

8400

"Actuator Torque" technology application
for 8400 HighLine C and 8400 TopLine C _ _ _



Software Manual

EN



Contents

1	About this documentation	3
1.1	Document history	3
1.2	Conventions used	4
1.3	Terminology used	5
1.4	Definition of notes used	6
2	Features of the technology application	7
2.1	Functional overview	7
2.2	Application ranges	8
2.3	System requirements	9
2.4	Influencing factors of the torque setting range	9
2.5	Basic signal flow	10
2.6	Parameter setting in the FB Editor view	10
2.7	Pre-assignment of the I/O terminals	11
3	Short setup of the technology application	12
3.1	Preconditions	12
3.2	Step 1: Load "Actuator Torque" technology application	13
3.3	Step 2 (optional): Establish control via the fieldbus interface (MCI)	14
3.3.1	Pre-assignment of the process data input words	15
3.3.2	Pre-assignment of the process data output words	16
3.4	Step 3: Set commissioning parameters	17
3.5	Step 4: Go online and transmit parameter set to the controller	18
3.6	Step 5: Enable controller and select setpoints	18
3.7	Step 6 (optional): Set optimisation parameters	19
4	Detailed functions of the technology application	21
4.1	Signal flow of the technology application	22
4.2	Signal flow of the motor control	23
4.3	Basic drive functions (MCK)	24
4.3.1	Torque-controlled operation with the basic "speed follower" drive function	24
4.3.2	Holding brake control	25
4.4	Manual jog (inching mode)	26
4.5	Functions for the torque-controlled operation	27
4.5.1	Offset and gain of the torque setpoint	27
4.5.2	Ramp generator for the torque setpoint	27
4.5.3	Speed limitation/forward motion for the speed setpoint	28
4.5.4	Inversion of the effective direction for the torque setpoint	29
4.6	Monitoring functions	30
4.6.1	Web break/slip monitoring	30
	Your opinion is important to us	31

1

About this documentation

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

**Danger!**

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

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

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

Target group

This documentation is intended for all persons who want to use the "Actuator Torque" technology application for the 8400 HighLine/TopLine controller.

Validity

The information in this documentation are valid for the following technology applications:

Technology application	from version
Actuator Torque	01.00

Screenshots/application examples

All screenshots provided in this documentation are application examples. Depending on the software version of the controller and the version of the installed »Engineer« software, 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

1.1

Document history

Version			Description
1.1	07/2014	TD05	Error corrections
1.0	03/2014	TD05	First edition

1.2

Conventions used

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

Type of information	Writing	Examples/notes
Spelling of numbers		
Decimal separator	Point	The decimal point is generally used. Example: 1234.56
Hexadecimal number	0x	For hexadecimal numbers, the prefix "0x" is used. Example: 0x60F4
Binary number	0b	For binary numbers, the prefix "0b" is used. Example: 0b00010111
Text		
Version information	Blue text colour	All information that only applies to a certain controller software version or higher is identified accordingly in this documentation. Example: This function extension is available from software version V3.0!
Program name	» «	The Lenze »Engineer« PC software ...
Window	<i>italics</i>	The <i>Message</i> window ... / The <i>Options</i> dialog box...
Variable name		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 the execution of a function requires several commands, the individual commands are separated by an arrow: Select File→Open to...
Shortcut	< bold >	Press < F1 > to open the online help.
		If a command requires a combination of keys, a "+" is placed between the key symbols: Use < Shift >+< ESC > to...
Hyperlink	<u>underlined</u>	Optically highlighted reference to another topic. In this documentation activated by mouse-click.
Icons		
Page reference	 4	Optically highlighted reference to another page. In this documentation activated by mouse-click.
Step-by-step instructions		Step-by-step instructions are indicated by a pictograph.

1.3

Terminology used

Term	Meaning
Engineering Tools	Software solutions for simple engineering at all stages
	 »EASY Navigator« – Ensures easy operator guidance • All practical Lenze engineering tools at a glance • Tools can be selected quickly • Clearly arranged, simplifying the engineering process from the start
	 »EASY Starter« – Simple tool for service technicians • Especially developed for the commissioning and maintenance of Lenze devices • Graphical user interface with few buttons • Simple online diagnostics, parameterisation and commissioning • No risk of accidentally changing the application • Ready applications can be loaded to the device
	 »Engineer« – Multi-device engineering • For all products from our L-force portfolio • Practice-oriented user interface • Easy handling due to graphical user interfaces • Suitable for all project stages (configuration, commissioning, production) • Parameter setting and configuration
Code	Parameter used for controller parameterisation or monitoring. The term is usually called "index".
Display code	Parameter that displays the current status or value of an input/output of a system block.
FB Editor	Abbreviation for function block editor. Graphic interconnection tool which is available in the »Engineer« for function block interconnections on the FB Editor .
Function block	General designation of a function block for free interconnection in the FB Editor. A function block (short: FB) can be compared with an integrated circuit that contains a specific control logic and delivers one or several values when being executed. Example: "L_Arithmetik_1" (FB for arithmetic operations)
Lenze setting	This setting is the default factory setting of the device.
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.
Port block	Block for implementing the process data transfer via a fieldbus
Subcode	If a code contains several parameters, these are stored in "subcodes". This Manual uses a slash "/" as a separator between code and subcode (e.g. "C00118/3"). The term is usually called "subindex".
System block	System blocks provide interfaces to basic functions and to the hardware of the controller in the FB Editor of the »Engineer« (e.g. to the digital inputs).
USB diagnostic adapter	The USB diagnostic adapter is used for the operation, parameterisation, and diagnostics of the controller. Data are exchanged between the PC (USB connection) and the controller (diagnostic interface on the front) via the diagnostic adapter. Order designation: E94AZCUS

1.4

Definition of 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

2

Features of the technology application

The "Actuator Torque" technology application serves to set a selectable torque at the motor independent of the speed ("torque-controlled operation"). A superimposed speed limitation prevents the drive from accelerating in an uncontrolled way. If the positive or negative speed limit value (for CW and CCW rotation) is reached, the drive changes from the torque-controlled to the speed-controlled operation. The set speed limit values will not be exceeded. The torque setpoint and the speed limit value are the main setpoint values of the application.

The setpoint for the motor torque can be specified for both directions. Hence, the drive has a driving or braking effect. In case of a unipolar setpoint, the effective direction can be switched over via a boolean signal.

2.1

Functional overview

Function	8400 HighLine	8400 TopLine
Two modes for motor control switchable via a boolean signal: • Torque control with speed limitation • Speed control with torque limitation	●	●
Offset, gain and ramp generator for the torque setpoint	●	●
Inching mode with ramp generator: • "Hard" inching: Normal speed setting without torque limitation • "Smooth" inching: Operated with speed limitation in torque-controlled mode	●	●
Signal processing functions for speed limitations in torque-controlled mode or the speed setpoint in case of speed control: • Ramp function generator with linear ramps or S-shaped ramp (PT1 rounding) • Fixed setpoints (JOG setpoints)	●	●
Offset and gain for speed limitations	●	●
Forward motion for speed setpoint in torque-controlled mode	●	●
Inversion of the effective direction for the torque setpoint via a boolean signal	●	●
Web break/slip monitoring	●	●

2.2

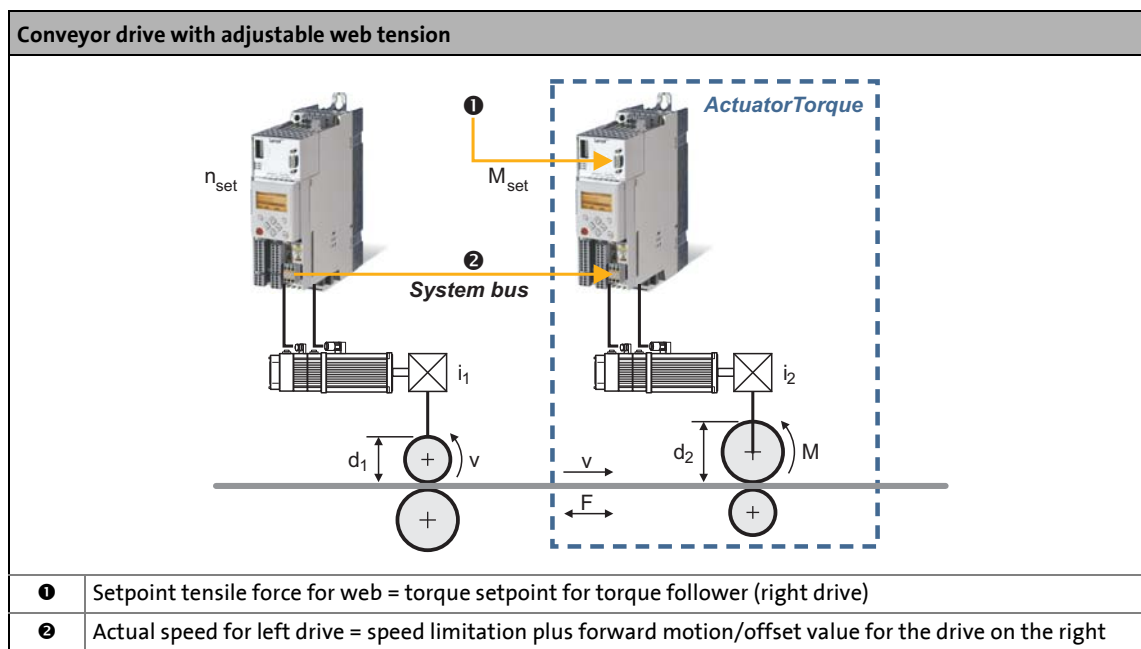
Application ranges

- Material transport with torque distribution (supporting drives)
- Conveyor drives with adjustable tension
- Chain conveyors
- S frame structure
- Bilateral tandem drives
- Test benches for tensile stress
- Test benches for motors and gearboxes
- Brake assemblies
- Traction-controlled winders with superimposed setpoint conditioning (e.g. diameter calculator in the PLC)

Example: Conveyor drive with adjustable web tension

This application can be directly implemented using the "Actuator Torque" technology application.

The torque setpoint results from a setpoint tensile force for the web. This setpoint is defined as process data, e.g. by a control or an HMI. The value of the speed limitation derives from the actual speed of the speed-determining drive of the total machine plus a forward motion or offset value.



2.3 System requirements

The technology application was created with the L-force »Engineer« V2.19 and can only be used with the versions V2.19 or higher.

Software

Product	Order designation	from version
L-force »Engineer« HighLevel	ESPEV-EHNNN	2.19

Hardware

Product	Order designation	from hardware version	from software version
Inverter Drives 8400 HighLine C	E84AVHCxxxxx	VD	13.00
Inverter Drives 8400 TopLine C	E84AVTCxxxxx	VD	13.00

2.4 Influencing factors of the torque setting range

Typically, the torque setting range of the drive is in the range 1:20 to 1:40. The following factors influence the setting range in a positive way:

- Motor model adjusted in the best possible way by entering extended motor type data or by the motor parameter identification.
- Compensation of the change in motor resistance as a function of the winding temperature. For this purpose, a temperature feedback (KTY) is required via the motor encoder cable. An evaluation of KTY sensors for temperature detection is only possible for the 8400 TopLine via the encoder interface X7 and X8.
- In case of permanent-magnet synchronous motors: Compensation of the change in flux formation as a function of the winding temperature. An evaluation of KTY sensors for temperature detection is only possible for the 8400 TopLine via the encoder interface X7 and X8.



Stop!

Torque setting without motor feedback

In principle, a torque can also be set for asynchronous motors using the sensorless vector control (SLVC). Theoretically, this could serve to also use motors without speed feedback in applications with reduced torque setting range requirements. However, the following aspects have to be considered here:

- The sensorless vector control does not enable the torque to be controlled in a stable way in the range of zero field frequency.
- An operation in generator mode with low field frequencies shall be prevented when using sensorless vector control as the motor cannot be controlled then.
- The field frequency has to amount to double the rated motor slip in order to set a torque in a stable way.

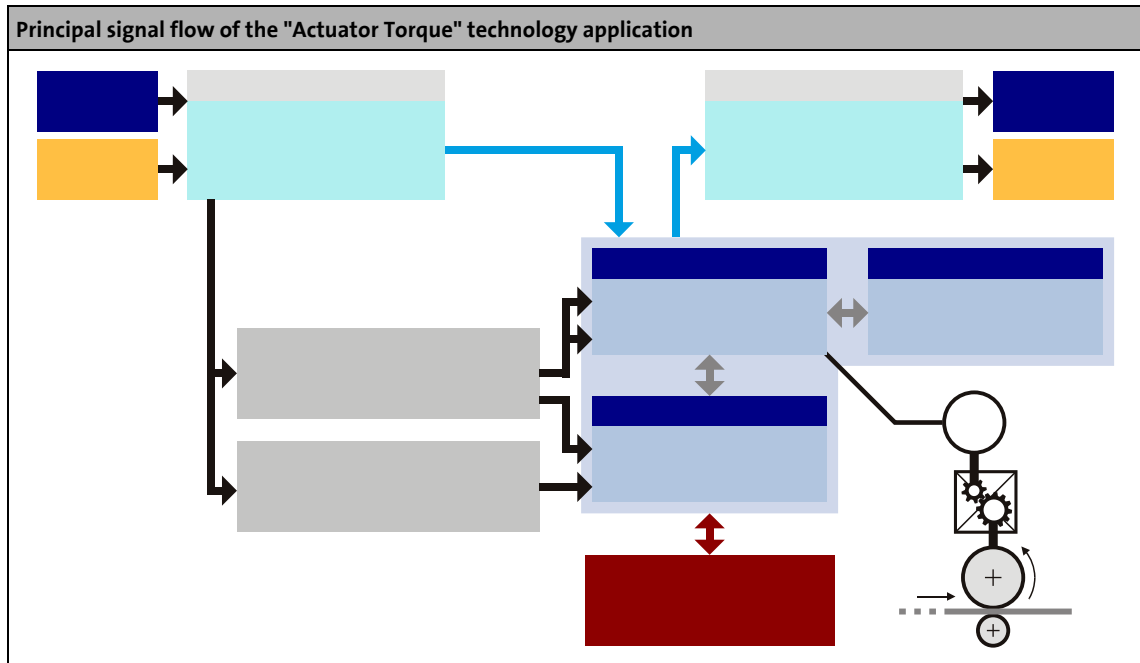
The V/f characteristic control (VFCplus) is not suitable to set a torque.

2.5

Basic signal flow

In the technology application, function and system blocks are interconnected such that typical basic functions of the torque controllers can be implemented from the application ranges mentioned before.

The following describes the principal signal flow with the essential functions.



2.6

Parameter setting in the FB Editor view

You can make the settings of the application-specific parameters directly in the FB Editor. This has the advantage that the signal flow can be traced. The interaction of the modules becomes clear. Moreover, you can reconfigure the I/O interconnection using the FB Editor and carry out an online monitoring of the application running in the device (e.g. for diagnostic purposes).

- The  icon in the head of the module, a double-click on the module, or the **Parameter...** command in the *Context menu* of the module serve to open the parameterisation dialog or the parameter list for the module.
- Colour codes and comments support you in handling 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.



Detailed information on how to work with the FB Editor can be found in the reference manual/online help of the controller in the chapter "Working with the FB Editor".

2.7

Pre-assignment of the I/O terminals

Terminal	Function		
Digital input terminals			
X5/RFR	Controller enable		
X5/DI1	- (reserved for HTL encoder)		
X5/DI2	- (reserved for HTL encoder)		
X5/DI3	Switch on torque-controlled operation		
	DI3	Function	
	LOW	Speed control with torque limitation	
	HIGH	Torque control with speed limitation	
X5/DI4	Activate quick stop		
	DI4	Function	
	LOW	Deactivate quick stop	
	HIGH	Activate quick stop - The motor control is decoupled from the setpoint selection (speed and torque) and within the deceleration time parameterised in C00105, the motor is brought to standstill ($n_{act} = 0$). - A pulse inhibit is set if the auto-DCB function has been activated via C00019.	
X5/DI5 X5/DI6	Selection of fixed setpoints for inching mode For "soft inching", DI3 has to be set to HIGH.		
	DI5	DI6	Function
	LOW	LOW	Speed selection via analog input 2
	HIGH	LOW	Selection of fixed setpoint 1 = C00039/1 = 10 % reference speed (C00011) → Manual inching in positive direction
	LOW	HIGH	Selection of fixed setpoint 2 = C00039/2 = -10 % reference speed (C00011) → Manual inching in negative direction
	HIGH	HIGH	Selection of fixed setpoint 3 = C00039/3 = 0 % reference speed (C00011)
X5/DI7	Reset error message		
Analog input terminals			
X3/A1U	Torque setpoint Scaling: 10 V = 100 % maximum torque (C00057)		
X3/A2U	Speed setpoint/speed limitations (in torque-controlled operation) Scaling: 10 V = 100 % reference speed (C00011)		
Digital output terminals			
X4/DO1	Status "Drive is ready"		
X4/DO2	- (not assigned, can be used freely)		
X4/DO3	- (not assigned, can be used freely)		
X107/BD1, BD2	Control of a holding brake by the basic function "holding brake control"		
X101/COM, NO	Status "Error is pending"		
Analog output terminals			
X3/O1U	Actual speed value Scaling: 10 V = 100 % reference speed (C00011)		
X3/O2U	Actual torque 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, the setting of the most important parameters (motor, feedback system, etc.) is assumed.

The "commissioning wizard 8400" serves to carry out a guided commissioning of the controller based on the Lenze setting of the parameters.

How to proceed:

1. Before switch-on: Make sure that the controller is inhibited (input RFR open).
2. Switch on voltage supply of the controller.
For parameter setting and diagnostics of the controller without motor operation, an external 24-V supply through a safely separated power supply unit (SELV/PELV) is sufficient.
3. Establish a communication link between controller and Engineering PC, e.g. via 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 »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.



You can find detailed information on the options of the start-up wizard and on the general use of the »Engineer« in the online help for the program which you can call with [F1].

5. Create a new project or open a project already available.
6. Go to *Project View* and select the 8400 controller.
7. Click the  icon to go online.
After a connection to the controller has been established, the following status is displayed in the *Status line*:



8. Click the  icon to start the *commissioning wizard 8400*.
 - 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.

3.2

Step 1: Load "Actuator Torque" technology application

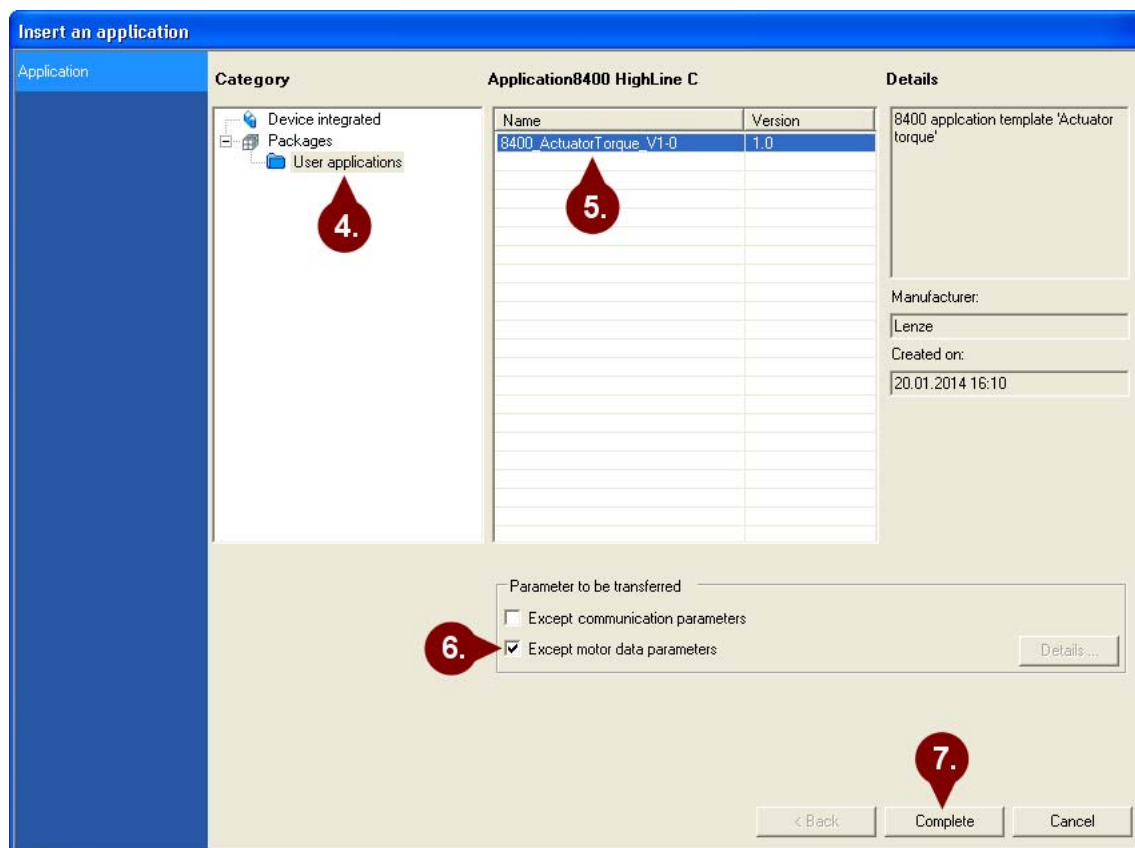
In the Lenze setting, the controller uses the "speed actuating drive" technology application integrated in the device. Execute the following steps to use the "Actuator Torque" technology application instead:

1. Select the controller in the *Project view*.
2. If there is still an online connection to the controller:

Click the  icon to go offline again.
(the application can only be selected offline.)

3. Click the  icon to select another application.

The *Insert application* dialog box appears:



4. In the left field, select the category "Packages" → "User applications".
5. In the right field, select the "8400_ActuatorTorque_V1-0" 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 selected application into the »Engineer« project.
8. Confirm the request whether the current application is to be replaced by the "8400_ActuatorTorque_V1-0" application with **Yes**.

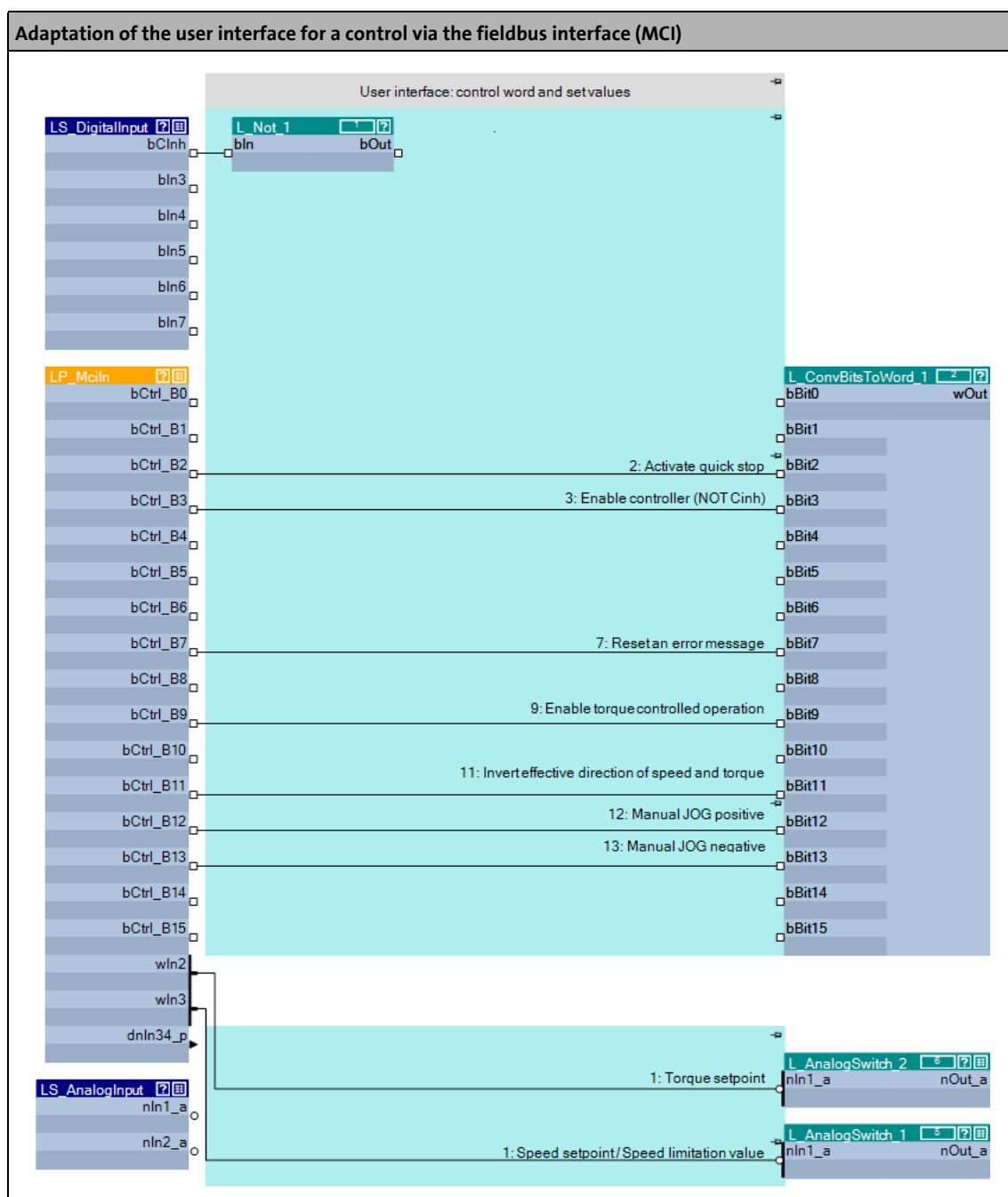
3.3

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

In the default setting, the setpoints are selected via the analog input terminals and the application is controlled via the digital input terminals. For the control via the fieldbus interface (MCI), the user interface (highlighted in turquoise) in the FB Editor has to be adapted for the application control 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.

The following sample illustration shows the interconnection required for achieving the [Pre-assignment of the process data input words](#) described in the following subchapter:



[3-1] User interface for application control word and setpoints in the FB Editor

3.3.1 Pre-assignment of the process data input words

After adapting the interconnection according to the [\[3-1\]](#) illustration, the process data input words for a control via the fieldbus interface (MCI) are assigned as follows:

Input words	Assignment
Word 1	Control word (for bit assignment see the following table)
Word 2	Torque setpoint • Scaling: 16384 = 100 % maximum torque (C00057)
Word 3	Speed setpoint/speed limitations (in torque-controlled operation) • Scaling: 16384 = 100 % reference speed (C00011)
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 controller (RFR)															
Bit 4	- (not preconfigured)															
Bit 5	- (not preconfigured)															
Bit 6	- (not preconfigured)															
Bit 7	1 = Reset fault (trip reset)															
Bit 8	- (not preconfigured)															
Bit 9	0 = Speed control with torque limitation 1 = Torque control with speed limitation (torque-controlled operation)															
Bit 10	- (not preconfigured)															
Bit 11	1 = Invert effective direction • Inversion of the torque setpoint, the speed limitations and the parameterised fixed setpoints.															
Bit 12 ... 13	Selection of fixed setpoints for inching mode • For "soft inching", bit 9 has to be set to "1" in addition.															
	<table><tr><th>Bit 12</th><th>Bit 13</th><th>Function</th></tr><tr><td>0</td><td>0</td><td>Speed selection via process data word 3 (with a correspondingly adapted interconnection, see above)</td></tr><tr><td>1</td><td>0</td><td>Selection of fixed setpoint 1 = C00039/1 = 10 % reference speed (C00011) → Manual inching in positive direction</td></tr><tr><td>0</td><td>1</td><td>Selection of fixed setpoint 2 = C00039/2 = -10 % reference speed (C00011) → Manual inching in negative direction</td></tr><tr><td>1</td><td>1</td><td>Selection of fixed setpoint 3 = C00039/3 = 0 % reference speed (C00011)</td></tr></table>	Bit 12	Bit 13	Function	0	0	Speed selection via process data word 3 (with a correspondingly adapted interconnection, see above)	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 12	Bit 13	Function													
	0	0	Speed selection via process data word 3 (with a correspondingly adapted interconnection, see above)													
	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	- (not preconfigured)															

3.3.2 Pre-assignment of the process data output words

The **LP_MciOut** port block is already implemented in the technology application. The process data output words are assigned as follows:

Output words	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	Actual torque • Scaling: 16384 = 100 % maximum torque (C00057)
Word 4 ... 16	- (not preconfigured)

Status word	Status																																																																														
Bit 0	1 = Group error active (configurable in C00148)																																																																														
Bit 1	1 = Inverter control inhibited (pulse inhibit is active)																																																																														
Bit 2	1 = Drive controller is ready for operation																																																																														
Bit 3	1 = Quick stop is active																																																																														
Bit 4	1 = Setpoint torque is in the limitation																																																																														
Bit 5	1 = Speed controller is in the 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 7	1 = Controller inhibited (controller inhibit is active)																																																																														
Bit 8 ... 11	Bit coded display of the active device status <table><tr><th>Bit 11</th><th>Bit 10</th><th>Bit 9</th><th>Bit 8</th><th>Device status</th><th>Meaning</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>FirmwareUpdate</td><td>Firmware update function is active</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>Init</td><td>Initialisation active</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>Ident</td><td>Identification active</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>ReadyToSwitchOn</td><td>Device is ready to start</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>SwitchedOn</td><td>Device is switched on</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>OperationEnabled</td><td>Operation</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>-</td><td>-</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>Trouble</td><td>Trouble active</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>Fault</td><td>Fault active</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>TroubleQSP</td><td>TroubleQSP is active</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>SafeTorqueOff</td><td>Safe torque off is active</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>SystemFault</td><td>System fault active</td></tr></table>	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	-	-	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 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	-	-																																																																										
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 = Controller is in the "Trouble" device status																																																																														
Bit 14	1 = Torque-controlled operation active																																																																														
Bit 15	1 = Speed limitation active (web break/slip monitoring has tripped)																																																																														

3.4 Step 3: Set commissioning parameters

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

- In order that you quickly find the respective parameterisation dialog in the FB Editor, the following table lists the block related to each parameter.
- The  icon in the head of the module, a double-click on the module, or the **Parameter...** command in the *Context menu* of the module serve to open the parameterisation dialog or the parameter list for the module.

Parameter (Block)	Possible settings			Info
C00470/1 (LS_ParFree_b)				1 = Invert effective direction • Inversion of the torque setpoint, the speed limitations and the parameterised fixed setpoints. • Lenze setting: 0
	0	Effective direction CW		
	1	Effective direction CCW		
Condition speed setpoint/speed limitations				
C00660/2 (L_FixSet_a_1)	-199.99	%	199.99	Common speed offset value for both speed limitations • Only effective in the torque-controlled operation. • Lenze setting: 5 % reference speed (C00011)
C00039/1 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 1 • For manual inching in positive direction. • Lenze setting: 10 % reference speed (C00011)
C00039/2 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 2 • For manual inching in negative direction. • Lenze setting: -10 % reference speed (C00011)
C00039/3 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 3 • Fixed setpoint 3 is selected if bit 12 AND bit 13 of the application control word are set to "1". • Lenze setting: 0 % reference speed (C00011)
Condition torque setpoint				
C00472/1 (LS_ParFree_a)	-199.99	%	199.99	Gain factor for torque setpoint • Lenze setting: 100 %
C01040/1 (L_SRFG_1)	0.001	s	999.999	Linear ramp time for the torque setpoint • Lenze setting: 0.010 s
Creation of the "torque-controlled operation active" status (bit 14 in the status word)				
C00825/12 (L_DigitalLogic5_1)				Influence of the "brake released" status signal on the "torque-controlled operation active" status • Lenze setting: 0 (no influence)
	0	bMBrakeReleased is ignored		The "torque-controlled operation active" status is set irrespective of the brake status.
	1	bMBrakeReleased is additionally AND'ed		The "torque-controlled operation active" status also requires a released brake.

3.5

Step 4: Go online and transmit parameter set to the controller

In order to set the current parameter settings in the controller to the settings in the project, transmit the parameter set to the controller.

1. Click the  icon to go online.
2. Click the  icon to transmit the parameter set to the controller.
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: Enable controller and select setpoints

After the parameter set has been transmitted to the controller, the controller can now be enabled and the setpoints can be selected via the corresponding interfaces.

- ▶ [Pre-assignment of the I/O terminals](#) ( 11)
- ▶ [Pre-assignment of the process data input words](#) ( 15)

3.7

Step 6 (optional): Set optimisation parameters

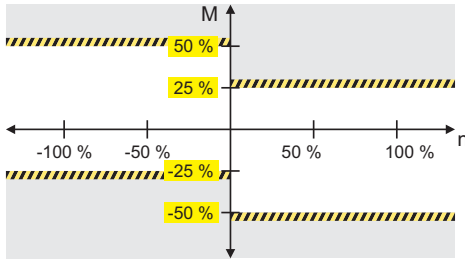
The following application-specific parameters are used for optimisation and can also be adapted during operation.

**Stop!**

If you change parameters in the »Engineer« during an online connection to the device, the changes are directly transferred to the device!

**Tip!**

Do not forget to save the executed parameter changes safe against mains failure in the integrated Memory Module!

Parameter (Block)	Possible settings			Info
Torque limitation in motor mode/in generator mode				
The set torque limitation is always effective, even in torque-controlled operation.				Example: Definition of the torque limitations C00472/3 = 25 % C00472/4 = 50 % 
C00472/3 (LS_ParFree_a)	-199.99	%	199.99	Torque limitation in motor mode • Lenze setting: 100 % maximum torque (C00057)
C00472/4 (LS_ParFree_a)	-199.99	%	199.99	Torque limitation in generator mode • Lenze setting: 100 % maximum torque (C00057)
Condition speed setpoint/speed limitations				
C00721/2 (L_DigitalDelay_2)	0.000	s	3600.000	Delay for the change-over of acceleration/deceleration time for manual jog back to the acceleration/deceleration time for the speed setpoints/speed limitations if manual jog is not requested anymore. The delay has to be set according to the following equation: Delay = fixed setpoint (C39/x) * deceleration time (C103/x) • Example for fixed setpoint 1: Delay = 10 [%] * 1 [s] = 10 [s] • Lenze setting: 0.1 s
C00012 (L_NSet_1)	0.000	s	999.99	Acceleration time for the speed setpoint/speed limitations • Lenze setting: 0 s
C00013 (L_NSet_1)	0.000	s	999.99	Deceleration time for the speed setpoint/speed limitations • Lenze setting: 0 s
C00101/1...3 (L_NSet_1)	0.000	s	999.999	Acceleration times for fixed setpoints 1 ... 3 • Lenze setting: 1 s

Parameter (Block)	Possible settings			Info
C00103/1...3 (L_NSet_1)	0.000	s	999.999	Deceleration times for fixed setpoints 1 ... 3 • Lenze setting: 1 s
C00677/1 (L_GainOffsetP_1)	-199.99	%	199.99	Separate gain factor for the positive speed limitation • Lenze setting: 100 %
C00677/2 (L_GainOffsetP_1)	-199.99	%	199.99	Separate offset value for the positive speed limitation • Lenze setting: 0 % reference speed (C00011)
C00677/3 (L_GainOffsetP_2)	-199.99	%	199.99	Separate gain factor for the negative speed limitation • Lenze setting: 100 %
C00677/4 (L_GainOffsetP_2)	-199.99	%	199.99	Separate offset value for the negative speed limitation • Lenze setting: 0 % reference speed (C00011)
Condition torque setpoint				
C00472/2 (LS_ParFree_a)	-199.99	%	199.99	Offset value for torque setpoint • Lenze setting: 0 % maximum torque (C00057)
Web break/slip monitoring				
C00472/5 (LS_ParFree_a)	-199.99	%	199.99	Speed threshold for activating the web break/slip monitoring • Lenze setting: 5 % reference speed (C00011) ▶ Web break/slip monitoring (🔒 30)
C00581/1 (LS_SetError_1)				Response when web break/slip monitoring has tripped • Lenze setting: "4: WarningLocked"
	0	No Reaction		
	1	Fault		
	2	Trouble		
	3	TroubleQuickStop		
	4	WarningLocked		
	5	Warning		
	6	Information		
C00720/1 (L_DigitalDelay_1)	0.000	s	3600.000	Tripping delay for web break/slip monitoring • Lenze setting: 0.1 s

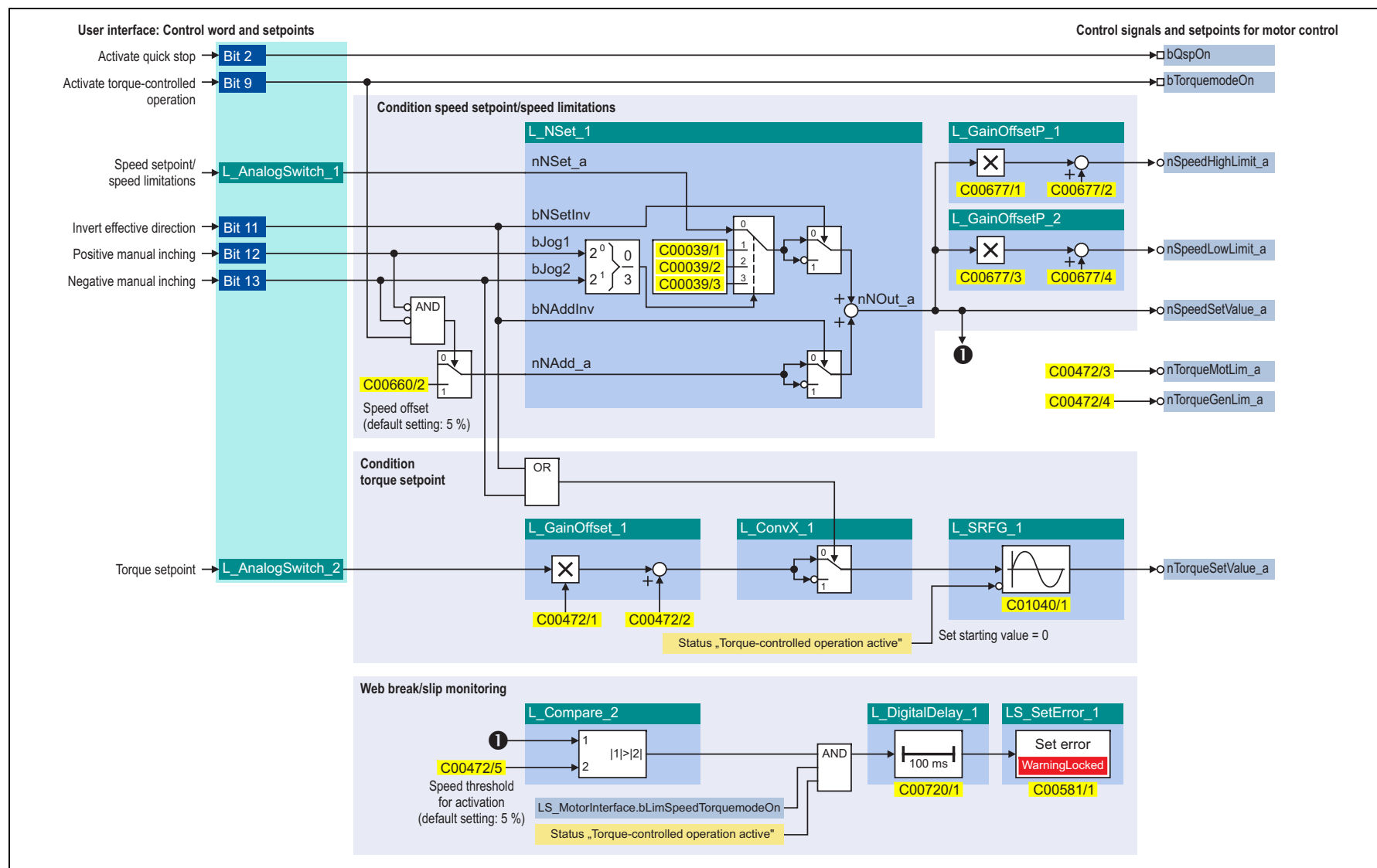
4 Detailed functions of the technology application

This chapter describes the functions implemented in the "Actuator Torque" technology application with the possible settings relevant for the application.



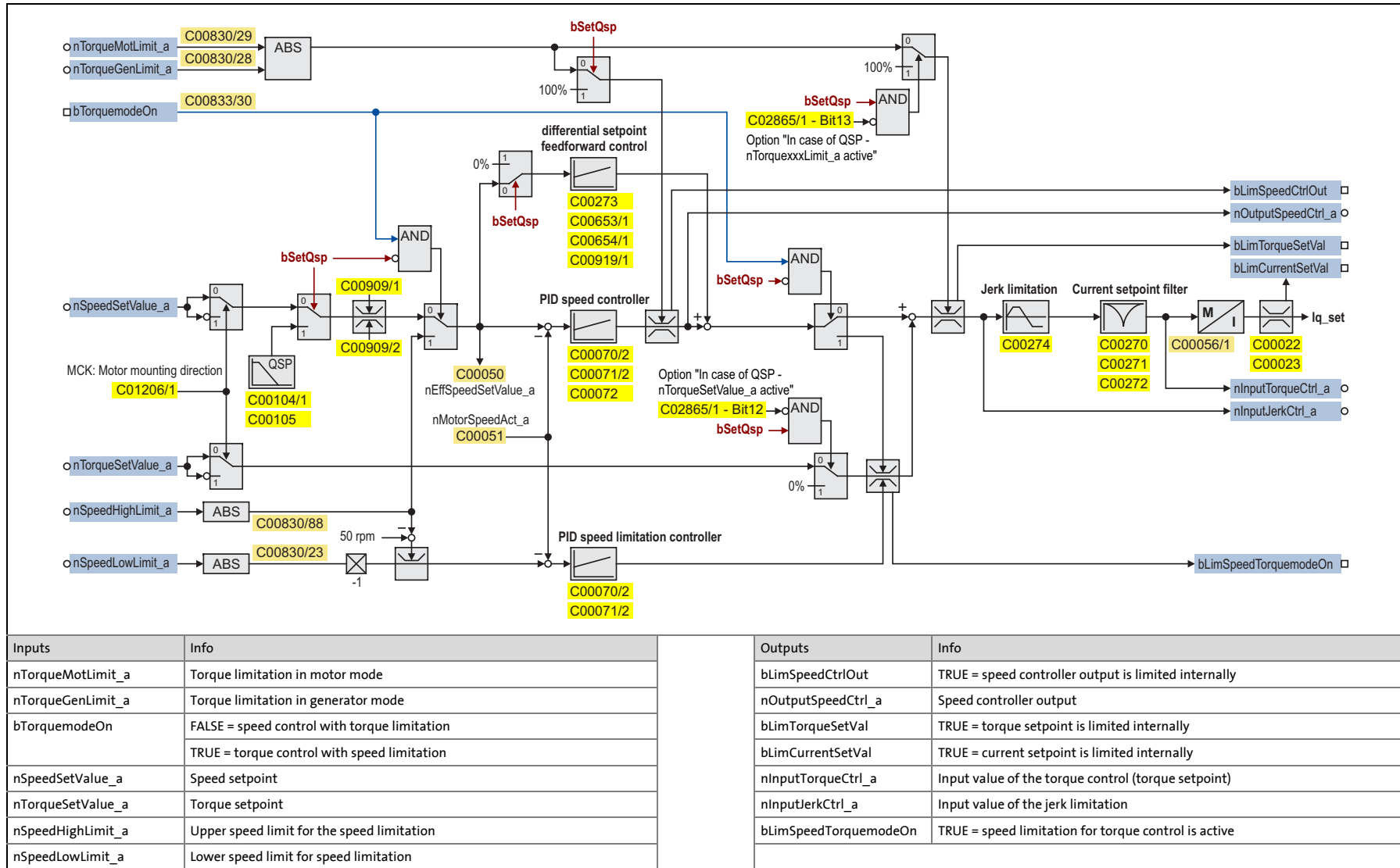
Detailed information on the function and parameterisation of the functions described in the following can be found in the reference manual/online help of the controller.

4.1 Signal flow of the technology application



4.2 Signal flow of the motor control

The following basic signal flow makes it easier to understand the setpoint generation in the torque-controlled operation. The change-over between speed and torque control is carried out via the *bTorquemodeOn* input of the **LS_MotorInterface** system block.



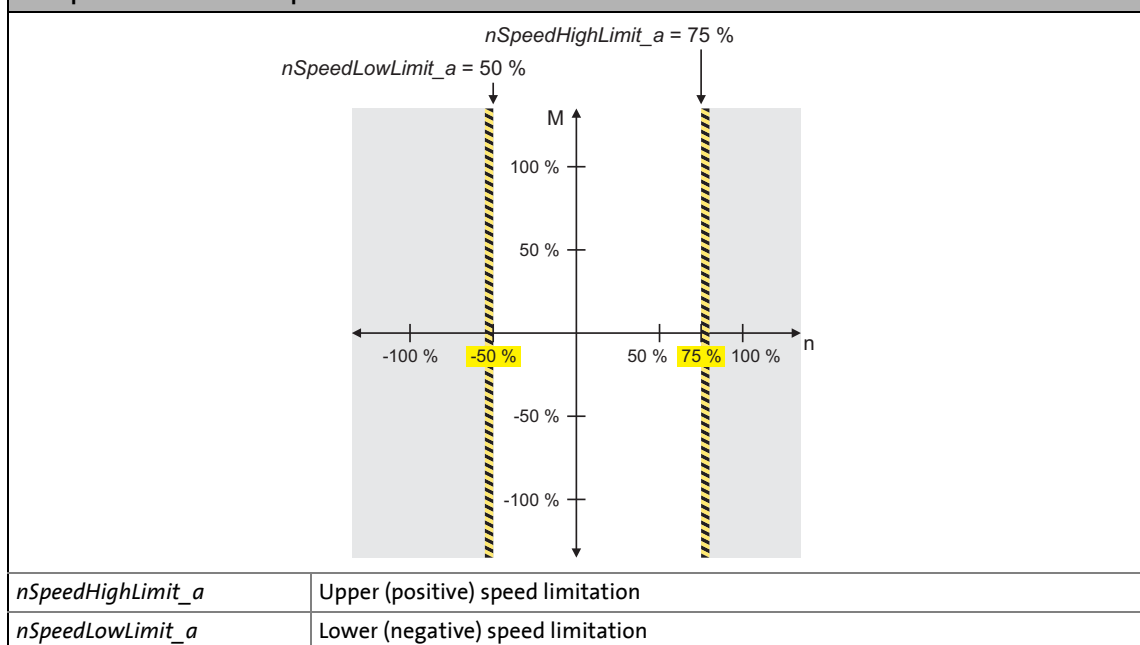
4.3 Basic drive functions (MCK)

4.3.1 Torque-controlled operation with the basic "speed follower" drive function

The torque-controlled operation is not implemented by an own operating mode in the Motion Control Kernel (MCK) of the 8400. Thus, the basic drive function "speed follower" is used in the technology application for the torque-controlled operation.

- With reference to the maximum torque (C00057), the torque setpoint is defined in a scaled way via the *nTorqueSetValue_a* input of the **LS_MotionControlKernel** system block.
 - *nTorqueSetValue_a* always has an additive effect on the torque setpoint in the motor control, even in case of speed control. Thus, this interface can also be used for defining an acceleration torque.
 - In the technology application, it is ensured that the value at *nTorqueSetValue_a* is = 0 if no torque-controlled operation is requested (*bTorquemodeOn* = FALSE).
- With reference to the reference speed (C00011), the speed limitations are defined in a scaled way via the two inputs *nSpeedHighLimit_a* and *nSpeedLowLimit_a* of the **LS_MotorInterface** system block.
 - *nSpeedHighLimit_a* and *nSpeedLowLimit_a* act as an amount, the sign is neglected.
 - The compliance with the upper and lower speed limitation is ensured via two independent speed controllers. Both speed controllers work with the parameters Vp (C00070) and Ti (C00071).
 - If speed limitation is active, the drive can generate up to 100% of its torque depending on the deviation of the speed setpoint from the actual speed value!

Example: Definition of the speed limitations



► [Signal flow of the motor control](#) (23)

4.3.2 Holding brake control

This basic function is used for low-wear control of a holding brake.



Danger!

Please note that the holding brake is an important element of the safety concept of the entire machine.

Thus, proceed very carefully when commissioning this system part!



Detailed information on how to parameterise the holding brake control can be found in the reference manual/online help of the controller in the chapter "Basic drive functions (MCK)".

The documentation of the holding brake control contains safety instructions which must be observed!

Application-specific notes on the holding brake control:

- In the Lenze setting, the mode 0 (brake control off) is preset in C02580.
- The technology application is prepared for the control of a 24-V holding brake via the high current output.
- When the holding brake control is used, the *nSpeedSetValue_a* input of the **LS_MotionControlKernel** system block has to be connected in a plausible way. In the automatically controlled operation (C02580 = "12: Autom. controlled") the brake is released/closed based on the speed setpoint provided at this input and the set switching thresholds:
 - Release brake:
 $nSpeedSetValue_a > \text{switching threshold (C02581/1)} + \text{hysteresis for release (C02581/2)}$
 - Close brake:
 $nSpeedSetValue_a < \text{switching threshold (C02581/1)} - \text{hysteresis for closing (C02581/3)}$
- The current torque setpoint *nTorqueSetValue_a* does not influence the holding brake control.
 - The brake would also be released if *nTorqueSetValue_a* = 0 % if the *nSpeedSetValue_a* speed setpoint exceeds the switching threshold!
 - The brake is also released if the torque setpoint has the inverted sign of the speed setpoint.
- In the technology application, the holding brake control in the Lenze setting works with the same setpoints as the speed limitation. A separate adaptation of the limitations is possible by parameterising the blocks **L_GainOffsetP_1** and **L_GainOffsetP_2**.
- When the holding brake control (C02580 ≠ 0) is used, the drive can only follow an external torque if the brake is released.
 - The **LS_MotionControlKernel** system block signals the "brake released" status via its *bMBrakeReleased* output.
 - When C00825/12 = "1: True" in the FB **L_DigitalLogic5_1**, the "torque-controlled operation active" status (bit 14 in the [Status word](#)) additionally requires the brake to be released (*bMBrakeReleased* is AND'ed in addition).

4.4 Manual jog (inching mode)

The "manual jog (inching mode)" function is implemented via the **L_NSet_1** ramp generator.

► [Signal flow of the technology application](#) (□ 22)

The FB **L_NSet_1** supports up to 15 fixed setpoints (JOG setpoints) with individually adjustable acceleration and deceleration times.

- For a manual inching in positive direction, the fixed setpoint 1 (C00039/1) is used.
- For a manual inching in negative direction, the fixed setpoint 2 (C00039/2) is used.
- The respective function is activated via bit 12 and bit 13 of the application control word (FB **L_ConvBitsToWord_1**). In the default setting, bit 12 and bit 13 are linked to the digital inputs DI5 and DI6.

An activation via the fieldbus interface (MCI) is possible after a corresponding adaptation of the user interface. See commissioning; [Step 2 \(optional\): Establish control via the fieldbus interface \(MCI\)](#). (□ 14)

Parameter (Block)	Possible settings			Info
C00039/1 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 1 • For manual inching in positive direction. • Lenze setting: 10 % reference speed (C00011)
C00039/2 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 2 • For manual inching in negative direction. • Lenze setting: -10 % reference speed (C00011)
C00039/3 (L_NSet_1)	-199.99	%	199.99	Fixed setpoint 3 • Fixed setpoint 3 is selected if bit 12 AND bit 13 of the application control word are set to "1". • Lenze setting: 0 % reference speed (C00011)
C00101/1...3 (L_NSet_1)	0.000	s	999.999	Acceleration times for fixed setpoints 1 ... 3 • Lenze setting: 1 s
C00103/1...3 (L_NSet_1)	0.000	s	999.999	Deceleration times for fixed setpoints 1 ... 3 • Lenze setting: 1 s

"Hard" inching

In case of speed control, the torque results from the load and the moment of inertia to be accelerated. It can assume maximum values. Thus, the inching mode at speed control can also be called "hard inching".

"Soft" inching

In parallel to the preselection of the respective fixed setpoint for the inching mode, the torque-controlled operation can be switched on via bit 9 of the application control word (FB **L_ConvBitsToWord_1**). In the default setting, bit 9 is linked to the digital input DI3.

In contrast to the inching mode at speed control, only the defined torque setpoint is available. Thus, the inching mode in the torque-controlled operation can also be called "soft" inching.

4 Detailed functions of the technology application

4.5 Functions for the torque-controlled operation

4.5 Functions for the torque-controlled operation

4.5.1 Offset and gain of the torque setpoint

The torque setpoint can be increased via the FB **L_GainOffset_1** and an offset can be applied.

► [Signal flow of the technology application](#) (□ 22)

- The gain factor (C00472/1) serves to adapt the percentage setpoint to the reference value maximum torque (C00057) of the controller.

Example: The technology application is the basis for a torque-supporting drive. The current torque of a master drive is the setpoint for the supporting drive. Both drives have different maximum torques (C00057) for the scaled torque selection. The torque, however, is to split 1:1.

- Maximum torque - master = 20 Nm
- Maximum torque - slave = 30 Nm

→ This results in a gain factor of 20 Nm/30 Nm = 66.66 %

- The setting of an offset value (C00472/2) may be required to precontrol a constant torque. An offset, for instance, serves to compensate the constant part of a friction torque.

Parameter (Block)	Possible settings			Info
C00472/1 (LS_ParFree_a)	-199.99	%	199.99	Gain factor for torque setpoint • Lenze setting: 100 %
C00472/2 (LS_ParFree_a)	-199.99	%	199.99	Offset value for torque setpoint • Lenze setting: 0 % maximum torque (C00057)

4.5.2 Ramp generator for the torque setpoint

After the FB **L_GainOffset_1**, the torque setpoint is applied to the ramp generator **L_SRFG_1**.

► [Signal flow of the technology application](#) (□ 22)

- A ramp generation in the torque setpoint path may be required to smooth setpoint step-changes.
- In case of typical torque followers – distribution of the load torque to several axes - no ramp generation is required.
- The ramp generator is loaded with the setpoint "zero" if
 - the Motion Control Kernel (MCK) is in "StandBy" mode ("StandBy" = internal operating mode at quick stop, pulse inhibit and DC-injection braking)**OR**
 - if no torque-controlled operation has been requested.

Parameter (Block)	Possible settings			Info
C01040/1 (L_SRFG_1)	0.001	s	999.999	Linear ramp time for the torque setpoint • Lenze setting: 0.010 s

4.5.3 Speed limitation/forward motion for the speed setpoint

The speed of torque-controlled motors is determined by external factors, e.g. via the material in case of a withdrawal. For this purpose, the set speed limitations have to be considerably higher than the current speed of the motor. In order to ensure this, an offset or forward motion value is added to the speed setpoint.

The technology application provides two options to adapt the speed limitations for the torque-controlled operation:

- A. Common offset for both limit values via the FB **L_FixSet_a_1**.
- B. Separate offset and gain factor via the two FBs **L_GainOffsetP_1** and **L_GainOffsetP_2**.

If the speed control is active instead, both adaptations do not affect the speed setpoint.

Parameter (Block)	Possible settings			Info
C00660/2 (L_FixSet_a_1)	-199.99	%	199.99	Common speed offset value for both speed limitations • Only effective for torque followers. • Lenze setting: 5 % reference speed (C00011)
C00677/1 (L_GainOffsetP_1)	-199.99	%	199.99	Separate gain factor for the positive speed limitation • Lenze setting: 100 %
C00677/2 (L_GainOffsetP_1)	-199.99	%	199.99	Separate offset value for the positive speed limitation • Lenze setting: 0 % reference speed (C00011)
C00677/3 (L_GainOffsetP_2)	-199.99	%	199.99	Separate gain factor for the negative speed limitation • Lenze setting: 100 %
C00677/4 (L_GainOffsetP_2)	-199.99	%	199.99	Separate offset value for the negative speed limitation • Lenze setting: 0 % reference speed (C00011)

Details on the signal flow

In the torque-controlled operation, the selection for both speed limitations is led via the **L_NSet_1** setpoint generator. this serves to apply the functions for signal conditioning to the speed limitations.

In the speed-controlled operation, not the speed limitations but the speed setpoint is led via the **L_NSet_1** setpoint generator. All functions for signal conditioning can now be applied to the speed-controlled operation.

► [Signal flow of the technology application](#) (22)

4.5.4 Inversion of the effective direction for the torque setpoint

A simple inversion of the effective direction of the torque setpoint via bit 11 of the application control word (FB **L_ConvBitsToWord_1**) is implemented in the technology application. In the default setting, bit 11 is linked to C00470/1.

Parameter (Block)	Possible settings		Info
C00470/1 (LS_ParFree_b)			1 = Invert effective direction • Inversion of the torque setpoint, the speed limitations and the parameterised fixed setpoints. • Lenze setting: 0
	0	Effective direction CW	
	1	Effective direction CCW	

The inversion can be applied if the effective direction of the torque is to be inverted as requested by the process.



Stop!

An inversion of the torque setpoint causes a reversal of the speed limitations if no further measures are taken! (The speed limitations act with regard to the sign of the motor speed.) Depending on the application case, the set values for the two speed limitations have to be inverted as well.

As a second condition, the request of manual inching in negative direction also causes an inversion of the torque setpoint. This is required to enable "soft" inching in negative direction. ▶ [Manual jog \(inching mode\)](#) (26)

Details on the signal flow

For signal inversion of the torque setpoint, the FB **L_ConvX_1** is used.

The signal inversion of the speed limitations, the fixed setpoints and the speed offset value is carried out in the **L_NSet_1** setpoint generator via the functions *bNSetInv* and *bNAddInv*.

▶ [Signal flow of the technology application](#) (22)

4.6 Monitoring functions

4.6.1 Web break/slip monitoring

In the torque-controlled operation (*bTorqueModeOn* = TRUE), the normal state is that the motor follows the torque setpoint and no speed limitation is active. If the load is omitted (e.g. by web break or slip), the axis is accelerated by the torque until the speed limitation takes effect.

In the default setting, the monitoring function implemented in the technology application triggers the user error 1 with the "WarningLocked" response after a tripping delay of 100 ms if:

1. the torque-controlled mode is active **AND**
2. the motor control signals that a speed limitation is active in the torque-controlled operation (*bLimSpeedTorquemodeOn* = TRUE) **AND**
3. the amount of the speed setpoint is higher than the speed threshold set in C00472/5.

The web break/slip monitoring can be adapted via the following parameters:

Parameter (Block)	Possible settings			Info
C00472/5 (LS_ParFree_a)	-199.99	%	199.99	Speed threshold for activating the web break/slip monitoring • Lenze setting: 5 % reference speed (C00011)
C00581/1 (LS_SetError_1)				Response when web break/slip monitoring has tripped • Lenze setting: "4: WarningLocked"
	0	No Reaction		
	1	Fault		
	2	Trouble		
	3	TroubleQuickStop		
	4	WarningLocked		
	5	Warning		
	6	Information		
C00720/1 (L_DigitalDelay_1)	0.000	s	3600.000	Tripping delay for web break/slip monitoring • Lenze setting: 0.1 s

► [Signal flow of the technology application](#) (22)



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.

If you have suggestions for improvement, please e-mail us to:

feedback-docu@Lenze.de

Thank you for your support.

Your Lenze documentation team



Lenze Drives GmbH

Breslauer Straße 3

D-32699 Extertal

Germany

☎ +49 5154 82-0

📠 +49 5154 82-2800

@ lenze@lenze.com

🌐 www.lenze.com

Service

Lenze Service GmbH

Breslauer Straße 3

D-32699 Extertal

Germany

☎ 008000 24 46877 (24 h helpline)

📠 +49 5154 82-1112

@ service@lenze.com