

8400

"Winder Tension-controlled" technology application
for 8400 TopLine C -----



Software Manual

EN



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1 About this documentation

This documentation describes the software-based solution of a task. The transferability of the described solution to the respective application needs to be checked by the user. If required, the user has to adapt the solution accordingly. Physical aspects such as the drive dimensioning are not part of this documentation.



Danger!

The inverter is a source of danger which may lead to death or the severe injury of persons.

To protect yourself and others against these dangers, observe the safety instructions before switching on the inverter.

Please read the safety instructions provided in the **Inverter Drives 8400 mounting instructions** and in the **Inverter Drives 8400 hardware manual**. Both documents are supplied with the inverter.

Target group

This documentation addresses to all persons who ...

- want to use the "Winder Tension-controlled" technology application for the Inverter Drive 8400 TopLine and ...
- who are familiar with handling the device and the »Engineer« software.

Information regarding the validity

The information in this documentation applies to the following technology applications:

Technology application	From version
Winder Tension-controlled	1.0

Screenshots/application examples

All screenshots provided in this documentation are application examples. Depending on the software version of the inverter and the version of the »Engineer« software installed, the screenshots in this documentation may differ from the representation in the »Engineer«.



Tip!

Information and tools for Lenze products are provided in the Download area at

<http://www.lenze.com> → Download

About this documentation

Document history

1.1 Document history

Version			Description
1.0	07/2017	TD29	First edition

1.2 Conventions used

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

Type of information	Highlighting	Examples/notes
Spelling of numbers		
Decimal separator	Point	The decimal point is always used. Example: 1234.56
Hexadecimal number	0x	For hexadecimal numbers, the "0x" prefix is used. Example: 0x60F4
Binary number	0b	For binary numbers, the "0b" prefix is used. Example: 0b00010111
Text		
Version information	Blue text colour	All information that only applies to a certain inverter software version or higher is identified accordingly in this documentation. Example: This function extension is available from software version V3.0 onwards!
Program name	» «	The »Engineer«... Lenze PC software
Window	<i>italics</i>	The <i>Message window</i> ... / The dialog box <i>Options</i> ...
Variable names		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 must be used in sequence to carry out a function, the individual commands are separated by an arrow: Select File→Open to...
Shortcut	<bold>	Use <F1> to open the online help.
		If a shortcut is required for a command to be executed, a "+" has been put between the key identifiers: With <Shift>+<ESC> ...
Hyperlink	<u>underlined</u>	Optically highlighted reference to another topic. It is activated with a mouse-click in this online documentation.
Icons		
Page reference	 4	Optically highlighted reference to another page. In this online documentation activated via mouse-click.
Step-by-step instructions		Step-by-step instructions are indicated by a pictograph.

About this documentation

Terminology used

1.3 Terminology used

Term	Meaning
Engineering tools	Software solutions for easy engineering in all project stages
	 »EASY Navigator« – ensures easy operator guidance • All convenient Lenze engineering tools at a glance • Tools can be quickly selected • The clear structure simplifies the engineering process from the start
	 »EASY Starter« – simple tool for service technicians • Specially designed for the commissioning and maintenance of Lenze devices • Graphical user interface with only a few buttons • Simple online diagnostics, parameterisation, and commissioning • No risk of an unintended change in applications • Loading of ready-to-use applications to the device
	 »Engineer« – multi-drive engineering • For all products in our L-force portfolio • Practical user interface • Easy handling by graphical user interfaces • Can be applied in every phase of a project (project planning, commissioning, production) • Parameter setting and configuration
Code	Parameter used for inverter parameterisation or monitoring. Is usually referred to as "index".
Subcode	If a code contains several parameters, they are stored in "subcodes". This manual uses a slash "/" as a separator between code and subcode (e.g. "C00118/3"). Is usually referred to as "subindex".
Lenze setting	This setting is the default factory setting of the device.
FB Editor	Abbreviation for "function block editor". Graphic interconnection tool which is available in the »Engineer« Abbreviation for "function block editor". Graphic interconnection tool which is available in the FB Editor tab.
Function block	General designation of a function block for free interconnection in the FB Editor. A function block (short: "FB") can be compared to an integrated circuit which contains a specific control logic and supplies one or more values when it is executed. Example: "L_Arithmetic_1" (FB for arithmetic operations) Many function blocks are available several times (e.g. L_And_1, L_And_2, and L_And_3).
System block	In the function block editor of the »Engineer«, system blocks provide interfaces to basic functions, "free codes", and to the hardware of the inverter (e.g. to the digital inputs). Each system block is available only once.
Port block	Block for implementing the process data transfer via a fieldbus
LP	Abbreviation for Lenze Port block Example: "LP_CanIn1" (CAN1 port block)
LS	Abbreviation for Lenze System block Example: "LS_DigitalInput" (system block for digital input signals)
MCI	Abbreviation for M otionbus C ommunication I nterface (fieldbus interface) The Inverter Drives 8400 can accommodate plug-in communication modules and can therefore take part in the data transfer of an existing fieldbus system.
Technology application	A technology application is a drive solution based on Lenze's experience and know-how, in which function blocks interconnected to a signal flow form the basis for implementing typical drive tasks.
USB diagnostic adapter	The USB diagnostic adapter is used for the operation, parameterisation, and diagnostics of the inverter. Data are exchanged between the PC (USB connection) and the inverter (diagnostic interface on the front) via the diagnostic adapter. Order designation: E94AZCUS

About this documentation

Definition of the notes used

1.4 Definition of the notes used

The following signal words and symbols are used in this documentation to indicate dangers and important information:

Safety instructions

Layout of the safety instructions:



Pictograph and signal word!

(characterise the type and severity of danger)

Note

(describes the danger and gives information about how to prevent dangerous situations)

Pictograph	Signal word	Meaning
	Danger!	Danger of personal injury through dangerous electrical voltage Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	Danger!	Danger of personal injury through a general source of danger Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	Stop!	Danger of property damage Reference to a possible danger that may result in property damage if the corresponding measures are not taken.

Application notes

Pictograph	Signal word	Meaning
	Note!	Important note to ensure trouble-free operation
	Tip!	Useful tip for simple handling

Properties of the technology application (TA)

Control modes for winding processes

2 Properties of the technology application (TA)

With the "Winder Tension-controlled" technology application, a tension-controlled (open loop) or tension-controlled (closed loop) winding drive can be implemented on an Inverter Drive 8400 TopLine from V14.00 onwards.

2.1 Control modes for winding processes

The following technology applications (TA) designed by Lenze can be used for winding processes:

"Winder Dancer-controlled" TA

With **dancer position control**, the drive is operated in the speed control mode. For feedforward control, the line speed signal multiplied by the reciprocal value of the diameter is used. The dancer position is recorded and compared with the setpoint position. If there is a deviation, the dancer position controller corrects the speed setpoint.

"Winder Tension-controlled" TA

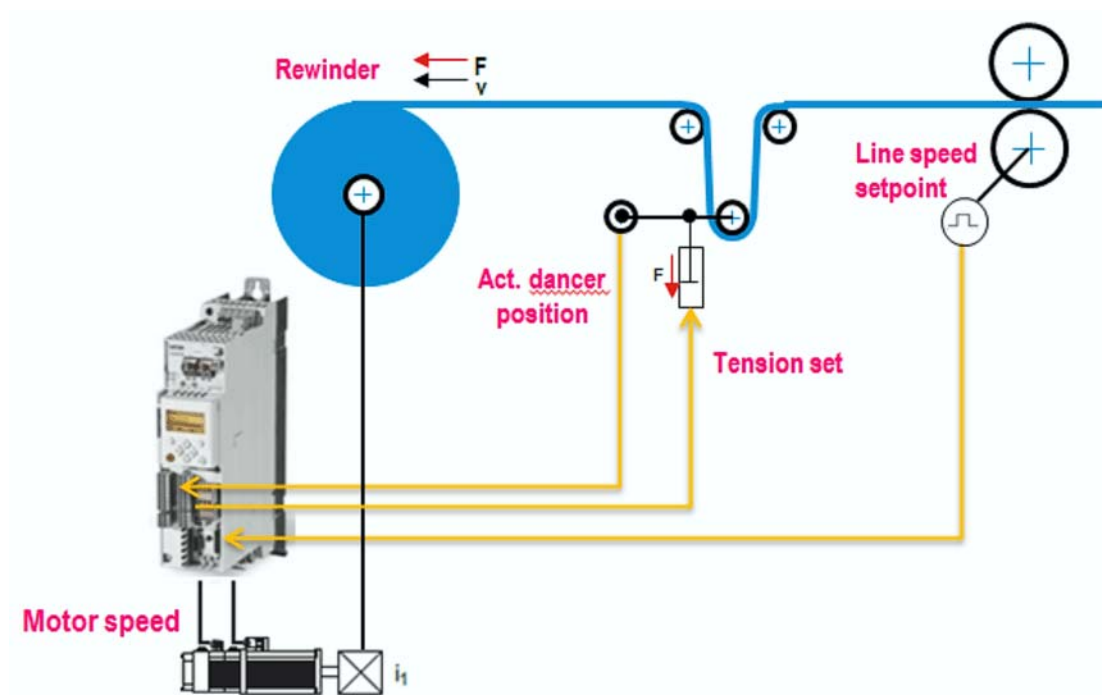
With **tension control open loop/closed loop**, the drive torque is directly provided. A higher-level speed control only takes corrective action in the event of a web break, in order to limit the speed of the drive. To prevent the setpoint torque from being affected by the speed limitation during normal operation, a speed offset must be added to the speed setpoint calculated from the current line speed and the current diameter. The torque setpoint is composed of the tensile force setpoint multiplied by the current radius, the correcting signal for the compensation of the mechanical friction and the correcting signal for the compensation of the acceleration torque.

2.1.1 Comparison of the functional principles

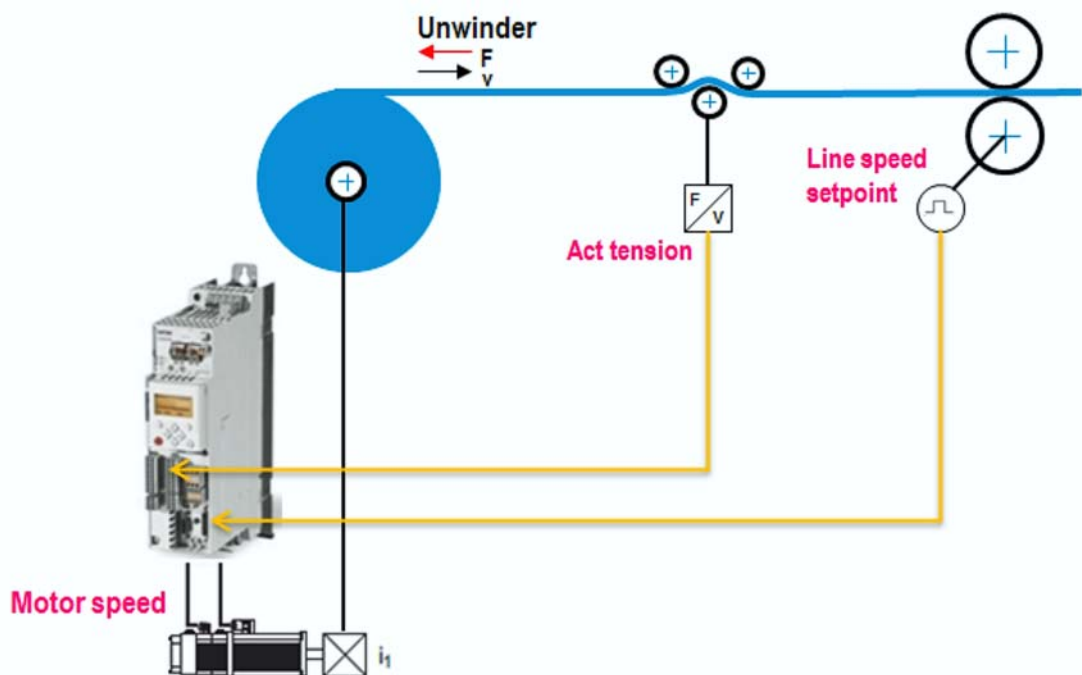
Winder Dancer-controlled -> dancer position control	Winder Tension-controlled -> tension control open loop/closed loop
• The web tension force is determined by the dancer mechanics.	• Depending on the tensile force setpoint and the current diameter of the winding material, the drive torque directly defines the tensile force at the winding material.
• The drive is actuated in speed control mode.	• The drive is operated as torque actuator.
• The line speed signal multiplied by the reciprocal value of the winding material diameter is used for feedforward control. • The dancer position is recorded and compared to the setpoint position. If a deviation is detected, the dancer position controller corrects the speed setpoint. • An acceleration torque can be compensated. • A dancer actuator can be optionally controlled from the inverter, e.g. in order to implement a reduction in tensile force with an increasing diameter.	• The line speed signal multiplied with the reciprocal value of the reel diameter + offset serves as a limit for speed limitation. • If an optional tensile force recognition system is provided, deviations can be compensated using a process controller (closed loop). • An acceleration torque and the friction losses can be compensated.
• The diameter is calculated in the inverter. • The control and setpoint selection are optionally taken over by ... • an HMI. • the digital and analog interfaces of the inverter. • a higher-level control via a bus system.	

Properties of the technology application (TA)

Control modes for winding processes



[2-1] Functional principle of a dancer position control ("Winder Dancer-controlled" TA)



[2-2] ¹ Functional principle of a tension control open loop/closed loop ("Winder Tension-controlled" TA)

Properties of the technology application (TA)

Application ranges

2.1.2 Functional overviews

Winder Dancer-controlled -> dancer position control	Winder Tension-controlled -> closed loop/open loop tension control
• Inching mode with ramp generator • Diameter calculation from line speed and winding speed • Holding/setting the diameter value • Web break monitoring using the diameter calculator • Winding from the top or the bottom • Automatic detection of the winding direction (unwinding/rewinding) by means of the sign of the line speed	
• If the dancer actuator is controlled from the inverter: reduction of tensile force via the characteristic function for rewinders (winding characteristic)	• Reduction of tensile force via the characteristic function for rewinders (winding characteristic)
• Acceleration compensation	• Acceleration compensation • Friction compensation • Ramp generator for tensile force setpoint • Speed limitation via the line speed plus the offset, 1/d-evaluated
• PI controller dancer position control with various possibilities of adaptation • "Teach-In" function for the dancer limit positions • consideration of the dancer movement in the diameter calculation	• PI controller tension control with various possibilities of adaptation
• Adaptation of the speed controller gain as a function of the current moment of inertia	



In the following, the "Winder Tension-Controlled" technology application is described. A description of the "Winder Dancer-Controlled" TA can be found in the separate software manual of the TA.

2.2 Application ranges

- Rewinding and unwinding of material webs in the field of surface finishing
 - Winding facilities in the textile industry
 - Unwinders in packaging machines
 - Rewinders/unwinders of round materials (threads, wires, cables, tubes,...)
- ... and many things more.

2.3 System requirements

Software

Product	Order designation	From version
»Engineer«	ESPEV-EHNNN	2.22.1.0

Hardware

Product	Order designation	From hardware version	From software version
Inverter Drive 8400 TopLine	E84AVTCxxxxx	VD	14.00

2.4 Parameter setting in the function block editor view

Enter application-specific parameters directly in the function block editor (FB Editor). In this way, the signal flow is traceable and the interaction of the blocks is illustrated.

Furthermore you can use the FB Editor to configure the I/O interconnection and monitor the applications running on the device, e.g. for diagnostics purposes.

- Open the parameterisation dialog or the parameter list for the block ...
 - via the  icon in the block header,
 - by double-clicking the block, or
 - by executing the **Parameter...** command in the *context menu* for the block.
- Colour coding and coloured comments provide for a clearly arranged structure of the FB Editor.
 - The areas highlighted in turquoise represent the "user interface". If required, the pre-assignment of the I/O terminals can be adapted here and a control via the fieldbus interface (MCI) can be established.
 - In the areas highlighted in yellow, application-specific settings are required.



Reference manual / online help for the Inverter Drive 8400

In the "Working with the FB Editor" chapter you'll find some detailed information on how to handle the FB Editor.

Properties of the technology application (TA)

Pre-assignment of the user interface

2.5 Pre-assignment of the user interface

Terminal	Function		
Digital input terminals			
X5/RFR	Controller enable		
	RFR	Function	
	LOW	Inhibit drive	
	HIGH	Enable drive	
X5/DI1	- (reserved for HTL encoder)		
X5/DI2	- (reserved for HTL encoder)		
X5/DI3	Enable winder (follow line speed)		
	DI3	Function	
	LOW	Inhibit winder	
	HIGH	Enable winder	
X5/DI4	Enable dancer control		
	DI3	Function	
	LOW	Inhibit dancer control	
	HIGH	Enable dancer control	
X5/DI5 X5/DI6	Selection of a preset setpoint for inching mode. At activation, an additional acceleration time is activated; positive manual inching		
	DI5	DI6	Function
	LOW	LOW	Follow the line speed
	HIGH	LOW	Selection of preset setpoint 1 = C00039/1 = 10 % • "Positive inching"
	LOW	HIGH	Selection of preset setpoint 2 = C00039/2 = -10 % • "Negative inching"
	HIGH	HIGH	Selection of preset setpoint 3 = C00039/3 = 0 %
X5/DI7	HIGH = reset error		
Analog input terminals			
X3/A1U	Line velocity • Scaling: 10 V = 100 % reference line speed (C0471/3)		
X3/A2U	Actual value of dancer position • Scaling: 10 V = 100 % reference)		
Digital output terminals			
X4/DO1	HIGH = "Drive is ready" state		
X4/DO2	Not assigned, can be freely used		
X4/DO3	Not assigned, can be freely used		
X107/BD1, BD2	Control of a holding brake by the basic function "holding brake control"		
X101/COM, NO	Relay contact closed = "An error is pending" state		
Analog output terminals			
X3/O1U	Actual speed value • Scaling: 10 V = 100 % reference speed (C00011)		
X3/O2U	Actual torque value • Scaling: 10 V = 100 % maximum torque (C00057)		

3 Short setup of the technology application

3.1 Preconditions

For the execution of the short setup described in the following, it is assumed that the basic parameters (motor, feedback system, etc.) have been set.

The "8400 commissioning wizard" enables guided commissioning of the Inverter Drive 8400, taking the Lenze parameter setting as a basis.

How to proceed:

1. Before switching on: ensure that the inverter is inhibited (digital input terminal X5/RFR open).
2. Switch on voltage supply of the inverter.
The parameterisation and diagnostics of the inverter without motor operation solely requires an external 24 V supply by a safely separated power supply unit (SELV/PELV).
3. Establish a communication link between the inverter and the Engineering PC, e.g. via a USB diagnostic adapter (E94AZCUS):
 - connect the USB diagnostic adapter to the X6 diagnostic interface.
 - establish a connection between the USB diagnostic adapter and the PC via a free USB port.
4. Start the »Engineer« on the Engineering PC, e.g. via the Windows start menu:
Start → All programs → Lenze → Engineering → L-force Engineer...
After the program start, no project has been loaded first and the *start-up wizard* is displayed.



»Engineer« Online help

Here you'll find some detailed information with regard to the options of the start-up wizard and to the general handling of the »Engineer«.

5. Create a new project or open a project already available.
6. Go to the *Project view* and select the 8400 inverter.
7. Click the  icon to go online.
When the connection to the inverter has been established successfully, the *status line* shows  **ONLINE** .
8. Click on the  icon to start the "8400 commissioning wizard".
 - Now the commissioning wizard guides you step by step through the setting of the important parameters for a quick commissioning.
 - The **Next** button can only be activated again after all parameter settings in the device have been reset via the **Load Lenze setting** button.
 - Execute the commissioning wizard right up to the end.
 - You can skip the "Control mode" step by clicking **Next** (only relevant for "Speed actuating drive" technology application).

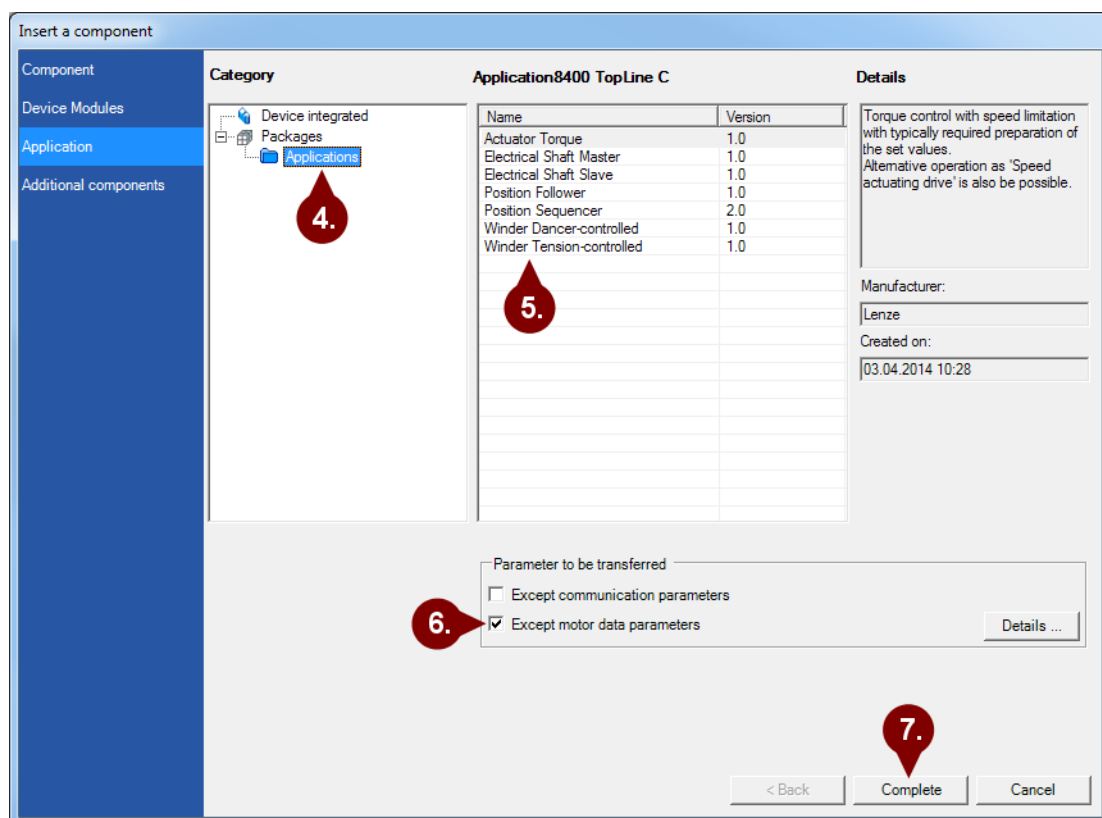
Short setup of the technology application

Step 1: Load "Winder Tension-Controlled" technology application

3.2 Step 1: Load "Winder Tension-Controlled" technology application

In the Lenze setting, the inverter uses the "Actuator speed" technology application integrated in the device. Execute the following steps to use the "Winder Tension-Controlled" technology application instead:

1. Go to the *Project view* and select the inverter.
2. If there is still an online connection to the inverter, click on the  icon to go offline.
The application can only be selected when you are offline.
3. Click the  icon to select another application.
The *Insert application* dialog box appears:



4. In the left field, select the **Packages → Applications** category.
5. In the right field, select the **"Winder Dancer-controlled"** application.
6. Activate the **Except motor data parameters** option in order that the settings of the motor data parameters made before will not be overwritten.
7. Press **Complete** to close the dialog box again and load the application selected into the »Engineer« project.
8. Confirm the prompt on whether the current application is to be replaced by the new application with **Yes**.

Short setup of the technology application

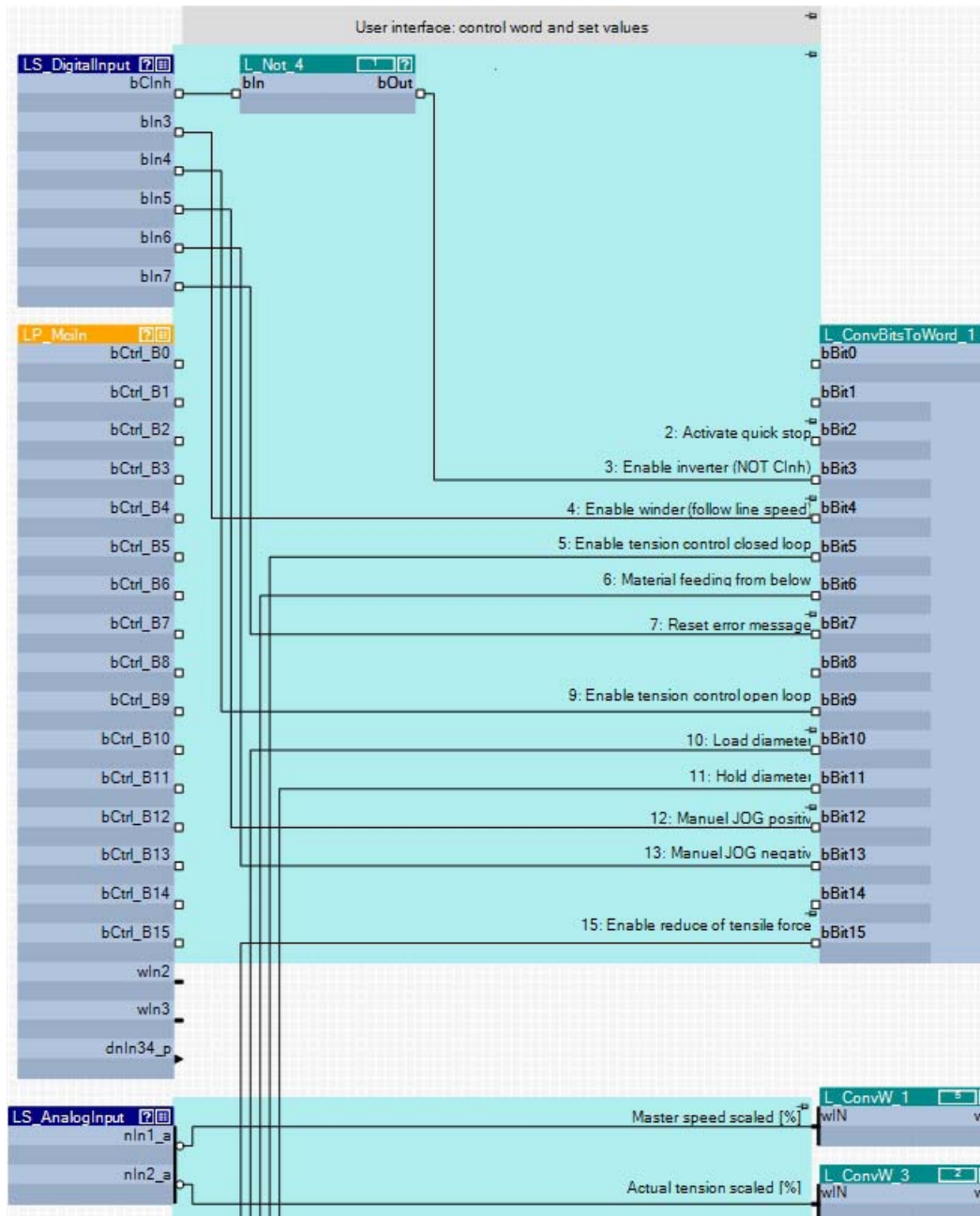
Step 2 (optional): Set up control via the fieldbus interface (MCI)

3.3 Step 2 (optional): Set up control via the fieldbus interface (MCI)

The Lenze default setting provides for controlling the application via the digital input terminals and specifying setpoints via the analog input terminals. If this is desired, continue with step 3.

If the fieldbus interface (MCI) is to be used instead of the terminals, the user interface in the FB Editor (area highlighted in turquoise) is to be adapted accordingly for the application control word and the setpoints.

- The assignment of the outputs (on the left) to the inputs (on the right) can be changed at will.
- The inputs (on the right) are permanently linked to functions of the application.



[3-1] Example of an interconnection

Short setup of the technology application

Step 2 (optional): Set up control via the fieldbus interface (MCI)

3.3.1 Pre-assignment of the process data input words

In the model connection (see Fig. [3-1](#)), the process data input words are assigned as follows:

Input word	Assignment
Word 1	Control word (for bit assignment see the following table)
Word 2	Line velocity • Scaling: 16384 $\equiv$ 100 % reference speed C00011
Word 3	Tensile force setpoint • Scaling: 16384 $\equiv$ 100 % tensile force
Word 4 ... 16	Not preconfigured

Control word	Function		
Bit 0	Not preconfigured		
Bit 1	Not preconfigured		
Bit 2	1 ≡ Activate quick stop (QSP)		
Bit 3	1 ≡ Enable inverter (RFR)		
Bit 4	1 ≡ enable winder		
Bit 5	1 ≡ enable tension control		
Bit 6	0 ≡ material feeding from the top 1 ≡ material feeding from the bottom		
Bit 7	1 ≡ reset error (Trip reset)		
Bit 8	Not preconfigured		
Bit 9	1 ≡ enable tension control open loop		
Bit 10	1 ≡ load diameter		
Bit 11	1 ≡ hold diameter		
Bit 12 ... 13	Selection of preset setpoints for inching mode		
	Bit 12	Bit 13	Function
	0	0	Inching mode not active
	1	0	Selection of fixed setpoint 1 = C00039/1 = 10 % reference speed (C00011) -> manual inching in positive direction
	0	1	Selection of fixed setpoint 2 = C00039/2 = -10 % reference speed (C00011) -> manual inching in negative direction
	1	1	Selection of fixed setpoint 3 = C00039/3 = 0 % reference speed (C00011)
Bit 14	Not preconfigured		
Bit 15	1 ≡ enable reduction in tensile strength for rewinder (tension characteristic)		

Short setup of the technology application

Step 2 (optional): Set up control via the fieldbus interface (MCI)

3.3.2 Pre-assignment of the process data output words

In the model connection (see Fig. [3-1](#)), the process data output words are assigned as follows:

Output word	Assignment
Word 1	Status word (for bit assignment see the following table)
Word 2	Actual speed value • Scaling: 16384 = 100 % reference speed C00011
Word 3	Current diameter • Scaling: 16384 = 100 % maximum diameter C00471/1
Word 4 ... 16	Not preconfigured

Status word	Status					
Bit 0	1 ≡ group error active (configurable in C00148)					
Bit 1	1 ≡ inverter control is inhibited (pulse inhibit is active)					
Bit 2	1 ≡ inverter is ready for operation					
Bit 3	1 ≡ quick stop is active					
Bit 4	1 ≡ setpoint torque is in limitation					
Bit 5	1 ≡ speed controller is in limitation					
Bit 6	During open-loop operation: 1 ≡ speed setpoint < comparison value (C00024) During closed-loop operation: 1 ≡ actual speed value < comparison value (C00024)					
Bit 6						
Bit 7	1 ≡ inverter is inhibited (controller inhibit is active)					
Bit 8 ... 11	Bit 11	Bit 10	Bit 9	Bit 8	Device status	Meaning
	0	0	0	0	FirmwareUpdate	Firmware update function is active
	0	0	0	1	Init	Initialisation active
	0	0	1	0	Ident	Identification active
	0	0	1	1	ReadyToSwitchOn	Device is ready to start
	0	1	0	0	SwitchedOn	Device is switched on
	0	1	0	1	OperationEnabled	Operation
	0	1	1	0	-	-
		1	1	1	Trouble	Trouble active
	1	0	0	0	Fault	Fault active
	1	0	0	1	TroubleQSP	TroubleQSP is active
	1	0	1	0	SafeTorqueOff	Safe torque off is active
	1	0	1	1	SystemFault	System fault active
Bit 12	1 ≡ a warning is indicated					
Bit 13	1 ≡ inverter is in the "Trouble" state					
Bit 14	1 ≡ tension-controlled (open loop) operation active					
Bit 15	1 ≡ web break (implausible diameter change)					

Short setup of the technology application

Step 3: Set commissioning parameters

3.4 Step 3: Set commissioning parameters

Open the parameterisation dialog or the parameter list for the block ...

- via the  icon in the block header,
- by double-clicking the block, or
- by executing the **Parameter...** command in the *Context menu* for the block.

For quick commissioning, only the following application-specific parameters have to be set or their default setting has to be checked:

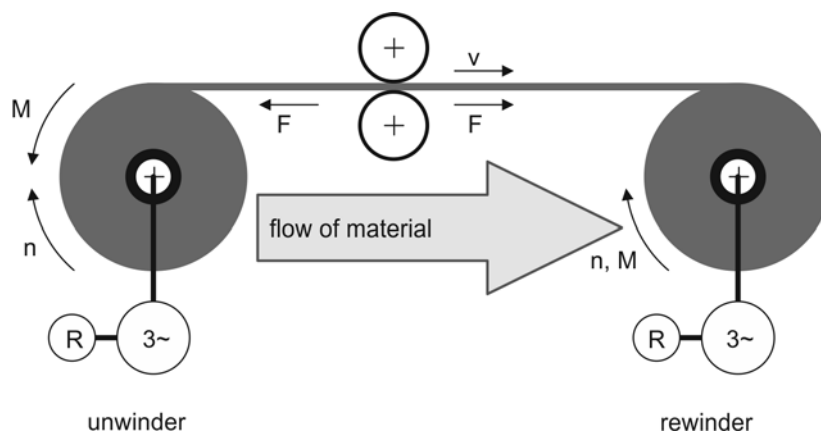
- "Normal" winding direction (rewinder or unwinder)
- Winding from the top or the bottom
- Reference variables

In the following, these parameters are described in detail.

3.4.1 Winding direction (rewinder or unwinder)

To ensure that the feedforward control values, the disturbance compensation, and the correcting signal of the tension control always act in the correct direction, the "normal" winding direction must be defined once.

- If the drive **unwinds** the material while the line speed is positive, **C00470/1 = 1** (unwinder) must be set.
- If the drive **rewinds** the material while the line speed is positive, **C00470/1 = 0** (rewinder) must be set.



Note!

When the "normal" winding direction has been defined once, the winding drives can also run in the opposite direction, with a negative line speed. Intervening in the signal flow is not necessary for this.

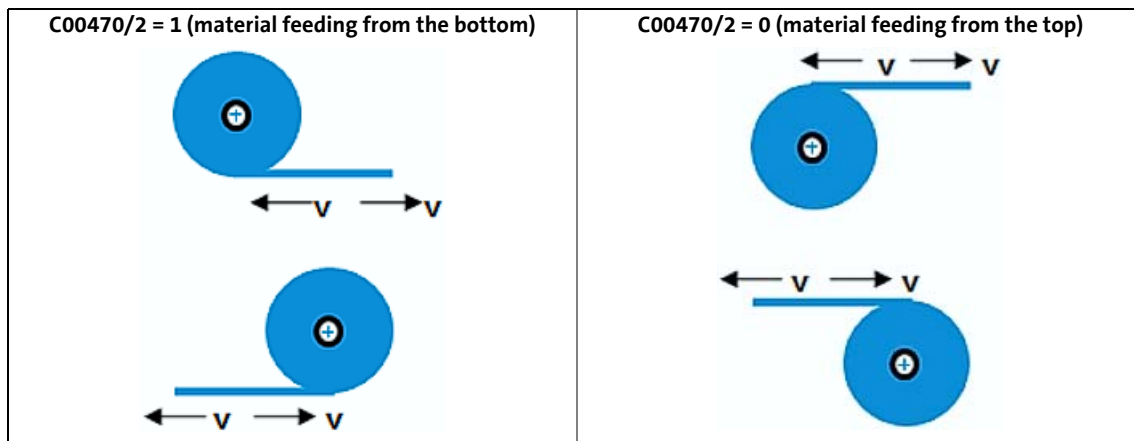
By means of the parameter C01206/1, "motor mounting direction = inverted", a potential inversion of the direction of rotation due to uneven-numbered gearbox stages and/or an inverted motor mounting position can be eliminated.

Short setup of the technology application

Step 3: Set commissioning parameters

3.4.2 Material feeding (winding from the top or the bottom)

Define the material feeding (effective direction of speed and torque at the motor shaft) in code C00470/2 or using control bit 6.



3.4.3 Defining reference variables

The setpoints for the speed, line speed, and tensile force are processed as scaled values. Therefore the reference variables have to be parameterised accordingly.

The reference variable for all scaled speeds is C00011. This value must be parameterised so that it matches the present machine data (gearbox factor i , minimum diameter $d_{\min}$) and the reference line speed $v_{100\%}$.

The reference value for the tensile force is a reference force $F_{100\%}$ provided by the application. The torque setpoint refers to C00057 and is calculated online in the inverter by entry of the motor parameters and C00022.

$F_{100\%}$ is to be selected so that when this tensile force is provided at the motor and with a maximum diameter, still a minimum reserve torque of 10 % to the maximum possible value (C00057) is provided. This reserve is to be kept as a control margin for the acceleration in the friction compensation process. Depending on the actual requirements of the application, also greater reserves may be required here.

The tensile force is adapted to the torque in the inverter.

Conversion factor: $C0471/4 / C00471/5$

(These factors are calculated from $F_{100\%}$ and C00057 in the Excel support tool designed by Lenze, "Tool_TA8400_TensionControlled_V1-0.xlsx".)

The reference variables are preselected via the basic parameters described in the following.



Note!

The **basic parameters** must be defined at the start of commissioning.

The **other parameters** can be adapted as optimisation parameters in the course of commissioning.

Short setup of the technology application

Step 3: Set commissioning parameters

The Lenze settings are selected so that the technology applications can be tested on the Lenze winder training model:

- Left -> "Winder Tension-controlled" TA as unwinder
- Right -> "Winder Dancer-controlled" TA as rewinder

Parameter (block)	Possible setting		Info
Basic parameter			
C00011	50 ... 60000		Motor speed at reference line speed and minimum diameter C00011 = $\text{ROUNDS}(i/(d_{\min}/1000 \cdot \pi) \cdot v_{100} \%)$ i: total ratio between motor shaft and winding shaft d_min: minimum diameter [mm] v_100 %: reference line speed [m/min] Please note: This value must be defined accordingly and adapted when v_100%, i or d_min is changed. • Lenze setting: 955 rpm
C00470/1 (LS_ParFree_b)			Function of the winder with a positive line speed signal • Lenze setting: 1
	0	Rewinder	
	1	Unwinder	
C00470/2 (LS_ParFree_b)			Material feeding • Lenze setting: 1
	0	From the top	
	1	From the bottom	
C01202/1 (LS_MotionControlKernel)	1 ... 65535		Gearbox factor numerator Z2 • Lenze setting: 1
C01202/2 (LS_MotionControlKernel)	1 ... 65535		Gearbox factor denominator Z1 • Lenze setting: 1
C00471/1 (LS_ParFree)	1 ... 65535		Maximum diameter [mm] • Lenze setting: 200
C00471/2 (LS_ParFree)	1 ... 65535		Minimum diameter [mm] • Lenze setting: 50
C00471/3 (LS_ParFree)	1 ... 65535		Reference line speed [0.1 x m/min] • Lenze setting: 1500
C00471/4 C00471/5 (LS_ParFree)	1 ... 65535		Conversion factor tensile force to torque C00471/4 = numerator = F_100% x 10 C00471/5 = denominator = d_max / 1000 x C00057 x 10 F_100 % = rated tensile force [Nm] d_max = maximum diameter [mm] C00057 = maximum torque (online value according to corresponding parameterisation of the motor and C00022) • Lenze setting: C00471/4=50; C00471/5=102
C00472/5 (LS_ParFree)	-199.99 % ... 199.99 %		Threshold of minimum line speed • Lenze setting: 1 %
C00472/6 (LS_ParFree)	-199.99 % ... 199.99 %		Comparison value of the line speed sign recognition • Lenze setting: -0.2 %

Short setup of the technology application

Step 3: Set commissioning parameters

Parameter (block)	Possible setting		Info
Condition speed setpoint /limitation threshold values; inching mode			
C00470/9 (LS_ParFree_b)			Adaptive adjustment of the speed controller gain Please note: requires a correspondingly parameterised acceleration compensation. • Lenze setting: 0
	0	Adaptation active	The speed controller gain is set to a permanent value (C00070).
	1	Adaptation not active	The speed controller gain is increased linearly to the current moment of inertia.
C00660/2 (L_FixSet_a_1)	-199.99 % ... 199.99 %		Line speed offset for the speed limitation with a positive line speed signal Lenze setting: 5 %
C00660/4 (L_FixSet_a_1)	-199.99 % ... 199.99 %		Line speed offset for the speed limitation with a negative line speed signal • Lenze setting: 5 %
C00721/2 (L_DigitalDelay_2)	0.00 ... 3600.00 s		Delay of the deceleration time deactivation for the inching mode • Lenze setting: 0.1 s
C00039/1	-199.99 % ... 199.99 %		Preset setpoint 1: positive inching • Lenze setting: 10 %
C00039/2	-199.99 % ... 199.99 %		Preset setpoint 2: negative inching • Lenze setting: -10 %
C00039/3	-199.99 % ... 199.99 %		Preset setpoint 3: alternative inching speed • Lenze setting: 5 %
C00101/1	0.001 ... 999.99 s		Inching mode: acceleration time • Lenze setting: 5 s
C00101/3	0.001 ... 999.99 s		Inching mode: deceleration time • Lenze setting: 5 s
C00677/1	-199.99 % ... 199.99 %		Adaptation factor of the moment of inertia for the speed controller adaptation • Lenze setting: 60 %
C00677/1	-199.99 % ... 199.99 %		Lower limitation of the speed controller adaptation • Lenze setting: 40 %

Short setup of the technology application

Step 3: Set commissioning parameters

Parameter (block)	Possible setting		Info
Tensile force open loop control/closed loop control, tensile force characteristic, tensile force controller			
C00470/3 (LS_ParFree_b)			Enable tension control. • Lenze setting: 0
	0	Tensile force controller reset	
	1	Tensile force controller active	
C00472/2 (LS_ParFree)	-199.99 % ... 199.99 %		Tensile force setpoint scaled [%] • Lenze setting: 20 %
C01040/1 (L_SRFG_1)	0 ... 999.99 s		Acceleration time for tensile force setpoint • Lenze setting: 0.5 s
C00472/7 (LS_ParFree)	-199.99 % ... 199.99 %		Influence of tensile force controller • Lenze setting: 5 %
C01056/1 (LS_ProcessCtrl_1)	0 ... 100		Tensile force controller gain • Lenze setting: 1
C01053/4 (LS_ProcessCtrl_1)	0 ... 30 s		Tensile force controller reset time • Lenze setting: 5 s
C01053/2 (LS_ProcessCtrl_1)	0 ... 30 s		Filter time constant for actual tensile force value • Lenze setting: 0.1 s
C00470/4 (LS_ParFree_b)			Enable tensile force reduction for rewinder (tensile force characteristic). • Lenze setting: 0
	0	Tensile force adaptation not active	The tensile force setpoint is not adapted.
	1	Tensile force adaptation active	Tensile force is reduced with an increased diameter according to the characteristic in the L_Curve_3.
C01030/1 (L_Curve_3)	4	Characteristic	L_Curve_3: do not change function! • Lenze setting: 4
C01035/1 (L_Curve_3)	0	Linear tensile force profile	L_Curve_3: selection of the tensile force characteristic • Lenze setting: 0
	1	Linear torque profile	
	2	Tensile force profile according to characteristic	
C00472/3 (LS_ParFree)	-199.99 % ... 199.99 %		Starting point of the tensile force characteristic • Lenze setting: 50 %
C00472/4 (LS_ParFree)	-199.99 % ... 199.99 %		Slope of the tensile force characteristic • Lenze setting: 60 %

Short setup of the technology application

Step 3: Set commissioning parameters

Parameter (block)	Possible setting		Info
Friction compensation			
C00960/1 (L_Curve_1)			Activate friction compensation. • Lenze setting: 0
	0	Inactive	The compensation torque is permanently set to 0 %.
	3	Active	Via the characteristic of L_Curve_1, a speed-dependent compensation torque is connected.
C00963/1 ... 32 (L_Curve_1)	-32767 ... 32767		X values of the tensile force characteristic (speed)
C00964/1 ... 32 (L_Curve_1)	-32767 ... 32767		Y values of the tensile force characteristic (torque)
Acceleration compensation			
C01025/1 (L_Curve_2)			Enable acceleration compensation. • Lenze setting: 0 Note: The acceleration compensation can only be used reasonably if the cam table (C01028/C01029) and blocks L_DT1, L_ConW_2, and L_ConW_4 are parameterised accordingly. Use the "Tool_TA8400_TensionControlled_V1-0.xlsx" Excel support tool to determine the matching parameters of these blocks!
	0	Inactive	The compensation torque is permanently set to 0 %.
	3	Active	Via the characteristic of the L_Curve_2 block and the current diameter, a compensation torque is connected, which is proportional to the inertia.
C01028/1 c 32 (L_Curve_2)	-32767 ... 32767		X values of the characteristic adaptation of the moment of inertia
C01029/1 c 32 (L_Curve_2)	-32767 ... 32767		Y values of the characteristic adaptation of the moment of inertia
C00251/0 (L_DT1)	10 ... 5000 ms		L_DT1 time constant • Lenze setting: 10 ms (do not change)
C00252/0 (L_DT1)	-320 ... 320		Speed differentiation gain • Lenze setting: 100
C00940/2 (L_ConvW_2)	-32767 ... 32767		Acceleration scaling • Lenze setting: 1000
C00940/4 C0941/4 (L_ConvW_4)	-32767 ... 32767		Scaling of the moment of inertia • Lenze setting: C00940/4 = 330; C00941/4 = 1020
C00472/8 (LS_ParFree)	-199,99 % ... 199,99 %		Material width scaled • Lenze setting: 100 %

Short setup of the technology application

Step 3: Set commissioning parameters

Parameter (block)	Possible setting		Info
Calculation of the diameter			
C00470/5 (LS_ParFree_b)			Load diameter.
	0	-	
	1	Load diameter	The <i>nSetDiameter_a</i> input value is accepted as the current diameter.
C00470/6 (LS_ParFree_b)			Hold last diameter value.
	0		Diameter is recalculated cyclically.
	1		No recalculation of diameter. The value calculated or loaded last is maintained.
C00470/7 (LS_ParFree_b)			Activate web break monitoring (<i>bUniDirect</i>). • Lenze setting: 0
	0	Inactive	The diameter may change in rewinding and unwinding direction.
	1	Active	An implausible change in diameter opposed to the winding direction preselected via <i>bUnwind</i> AND beyond the C01052/1 tolerance window sets the <i>bWebBreak</i> output to TRUE. The calculation of the change in diameter in the opposite direction is prevented. Therefore only activate the web break monitoring if the <i>dwOutDiameter</i> output value corresponds to the real diameter.
C00470/8 (LS_ParFree_b)			Calculation cycle for the diameter calculation • Lenze setting: 0
	0	Standard cycle	Use diameter recalculation 0 (C01050/1).
	1	Short cycle	Use diameter recalculation 1 (C01050/1).
C00472/1 (LS_ParFree)			Start diameter scaled to <i>d_max</i> C471_1 • Lenze setting: 50 %

Short setup of the technology application

Step 4: Transferring the parameter set to the inverter

3.5 Step 4: Transferring the parameter set to the inverter

1. Click the  icon to go online.
2. Click on the  icon to transmit the parameter set to the inverter.
3. After a successful transmission, click the  icon to save the parameter set safe against mains failure in the integrated memory module.

3.6 Step 5: enabling the inverter

- Set motor (»Engineer« motor catalogue or nameplate)
The motor rotates freely with an empty winding shaft.
- Load the diameter calculator with the minimum diameter so that the diameter is held on the smallest diameter possible during the calculation.

In order to achieve this, ...

- set C00472/1 = 0;
- set the "Load diameter" control bit (C00470/5 = 1, bit 10 = 1);
- set the "Hold diameter" control bit (C00470/5 = 1, bit 10 = 1).

Short setup of the technology application

Step 6: checking the parameter setting

3.7 Step 6: checking the parameter setting

3.7.1 Checking the winding direction

The "normal" winding direction has been defined in step 3:

► [Winding direction \(rewinder or unwinder\)](#) (17)

The effective direction of a positive tensile force setpoint at the winding shaft is determined as follows:

- Select operation without feedback of the tensile force (open loop).
- Specify a small tensile force setpoint for line speed = 0.
- Enable winder and tension control open loop (DI3 = 1 and DI4 = 0 or bit 4 = 1 and bit 9 = 1).

The following effective directions are to be expected:

Winding direction	Unwinder (C00470/1 = 1)		Rewinder (C00470/1 = 0)	
Material feed	From the top (C00470/2 = 0)	From the bottom (C00470/2 = 1)	From the top (C00470/2 = 0)	From the bottom (C00470/2 = 1)
Movement of the winder	Counter-clockwise	Clockwise	Clockwise	Counter-clockwise



Note!

"Motor mounting direction = inverted" (C01206/1) may eliminate a potential inversion of the direction of rotation due to uneven-numbered gearbox stages and/or an inverted motor mounting position.

3.7.2 Check speed feedforward control

Check the speed feedforward control as follows:

- Enable the winder (DI3 = 1, bit 4 = 1) to actuate the drive in the "Follow line speed" operating mode.
- Start the line speed master and increase the speed to 50 %.

The winder must now rotate with half the speed parameterised in C00011.

When the material is fed from the top, the winding shaft rotates clockwise, whereas material feeding from the bottom makes the winding shaft rotate in counter-clockwise direction.

If the speed or direction of rotation is incorrect, check the above-mentioned definition of the basic parameters (C00470/1, C00470/2, C01206/1).

Short setup of the technology application

Step 7 (optional): Setting the disturbance compensation

3.8 Step 7 (optional): Setting the disturbance compensation

In order to improve the dynamic properties, the following disturbance can be compensated:

- Acceleration torque
- Friction

3.8.1 Setting the acceleration compensation

The disturbance of the acceleration torque can be compensated via a characteristic. This characteristic is defined via an Excel support tool (Tool_TA8400_TensionControlled_V1-0.xlsx) and is imported into the »Engineer« in the form of a gdc file.

Function of the Excel support tool

The acceleration torque required for instance depends on the constant mass inertia (motor + mechanics) and the variable moment of inertia (reel). By means of the Excel support tool, the moment of inertia is determined as a function of the diameter and is scaled to the maximum moment of inertia. The grid points of this function are stored in the L_CurveW_2 block. The input variable is the scaled diameter of the reel. The output is scaled, i.e. to the total maximum moment of inertia (constant + variable) relating to the motor shaft.

The quantisation of the acceleration signal at the output of the L_DT_1 block significantly increases with great acceleration times (> 5 s). In order to counteract this, the acceleration is scaled to a standard acceleration time. This is taken into consideration with the factors in the L_DT_1 and L_ConvW_2 blocks when determining the acceleration. The moment of inertia is scaled to the acceleration required for this purpose using block L_ConvW_4 .

If possible, the line speed signal should be derived from a stable setpoint of the speed-determining drive in the machine. For a less stable line speed signal, the number of significant bits which are taken into consideration in the differentiation process so that acceleration jumps are avoided can be set in the L_DT1_1 block.

Conditional equations for the scaling:

- Acceleration scaling

Acceleration time t_{acc} less than or equal to 3.2 s:

$$L_DT1_1, C00252: t_{acc} * 10$$

$$L_ConvW_2, C00940/2: 1000$$

Acceleration time t_{acc} greater than 3.2 s:

$$L_DT1_1, C00252: 320$$

$$L_ConvW_2, C00940/2: t_{acc} * \frac{100000}{320}$$

- Scaling of the moment of inertia to the reference acceleration:

$$L_ConvW_4, C00940/4: 2\pi * \frac{C00011}{60} * \frac{1}{t_{acc}} * J_{max}$$

$$L_ConvW_4, C00941/4: C00057 * 1000$$

J_{max} : maximum moment of inertia relating to the motor shaft in kgm²

t_{acc} : rated acceleration time of the winder in s

Short setup of the technology application

Step 7 (optional): Setting the disturbance compensation

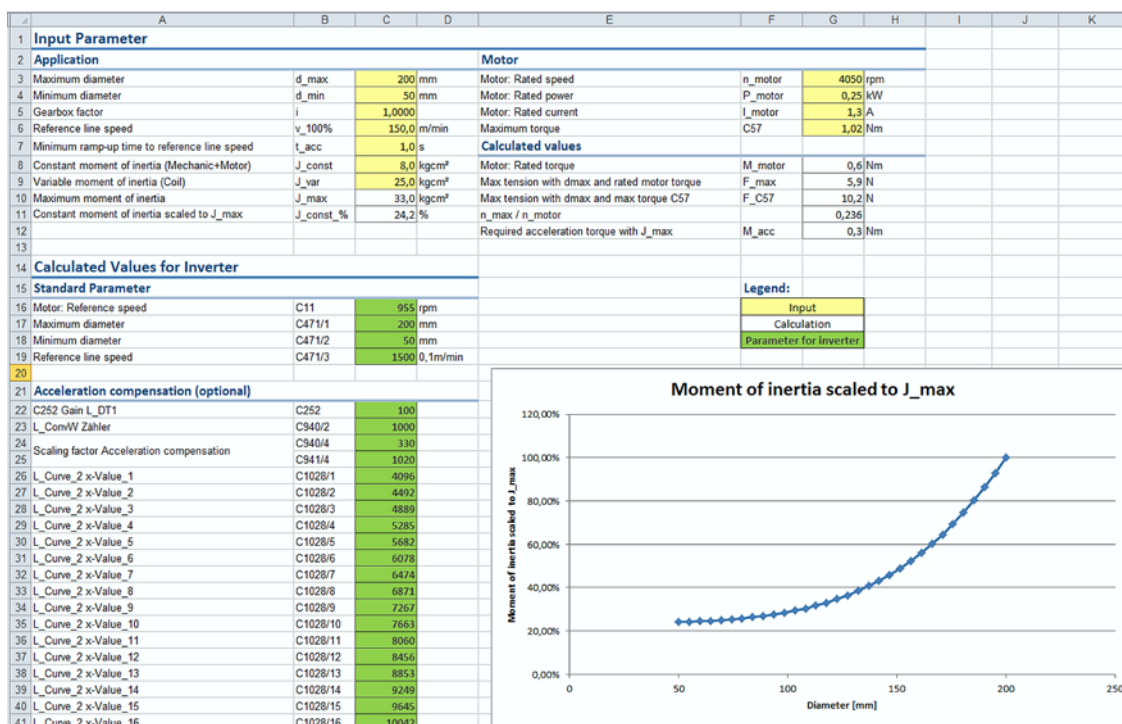
Handling the Excel support tool

The entries required for calculating the parameters are made in the support tool in the cells highlighted in yellow. Afterwards the development of the moment of inertia as a function of the current diameter is calculated and represented graphically.



Note!

The maximum torque C00057 can only be read out online after having entered the motor model and after having adapted C00022 in the Inverter Drive 8400 TopLine.



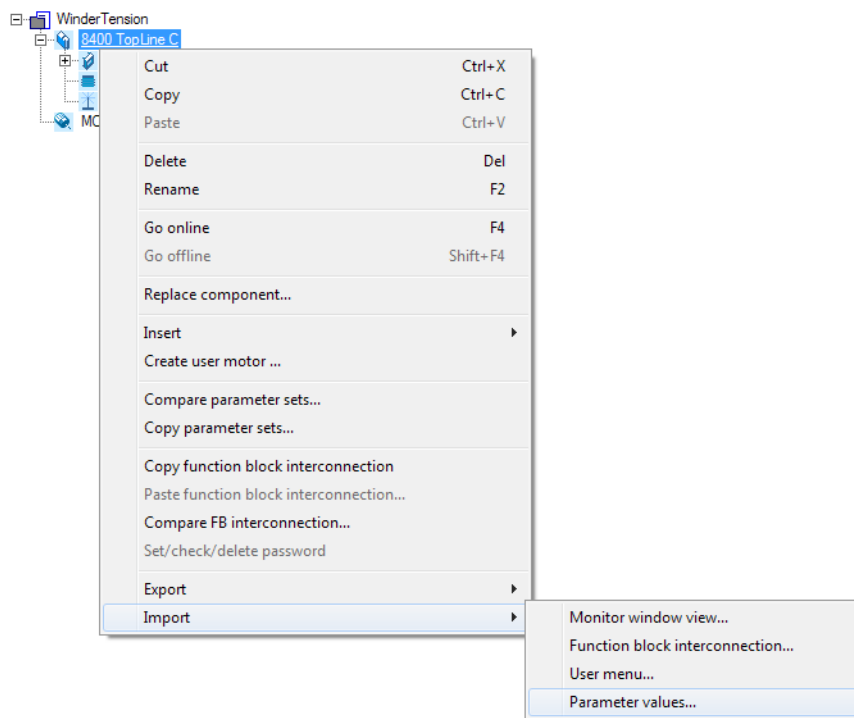
Short setup of the technology application

Step 7 (optional): Setting the disturbance compensation



How to import parameters in the »Engineer«:

1. Open the "Inertia_Export_Dancer" worksheet in the Excel tool.
2. Copy the content of cells E1 to E76 to a text editor using the Windows clipboard.
3. Save this text file and rename its file extension to ".gdc".
4. Click on the axis in the project tree using the left mouse button.
5. Select **Import** → **Parameter** values and select the file created.



Short setup of the technology application

Step 8 (optional): Optimising the closed-loop control parameters

3.9 Step 8 (optional): Optimising the closed-loop control parameters

3.9.1 Optimising the closed-loop speed control

The optimisation of the speed controller is only relevant for the inching mode and for the quick stop procedure, since the speed controller is not used in normal winding operation (torque open-loop-controlled).

In order to obtain a scaled setpoint speed for the speed controller, the scaled line speed signal is multiplied by the reciprocal diameter ($1/d_{act}$).

In order to ensure that the scaled setpoint winder speed complies with the scaled setpoint motor speed and the scaled line speed signal, carrying out the correct setting in C00011 (motor reference speed) is absolutely necessary. The scaled setpoint winder speed refers to the motor speed which, with the minimum diameter (d_{min}), is required to obtain the reference line speed at the circumference of the reel.

Adaptation of the speed controller gain

Under ideal circumstances, the gain of the speed controller must increase linearly with the moment of inertia effective at the motor shaft.

When the acceleration compensation has been parameterised correctly, the current moment of inertia is calculated automatically and is output at L_ConW_4 as a scaled value. This signal can be used for the percentage speed controller adaptation.

Since, in practice, the gain must not increase proportionally with the moment of inertia, the process of adaptation is carried out via $L_GainOffsetP_1$:

- The scaled moment of inertia is multiplied by C00677/1.
- C00677/2 indicates the lower limit value of the speed controller gain.

In addition, the speed controller adaptation must be enabled with C00470/9 = TRUE.

The speed controller in the marginal areas should be optimised with a small and a very great diameter.



Online help for the Inverter Drive 8400 TopLine

In the "Optimising the speed controller" chapter, the general optimisation procedure is described.

3.9.2 Optimising the dancer position control

The control path of the dancer position control depends on many factors in the application and must therefore be optimised individually.

- Gain: C01056/1
- Reset time: C01053/4
- C00740/2 = TRUE (control bit 5 = TRUE) enables the PI controller. The influence is determined in C00472/7.

Short setup of the technology application

Step 9 (optional): Activating the web break monitoring function

3.10 Step 9 (optional): Activating the web break monitoring function

For the purpose of diameter calculation, web break monitoring can be implemented using the *L_CalcDiameter_1* block. It is based on the fact that, in the event of a web break, the diameter calculated develops so that it opposes the winding direction.

The web break monitoring function is activated with C00470/7 = TRUE. This only makes a change in diameter opposite to the winding direction possible and permissible within the window parameterised in C01052.

The rewinding or unwinding operation is detected automatically, on the basis of the line speed sign and the winding direction parameterised. The response to this monitoring function is stored in the "Warning locked" Lenze setting and can be adapted in C00581/1.



Note!

If the web break monitoring function is active, a change in diameter opposing the winding direction specified via *bUnwindActive* is prevented. After loading a start diameter which significantly deviates from the real diameter in the direction opposing the winding direction, this may cause unintended triggering of the monitoring function.

Example :

In the case of the rewinder, a start diameter of 50 % is loaded, however, the real diameter is only 45 %. The change in the diameter value to the real 45 % is prevented with an active web break monitoring function.

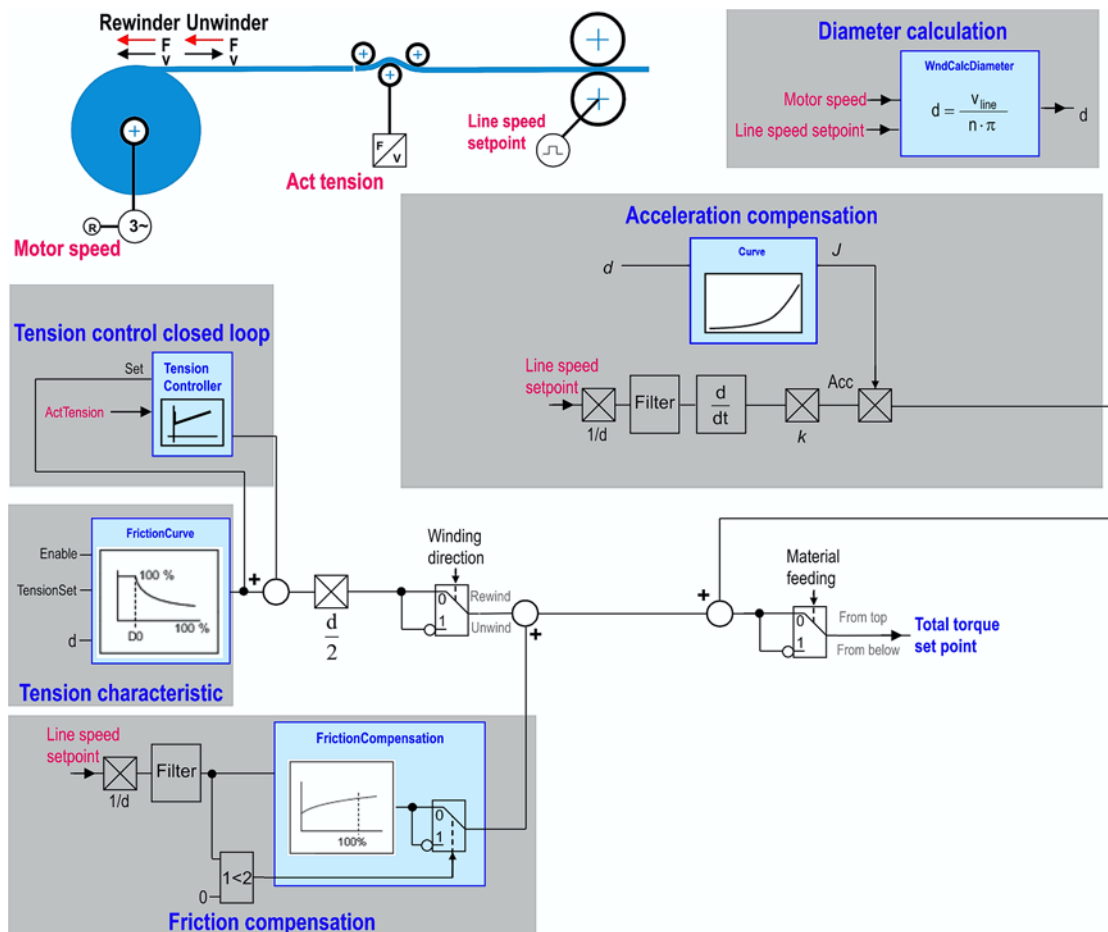
Web break monitoring may only be activated when the calculated diameter corresponds to the real diameter!

Detailed functions of the technology application

Signal flow of the technology application

4 Detailed functions of the technology application

4.1 Signal flow of the technology application



Detailed functions of the technology application

Functions for winding operation

4.2 Functions for winding operation

4.2.1 Speed feedforward control

The speed feedforward control on the one hand provides the speed limits for open/closed loop tension-controlled operation, and on the other hand provides the setpoint for the "Follow line speed" set-up mode.

In order to obtain a scaled winder setpoint speed for the speed controller, the scaled line speed signal is multiplied with the reciprocal diameter ($1/d_{act}$).

To make the scaled winder setpoint speed comply with the scaled motor setpoint speed and the scaled line speed signal, the matching setting in C00011 (motor reference speed) is absolutely required.

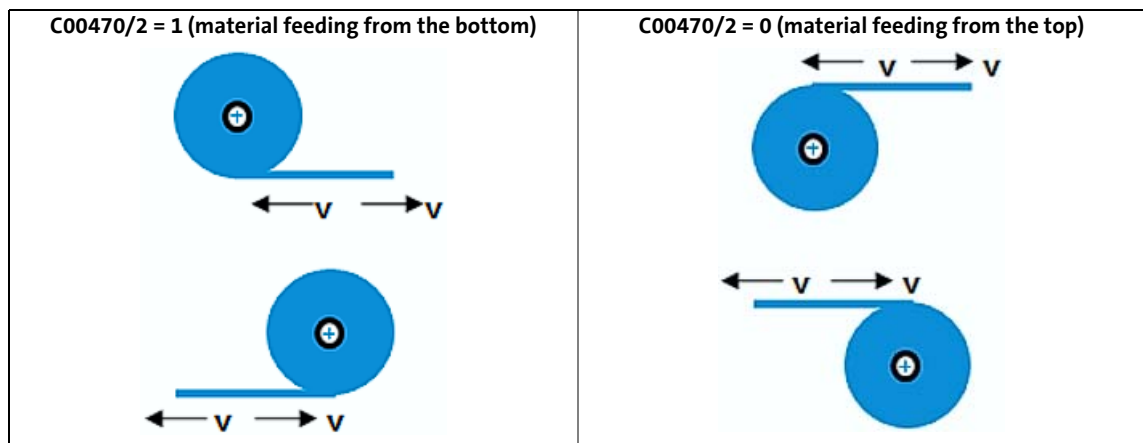
The scaled winder setpoint speed refers to the motor speed required with a minimum diameter d_{min} to achieve the reference line speed at the circumference of the reel.

Adaptation of the speed controller gain: ▶ [Optimising the closed-loop speed control](#) (□ 29)

4.2.2 Material feeding

The basic adjustment of the direction of rotation of the winder to the material flow is effected via parameter C01206/1 "motor mounting direction = inverted".

When the material is applied in an alternating fashion (from the top or from the bottom), the direction of rotation can be set via parameter C00470/2 or control bit 6. The signs of the speed follower setpoints are correspondingly inverted.



4.2.3 Inching mode

In order to traverse the winding shaft manually in inching mode, the generation of preset setpoints of the block L_NSet_1 is used.

This automatically causes the main setpoint path to be decoupled via the line speed signal. This means that the winder can be moved independently of the speed-determining drive of the machine.

The overall setpoint is then evaluated with $1/d$. Therefore parameterised setpoints in C00039/1 or C00039/2 for the positive and negative inching mode also refer to the circumferential speed or the line speed again and not to the motor speed.

Detailed functions of the technology application

Functions for winding operation

4.2.4 Speed limitation

In the open-loop/closed-loop tension-controlled operation mode with material, the winder speed is determined by the circumferential speed and the current diameter. A speed limitation must take effect in the event of a web break or an overcompensation of a disturbance and prevent that the reel is accelerated in the direction of $n_{\max}$.

Speed limitation in the event of a web break

Whereas the calculated diameter values are increasing (rewinder) or decreasing (unwinder) continuously during normal operation, a web break causes a change in direction in the diameter calculation.

In this process, the diameter of the rewinder might run towards $d_{\min}$, which, without speed limitation, would cause acceleration of the winder up to $n_{\max}$.

The unwinder diameter will run towards $d_{\max}$ in the event of a web break. With the speed limitation implemented, the speed in rewinding direction is not evaluated via the speed offset parameterised (C00660/2, C00660/4), but it will increase with $1/d_{\max}$.

Speed limitation for disturbance overcompensation on an unwinder

In the case of an unwinder, an overcompensation of the friction or acceleration may result in acceleration in the unwinding direction. During normal operation, an unwinder always works in generator mode (speed in unwinding direction, torque in rewinding direction).

When the winder is accelerated, and during friction compensation, a change in the effective torque direction may occur. Then the winder works in motor mode. In this operating status, an overcompensation could lead to acceleration in the unwinding direction, in which case also the speed limitation function would take effect:

$$n_{\text{set}} = \frac{\text{LineSpeedSetPoint} + \text{LineSpeedOffset}}{d_{\text{act}}}$$



Note!

On an unwinder, an overcompensation of friction and/or acceleration should be avoided at all costs! The speed limitation, too, cannot prevent the generation of material slack. This results in the diameter approaching $d_{\min}$ and the winder rotating even faster (positive feedback).

For the speed limitation in torque-controlled operation, the speed offset is converted separately into a rotational speed offset by multiplication by $1/d$. This value is added to / subtracted from the speed setpoint to calculate the upper and lower speed limits.

4.2.5 Calculation of the diameter

The current diameter is calculated by dividing the line speed by the motor speed. The following relationship can be established between the diameter, circumferential speed, and winding shaft speed:

$$d[mm] = \frac{v_{line} \left[\frac{m}{min} \right]}{n_{Wickler} \left[\frac{1}{min} \right] * \pi} * 1000$$

For further information, please see the description for the `L_CalcDiameter` block.

Setting the diameter value (transferring the sensor signal)

At the start of a winding procedure, the start diameter must be defined. It can be set or gathered from the signal of a diameter sensor.

- Parameterising the start diameter: C00472/1
- Loading the start diameter: C00470/5 = TRUE

An external diameter value (e.g. from an ultrasonic sensor) can be transferred via the same setting function. The sensor signal can also be loaded permanently.

Holding the diameter

For some operating states of the winder, in which the line speed signal does not correspond to the circumferential speed of the reel, the current diameter cannot be calculated from the line speed and the motor speed. In this case, the calculation of new values must be prevented and the diameter must be held at the old value. This is done automatically if:

- the line speed is smaller than the minimum line speed from C00472/5;
- control bit 11 "Hold diameter" is TRUE;
- tension-controlled (open loop) operation is not enabled;
- the motor speed is lower than C00024.

4.2.6 Tension control open loop and winding characteristic

In the case of some winding materials it may be required to adapt the tensile force with the diameter becoming smaller. Otherwise the reel may drift to the sides, meaning it telescopes.

The diameter-dependent winding characteristic or tensile force characteristic is defined via a characteristic function in the `L_Curve_3` block.

The tensile force setpoint is defined in a scaled fashion relating to a reference force. The setpoint is guided via a ramp generator. The acceleration/deceleration time can be set in C01040/1.

For further information, please see the description for the `L_Curve_3` block.

4.2.7 PI controller for the tensile force control

By enabling the *L_ProcessCtrl_1* process controller, optionally closed-loop control to an actual tensile force value can be carried out. Enable is executed with C00470/3 = TRUE. Use parameter C00472/7 to define the influence that the PI controller is to have on the motor control.

In order to avoid discontinuities in the tensile force profile during the enabling process, the actual value is loaded into the ramp generator first before the tensile force setpoint is loaded. When the tension-controlled (open loop)/closed-loop controlled operation "TensionMode" has been activated, the setpoint for the controller is identical to the actual value at first. Then, controlled via the ramp generator, a switch-over to the current tensile force setpoint takes place.

The actual tensile force value must be adapted using the settings of the analog input and the *L_ConvW_3* block, so that 100 % = 16384 is shown at *L_ConvW.wOut* when a reference force (nominal tension in the Excel tool) is applied.

The PID controller that is used for tension control offers various possibilities of conditioning the setpoints and actual values.

For further information, please see the description for the *L_ProcessCtrl* block.

4.3 Disturbance compensation functions

4.3.1 Acceleration compensation

The acceleration in the line speed setpoint constitutes a disturbance in the winding process, because the torque that is "consumed" for the process of acceleration is missing in the tensile force. Therefore the acceleration torque must be calculated and pilot-controlled as an additional torque.

In this process, scaled values are used for calculation. The additional scaling to the acceleration time is to improve the resolution of the acceleration torque.

In practice, a line speed signal that does not ideally increase is to be expected. Use parameter C00253 to set the resolution of the signal that is differentiated.

Only the number of higher-order bits that is set is taken into consideration for the differentiation. Furthermore the signal is smoothed via a PT1 functionality subsequently. The time constant can be set via parameter C00251.

The gain of the DT1 element and the scaling of the L_ConvW_2 are used for taking the acceleration time t_acc into consideration.

The mass inertia of the drive results from the current diameter by a characteristic in which the moment of inertia scaled to the maximum moment of inertia J_max as a function of the diameter scaled to d_max is stored. Then the moment of inertia is evaluated with M_acc / M_max in order to achieve an improved scaling of the acceleration.

The moment of inertia is multiplied with parameter C00741/8 in order to provide for different material widths with all other settings remaining consistent.



Note!

The speed is resolved with 16 bits in the Inverter Drive 8400, $100\% = 2^{14} = 16384$ corresponding to the rated speed (C00011).

The rated speed is to be selected so that it is obtained with a minimum diameter at a line speed of 100 %. In the case of slow acceleration processes, the limited speed resolution produces quantisation steps of the same size as the change in setpoint values. Therefore, in particular for slow acceleration processes ($>10\text{ s}$), the feedforward control value is to be checked and deactivated, if necessary.

A greater filter time constant in the PT1 filter of the acceleration (C00250) can bring about an improvement.

If possible, the line speed signal should be derived from a stable setpoint instead of from an actual speed value, in order to obtain a utilisable acceleration feedforward control.

4.3.2 Friction compensation

The reference speed of the characteristic for compensating the friction is derived from the line speed signal. Therefore the compensation is a setpoint-based process, which is usually advantageous compared to using the actual motor speed as reference, since the setpoint is more stable. Furthermore the reference speed can also be filtered in order to increase the stability of the compensation process.

Effective direction of friction compensation

In the case of a rewinder, the friction compensation increases the total torque setpoint, whereas for the unwinder, the friction torque must be subtracted from the total torque setpoint.

In the Lenze setting, this effective direction is automatically switched over depending on the sign of the line speed and the winding direction set in C00470/1. The friction torque is inverted if, due to the negative sign of the line speed, the winder is working so that it opposes the winding direction parameterised in C00470/1. Depending on the application, it may be reasonable to switch off this automatic feature, for instance if no rewinding/unwinding/half-duplex operation is required, or if the rewinding/unwinding/half-duplex operation is defined externally by a control.

If the automatic feature takes effect in half-duplex operation, the effective direction of the friction compensation may be incorrect at a standstill (line speed = 0), since the sign can only be determined at a line speed $\neq 0$. In these cases it is necessary to externally define the desired effective direction via a Boolean signal (control, visualisation, DigIn). This requires interfering in the signal flow of the friction compensation.



Note!

If the friction is also to be compensated at a line speed = 0, the current motor speed must be used as reference speed for the characteristic. This case for instance occurs if, when the winder is started, a web tension has to be established first as long as the line is still at a standstill, and, in addition, the tensile force setpoint torque is smaller than the friction torques.

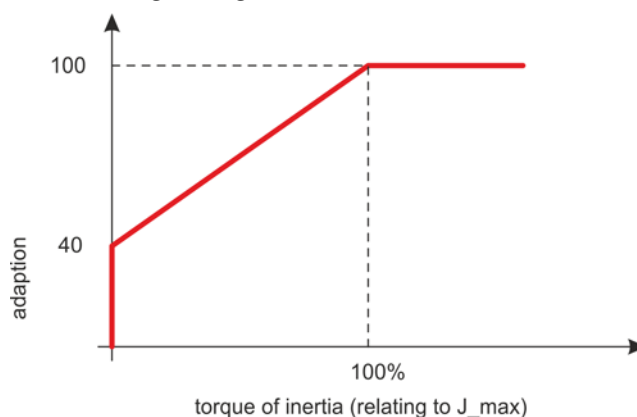
4.4 Adaptation of the speed controller gain

If we consider the motor and the reel as a rigid one-mass system, the optimum gain of the speed controller is directly proportional to the moment of inertia.

Since the moment of inertia usually changes significantly during the winding process, for a good control response it may be necessary to continuously adapt the gain of the speed controller to the moment of inertia.

The adaptation of the speed controller gain can only be used reasonably if the acceleration compensation is configured (J characteristic stored) so that the calculation of the current moment of inertia supplies correct values.

In the default setting, the speed controller is adapted linearly in the range from 40 ... 100 % of the moment of inertia. Below this range, the gain is held constant.



Note!

In tension-controlled (open loop)/closed-loop controlled operation, the speed controller does not interfere. However, the adaptation of the gain may be reasonable to work with an adapted gain in [Inching mode](#) (32) and at quick stop (QSP).



Your opinion is important to us

These instructions were created to the best of our knowledge and belief to give you the best possible support for handling our product.

Perhaps we have not succeeded in achieving this objective in every respect. If you have suggestions for improvement, please e-mail us to:

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Thank you very much for your support.

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