensor (KTY/PT1000) for compensation of the motor temperature.

Cause	Effects	Possible remedies
The torque setting range results from the entered values for tensile force and diameter.	Minimum tensile forces cannot be reached or cannot be repeated.	Carry out recommended measures.

19.2.7 Torque setting range yyy requires measures


Note!

For the winding control mode xxx selected and the torque setting range yyy, we recommend using low-friction, mechanical transmission elements between the motor and the winding shaft as well as a motor temperature sensor (KTY/PT1000) for compensation of the motor temperature.

Cause	Effects	Possible remedies
The torque setting range results from the entered values for tensile force and diameter.	Minimum tensile forces cannot be realised without the recommended measures.	Carry out recommended measures.

19.2.8 Torque setting range yyy and tensile force setting range zzz require measures


Note!

For the winding control mode xxx selected, the torque setting range yyy, and the tensile force setting range zzz, we recommend using low-friction, mechanical transmission elements between the motor and the winding shaft as well as a motor temperature sensor (KTY/PT1000) for compensation of the motor temperature.

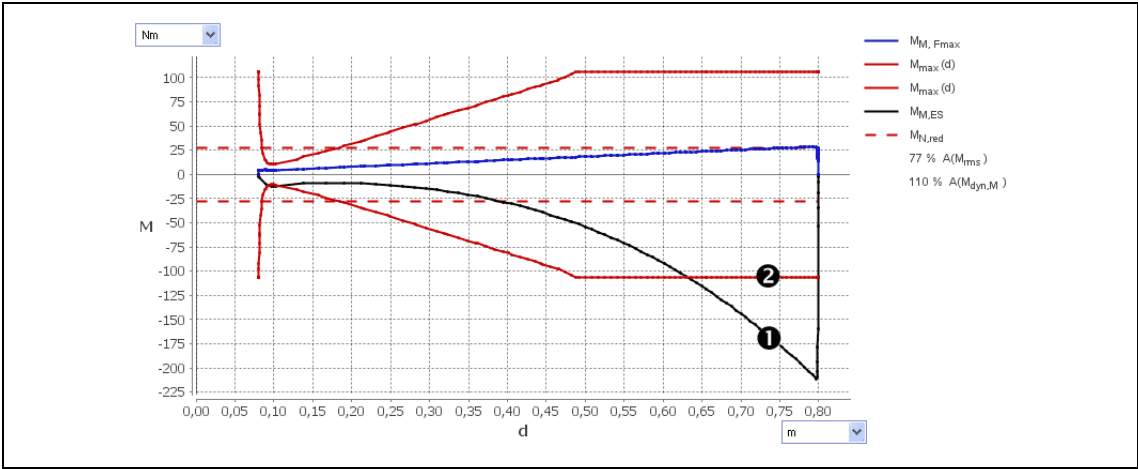
Cause	Effects	Possible remedies
The torque setting range results from the entered values for tensile force and diameter.	Minimum tensile forces cannot be realised without the recommended measures.	Carry out recommended measures.

19.2.9 Max. torque for emergency stop exceeded


Warning!

The motor torque required for emergency stop exceeds the limit torque of the drive system.

Cause	Effects	Possible remedies
The emergency stop time specified is too short. The torque required for emergency stop is calculated and represented in the diameter-dependent torque diagram of the motor. The calculation is based on the emergency stop time, a linear motion profile, and a tensile force = 0 N (material crack). The thermal utilisation of the drive components is not checked. Braking circuits are not dimensioned.	The drive system cannot brake from max. speed to standstill in the emergency stop time required.	• Increase emergency stop time. • Dimension drive with a higher drive torque.



[19-1] Motor diagram: winder torque (diameter-related)

Description	
❶	Torque required for emergency stop
❷	Max. available drive torque

19.2.10 Product options for component are not available



Note!
The drive dimensioning contains components for which no product options are available.
Contact your Lenze sales partner.

Cause	Effects	Possible remedies
The selected component is no standard product.	Possibly, the product cannot be ordered anymore to the desired conditions.	• Contact Lenze sales partner. • Select another component.

19.3 Additional drive element

19.3.1 Rated torque loss is exceeded


Stop!

The constant torque loss at the output end of the additional drive component is xxx. Thus the rated torque loss of yyy is exceeded.

Cause	Effects	Possible remedies
The general ratio is characterised by the "permissible torque". The efficiency in this operating point defines the max. constant loss of yyy. According to this definition, the constant torque loss exceeds the limit value. ▶ Constant torque loss (📖 381)	The entered values are not consistent. The calculation leads to wrong results.	Correct the entries.

19.3.2 Min. ratio (K) is higher than max. ratio (K)


Stop!

The ratio range of the additional drive element has not been entered correctly.
The minimum value is greater than the maximum value.
With these values, dimensioning is not possible.

Cause	Effects	Possible remedies
The entered min. ratio ($i_{\min,K}$) of the "additional drive element" is higher than the entered max. ratio ($i_{\max,K}$).	Drive dimensioning cannot be carried out.	Exchange the entered values for $i_{\min,K}$ and $i_{\max,K}$.

19.4

Lenze gearbox

**Note!**

Warnings concerning the gearbox selection can already be caused by an unfavourable selection of the motor. If required, it is then reasonable to select a different motor.

19.4.1

Utilisation >100 % regarding the equivalent torque

**Note!**

The utilisation of the gearbox with regard to the equivalent torque is xxx %. Thus the limit value of 100 % is exceeded. The gearbox is subject to heavy use.

Cause	Effects	Possible remedies
The gearbox is operated in the range of fatigue strength and is not rated for endurance strength anymore. This load may only occur sporadically.	The expected service life possibly is not attained anymore at cyclic operation.	- Select gearbox with higher M_{2GN}. - Select greater frame sizes (motor, gearbox).
▶ Check of the torque load (373)		

19.4.2

Utilisation > yyy %, regarding the max. torque

**Warning!**

The utilisation of the gearbox relative to the max. torque is xxx %. Thus the limit value of yyy % is exceeded.

Cause	Effects	Possible remedies
The gearbox is overloaded mechanically. It is operated beyond the static strength. - This load is not permissible! Limit values 200 % ($2 \times M_{per,out}$) in case of helical gearbox, shaft-mounted helical gearbox, bevel gearbox, helical-bevel gearbox, helical-worm gearbox. 160 % ($1.6 \times M_{per,out}$) in case of planetary gearbox.	The gearbox is destroyed after a short time!	Select bigger gearboxes.
▶ Check of the torque load (373)		

19.4.3 Utilisation >100 % regarding the max. speed


Warning!

The utilisation of the gearbox relative to the max. speed is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The gearbox is thermally and mechanically overloaded, i. e. it is overheated and damaged by too higher speeds. • This load is not permissible!	The gearbox is destroyed after a short time!	• Reduce the entry of intended gearbox input speed. • Select motor with lower rated speed. • Select lower ratio. • Select different mounting position.
▶ Check of the speed load (📖 377)		

19.4.4 Utilisation >100 % regarding the thermal speed


Warning!

The utilisation of the gearbox relative to the thermal speed is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The medium input speed of the gearbox is too high.	• The gearbox is thermally overloaded. • By the losses generated within the gearbox, the gearbox will be destroyed within a short time!	Select a different gearbox!
▶ Thermal utilisation (📖 377)		

19.4.5 Utilisation of the clutch >100 % regarding the torque


Warning!

The utilisation of the clutch relative to the torque is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The torque transmitted via the clutch is too high.	• The clutch between motor and gearbox in standard mounting is mechanically overloaded. • The clutch is destroyed after a short time!	Select different gearbox or motor in direct mounting.
▶ Check of the torque load (📖 373)		

19.4.6 Utilisation of the clutch >100 % regarding the speed


Warning!

The utilisation of the clutch (motor-gearbox) relative to the speed is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The medium motor speed is too high.	- The clutch between motor and gearbox is overused. - The clutch is destroyed after a short time!	- Select a different gearbox. - Optimise application.
▶ Check of the torque load (📖 373)		

19.4.7 Thermal overload when mineral gearbox oil is used


Note!

When mineral oil is used, the gearbox will be thermally overloaded.
Use Viton shaft sealing rings and use synthetic oil!

Cause	Effects	Possible remedies
Mineral oil is less temperature-stable, less powerful and has a smaller viscosity range than synthetic oil.	Use of mineral gearbox oil: - The gearbox is too hot. - The oil pressure increases. - The shaft sealing rings wear out. - The service life of the gearbox oil is considerably reduced.	- Use synthetic gearbox oil. - When synthetic gearbox oil is used, Viton shaft sealing rings have to be used.
▶ Thermal utilisation (📖 377)		

19.4.8 Utilisation is xxx %, regarding the max. torque


Note!

The utilisation of the gearbox is xxx %, regarding the max. torque.
Thus the limit value of 100 % is exceeded.
The gearbox is overloaded for a short time. The increased wear is within the permissible range.
The utilisation is xxx %, regarding the fatigue strength.

Cause	Effects	Possible remedies
The gearbox is not rated for endurance strength and will be overloaded after the simplified fatigue strength calculation.	- The service life of the gearbox is reduced. - The increased wear is within the permissible range.	Select a different gearbox.

19.4.9 Load of the shaft sealing ring is xxx %, regarding the speed


Note!

The load of the shaft sealing ring is xxx %, regarding the speed.
This may cause reduced service intervals.

Cause	Effects	Possible remedies
The input speed for the shaft sealing ring on the motor side is too high.	The service life of the shaft sealing ring on the motor side is considerably reduced.	• Select a different gearbox. • Select motor with lower input speed.
▶ Thermal utilisation (📖 377)		

19.4.10 Wear of the gearbox >100 %


Warning!

DSD has calculated a wear of xxx % for the gearbox.
Thus the limit value of 100 % is exceeded.
Contact your Lenze sales partner.

Cause	Effects	Possible remedies
DSD has detected in accordance with the defined operating conditions that the gearbox will not safely withstand five years of operation.	The expected service life will be possible not attained at cyclic operation.	• Can only be scrutinised by Lenze. • Contact Lenze sales partner and arrange for the check to be made.

19.4.11 Using synthetic oil for gearboxes of the winding application


Note!

Use synthetic oil (fuel-efficient engine oil) for the gearbox of this winding application.
That way, friction is reduced.

Cause	Effects	Possible remedies
The viscosity and temperature stability of mineral oils are not suitable for repeatable, high torque setting ranges.	Repeatable minimum tensile forces cannot be reached.	Use synthetic oil.

19.4.12 No product options available**Note!**

No product options are available for the selected geared motor.
Configure product options manually.

Cause	Effects	Possible remedies
In DSD, no product options are stored for the geared motor.	Product options cannot be selected.	Configure product options manually: • »EASY Product Finder« • Product catalogue • SAP • Contact Lenze Sales department

19.4.13 Too low load capacity of the geared motor for applications with a safety encoder**Warning!**

A geared motor in combination with a safety encoder has been selected.
The load capacity c of the geared motor is too low.
In order to meet the requirements of the safety features, a geared motor with $c > 1$ must be used.

Cause	Effects	Possible remedies
When selecting a safety encoder it is automatically assumed that the application is to be combined with a safety system. In this case, the gearbox must only be loaded with a factor $c \geq 1$.	When loading the gearbox with $c < 1$, the safe operation requested is no longer ensured.	Select a gearbox with a greater load capacity, so that $c \geq 1$ is complied with.

19.5

Lenze motor

19.5.1

Utilisation >100 %, regarding the effective torque

**Warning!**

The utilisation of the motor relative to the effective torque is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The calculated effective torque of the application on the motor is higher than the permissible torque.	The motor is thermally overloaded.	• Select different motor. • Select a higher ratio if the speed range of the motor is badly utilised.

19.5.2

Max. motor speed is higher than the permissible motor speed

**Warning!**

The max. occurring motor speed is xxx rpm. Thus the max. permissible motor speed of yyy rpm is exceeded.

Cause	Effects	Possible remedies
The maximum speed that occurs is higher than the maximum permissible speed of the motor.	The motor is mechanically destroyed!	• Reduce gearbox ratio or speed. • Select motor with a higher permissible speed.

19.5.3

Max. output torque is higher than the permissible motor torque

**Warning!**

The max. permissible output torque of the motor is exceeded.

Cause	Effects	Possible remedies
The maximum permissible output torque of the motor must not be exceeded. This limit is compared to the occurring max. torque (absolute value).	The motor is mechanically/ electrically overloaded.	• Select bigger motor. • If required, reduce load. • If the use of a gearbox is intended, the torque can be reduced by a greater ratio.

19.5.4 Motor is operated in the field weakening range


Note!

The field weakening factor of the motor is xxx.

Hence, the limit value of yyy is exceeded. The motor is operated in the field weakening range.

During field weakening operation, larger reserves must be provided for the inverter.

Cause	Effects	Possible remedies
In the field weakening range, the accuracy of the DSD current model is restricted. DSD cannot calculate correctly the thermal utilisation of the inverter.	The inverter is thermally overloaded.	Select inverter with higher thermal reserves.
▶ Field weakening (□ 491)		

19.5.5 Max. mismatch is higher than permissible mismatch


Note!

The max. mismatch of the motor is xxx.

Hence, the max. permissible mismatch of the motor of yyy is exceeded.

(only applicable to speed-controlled systems)

Cause	Effects	Possible remedies
The maximum mismatch exceeds the limit value defined.	The drive is inclined to vibrations and possibly is not controllable with regard to feedback control (only for speed control or position-controlled systems). For torque-controlled or VFC plus-controlled systems this value has a lower priority.	• Select gearbox with higher transmission ratio. • Select motor with higher inertia (standard motor instead of servo motor).
▶ Load-matching factor (□ 353)		

19.5.6 Unstable control mode of the winding drive in the case of speed-controlled operation


Note!

The load-matching factor k_j of xxx which has been determined is non-critical for this torque-controlled winding drive.

However, if you switch over to a speed-controlled operating mode in specific operating phases (e.g. setting-up operation, emergency stop), other limit values apply to the k_j factor.

Cause	Effects	Possible remedies
Unlike with the torque-controlled winding drive, the k_j factor has a major impact when the speed-controlled winding drive is concerned.	Unstable response in speed-controlled operation.	Do not exceed the limit value for the mismatch k_j for a speed-controlled winding drive.
▶ Load-matching factor (□ 353)		

19.5.7 Required motor speed too low


Tip!

The required max. motor speed is too low. It is $xxx \text{ min}^{-1}$.

The recommended limit value of an optimum drive dimensioning is $yyy \text{ min}^{-1}$.

Cause	Effects	Possible remedies
With regard to their size, inverters are defined by the motor current. If the motor is only operated in the lower speed range with regard to its rated speed, the voltage provided by the inverter is not utilised. A different motor that would be operated more near its rated speed would improve the utilisation of the inverter.	Drive system possibly may not be at optimal cost.	Use a gearbox with a higher ratio, so that the motor at the same power is better utilised with regard to speed, and the inverter is better utilised with regard to voltage.

19.5.8 Max. permissible motor current of yyy is exceeded


Note!

The max. output current of the inverter is $xxx \text{ A}$. Thus the max. permissible motor current of $yyy \text{ A}$ is exceeded.

Cause	Effects	Possible remedies
The max. output current of the inverter is higher than the max. permissible motor current. • Compared to the motor, the inverter is overdimensioned.	- The motor winding can be destroyed by the too high output current. - Synchronous motors can be demagnetized.	Limit the output current of the inverter to the value permissible for the motor.

19.5.9 Overload of the motor $>xxx \%$


Note!

The overload of the motor is higher than $xxx \%$. The thermal utilisation of the motor and the currents calculated for inverters and other components are not correct anymore. Up to an overload of $yyy \%$ the DSD can execute calculations with a sufficient accuracy.

Cause	Effects	Possible remedies
In case of high overloads, the torque-generating current share increases more than the torque due to saturations in the motor.	The currents calculated for the inverter and other components are not correct anymore.	Consider corresponding reserves when selecting the inverter.

19.5.10 Max. permissible ambient temperature of the blower is exceeded


Warning!

The ambient temperature of the motor or geared motor is XXX °C. Thus, the max. permissible ambient temperature of the blower of 40 °C is exceeded.

Cause	Effects	Possible remedies
The permissible ambient temperature of the blower is exceeded.	The blower is overheated and may fail. This may cause the motor to overheat and fail as well.	Select motor without blower.

19.5.11 A continuous operation characteristic for inverter operation is not available


Note!

There is no continuous operation characteristic for the motor if operated on an inverter. The equivalent characteristic does not take account of restrictions on motor operation due to its ventilation.

Cause	Effects	Possible remedies
There is no data for this self-ventilated motor.	The motor may get too hot when being operated at field frequencies < 20 Hz.	• In case of long operations at low speed or with high thermal utilisation, select a motor with forced ventilation. • Select a more powerful motor.

19.5.12 Motor temperature too high at switching frequency < 8 kHz


Note!

The motor selected must not be permanently operated at a switching frequency < 8 kHz. Set a fixed switching frequency on the inverter to ensure that it is not automatically reduced.

Cause	Effects	Possible remedies
At low switching frequencies the losses in the motor increase.	Motor gets too hot.	• Select bigger motor. • Set switching frequency permanently to min. 8 kHz if the drive continuously runs with a too low switching frequency.
► Effects of low switching frequencies on the motor (📖 498)		

19.5.13 Limit value of xxx % of the rated torque is exceeded


Warning!

The utilisation of the motor is xxx % of the rated torque.

If the motor is operated on an inverter with V/f control, the limit value of yyy % is exceeded.

The operation is not permissible!

Cause	Effects	Possible remedies
With a V/f characteristic control without feedback and low speed range, the motor is not magnetised as required. The motor cannot reach the rated torque anymore.	The hoist drive cannot hold the load.	• With a rated motor power < 7.5 kW, select a bigger motor. • Select a control mode with feedback.

19.5.14 Compliance with ErP Directive 2009/125/EC


Note!

According to the ErP Directive, the selected motor may only be put into circulation in the European Economic Area if it has a brake or inverter.

Cause	Effects	Possible remedies
In accordance with the specifications laid down by ErP Directive 2009/125/EC, the following requirements for placing electric motors on the market shall apply until 30/06/2021. • If operating the motor without a brake and without a frequency inverter, a motor with a minimum efficiency class of IE3 must be used in the power range of 0.75 to 375 kW. • If operating the motor without a brake and with a frequency inverter, a motor with a minimum efficiency class of IE2 must be used in the power range of 0.75 to 375 kW. In accordance with the implementation provision 2019/1781 of the ErP Directive, the following requirements for placing machines with electric motors on the market apply with effect from 01/07/2021: • A motor with a minimum efficiency class of IE2 must be used in the power range of 0.12 to <0.75 kW. • A motor with a minimum efficiency class of IE3 must be used in the power range of 0.75 to 1000 kW. Please pay attention to special regulations for countries outside of the European Economic Area.	The machine is not permitted to be put into circulation with the selected motor in the European Economic Area.	Select a motor meeting the efficiency class required, e.g.: • IE2 motor from the m550-H series • IE3 motor from the m550-P series • Motor from the MFxMA series optimised for frequency inverters • Lenze Smart motor • Servo motor
Hinweise zu Energieverordnungen finden Sie unter https://www.Lenze.com/de-de/oekodesign-richtlinie/ Notes on energy directives can be found on https://www.lenze.com/en-de/ecodesign-directive/		

19.5.15 No check of the thermal motor utilisation in accordance with UL requirements


Note!

The DSD does not check the UL-compliant thermal motor utilisation in the lower speed range.

Cause	Effects	Possible remedies
In order to meet UL requirements, the motor requires sufficient thermal overload protection. The DSD does not check whether the requirements in compliance with UL are met. In order to meet these requirements, the I²t motor monitoring function in the inverter must be activated, which is not checked in the DSD.	The thermal overload protection of the motor may not be UL-compliant.	- Parameterise motor protection by a motor monitoring function integrated in the inverter (e.g. I²t monitoring) - Ensure motor protection by external components. - Derating of the thermal continuous operation characteristic of the motor of 0 ... 40 Hz. - The characteristic may deviate from the characteristic shown in the DSD. - More information can be found in the inverter hardware manual.

19.5.16 Overdimensioned motor in the case of traction-controlled winding drive


Tip!

The utilisation of the motor is xxx, relative to the stationary torque.

The motor is clearly overdimensioned for traction-controlled winding drives with a torque setting range of yyy. Select another motor.

Cause	Effects	Possible remedies
In this torque setting range, a clearly overdimensioned motor is only able to work to a limited extent.	Lower tensile forces cannot be reached or cannot be repeated.	Dimension the motor in a demand-oriented way.

19.5.17 Speed-controlled winding drive may show unstable behaviour


Note!

With a load-matching factor of xxx, the control system of speed-controlled drives in combination with load alternations and weakly damped mechanical transmission elements with backlash between motor and winding shaft may show unstable behaviour.

Have the application checked by the technical support.

Cause	Effects	Possible remedies
The load-matching factor k_j results from the mass and the diameter of the full reel, the gearbox ratio and the moment of inertia of the motor.	Unstable control mode.	- Reduce the load-matching factor k_j through a higher moment of inertia of the motor or a higher gearbox ratio. - Optimise the motor control.

19.5.18 Field weakening factor $k_f >$ as winding ratio q


Warning!

The field weakening factor k_f is xxx.

The winding ratio q is yyy.

For an optimally adapted drive, k_f must be $< q$.

Cause	Effects	Possible remedies
The field weakening factor k_f entered is greater than the winding ratio q .	The drive solution is not optimal with regard to the utilisation of the torque-speed requirement.	Check the torque-speed requirement in the M-n characteristic of the motor, or set $k_f < q$.

19.5.19 Activate "brake at standstill"


Stop!

You have selected a mechanical brake.

For the Lenze Smart Motor, the brake at standstill is automatically activated.

In order that the DSD can consider this function correctly, you have to activate the "brake at standstill" in the "motion" dimensioning step.

Cause	Effects	Possible remedies
In case of the Lenze Smart Motor, a brake at standstill is automatically applied.	The brake control cannot be selected.	Correct the selection in the <i>Motion</i> dimensioning step.

19.5.20 Activate "controller inhibit at standstill"


Stop!

At standstill, the Lenze Smart Motor is automatically deenergised.

In order that the DSD can consider this function correctly, you have to activate the "controller inhibit at standstill" in the "motion" dimensioning step.

Cause	Effects	Possible remedies
For the Lenze Smart Motor, the controller inhibit at standstill is automatically activated.	The activation of the controller inhibit cannot be configured.	Correct the selection in the <i>Motion</i> dimensioning step.

19.5.21 Motor speed falls below the limit speed of 500 rpm**Stop!**

The steady-state motor speed of xxx falls below the limit speed of 500 rpm.
Select another gearbox ratio.

Cause	Effects	Possible remedies
Unfavourable adaptation of the motor speed to the speed of the application.	The desired speed is not reached with the selected gearbox ratio.	• Select another gearbox ratio. • Adapt motor speed: • Select additional ratio. • Increase velocity or speed of the application.

19.5.22 Motor speed exceeds limit speed of 2600 rpm**Stop!**

The steady-state motor speed of xxx exceeds the limit speed of 2600 rpm.
Select another gearbox ratio.

Cause	Effects	Possible remedies
Unfavourable adaptation of the motor speed to the speed of the application.	The desired speed is not reached with the selected gearbox ratio.	• Select another gearbox ratio. • Adapt motor speed: • Select additional ratio. • Reduce velocity or speed of the application.

19.5.23 Thermal utilisation of the synchronous servo motor is exceeded**Warning!**

Under unfavourable conditions, the motor at standstill is thermally overloaded.

Cause	Effects	Possible remedies
Depending on the position of the rotor at standstill, the current of a phase can overload the motor winding.	The motor is thermally damaged.	Dimension the drive with electromechanical brake and activated the brake at standstill.

19.5.24 Deceleration time exceeds permissible time of 20 s**Stop!**

The deceleration time of xxx s to be parameterised in the Lenze Smart Motor exceeds the permissible time of 20 s.

Change the deceleration time or the gearbox ratio.

Cause	Effects	Possible remedies
The deceleration time of the Lenze Smart Motor corresponds to the deceleration time of the ramp generator from $n_{\max}$ to $n = 0$. DSD calculates the deceleration time from the defined motion.	The deceleration time calculated by the DSD cannot be entered into the Lenze Smart Motor.	• Select another gearbox ratio. • Reduce deceleration time.

19.5.25 Acceleration time exceeds permissible time of 20 s**Warning!**

The acceleration time of xxx s to be parameterised in the Lenze Smart Motor exceeds the permissible time of 20 s.

Change the acceleration time or gearbox ratio.

Cause	Effects	Possible remedies
The acceleration time of the Lenze Smart Motor corresponds to the acceleration time of the ramp generator from $n = 0$ to $n_{\max}$. DSD calculates the acceleration time from the defined motion.	The acceleration time calculated by the DSD cannot be entered into the Lenze Smart Motor.	• Select another gearbox ratio. • Reduce acceleration time.

19.5.26 Max. motor torque is exceeded**Warning!**

The available maximum torque of the Lenze Smart Motor is exceeded.

Cause	Effects	Possible remedies
The maximum torque is limited by the gearbox or the motor.	The drive system cannot execute the defined motion.	• Adapt data to the application. • Select a different gearbox.

19.5.27 Longer braking distance during operation in generator mode below 500 rpm


Note!

When decelerating during operation in generator mode below 500 rpm, the braking distance may slightly increase (longer deceleration ramp).

Cause	Effects	Possible remedies
The torque in generator mode at low speeds is reduced.	The deceleration ramp specified is not complied with; the braking distance increases. The deviation is usually substantially below the braking distance tolerance of an electromechanical brake.	If the impact to the application is relevant: - Select bigger motor. - Select a different drive concept.

19.5.28 Permissible ambient temperature exceeds 40 °C


Warning!

The Lenze Smart Motor cannot be actuated. The maximum permissible ambient temperature of 40 °C is exceeded.

Cause	Effects	Possible remedies
The maximum ambient temperature for the Lenze Smart Motor is 40 °C.	The Lenze Smart Motor is overheated and switches off.	Select a different drive concept.

19.5.29 Incomplete check of emergency stop


Note!

The check of emergency stop is incomplete.
The thermal utilisation of the drive components is not checked.
Braking circuits are not dimensioned.

Cause	Effects	Possible remedies
The DSD calculates the motor torque required for emergency stop from the emergency stop time entered, assuming a linear motion profile and a tensile force of 0 N (material crack). The torque calculated is represented in the M-n characteristic of the motor. Further important conditions for checking the emergency stop scenario cannot be taken into consideration by the DSD.	An emergency stop may proceed more unfavourable than has been calculated by the DSD.	Carry out dimensioning for the most unfavourable emergency stop case manually.

19.5.30 Dactivation of specific checks for the Lenze Smart Motor


Note!

The Lenze Smart Motor possibly is not suitable for this application.

The DSD deactivates some application- and device-specific checks for the Lenze Smart Motor.

Cause	Effects	Possible remedies
In the Lenze Smart Motor, up to five fixed speeds, each with a permanently defined ramp time, and the maximum and minimum speeds are predefined. There are some checks that the DSD is not able to carry out (e.g. a check with regard to the suitability of the Lenze Smart Motor for the application, a check with regard to limit values such as speeds and acceleration times), because individual torque-speed characteristics are imported for the "Import M-n operating points" application.	The drive solution will possibly not work with the Lenze Smart Motor.	• Check whether the Lenze Smart Motor is suitable for the application. • Ensure that the operating conditions for the Lenze Smart Motor are complied with.
► Applications using the Lenze Smart Motor (71)		

19.5.31 Additional check of the synchronous servo motor in the field weakening range required


Warning!

When actuating the synchronous servo motor in the field weakening range and with ambient temperatures >40 °C, an additional check is required.

Cause	Effects	Possible remedies
The iron losses may be dominant when a synchronous servo motor is actuated above rated speed. In this case, the DSD is not able to calculate the derating above the rated ambient temperature (40 °C) with sufficient precision.	This is relevant in particular if the motor is permanently actuated above rated speed.	• Avoid permanent field weakening operation at an ambient temperature >40 °C. • Contact Lenze Sales department.

19.5.32 Ambient temperature too high


Warning!

The ambient temperature of the motor is xxx °C. As a result of this, the max. permissible ambient temperature of the motor of yyy °C is exceeded.

Cause	Effects	Possible remedies
The ambient temperature is too high.	The motor is overheated and stops running.	• Select different motor. • Check other cooling concept.

19.5.33 Max. permissible site altitude exceeded


Warning!

The site altitude of the motor is xxx m. Thus the max. permissible site altitude of the motor of yyy m is exceeded.

Cause	Effects	Possible remedies
Due to the lower atmospheric pressure, the cooling effect of the air is reduced.	The motor is overheated and stops running.	Contact Lenze

19.5.34 Check of the standstill under load with real downtimes


Tip!

For a correct check of the standstill under load, the real downtimes must be specified.

Cause	Effects	Possible remedies
Since the synchronous motor is loaded whilst it is at a standstill, one phase of the motor winding may be overloaded, depending on the rotor position.	The motor is thermally damaged.	The downtimes under load specified in the dimensioning process must not be exceeded in practice.

19.6 Brake

19.6.1 Rated torque/dimensioning torque < safety factor of the brake



Warning!

The characteristic torque/dimensioning torque of the brake is xxx. Thus the required braking torque which was determined with the required safety factor of yyy is not reached.

Cause	Effects	Possible remedies
The required safety factor is not achieved.	The brake slips, the load is not held.	Use larger or uprated brake, or use a different motor with a larger brake.

19.6.2 Holding brake: Function and emergency stop



Note!

Function as holding brake

In the DSD, the dimensioning of the electromechanical brake as holding brake is only carried out for standstill.

Sizing the brake as a service brake and/or holding brake with emergency stop properties, taking the speed-dependent decreasing braking torque and the max. permissible friction energy into consideration, must be performed manually.

Holding brake with emergency stop function

Before commissioning, ensure that the brake installed at the motor is ground in correctly. Only a brake that is ground in and dimensioned correctly produces the braking torque required for the application. Due to their reduced braking effect, in particular for hoist applications or applications with a high kinetic energy (e.g. winders, motion drives), motor brakes that are not ground in present a source of danger. Depending on the application, the grinding process of the brake must be repeated cyclically.

The brake must not be used as a safety element without additional measures, in particular for hoist axes. The brakes used are not fail-safe brakes because the braking torque can be reduced due to disruptive factors that cannot be influenced, e.g. oil ingress! The friction surfaces must be kept free of oil and grease at all times, as even small quantities can greatly reduce the braking torque.

Cause	Effects	Possible remedies
The electromechanical brake is required as service brake or holding brake with emergency stop function for the selected application.	The function required is not implemented correctly. In case of an emergency, the drive is not safely braked.	The dimensioning as service brake must be carried out manually. Only brakes that have been bedded in must be used as holding brakes with emergency stop function.

19.6.3 No brake available


Warning!

No motor brake has been selected for the drive!

For safety reasons, a suitable brake assembly is required (electromechanical motor brake or another braking system).

Cause	Effects	Possible remedies
The application requires a mechanical brake.	In case of an emergency, the drive cannot be braked safely.	Select a motor with brake.

19.6.4 Permanent magnet holding brake is not suitable for hoist drives


Warning!

For safety reasons, the permanent magnet holding brake selected is not suitable for hoist drives (reduced braking torque at higher speeds).

Select a motor with a spring-applied brake or ensure that an additional brake assembly provides for the required safety.

Cause	Effects	Possible remedies
The braking torque decreases significantly at higher motor speeds.	Braking torque is too low in case of an emergency (mains failure, malfunction, inverter failure). Safe braking to standstill is not possible.	• Select a motor with a spring-applied brake. • Provide for redundant brake assembly. ► Mechanical brake selection (362)

19.6.5 Import of a motion profile - no check of the mechanical brake


Note!

During the import of a torque/speed motion profile, a check of the mechanical brake as holding brake is not possible.

Carry out this check manually.

Cause	Effects	Possible remedies
The drive dimensioning is based on imported data. With these data, DSD cannot check the brake in an application-specific way.	The required holding torque is too low. The drive is not braked safely.	Check the brake manually according to the requirements (brake type, braking torque, safety aspects). ► Mechanical brake selection (362)

19.6.6 Brake in the motion profile not activated - no check of the mechanical brake


Note!

It is not possible to check the mechanical brake as holding brake.

In the motion profile, application of the brake must be activated so that the DSD carries out the check.

Cause	Effects	Possible remedies
The DSD can only check the mechanical brake as holding brake if the application of the brake is set correctly in the motion profile.	It is not possible to check the mechanical brake as holding brake.	Correct the motion profile: Set the "Brake activated" basic value in the parameter profile for every application of the brake. ► "Line" tab": Parameter profile (269)

19.6.7 Holding brake is not suitable for the non-linear application


Note

Where applicable, please check that the selected holding brake is suitable for safely holding the load in place in all possible settings of the non-linear application.

The selected holding brake may not be suitable to safely hold the load in place in all positions of this non-linear application.

A manual check is required.

Cause	Effects	Possible remedies
The DSD checks the required torque at the brake in the specified standstill positions in the motion profile. If the actual position of the non-linear application deviates from the standstill position specified, a greater holding torque may be required. This situation may be brought about by an unscheduled stop of the slider-crank mechanism or eccentric lift table (e.g. in the event of a fault).	- The non-linear application can assume a position of equilibrium. - In a standstill position in the upper dead centre, a small deviation from the position already results in a significant increase in the torque required.	- Check whether the impacts are relevant for the application. - Use a suitable brake assembly.

19.6.8 Holding brake not suitable for active loads


Warning!

The selected holding brake does not have any emergency stop features. It is not suitable for applications with active loads (e.g. hoist drives, winders).

Cause	Effects	Possible remedies
The selected holding brake on the m550-P or m550-H motor is unable to absorb the braking energy generated in the event of an emergency stop.	In an emergency (mains failure, malfunction, inverter failure), the drive will not be braked safely to a standstill.	- Select a holding brake with emergency stop features (select an application brake for m550-P and m550-H). - Provide for redundant brake assembly. ► Mechanical brake selection (362)

19.7 Feedback

19.7.1 Inverter/feedback combination not possible


Note!

The operation of the feedback system on the selected inverter is not possible.

Cause	Effects	Possible remedies
The feedback system selected cannot be connected to the inverter.	Servo inverters cannot be operated without feedback.	Use a different feedback system. • If the feedback is not to be evaluated by the inverter (e.g. feedback for slave drive), this conflict can be ignored (not in the case of servo inverters). • Convert the output signal of the feedback system into a suitable signal.

19.7.2 No feedback selected


Note!

The inverter requires a speed feedback for the control process selected.

Cause	Effects	Possible remedies
A motor without feedback was selected, although the inverter requires a feedback system for the motor control.	Possibly the inverter cannot be operated.	Select the "Feedback" option in the dimensioning step "Structure of the drive axis/mechanical".

19.7.3 Feedback system is not checked


Note!

Checking the inverter-encoder evaluation is not possible. Check manually whether the inverter is able to evaluate the feedback system of the motor.

Cause	Effects	Possible remedies
The user motors are not provided with detailed information on the feedback system.	Checking the inverter-encoder evaluation is not possible in DSD.	Check the inverter-encoder evaluation manually.

19.7.4 Feedback system for safety-oriented applications is not checked


Note!

The feedback system selected is suitable for safety-oriented applications.

DSD does not check whether the inverter supports this functionality.

Ensure that the inverter used has integrated safety functions (e. g. "Safely limited speed"). 9400 servo inverters support the safety functions, e.g. using the SM301 safety module.

Cause	Effects	Possible remedies
DSD does not check whether the inverter supports safety functions.	The desired safety functions are not guaranteed.	Select the SM301 safety module from the product options for 9400 HighLine servo inverters.

19.7.5 Unstable control response of the speed-controlled winding drive


Note!

The resolution of the feedback system selected is too low.

In order to ensure an optimum control response, a feedback system with a resolution starting from 512 pulses per revolution is recommended.

Cause	Effects	Possible remedies
For a speed-controlled winding system, a feedback system with a very low resolution (e.g. 128, 256 increments) is used.	This very low resolution causes instabilities in the speed control.	• Select an encoder with a higher resolution (at least 512 pulses per revolution). • Select a resolver or a SinCos encoder.

19.7.6 Evaluation of feedback not possible in One Cable Technology


Warning!

A One Cable Technology feedback cable has been selected.

One Cable Technology is currently only supported by i950 servo inverters in the power range up to and including 15 kW.

Cause	Effects	Possible remedies
The selected feedback system cannot be connected to the inverter.	Servo inverters with the control mode "Servo control" cannot be operated without feedback.	Select a different feedback system.

19.7.7 The feedback is designed in One Cable Technology


Tip!

The selected feedback is designed in One Cable Technology.

Cause	Effects	Possible remedies
Digital absolute value encoders in One Cable Technology are available for series m850 and MCS servo motors in combination with i950 servo inverters.	The motor cable and encoder cable are combined in a hybrid cable.	—

19.8 Inverter

19.8.1 Ambient temperature too high

**Warning!**

The ambient temperature of the inverter is xxx °C. Thus the max. permissible ambient temperature of the inverter of yyy °C is exceeded.

Cause	Effects	Possible remedies
The ambient temperature is too high.	The inverter switches itself off due to a too high heatsink temperature.	• Select a different inverter. • Select air-conditioned control cabinet. • Check other cooling concept.

19.8.2 Max. permissible site altitude exceeded

**Warning!**

The site altitude of the inverter is xxx m. Thus the max. permissible site altitude of the inverter of yyy m is exceeded.

Cause	Effects	Possible remedies
Due to the lower atmospheric pressure, the cooling effect of the air is reduced.	The inverter is not cooled sufficiently and switches itself off due to a too high heatsink temperature.	Contact Lenze

19.8.3 Max. output current exceeded

**Warning!**

The utilisation of the inverter relative to the max. current is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The maximum output current of the inverter is too low.	• Drive does not start. • Hoist sags. • Drive cannot follow the motion profile.	• Select a greater inverter, or one with a higher overload capacity. • Improve the utilisation of the inverter voltage range: • If the motor is not operated at rated speed, it might be possible to improve the utilisation of the voltage range by adapting the gearbox ratio, and thus reduce the current required.

19.8.4 Max. thermal utilisation >100 %


Warning!

The max. thermal utilisation of the inverter is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The inverter is operated at a too high continuous current.	The inverter switches itself off via the device monitoring (lxt).	• Select a greater inverter. • Improve the utilisation of the inverter voltage range: • If the motor is not operated at rated speed, it might be possible to improve the utilisation of the voltage range by adapting the gearbox ratio, and thus reduce the current required.

19.8.5 Control mode not suitable for hoist drive


Warning!

The selected control mode xxx is not suitable for safely operating the hoist.

Cause	Effects	Possible remedies
With the selected control mode, the drive is not able to safely provide the required torque over the entire control range continuously.	The hoist may crash.	Select other control modes.

19.8.6 Inverter designed as double axis


Note!

The motor output of the inverter is a double axis.

The design in this DSD project only refers to one output of this double axis.

The second output can be dimensioned in a second DSD project.

Cause	Effects	Possible remedies
For double axes, DSD checks every axis individually. It is not checked whether both parts of the double axis are also used in the DC-bus system.	Not all parts of the double axis are used or the double axis is used too often.	Check manually.

19.8.7 Current resolution is not adapted to the motor


Note!

The current resolution of the inverter is not adapted to the motor. The rated motor current is vvv A. Thus the max. output current of the inverter of www A is much greater than the rated motor current.

The factor for the ratio of the rated motor current and the max. output current of the inverter is xxx.

The factor is still reasonable.

The factor zzz must not be exceeded.


Note!

The current resolution of the inverter is not adapted to the motor. The rated motor current is vvv A. Thus the max. output current of the inverter of www A is much greater than the rated motor current.

The factor for the ratio of the rated motor current and the max. output current of the inverter is xxx.

The factor is still reasonable.

The factor zzz must not be exceeded.

Cause	Effects	Possible remedies
Due to the high rated current of the inverter compared to the rated motor current, the current detection in the inverter is unfavourable with regard to the motor currents.	Unfavourable control properties and a disadvantageous behaviour with regard to smooth running.	• Select a smaller inverter. • Select an inverter with an overload behaviour that is better adapted.
▶ Dimensioning criteria (386)		

19.8.8 Utilisation of the inverter >100 %


Warning!

The max. utilisation of the inverter is xxx %, regarding the power pulse current.

Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The inverter is overloaded by a too high and too long current pulse (e.g. due to an acceleration process).	The device is switched off with an error message due to device utilisation.	• Select a more powerful inverter. • Change motion or load profile to reduce the height or duration of the current pulse.

19.8.9 Utilisation of the inverter too high after mains connection


Note!

The max. utilisation directly after mains connection and with max. ambient temperature is max. xxx %. The drive cannot start with the motion profile.

Cause	Effects	Possible remedies
After mains connection, the inverter is overloaded by a too high and too long current pulse (e.g. due to an acceleration process). For safety reasons, a preload of the inverter is assumed before mains connection.	The device is switched off with an error message due to overload.	• Switch on a load with a short delay. • Select a more powerful inverter. • Change motion or load profile to reduce the height or duration of the current pulse.

19.8.10 VFC plus control mode without feedback not permissible**Warning!**

In the case of the hoist drive, it is not permissible to combine a Servo Drive 9400 greater than 55 kW with a VFC plus control mode without feedback.

Cause	Effects	Possible remedies
The control mode is not suitable for hoist drives.	The drive must not be operated in this control mode.	Select a control mode with feedback.

19.8.11 The SLVC control mode is not permissible for inverters >55 kW**Warning!**

The SLVC control mode is not permissible for inverters with a rating of more than 55 kW.

Cause	Effects	Possible remedies
The SLVC control mode must not be used for inverters in this power range.	The drive must not be operated in this control mode. The control is not stable!	Select a control mode with feedback.

19.8.12 Too low braking torques at low speed**Note!**

The drive system only develops small amounts of braking torque at low speeds in SLVC operating mode. Use alternative braking methods such as DC-injection braking or mechanical brakes.

Cause	Effects	Possible remedies
The drive system only develops small amounts of braking torque at low speeds in the SLVC control mode.	At low speeds with operation in generator mode, the motor cannot be controlled.	• Select a control mode with feedback. • In this control mode, do not operate the drive permanently at low speeds. • Do not use the control mode with hoist drives.

19.8.13 Motor limit rating is exceeded**Warning!**

The rated motor power is xxx kW. In the "V/f control" mode, the max. motor limit rating of yyy kW is exceeded. The selected drive system cannot ensure a safe hoist operation.

Cause	Effects	Possible remedies
The rated motor power is too high for a hoist drive with V/f characteristic control.	At low speeds, the motor is magnetised as required. Overheating and torque losses are the result. In this control mode, a safe operation is not possible.	Select a control mode with feedback.

19.8.14 The inverter cannot provide the rated output current


Warning!

The rated current-inverter ratio to the rated motor current is xxx.

If V/f control is used, the required ratio of yyy is undershot.

For hoist drives with V/f control, drops at max. torque are possible during operation in generator mode and at low speeds.

Select an inverter that is one power class higher than the motor.

Cause	Effects	Possible remedies
In this operating mode, the inverter cannot provide the required current.	The hoist drive cannot hold the load.	Select an inverter that is one power class higher than the motor.

19.8.15 VFC plus eco control mode for quasi-stationary drives


Note!

The VFC plus eco V/f control can only be used for quasi-stationary drives with slow load changes.

Cause	Effects	Possible remedies
When the VFC plus eco control mode is used, the machine flux is reduced in partial load operation. Due to physical time constants of the machine, the machine flux cannot be increased abruptly.	If the machine is loaded heavily for a short time, only a following error takes place in the best case. In the worst case, the machine is not braked safely or stops.	• Use other control modes. • Magnetise machine in time before load impulses.

19.8.16 Activate VVC control


Warning!

Hoist may sag!

Activate the VVC control in the inverter during the commissioning phase if the VFC plus control mode without feedback is used.

Cause	Effects	Possible remedies
During the design process of the inverter (9400 HighLine servo inverters, i700 servo inverters) and the motor, DSD assumes that VVC control (Voltage Vector Control) is activated in the inverter. • Without VVC control, motor and inverter must be substantially overdimensioned when the hoist drive control mode is used.	Without an activated VVC control, the hoist may sag.	Activate the VVC control in the inverter during the commissioning phase.

19.8.17 SLVC and VFC plus control modes not for synchronous motors


Warning!

The SLVC and VFC plus control modes cannot be used for synchronous motors. Select other control modes.

Cause	Effects	Possible remedies
The vector control (SLVC) and V/f control (VFC plus) control modes are not intended for this operating mode.	Motor control is not possible.	Select other control modes.

19.8.18 No product options available


Note!

No product options are available for the selected inverter. Configure product options manually.

Cause	Effects	Possible remedies
No product options are available in the DSD.	Product options cannot be selected.	Configure product options manually: • »EASY Product Finder« • Product catalogue • SAP

19.8.19 Mains choke required


Note!

A mains choke is required for the inverter.

Cause	Effects	Possible remedies
The inverter must be operated via a mains choke for the selected operating mode.	Rectifier in the inverter is overloaded.	Use mains choke.

19.8.20 Special measures for operation with increased rated power


Note!

An operation with increased rated power (120% = "Light Duty") has been selected for the inverter. Special measures are required. Observe information in the hardware manual.

Cause	Effects	Possible remedies
The "Light Duty" load characteristic (higher rated power 120%) enables a higher output current with restrictions. This allows the motor required for the application to be operated with a lower-powered inverter.	A higher output current is possible with restrictions as regards overload capacity, ambient temperature, switching frequency, type of installation and accessories (fuses, cable cross-sections, mains chokes, filters).	• Implement required measures according to hardware manual. • Select the "Heavy Duty" load characteristic (rated power 100%) if the restricting measures cannot be implemented.

Comparison of Heavy Duty and Light Duty

	Heavy Duty	Light Duty
Characteristic	High dynamic requirements	Low dynamic requirements
Typical applications	Master tool drives, travelling drives, hoist drives, winders, forming drives and conveyor drives	Pumps, fans, general horizontal materials handling technology and line drives
Overload capacity	3 s/200%, 60 s/150% - Please refer to the technical data for the frequency inverter in the hardware manual	- Restricted - Please refer to the technical data for the frequency inverter in the hardware manual

19.8.21 Motor control xxx not suitable for winding control mode yyy


Warning!

Motor control xxx is not suitable for winding control mode yyy.
Select another motor control (e.g. SC: servo control).

Cause	Effects	Possible remedies
The winding application can only reach a low performance with the selected motor control.	- Unstable control mode. - Torque dips.	Select servo control.

19.8.22 Motor control xxx suitable to a limited extent for winding control mode yyy


Note!

The motor control xxx selected is only suitable to a limited extent for winder control mode yyy.
Have the application checked by the technical support.

Cause	Effects	Possible remedies
The winding application can only reach a low performance with the selected motor control.	- Unstable control mode. - Torque dips.	Select servo control.

19.8.23 No electrical brake components available


Note!

For this device, no electrical braking components are available.

Cause	Effects	Possible remedies
The device selected does not feature an integrated brake transistor.	Braking circuit cannot be checked.	—

19.8.24 Ixt utilisation of the brake transistor is >100 %**Warning!**

The Ixt utilisation of the brake transistor is xxx.
Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The integrated brake transistor in the inverter is overloaded.	The monitoring function is triggered; the drive can coast down.	Select a different inverter.

19.8.25 Thermal utilisation of the inverter is > 80 %**Warning!**

The thermal utilisation of the inverter is xxx.
A manual, thermal check of the inverter is required
in the case of longer or cyclic operating phases with field frequencies < 5 Hz and
an output current > rated current.

Cause	Effects	Possible remedies
The actual thermal utilisation (Ixt) is determined in the inverter as a function of the rotating field frequency. The DSD model works with a simplified algorithm.	At field frequencies < 5 Hz and an output current > rated current, the actual utilisation may be slightly higher than the utilisation determined by DSD.	• Provide for sufficient Ixt reserves by selecting a more powerful inverter. • Detailed check of the thermal utilisation. • Contact Lenze Support. • Determine thermal utilisation in tests.

19.8.26 Rated inverter current is < xxx % of the rated motor current**Note!**

The rated inverter current is less than xxx % of the rated motor current. The motor magnetising current requires a large part of the rated inverter current.

In the partial load operational range of the motor, this dimensioning is possible if exact values of the mechanical base load and the friction of the transmission elements are considered.

Otherwise, the inverter is thermally overloaded.

In case of doubt, select an inverter with an adapted rated current.

Cause	Effects	Possible remedies
Asynchronous motor: • The rated inverter current is lower than 0.85 times the rated motor current. Synchronous motor: • The rated inverter current is lower than 0.6 times the rated motor current.	If the motor control is set unfavourably, the inverter is overloaded. An error-free operation cannot be guaranteed.	• Select inverter with higher rated output current. • Reduce switching frequency.

19.8.27 Thermal sensor is not evaluated by the inverter**Note!**

For the winder control mode selected, a thermal sensor on the motor is recommended under the given conditions.

This thermal sensor cannot be evaluated by the inverter selected.

This may make it impossible to attain the desired torque setting range.

Cause	Effects	Possible remedies
The inverter selected is not provided with a thermal sensor interface.	The desired torque setting range will possibly not be attained.	Select a different inverter.

19.8.28 Control characteristics not optimal with servo control**Note!**

The drive system selected is actuated in the SC (servo control) control mode.

In order to provide for an optimum torque and torque behaviour, we recommend the use of a linear motor temperature sensor (KTY/PT1000).

The motor temperature sensor must be activated in the inverter for commissioning.

Cause	Effects	Possible remedies
A change in the temperature of the motor winding during operation may cause substantial changes on the torque output at the motor shaft.	No optimum torque and torque behaviour.	Use a motor with a linear thermal sensor and have it evaluated by the inverter.

19.8.29 Switching frequency reduction as a function of the I_{xt} utilisation**Note!**

In the case of the switching frequency setting selected, the inverter reduces the switching frequency as a function of the I_{xt} utilisation across several cycles.

Cause	Effects	Possible remedies
In the case of the i500 frequency inverter, the current switching frequency is influenced by the current I _{xt} utilisation. The Drive Solution Designer does not take this effect into consideration.	The desired switching frequency may not be reached.	Set fixed switching frequency.

19.8.30 i950 servo inverters must not be combined with products outside the i series**Warning!**

In terms of compatibility, the i950 servo inverter is optimised for i-series inverters. No general approval can be granted if it is combined with other products.

Cause	Effects	Possible remedies
No compatibility requirements with products outside the i-series.	If circumstances arise making it necessary to combine these inverters with products outside the i-series, these cases must be checked and approved individually.	Do not combine i950 servo inverters with inverters outside the i series.

19.8.31 With specific switching frequencies, the hoist may sag**Note!**

When actuating the hoist drive in the SC control mode (servo control), due to the reduced maximum current, the hoist may sag with specific switching frequencies and with low rotating field frequencies. Select a suitable switching frequency setting.

Cause	Effects	Possible remedies
With rotating field frequencies <5 Hz, the maximum current of the inverter is reduced, thus reducing the available torque at low speeds.	The hoist may sag.	• Select Lenze setting of the switching frequency. • Contact Lenze sales partner.

19.8.32 Loss of control of the hoist drive with specific switching frequencies**Warning!**

When actuating the hoist drive in the VFC plus control mode with or without feedback, due to the reduced maximum current, the inverter may lose control of the hoist drive with specific switching frequencies and with low rotating field frequencies. Select a suitable switching frequency setting.

Cause	Effects	Possible remedies
With rotating field frequencies <5 Hz, the maximum current of the inverter is reduced, thus reducing the available torque at low speeds.	The inverter may lose control of the hoist drive.	• Select Lenze setting of the switching frequency. • Contact Lenze sales partner.

19.8.33 No fixed assignment between the motor and inverter power in the case of single mounting


Note!

In the case of single mounting, the fixed assignment between the motor power and inverter power is deactivated. The installation feasibility is not checked.

Cause	Effects	Possible remedies
In contrast to motor mounting, single mounting does not feature any fixed assignment between motor power and inverter power. With single mounting, the Inverter Drive 8400 motec is still only provided for mounting onto the motor.	- If the difference between the motor power and inverter power is too great, the inverter cannot be mounted onto the motor. - The installation feasibility is not checked. - A product configuration is not possible in the DSD.	- Check installation feasibility manually. - Observe SAP options.
► 8400 motec frequency inverters: motor mounting or single mounting (📖 322)		

19.9 Regenerative power supply module

19.9.1 Ambient temperature too low


Note!

The ambient temperature of the inverter is xxx °C. Thus the value falls below the required minimum ambient temperature of the regenerative power supply module of yyy °C.

Cause	Effects	Possible remedies
The ambient temperature is too low.	The component can be damaged.	Select air-conditioned control cabinet.

19.9.2 Ambient temperature too high


Warning!

The ambient temperature of the inverter is xxx °C. Thus the max. permissible ambient temperature of the regenerative power supply module of yyy °C is exceeded.

Cause	Effects	Possible remedies
The ambient temperature is too high.	The regenerative power supply module switches itself off due to a too high temperature.	• Select a different regenerative power supply module. • Select air-conditioned control cabinet.

19.9.3 Max. site altitude exceeded


Warning!

The site altitude is xxx m. It thus falls below the max. permissible site altitude of the regenerative power supply module of yyy m.

Cause	Effects	Possible remedies
Due to the lower atmospheric pressure, the cooling effect of the air is reduced.	The regenerative power supply module is not cooled sufficiently.	Contact Lenze

19.9.4 Max. power in supply mode exceeded


Warning!

The max. permissible power of the regenerative power supply module in supply mode is exceeded. The utilisation is xxx %.

Cause	Effects	Possible remedies
The max. DC-bus current is higher than the permissible DC-bus current	The drive is overloaded.	Select larger drive.

19.9.5 Utilisation relative to the permissible continuous power exceeded


Warning!

The permissible continuous power of the regenerative power supply module is exceeded.
The utilisation is xxx %.

Cause	Effects	Possible remedies
The DC-bus power exceeds the permissible continuous power of the device.	The drive gets too hot and switches itself off.	Use larger drive.

19.9.6 Max. DC-bus power (power recovery) too high


Warning!

The max. permissible power of the regenerative power supply module in feedback operation is exceeded.
The utilisation is xxx %.

Cause	Effects	Possible remedies
The DC-bus power in feedback operation is higher than the max. permissible power.	The drive is overloaded.	Select larger drive.

19.9.7 I_{xt} utilisation of the brake transistor is >100 %


Warning!

The I_{xt} utilisation of the brake transistor in the regenerative power supply module (without feedback) is xxx %. Thus, the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The integrated brake transistor cannot take that load without mains feedback.	The brake transistor is overloaded.	Use mains power recovery.

19.9.8 Permissible pulse power is exceeded


Warning!

The permissible pulse power of the regenerative power supply module is exceeded.
The utilisation is xxx %.

Cause	Effects	Possible remedies
Too high pulse load for the module.	Module is destroyed.	• Select a bigger regenerative power supply module. • Connect several regenerative power supply modules in parallel.

19.9.9 Permissible power of the regenerative power supply module is exceeded


Warning!

The max. permissible power of the regenerative power supply module with assistance of the brake transistor is exceeded in regenerative feedback operation.

The utilisation is xxx %.

Cause	Effects	Possible remedies
The peak braking power is too high.	Even the support with a brake resistor does not provide for a safe electrical braking operation.	• Select a bigger regenerative power supply module. • Connect several regenerative power supply modules in parallel.

19 Drive sizing messages

19.10 Power supply module

19.10 Power supply module

19.10.1 Ambient temperature too low

**Note!**

The ambient temperature of the inverter is xxx °C. Thus the value falls below the required minimum ambient temperature of the power supply module of yyy °C.

Cause	Effects	Possible remedies
The ambient temperature is too low.	The component can be damaged.	Select air-conditioned control cabinet.

19.10.2 Ambient temperature too high

**Warning!**

The ambient temperature of the inverter is xxx °C. Thus the max. permissible ambient temperature of the power supply module of yyy °C is exceeded.

Cause	Effects	Possible remedies
The ambient temperature is too high.	The power supply module switches itself off due to a too high temperature.	• Select a different power supply module. • Select air-conditioned control cabinet.

19.10.3 Max. site altitude exceeded

**Warning!**

The site altitude is xxx m. It thus falls below the max. permissible site altitude of the power supply module of xxx m.

Cause	Effects	Possible remedies
Due to the lower atmospheric pressure, the cooling effect of the air is reduced.	The power supply module is not cooled sufficiently.	Contact Lenze

19.10.4 Utilisation exceeded, regarding the max power (supply)

**Warning!**

The max. permissible power of the power supply module in supply mode is exceeded.
The utilisation is xxx %.

Cause	Effects	Possible remedies
The max. power in the DC bus is too high for the device.	The drive is overloaded.	Select larger drive.

19.10.5 Utilisation exceeded, relative to the max. power of the brake transistor**Warning!**

The max. permissible power of the brake transistor in the power supply module is exceeded in feedback operation. The utilisation is xxx %.

Cause	Effects	Possible remedies
The power required exceeds the permissible power of the device.	The drive is overloaded.	Select larger drive.

19.10.6 Utilisation >100 %, regarding the DC-bus power (supply)**Warning!**

The utilisation of the power supply module relative to the DC-bus power for supply is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The power required exceeds the permissible power of the device.	The drive gets too hot and switches itself off.	Use larger drive.

19.10.7 Utilisation of the power supply module is >100 %**Warning!**

The utilisation of the power supply module relating to the pulse power in the DC bus is xxx %. Thus, the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The power supply module is actuated in overload operation for too long.	Operation is not permissible. The device is overloaded.	• Select larger power supply module. • Connect several power supply modules in parallel. • Observe notes in the documentation of the power supply module.

19 Drive sizing messages

19.11 Brake chopper

19.11 Brake chopper

19.11.1 Ambient temperature of the brake chopper too high



Warning!

The ambient temperature of the inverter is xxx °C. Thus the max. permissible ambient temperature of the brake chopper of yyy °C is exceeded.

Cause	Effects	Possible remedies
The permissible ambient temperature is exceeded.	The drive gets too hot and switches itself off (provided that a thermal contact is available and is evaluated). Fire hazard if the thermal contact is not evaluated!	Contact Lenze.

19.11.2 Permissible site altitude of the brake chopper exceeded



Warning!

The site altitude is xxx m. It thus falls below the max. permissible site altitude of the brake chopper of yyy m.

Cause	Effects	Possible remedies
Due to the lower atmospheric pressure, the cooling effect of the air is reduced.	The drive gets too hot and switches itself off (provided that a thermal contact is available and is evaluated). Fire hazard if the thermal contact is not evaluated!	Contact Lenze.

19.11.3 Permanent utilisation of the brake chopper > 100 %



Warning!

The permanent utilisation of the brake chopper is xxx %.
Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The brake resistor is continuously overloaded.	The brake resistor gets too hot. • The thermal contact is opened. Fire hazard if the thermal contact is not evaluated!	Use larger drive.

19.11.4 Utilisation >100 %, regarding the peak braking power


Warning!

The max. utilisation of the brake chopper is xxx %. Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The actual peak braking power per brake chopper is too high.	An overvoltage message is activated within the inverter.	• Use larger drive. • Generate a DC-bus system and use multiple brake choppers of the devices in the DC-bus system if required. Observe the respective Hardware Manual!

19.11.5 Regenerative power is not dissipated safely


Warning!

The dissipation of the regenerative power is not guaranteed.

Cause	Effects	Possible remedies
A hoist drive generates regenerative power during the lowering operation that has to be dissipated by the inverter. Lowering operation has not been configured in the DSD.	Hoist sags. DC-bus operation may also generate situations in which regenerative power cannot be absorbed by other drives.	• Use electrical braking components. • Use regenerative power supply modules.

19.12 Brake resistor

19.12.1 Resulting brake resistance too low


Warning!

The resulting equivalent resistance is xxx Ohm. Thus the value falls below the minimum permissible brake resistance on the brake transistor of yyy Ohm.

Cause	Effects	Possible remedies
The value falls below the minimum permissible resistance.	The brake chopper is overloaded.	• Use different resistor. • Select different resistor interconnection. • Increase number of the brake choppers.
▶ Brake resistor selection (407)		

19.12.2 Permanent utilisation of the equivalent resistance > 100 %


Warning!

The permanent utilisation of the equivalent resistance is xxx %.
Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The resistor is overloaded with regard to the continuous braking power.	The inverter indicates overvoltage. Drive moves in an uncontrolled way!	• Use different resistor. • Use different resistor interconnection (series connection).
▶ Brake resistor selection (407)		

19.12.3 Max. utilisation of the equivalent resistance is >100 %


Warning!

The max. utilisation of the equivalent resistance is xxx %.
Thus the limit value of 100 % is exceeded.

Cause	Effects	Possible remedies
The required peak braking power is too high.	The brake resistor is overheated. Fire hazard!	• Select longer braking times. • Use resistor with higher peak braking power. • Connect several brake resistor so that a higher peak braking power is possible.

19.12.4 Max. permissible resistance value is exceeded


Note!

The resulting brake resistance is $> 220 \text{ Ohms}$.
The inverter may shut off due to overvoltage.
Select resistance value between 180 and 220 Ohms.

Cause	Effects	Possible remedies
The max. permissible resistance has been exceeded.	Due to overvoltage, the inverter switches off. • The drive will not be braked to standstill at the deceleration ramp anymore.	Select brake resistor with a resistance between 180 and 220 Ohm.

19.12.5 Thermal time constant of the brake resistor is too small


Warning!

The brake resistor has a thermal time constant $< 120 \text{ s}$.
In case of an uncoordinated DC-bus connection, the time constant must be $> 120 \text{ s}$.
DSD cannot carry out a safe check of the brake resistor.

Cause	Effects	Possible remedies
With an uncoordinated multi-axis system, only brake resistors with thermal time constant $> 120 \text{ s}$ are permissible.	The brake resistor overheats. Fire hazard!	Select a brake resistor with a higher thermal time constant.

19.12.6 Temperature monitoring for the built-in/attached brake resistor is activated


Warning!

The temperature monitoring function for the built-in/attached brake resistor is activated.
Do not use built-in/attached brake resistor! The device may be destroyed!

Cause	Effects	Possible remedies
For the built-in/attached brake resistor, an additional temperature monitoring mode is calculated in the device. This temperature monitoring function responds.	The device may be destroyed.	• Use of the built-in/attached brake resistor is not permissible. • Use external brake resistor.

19.12.7 Check internal brake resistors**Note!**

We recommend an additional check of the utilisation for the internal brake resistors.

Cause	Effects	Possible remedies
DSD checks the utilisation of the internal brake resistors according to algorithms for external resistors.	The brake resistors can overheat.	Additionally let the utilisation be checked by the Lenze support.

19.12.8 Utilisation of the brake resistor is >yyy %**Note!**

The utilisation of the brake resistor selected is xxx %.
If the utilisation is >yyy %, select a more powerful brake resistor.

Cause	Effects	Possible remedies
With the roller conveyor, the brake resistor may be prestressed by vibrations due to control processes without a braking process taking place.	With the brake resistor, operation of the Lenze Smart Motor is restricted.	Select brake resistor with a greater power reserve.

19.13 User motor

19.13.1 Limited check of the user motor


Note!

DSD is only able to check the user motor to a limited extent. The drive dimensioning is based on the general rules for checking Lenze components.
Check the motor according to the guidelines of the manufacturer.

Cause	Effects	Possible remedies
Construction data of user motors are not known. DSD is not able to carry out manufacturer-specific checks.	Limit values may be exceeded. The motor may be thermally overloaded.	• Check the motor according to the guidelines of the manufacturer. • Have the motor checked by the manufacturer.

19.13.2 No options available for the user motor


Note!

No product options are available for the user motor.
Contact the motor manufacturer.

Cause	Effects	Possible remedies
Product options for user motors are not available in DSD.	Selection of product options is not possible.	Contact the manufacturer of the motor.

19.13.3 Configure gearbox mounting flange for user motor


Note!

You have combined a user motor with a Lenze gearbox.
The motor geometry must comply with the gearbox mounting flange.
Enter the required data in the "Assignment of mounting flange" dimensioning step.

Cause	Effects	Possible remedies
The required data was not entered.	The motor cannot be mounted to the selected gearbox.	Enter the required data in the <i>Assignment of mounting flange</i> dimensioning step.

20 Feedback, help & support

Your responsible Lenze sales department supports you with regard to all questions concerning the operation of the DSD and the drive dimensioning.

20.1 Recording usage data

In order to develop the DSD continuously and target-oriented, the program contains a [Recording usage data](#). The acquisition of application data provides answers to the following important questions:

- Which applications are used and how intensively?
- Which auxiliary tools are used and how intensively?
- Which drive components are used for which applications?



Note!

The acquisition of application data does **not** save or transmit personal data! The data to be transmitted can be viewed before they are sent.

- Please carry out the acquisition of application data regularly.
- Read the data protection notice at <http://www.Lenze.com>.

In the Lenze setting the usage data is acquired automatically. Every three months the data is transferred to the Lenze DSD server. The precondition for this is an established Internet connection.

The data for acquisition of application data is also saved locally on your PC in the "sent" and "outbox" directories under "Documents and settings\<User name>\User data\Lenze\DSD V3.x.x.x\user_data\mail".

- If there is an Internet connection, copies of the data transmitted are stored in the "sent" directory.
- If there is no Internet connection, the data to be transmitted are stored in the "outbox" directory.
 - At the next program start, the DSD will try to send these data again. Delete the files in the "outbox" directory if the DSD is not to send these data.
 - When the data have been transmitted successfully, copies of the data transmitted are stored in the "sent" directory.
 - Ask your responsible Lenze sales department if you want to send files from the "outbox" directory to Lenze via e-mail.

Modifying settings

- Open the *Settings* dialog with the command **Tools→Settings**.

- In the selection field *Acquisition of application data* the setting can be altered:
 - "Automatic" (acquired every three months)
 - "On request"
 - "No"

► [Settings](#) (42)

20.2

Your opinion is important to us!



We have created these instructions to the best of our knowledge with the objective of providing you with the best possible support for our product.

Perhaps we haven't achieved this goal in all points. If you notice this, please send us your suggestions and your comments in a short e-mail to:

feedback-docu@Lenze.de

Thank you for your support.

Your Lenze documentation team

21 Glossary

A

Actual ratio	Actual gearbox ratio resulting from the ratio of the motor speed to the maximum speed of the application.
Additional drive element	A dedicated gearbox or a downstream ratio to the gearbox.

B

Base process power	Product of the max. torque and max. speed.
Braking during operation	Repeated braking from full speed, preferably used for uncontrolled drives.
Brake chopper	Electrical brake unit, additionally requiring an external brake resistor.
Braking unit	See brake chopper.

C

Continuous braking power	Power that can be continuously dissipated by the brake system.
Continuous power	Power that can be dissipated by the inverter in continuous operation if a standard useful life is required.
Continuous rated curve	Thermal characteristic curve for continuous operation.

D

Derating	Decrease of rated values under specific preconditions.
Disengagement time	Time from the start of the release of the mechanical brake to the decrease to 10 % of the rated torque.
Drive analysis	
Drive end	Side to which a motor is attached.

E

Electrical supply conditions	Mains voltage, mains frequency, supply form, and number of phases.
Energy efficiency	
Energy Performance Certificate	
Engagement time	In the case of mechanical brakes is composed of the deceleration time t_{11} when the brake is activated and the rise time t_{12} of the braking torque.

F

Feedback energy	The regenerative energy to be received by the brake resistor.
------------------------	---

G

G+K	Series connection of a Lenze gearbox and an additional drive element. G: Lenze gearbox K: Additional drive element
Group drive	Several identical motors are supplied by one inverter and together power an application.

H

Hyperlink	Optically highlighted reference, activated via mouse-click.
------------------	---

I

Imperial American measuring system
Examples for imperial units: ft, lb, lbf

L

Lenze gearbox Standard gearboxes such as the g500.

Lenze motor Standard motors such as m550-P, m540-P, m850, MCS, MCA, MDxMA.

Load-matching factor Ratio of the load moment of inertia reduced to the motor shaft compared to the intrinsic moment of inertia of the motor.
The load-matching factor is an important appraisal criterion for speed- or angle controlled dynamic acceleration drives.

Log Statement in writing of calculation results:

- Summarised report
 - Scope: One page DIN A4
- Detailed report
- Lenze BlueGreen Solutions
 - Comparing several projects with regard to energy efficiency and amortisation

M

Master project Project defining the supply and braking unit for multi-axis dimensionings.

Menu bar Bar on the upper edge of the application window below the title bar, which displays the names of menus that are opened by mouse-click.

Metric Measuring system, essentially based on SI units.
Examples for imperial units: m, kg, Nm

Motion profile, predefined according to the operating mode Entry of the motion via a predefined motion profile, based on the standardised operating modes S1, S2, S3, or S6. The times and direction of movement can be adapted.

Motion profile, user-definable There are different options to create a motion profile:

- Graphical creation of the motion profile in the *MotionDesigner*
 - Values can be optimised numerically.
- Creation of the motion profile by importing the operating points.

Multi-axis project Master or slave project the inverter of which is part of a DC-bus connection.
[▶ Master project](#)
[▶ Slave project](#)

N

Network type Multi-axis system with i700 servo inverter and/or multi-axis system with 9400 HighLine servo inverter, 8400 frequency inverter.

O

Output end Side to which a load is attached.

Overload capacity Ratio of the max. torque to the rated torque of a motor-inverter combination.

P

PDF	Abbreviation for "Portable Document Format", universal file format developed by the company Adobe for the exchange of electronic documents. By means of the Adobe® Reader® software which is available from Adobe free of charge, PDF files can be displayed and printed, irrespective of the application and the platform used for the creation. ▶ Internet: http://www.adobe.com/
Peak braking power	Power which may occur for a short time.
Preview value	Parameter determined in advance from the loads; can still change after the actual selection of the components.
Project comparison	Comparison of the parameters of all projects open in the DSD. SAP list of the configuration. Results for the drive analysis.

R

Regenerative power	Power that is resupplied from the motor in operation in generator mode and that is either dispensed to the mains or to a brake resistor.
Resistance to motion	Auxiliary quantity for combining linear guides and wheel-controlled systems in one value.

S

Setpoint ratio	Intended gearbox ratio resulting from the ratio of the motor speed to the maximum speed of the application.
Single axis project	
Slave project	Project with regard to multi-axis applications, in which no dimensioning of the supply and braking unit is effected. ▶ Multi-axis project
Sliding friction	Coulomb friction; generates a force opposed to the movement.
Static friction	Friction that has to be overcome before a relative movement between two bodies is possible.
Supply power	Required power received from the mains.

T

Title bar	Bar on the upper edge of the application window, containing the program icon and program name on the left end as well as the window icons on the right end. ▶ Window icon
Travelling resistance	Force per mass which a vehicle sets against its movement.

U

Uncontrolled drive	Entry of the kinematic data via the standardised operating modes S1, S2, S3, S6.
Unit system	Group of units of different physical quantities.
Up-rating	Up-rating of rated values under specific preconditions.

V

Variable-speed drive	Entry of the kinematic data via a motion profile
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W

Window icon	Button on the right end of the title bar to alter the window display, or to close the window.
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We have created these instructions to the best of our knowledge with the objective of providing you with the best possible support for our product.

Perhaps we haven't achieved this goal in all points. If you notice this, please send us your suggestions and your comments in a short e-mail to:

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Thank you for your support.

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