



8400

"Electrical Shaft Master/Slave"
technology application
for 8400 TopLine C

Software manual

EN



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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 addresses to all persons

- who want to use the "Electrical Shaft Master" or "Electrical Shaft Slave" technology application for the 8400 TopLine inverter, and
- who are familiar with handling the device and the »Engineer« software.

Validity

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

Technology application	from version
Electrical Shaft Master	01.00
Electrical Shaft Slave	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
1.0	07/2014	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	 5	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".
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".
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« 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_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 the experience and know-how of Lenze 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 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 "Electrical Shaft" technology application serves to easily establish a so-called "electrical shaft" between several 8400 TopLine inverters, so that two or more devices can be used in angular synchronism.

The axis bus (terminal block X10) is used as transmission medium. A modification to the system bus (CAN) can be effected; however, this is not covered by this description.

2.1 Functional overview

General

- Electrical shaft in line topology (all drives receive the same master value)
- Transmission of the master value via axis bus
- 1 master drive and up to 61 slave drives

Master functions ("Electrical Shaft Master" technology application)

- Setpoint selection optionally via
 - plugged-in communication module/fieldbus interface (MCI)
 - "CAN on board" system bus (X1)
 - analog input (X3)
 - multi encoder input (X8)
- ramp function generator for main setpoint from the fieldbus or analog input
The ramp function generator with adjustable ramps prevents jerks during the changeover or in the case of abrupt setpoint changes. By this, a master control can easily select a setpoint without any ramps.
- Stop function with an individual deceleration ramp for the electrical shaft (bring whole interconnection synchronously to a standstill)
- Quick stop function (for stop in the event of a breakdown)
- Adjustable gearbox factor
- Speed trimming
For the connection of correction values, e.g. from a higher-level control loop. This permits an acceleration or deceleration of the drive.
- Position offset (angular adjustment)
For the selection of a fixed angular offset for the setpoint. The angular offset is controlled via a profile generator and can therefore be continuously adjusted during master-slave operation.
- Use of the state machine of the Motion Control Kernel (MCK) and the following basic drive functions:
 - Homing (homing/reference setting)
 - Manual jog (optionally with the following slave drives)
- Optionally setpoint- or actual value-based master value for slave drive(s)
- Optionally master function for slave drive(s) with "Position Follower" application
- Central reset (acknowledgement) of errors

Slave functions ("Electrical Shaft Slave" technology application)

- Setpoint selection optionally by the master drive or multi-encoder
- Quick stop function (for stop in the event of a breakdown)
- Adjustable stretch factor (mapping of the procedural speed/angle ratio to the master value)
This serves to vary the speed of the slave drive in an adjustable ratio to the master drive (e.g. for the purpose of material stretching)
- Adjustable gearbox factor (mapping of the mechanics of the respective slave)
- Speed trimming
- Position offset (angular adjustment)
- Mark correction via touch probe sensor
- Use of the state machine of the Motion Control Kernel (MCK) and the following basic drive functions:
 - Homing (homing/reference setting)
 - Manual jog
- Angle correction for transmission errors of the axis bus
- Error message from the slave to the master via I/O axis bus for central error handling

2.2**Application ranges**

- Conveyors
- Stretching lines
- Wire drawing machines
- Transport devices
- Printing machines
- Packaging machine
- ...

2.3**System requirements**

The technology application was created with the L-force »Engineer« V2.20 and can only be used with the versions V2.20 or higher.

Software

Product	Order designation	from version
L-force »Engineer« HighLevel	ESPEV-EHNNN	2.20

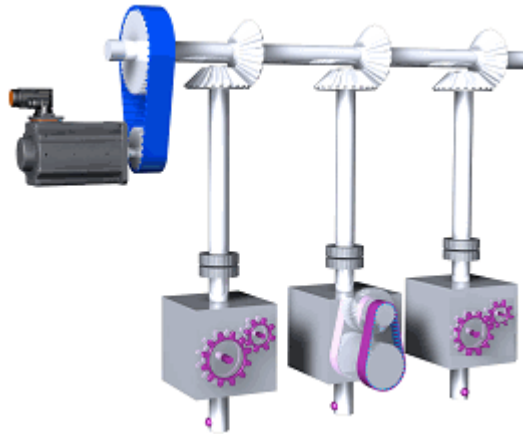
Hardware

Product	Order designation	from hardware version	from software version
Inverter Drives 8400 TopLine C	E84AVTCxxxxx	VD	14.00

2.4 Basics of the electrical shaft

2.4.1 Synchronisation of the drives via a master angle

Coupling the drives via a master angle results in a fixed position assignment for all drives of the electrical shaft like for a mechanical shaft:



The master drive provides the master angle and transfers it to the other (slave) drives following this master angle.

Advantages of this type of synchronisation

- Communication between the drives is kept very simple. A time-consuming evaluation of the status signals of each individual drive and the control signals to be generated for each individual drive is dispensed with.
- The flexible signal structures provide for an easy execution of trimming functions. This makes it possible to easily synchronise and optimise the motion sequences in machines.
- By variation of the master angle speed, the number of cycles or production speed of the machine is/are altered. In this process, the drives' position assignment towards each other is maintained.

2.4.2 Transmission of the master angle via axis bus

In the case of the 8400 TopLine, the integrated axis bus can be used for the transmission of the master angle.

The axis bus serves to couple several 8400 TopLine inverters in an axis interconnection. It is the main task of the axis bus to carry out simple cross-data exchange from axis to axis.

A distinction between the two transmission channels "data transfer axis bus" and "IO axis bus" is made, which can be used as follows:

- The data transfer axis bus is based on CAN physics and enables a high-performance data transfer of master values and control signals to other 8400 TopLine controllers. For this purpose, a synchronisation of the internal time base of the controllers via the IO axis bus is always required.
- The IO axis bus is a 1-wire bus with open-collector circuitry (5 V isolated). The IO axis bus can either be used to transfer controller errors in the interconnection ("release cord" principle) or as a pure open-collector IO function. In the first case, the internal time base of the controllers can be synchronised via the IO axis bus.

Max. 62 controllers can be connected to the axis bus.



Stop!

The data transfer axis bus of the 8400 TopLine controller is designed especially for performance and simplicity. HMIs and other peripherals as well as the »Engineer« are not supported at the axis bus.

The IO axis bus of the 8400 TopLine controller is not compatible to the state bus of the 9300/9400 device series due to different voltage levels!



Some detailed information about the axis bus can be found in the reference manual/in the online help of the inverter in the "Axis bus" chapter of the same name.

2.4.3 Master value or actual value transmission?

In contrast to the transmission of the actual value, the transmission of the master value results in a considerably smoother machine operation; however, mark corrections or higher-level controls as well as interference of the leading drive have no impact on the interconnection.

The transmission of the actual value causes a slightly more uneven machine operation. Higher-level controls as well as interference of the leading drives have an impact on the interconnection.

The selection of the value that is to serve as speed setpoint for the slave drives is defined in the master drive:

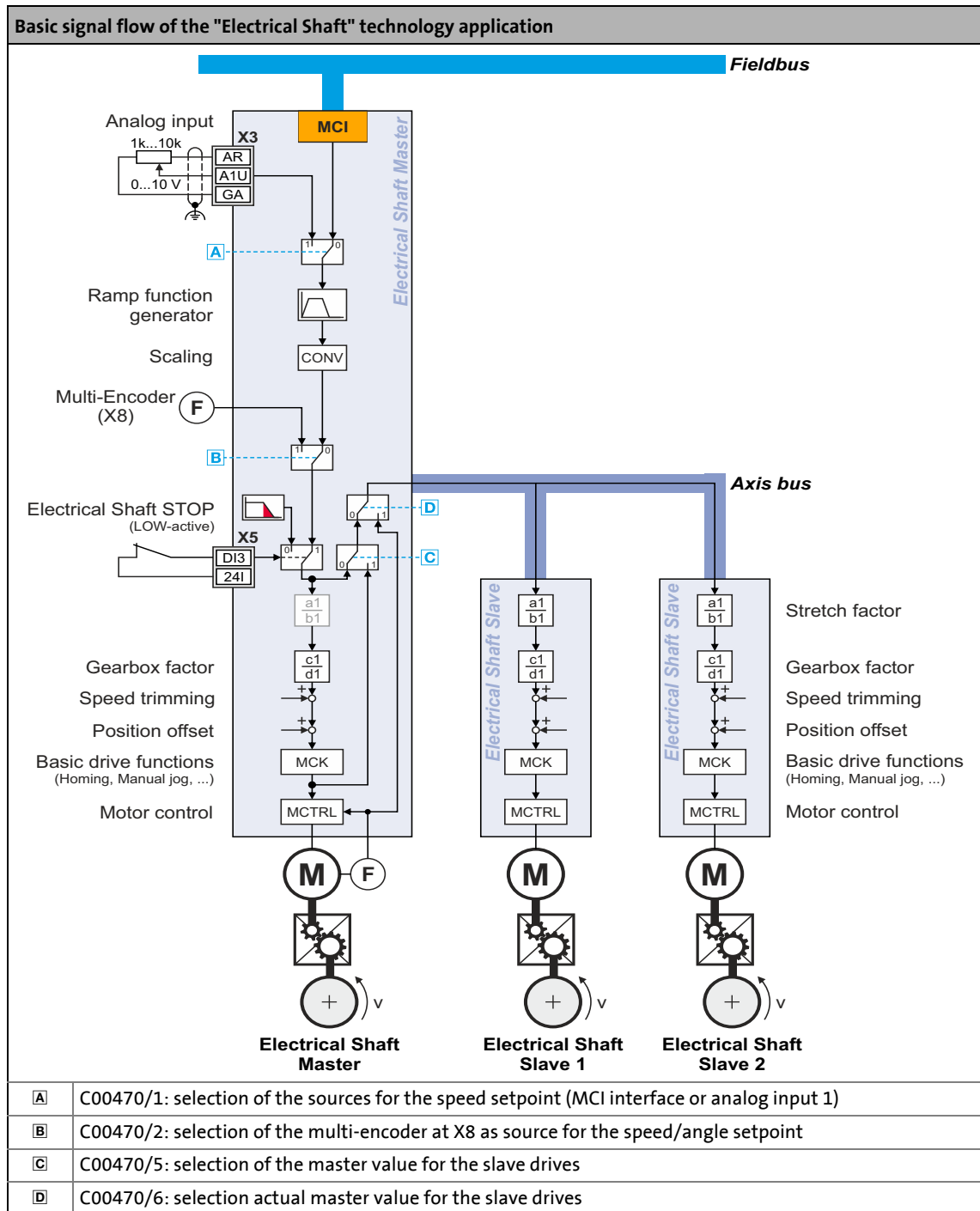
- Mere master value: speed setpoint irrespective of the master
- Master value of the master: speed setpoint of the master drive's motion control (speed setpoint of the Motion Control Kernel; including manual jog, homing, ...)
- Actual master value: exact master position including following errors

2.5

Basic signal flow

In the technology application, function blocks and system blocks are interconnected so that an electrical shaft can be implemented for the application ranges mentioned before.

In the following, the basic signal flow between a master drive and two slave drives with the basic functions is shown.



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 user interface for the master drive

2.7.1 I/O terminals

Terminal	Function		
Digital input terminals			
X5/RFR	Controller enable		
X5/DI1	Start/stop homing		
	DI1	Function	
	HIGH	For selection of homing modes "4" ... "15" in C01221: Start reference search	
		For selection of homing modes "100: SetRef" in C01221: Set home position manually	
HIGH↘LOW	Stop homing		
X5/DI2	Activate quick stop (e.g. in the case of a fault)		
	DI2	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/DI3	Stop electrical shaft The connection is configured in a fail-safe fashion (LOW = Electrical Shaft STOP).		
	DI3	Function	
	LOW	Stop electrical shaft: synchronously bring whole drive system to a standstill	
	HIGH	Electrical shaft running	
X5/DI4	Connection of pre-switch sensor for reference search The edge sensitivity of this input and the response to the pre-switch signal depend on the homing mode selected.		
X5/DI5 X5/DI6	Manual jog		
	DI5	DI6	Function
	LOW	LOW	-
	HIGH	LOW	Manual jog in positive direction
	LOW	HIGH	Manual jog in negative direction
	HIGH	HIGH	- / Manual jog in the direction selected first
X5/DI7	Reset error messages		
	DI7		Function
	LOW		No reset
	1. LOW↗HIGH		With the first positive edge, the error messages of all slave drives are reset.
	2. LOW↗HIGH		With the second positive edge, the error message in the master drive is reset. (The bus runtimes between the master and slave make a double LOW-HIGH edge necessary for the reset!)

Terminal	Function
Analog input terminals	
X3/A1U	Speed setpoint • If this input is to be used as setpoint source, C00470/1 is to be set to the value "1: True". • Scaling: 10 V $\equiv$ 100 % reference speed (C00011)
X3/A2U	- (not assigned, can be used freely)
Digital output terminals	
X4/DO1	Status "Drive is ready"
X4/DO2	- (not assigned, can be used freely)
X4/DO3	Status "Home position is known"
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 $\equiv$ 100 % reference speed (C00011)
X3/O2U	Actual torque • Scaling: 10 V $\equiv$ 100 % maximum torque (C00057)

2.7.2 Process data input words

Fieldbus interface (MCI); port block LP_MciIn

Input words	Assignment
Word 1	Control word (for bit assignment see the following table)
Word 2	Speed setpoint • Scaling: 16384 $\equiv$ 100 % reference speed (C00011)
Words 3 ... 16	- (not preconfigured)

Control word	Function
Bit 0	- (not preconfigured)
Bit 1	- (not preconfigured)
Bit 2	- (not preconfigured)
Bit 3	- (not preconfigured)
Bit 4	- (not preconfigured)
Bit 5	- (not preconfigured)
Bit 6	- (not preconfigured)
Bit 7	- (not preconfigured)
Bit 8	- (not preconfigured)
Bit 9	- (not preconfigured)
Bit 10	- (not preconfigured)
Bit 11	- (not preconfigured)
Bit 12	- (not preconfigured)
Bit 13	- (not preconfigured)
Bit 14	- (not preconfigured)
Bit 15	- (not preconfigured)

2.7.3 Process data output words

Fieldbus interface (MCI); port block LP_MciOut

Output words	Assignment
Word 1	Status word (for bit assignment see the following table)
Word 2	Actual speed value • Scaling: 16384 $\equiv$ 100 % reference speed (C00011)
Word 3	Actual torque • Scaling: 16384 $\equiv$ 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	- (not preconfigured)																																																																														
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 ≡ A fault is active. The inverter is in the "Trouble" device state. • The motor has no torque (is coasting) due to the inhibit of the inverter. • The "Trouble" device status is automatically abandoned if the error cause has been removed.																																																																														
Bit 14	- (not preconfigured)																																																																														
Bit 15	1 ≡ Home position is known																																																																														

2.8 Pre-assignment of the user interface for the slave drive

2.8.1 I/O terminals

Terminal	Function	
Digital input terminals		
X5/RFR	Controller enable	
X5/DI1	Speed trimming positive	
	DI1	Function
	HIGH	Speed trimming by the value set in C00476/1 (Lenze setting: +3 %)
X5/DI2	Speed trimming negative	
	DI2	Function
	HIGH	Speed trimming by the value set in C00476/2 (Lenze setting: -3 %)
X5/DI3	- (Reserved)	
X5/DI4	Option 1: Connection of a pre-switch sensor for reference search (Only relevant for the selection of homing modes "4" ... "7" in C01221)	
	DI4	Function
	LOW↗HIGH	Activate search profile data set for further reference search
	HIGH↘LOW	Enable home position detection
	Option 2: Connection of a touch probe sensor for mark synchronisation/TP correction • If the TP correction is to be used, C00470/3 is to be set to the value "1: True".	
X5/DI5	Connection of a master pulse for mark synchronisation/TP correction • If the TP correction is to be used, C00470/3 is to be set to the value "1: True".	
X5/DI6	Start/stop homing	
	DI6	Function
	HIGH	For selection of homing modes "4" ... "15" in C01221: Start reference search
		For selection of homing modes "100: SetRef" in C01221: Set home position manually
HIGH↘LOW	Stop homing	
X5/DI7	Reset error message	
	DI7	Function
	LOW	No reset
	LOW↗HIGH	Reset local error message in the slave drive
Analog input terminals		
X3/A1U	- (not assigned, can be used freely)	
X3/A2U	- (not assigned, can be used freely)	

Terminal	Function
Digital output terminals	
X4/DO1	Status "Drive is ready"
X4/DO2	- (not assigned, can be used freely)
X4/DO3	Status "Home position is known"
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 $\equiv$ 100 % reference speed (C00011)
X3/O2U	Current following error • Scaling: 10 V $\equiv$ 1 revolution

2.8.2 Process data input words

Fieldbus interface (MCI); port block LP_MciIn

Input words	Assignment
Word 1	Control word (for bit assignment see the following table)
Words 2 ... 16	- (not preconfigured)

Control word	Function		
Bit 0	- (not preconfigured)		
Bit 1	- (not preconfigured)		
Bit 2	1 $\equiv$ Activate quick stop (QSP)		
Bit 3	- (not preconfigured)		
Bit 4	- (not preconfigured)		
Bit 5	- (not preconfigured)		
Bit 6	- (not preconfigured)		
Bit 7	- (not preconfigured)		
Bit 8	- (not preconfigured)		
Bit 9	- (not preconfigured)		
Bit 10	- (not preconfigured)		
Bit 11	1 $\equiv$ deactivate X offset		
Bit 12 ... 13	Manual jog		
	Bit 12	Bit 13	Function
	0	0	-
	1	0	Manual jog in positive direction
	0	1	Manual jog in negative direction
	1	1	- / Manual jog in the direction selected first
Bit 14	- (not preconfigured)		
Bit 15	- (not preconfigured)		

2.8.3 Process data output words

Fieldbus interface (MCI); port block LP_MciOut

Output words	Assignment
Word 1	Status word (for bit assignment see the following table)
Word 2	Actual speed value • Scaling: 16384 $\equiv$ 100 % reference speed (C00011)
Word 3	Actual torque • Scaling: 16384 $\equiv$ 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	- (not preconfigured)																																																																														
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																																																																										
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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 ≡ A fault is active. The inverter is in the "Trouble" device state. • The motor has no torque (is coasting) due to the inhibit of the inverter. • The "Trouble" device status is automatically abandoned if the error cause has been removed.																																																																														
Bit 14	1 ≡ "Electrical Shaft" operation switched on																																																																														
Bit 15	1 ≡ Home position is known																																																																														

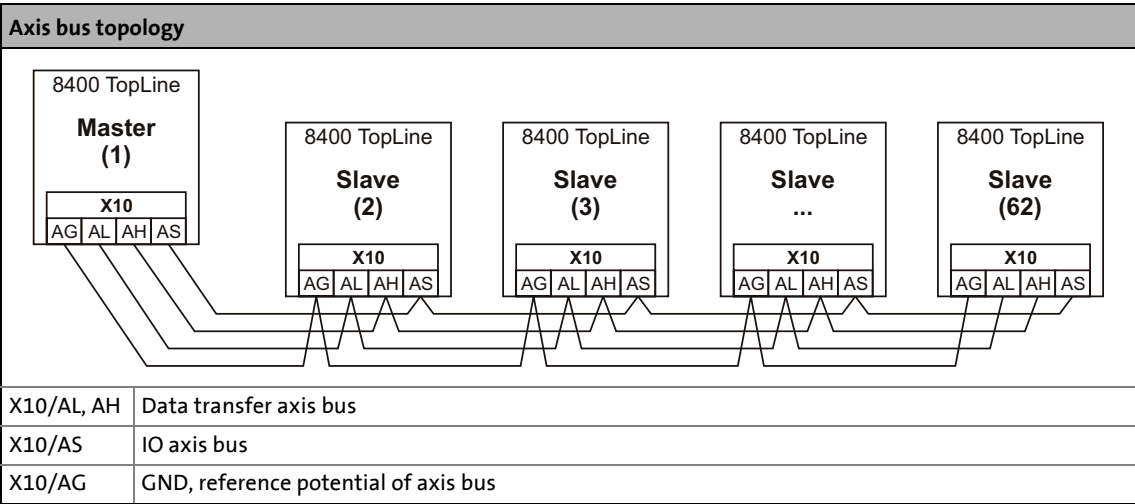
3 Short setup of the technology application

3.1 Hardware structure required

3 Short setup of the technology application

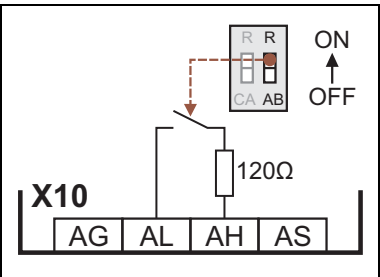
3.1 Hardware structure required

The "Electrical Shaft" technology application requires at least two 8400 TopLine inverters that are connected to each other via axis bus. A maximum of 62 nodes on the axis bus can be actuated:



The axis bus must be terminated between axis bus low (AL) and axis bus high (AH) at the first and last physical node each by a resistor (120 Ω).

The 8400 controller is provided with an integrated bus terminating resistor, which can be activated via the DIP switch labelled with "AB":



- OFF = bus terminating resistor is inactive
- ON = bus terminating resistor is active

3.2 Preconditions

For the execution of the short setup described in the following, the setting of the most important parameters (motor, feedback system, etc.) for each node on the axis bus 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 Short setup of the technology application

3.3 Short setup of the master drive

3.3 Short setup of the master drive

The following steps only have to be carried out for the inverter which is to be the master in the network.

3.3.1 Step 1: Load "Electrical Shaft Master" technology application

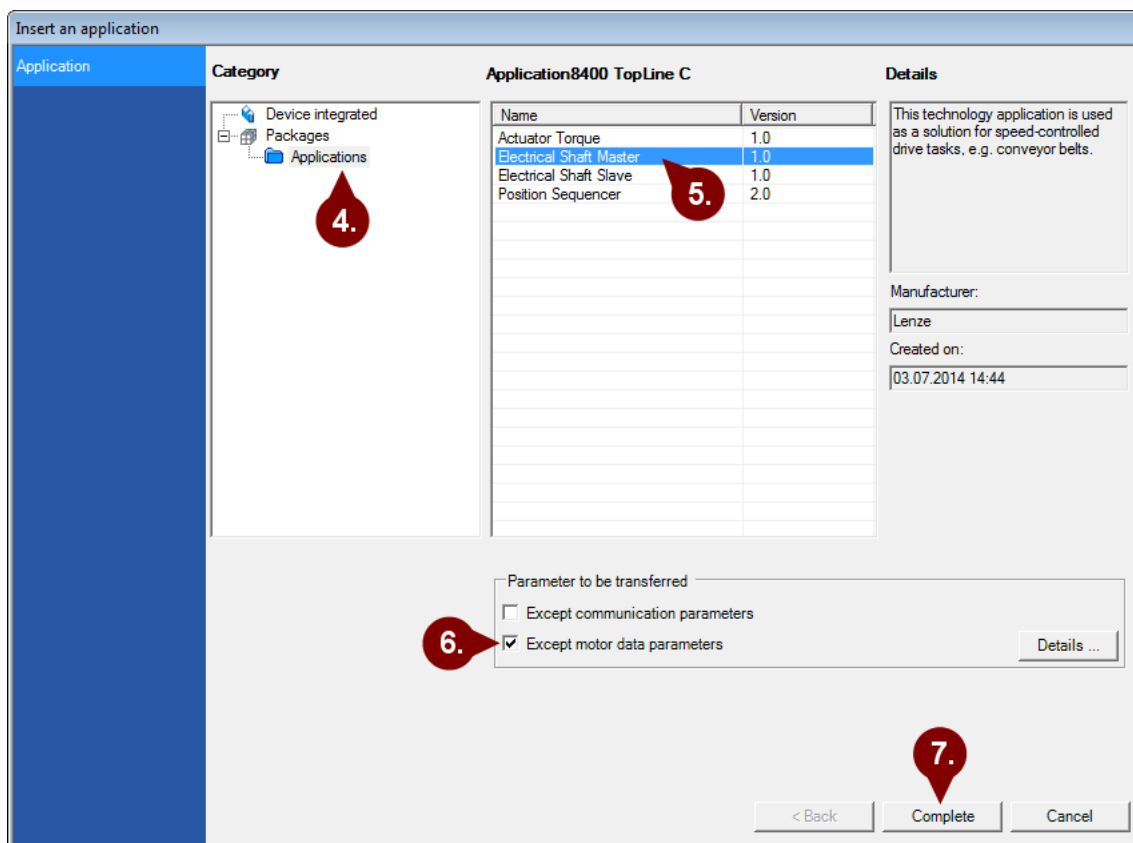
In the Lenze setting, the inverter uses the "speed actuating drive" technology application integrated in the device. Execute the following steps to use the "Electrical Shaft Master" technology application instead:

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 "Packages" → "Applications" category.
5. Select the "Electrical Shaft Master" application in the right field.
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 prompt on whether the current application is to be replaced by the "Electrical Shaft Master" application with **Yes**.

3.3.2 Step 2: Axis bus settings for the master

Carry out the following settings for the inverter which is to be the master in the network:

- Axis bus address (C02430/1) = "1"
 - With this setting, the controller automatically takes over the control in the network.
 - Only one master is allowed in the network.
- Axis bus IO function (C02440/1) = "1: Master"
 - With this setting, the controller outputs a synchronisation cycle to the I/O axis bus to which the slaves can orient themselves.
- If the network is created by more than two inverters:
Set the number of inverters connected to the axis bus in C02430/2.

3.3.3 Step 3 (optional): Set up control system via the fieldbus interface (MCI)

In the default setting, the application is controlled via the digital input terminals. For higher automated systems, mostly data bus systems are used for controlling the drives.

For control via the fieldbus interface (MCI), the user interface (area highlighted in turquoise) is to be adapted accordingly in the function block editor.

- 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.



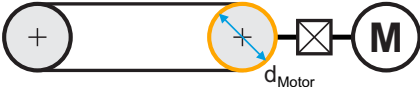
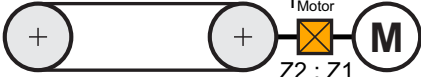
Tip!

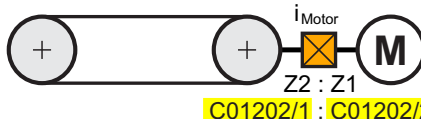
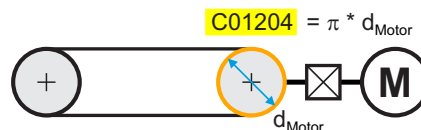
Control via the integrated CANopen interface ("CAN on board") can also be attained by means of simple interconnection changes. For this purpose, the **LP_CanIn** port block has to be inserted in the interconnection and connected to the corresponding inputs of the user interface.

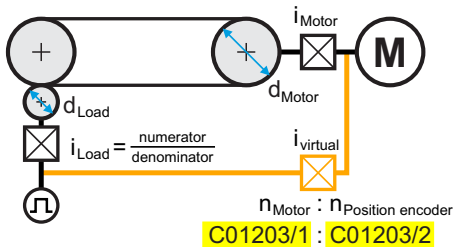
3.3.4 Step 4: Set commissioning parameters

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 (Lenze setting printed in bold)			Info
Machine parameters/axis settings				
C01201/1 (LS_MotionControl Kernel)	0.0000	units	214748.3647	Cycle length • For a modulo measuring system, the length of one cycle to the overflow is to be set. • For a limited measuring system, the Lenze setting "0.0000" is to be retained.
	Lenze setting: 0.0000 units			
C01204 (LS_MotionControl Kernel)	0.0001	units/re v.	214748.3647	Feed constant • The feed constant corresponds to the movement of the machine during one revolution of the gearbox output shaft. • The value is entered in application units relating to one gearbox revolution. • Schematic diagram of a conveyor drive: $\text{C01204} = \pi * d_{\text{Motor}}$
	Lenze setting: 360.0000 units/U			
C01206/1 (LS_MotionControl Kernel)				Motor mounting direction
	0	not inverted		Motor is mounted directly
	1	inverted		Motor is mounted with rotation by 180°
C01202/1..2 (LS_MotionControl Kernel)	1		65535	Gearbox ratio motor - load • Set the gearbox ratio with mathematical precision in the two subcodes: • Subcode 1: numerator term (Z2) • Subcode 2: denominator term (Z1) $i_{\text{motor}} = \frac{\text{C01202/1}}{\text{C01202/2}} = \frac{\text{Z2}}{\text{Z1}}$ • Schematic diagram of a conveyor drive:  $\text{C01202/1} : \text{C01202/2}$
	Lenze setting: 1:1			



Parameter (Block)	Possible settings (Lenze setting printed in bold)	Info		
Position encoder				
If the motor encoder is used as position encoder, you do not need to parameterise a separate position encoder. Keep the Lenze setting for the following codes.				
C01206/2 (LS_MotionControl Kernel)			Position encoder mounting direction	
	0	not inverted	Position encoder is mounted directly	
	1	inverted	Position encoder mounted with rotation by 180	
C01203/1..2 (LS_MotionControl Kernel)	1		65535	Speed ratio for motor - position encoder - Set the "virtual" speed ratio between the motor and the external position encoder with mathematical precision in the two subcodes: - Subcode 1: numerator term (motor speed) - Subcode 2: denominator term (encoder speed) - Schematic diagram of a conveyor drive:  - The "virtual" speed ratio can be calculated as follows:$i_{\text{virtual}} = \frac{C01203/1}{C01203/2} = \frac{i_{\text{motor}}}{i_{\text{load}}} \cdot \frac{\pi \cdot d_{\text{load}}}{\pi \cdot d_{\text{motor}}}$$i_{\text{virtual}} = \frac{C01202/1}{C01202/2} \cdot \frac{\text{denominator}}{\text{numerator}} \cdot \frac{\pi \cdot d_{\text{load}}}{C01204}$
	Lenze setting: 1:1			
Selection of the speed setpoint for the application				
C00470/1 (LS_ParFree_b)			Selection of the source for the speed setpoint (also see Basic signal flow)	
	0	MCI interface	Speed setpoint = process data input word 2 Scaling: 16384 ≡ 100 % reference speed (C00011)	
	1	Analog input 1	Speed setpoint = voltage signal at X3/A1U Scaling: 10 V ≡ 100 % reference speed (C00011)	
	C00470/2 (LS_ParFree_b)			Selection of the source for the speed setpoint (also see Basic signal flow)
0		Master value	Source set in C00470/1	
	1	Multi encoder	Multi-Encoder at X8	
	C00470/7 (LS_ParFree_b)			Setpoint direction
0		not inverted	• Not relevant if multi-encoder is set as speed setpoint source in C00470/2.	
1		inverted		
Settings for main setpoint via MCI interface or analog input 1				
C00012 (L_NSet_1)	0.000	s	999.999	Acceleration time - main setpoint
	Lenze setting: 2.000 s			• Not relevant if multi-encoder is set as speed setpoint source in C00470/2.
C00013 (L_NSet_1)	0.000	s	999.999	Deceleration time - main setpoint
	Lenze setting: 2.000 s			• Not relevant if multi-encoder is set as speed setpoint source in C00470/2.

Parameter (Block)	Possible settings (Lenze setting printed in bold)			Info
"Electrical shaft STOP" function				
C01040/1 (L_SRF _G _1)	0.001	s	999.999	Linear ramp time for Electrical Shaft STOP • $t_{\text{ramp}} = \text{C01040/1} \cdot \text{speed [\%]} + \text{C01041/1}$
	Lenze setting: 0.5 s			
C01041/1 (L_SRF _G _1)	0.001	s	50.000	S-ramp time for Electrical Shaft STOP
	Lenze setting: 0.1 s			
Stretch factor				
C00471/1..2 (LS_ParFree)	0		65535	Stretch factor • Subcode 1: numerator term • Subcode 2: denominator term
	Lenze setting: 1000:1000			
Gearbox factor				
C00471/3..4 (LS_ParFree)	0		65535	Gearbox factor • Subcode 1: numerator term • Subcode 2: denominator term
	Lenze setting: 1000:1000			
Speed trimming				
C00476/1 (LS_ParFree_a_2)	-199.99	%	199.99	Speed trimming positive • Scaling: 100 % $\equiv$ reference speed (C00011)
	Lenze setting: 3 %			
C00470/9 (LS_ParFree_b)				Activate positive speed trimming
	0	No speed trimming		
	1	Speed trimming by the value set in C00476/1		
C00476/2 (LS_ParFree_a_2)	-199.99	%	199.99	Speed trimming negative • Scaling: 100 % $\equiv$ reference speed (C00011)
	Lenze setting: -3 %			
C00470/10 (LS_ParFree_b)				Activate negative speed trimming
	0	No speed trimming		
	1	Speed trimming by the value set in C00476/2		
Position offset (angular adjustment)				
C00475/1 (LS_ParFreeUnit_1)	-214748.3647	units	214748.3647	Position offset (X offset) The angular adjustment is retained as long as the position offset is present.
	Lenze setting: 0.0000 units			
C01060/2 (L_PosCtrlLin_1)	0.010	s	130.000	Acceleration ramp for the higher-level positioning of the X axis via the position offset set in C00475/1.
	Lenze setting: 1.000 s			
C01060/3 (L_PosCtrlLin_1)	0.010	s	130.000	Deceleration ramp for the higher-level positioning of the X axis via the position offset set in C00475/1.
	Lenze setting: 1.000 s			

Parameter (Block)	Possible settings (Lenze setting printed in bold)	Info
Selection of the signal for slave drives to be output via axis bus		
C00470/4 (LS_ParFree_b)		Operation as position follower master
	0 Off	The signals are output via axis bus according to the settings in C00470/5 and C00470/6.
	1 On	This setting is only required if the drive is to be used as master for a slave drive with the "Position Follower" technology application. The following signals are then output via axis bus: Line data words 1 & 2 = current position Line data word 3 = current speed Note: With this setting, homing of the master causes a step in the slave position follower if the current position is set to the home position! Remedy: Inhibit the slave position follower when you are referencing the master!
C00470/5 (LS_ParFree_b)		Selection of the speed setpoint for slave drives (also see Basic signal flow)
	0 Mere master value	Speed setpoint set in C00470/2
	1 Master value	Speed setpoint of the master drive's motion control (speed setpoint of the Motion Control Kernel). With this setting, the slave drives follow the master drive even if it is executing manual jog or homing.
C00470/6 (LS_ParFree_b)		Selection of the speed setpoint for slave drives (also see Basic signal flow)
	0 Master value	Master value set in C00470/5
	1 Actual speed	Current speed

3.3.5

Step 5: Go online and transfer parameter set to the inverter

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.

3.4 Short setup of the slave drive

The following steps are to be carried out for all slave drives of the interconnection.

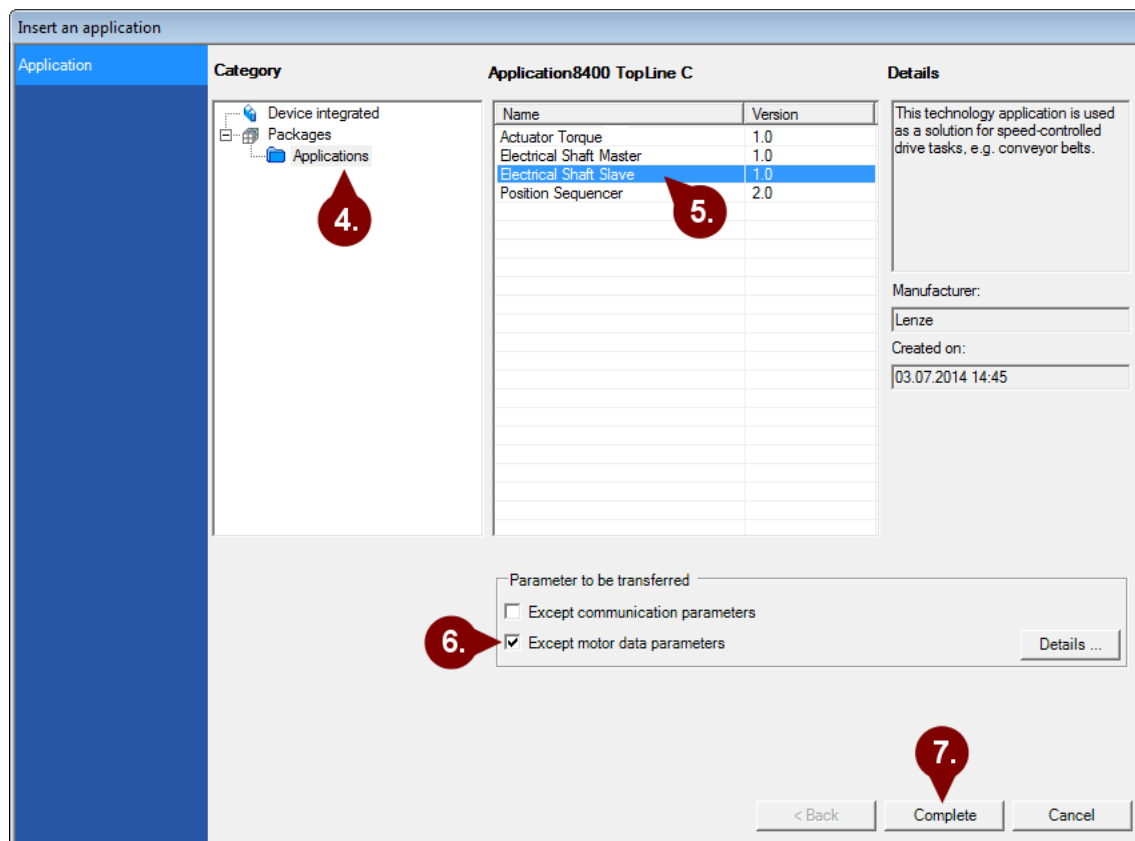
3.4.1 Step 1: Load "Electrical Shaft Slave" technology application

In the Lenze setting, the inverter uses the "speed actuating drive" technology application integrated in the device. Execute the following steps to use the "Electrical Shaft Slave" 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 "Packages" → "Applications" category.
5. Select the "Electrical Shaft Slave" application in the right field.
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 prompt on whether the current application is to be replaced by the "Electrical Shaft Slave" application with **Yes**.

3.4.2 Step 2: Axis bus settings for the slave

Make the following settings for every slave controller in the network:

- Axis bus address (C02430/1) = "2" ... "62"
 - Make sure that all controllers connected to the axis bus have different axis bus addresses.
- Sync signal source (C01120) = "2: AxisBusIO"
 - With this setting, the synchronisation cycle output by the master is used as synchronisation source. The parameters C01121 ... C01123 for the synchronisation of the internal time base are automatically set to fixed reasonable values to provide for a technically perfect operation of the axis bus!
 - Basically, only one source is allowed to synchronise the internal time base.
- Axis bus IO function (C02440/1) = "2: Slave"
 - This setting serves to define the slave.

3.4.3 Step 3 (optional): Set up control system via the fieldbus interface (MCI)

In the default setting, most functions are controlled via the digital input terminals.

Via the fieldbus interface (MCI), manual jog can be executed for the slave drive, and the X offset can be deactivated. If further functions are to be controlled via the fieldbus interface (MCI), the user interface (area highlighted in turquoise) must be adapted accordingly in the function block editor.

- 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.



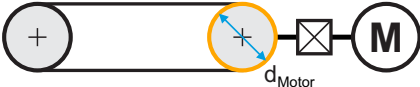
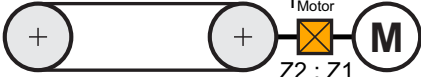
Tip!

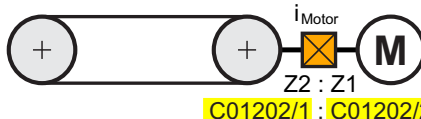
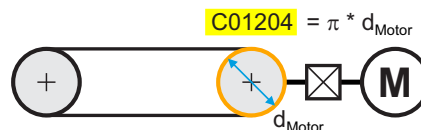
Control via the integrated CANopen interface ("CAN on board") can also be attained by means of simple interconnection changes. For this purpose, the **LP_CanIn** port block has to be inserted in the interconnection and connected to the corresponding inputs of the user interface.

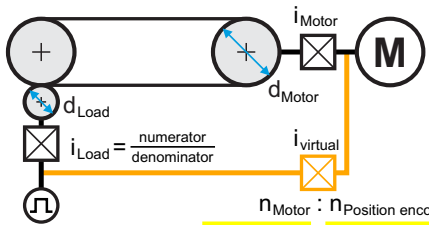
3.4.4 Step 4: Set commissioning parameters

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 (Lenze setting printed in bold)			Info
Machine parameters/axis settings				
C01201/1 (LS_MotionControl Kernel)	0.0000	units	214748.3647	Cycle length • For a modulo measuring system, the length of one cycle to the overflow is to be set. • For a limited measuring system, the Lenze setting "0.0000" is to be retained.
	Lenze setting: 0.0000 units			
C01204 (LS_MotionControl Kernel)	0.0001	units/re v.	214748.3647	Feed constant • The feed constant corresponds to the movement of the machine during one revolution of the gearbox output shaft. • The value is entered in application units relating to one gearbox revolution. • Schematic diagram of a conveyor drive: $\text{C01204} = \pi * d_{\text{Motor}}$
	Lenze setting: 360.0000 units/U			
C01206/1 (LS_MotionControl Kernel)				Motor mounting direction
	0	not inverted		Motor is mounted directly
	1	inverted		Motor is mounted with rotation by 180°
C01202/1..2 (LS_MotionControl Kernel)	1		65535	Gearbox ratio motor - load • Set the gearbox ratio with mathematical precision in the two subcodes: • Subcode 1: numerator term (Z2) • Subcode 2: denominator term (Z1) $i_{\text{Motor}} = \frac{\text{C01202/1}}{\text{C01202/2}} = \frac{\text{Z2}}{\text{Z1}}$ • Schematic diagram of a conveyor drive:  $\text{C01202/1} : \text{C01202/2}$
	Lenze setting: 1:1			



Parameter (Block)	Possible settings (Lenze setting printed in bold)			Info
Position encoder				
If the motor encoder is used as position encoder, you do not need to parameterise a separate position encoder. Keep the Lenze setting for the following codes.				
C01206/2 (LS_MotionControl Kernel)				Position encoder mounting direction
	0	not inverted		Position encoder is mounted directly
	1	inverted		Position encoder mounted with rotation by 180
C01203/1..2 (LS_MotionControl Kernel)	1		65535	Speed ratio for motor - position encoder
	Lenze setting: 1:1			- Set the "virtual" speed ratio between the motor and the external position encoder with mathematical precision in the two subcodes: - Subcode 1: numerator term (motor speed) - Subcode 2: denominator term (encoder speed) - Schematic diagram of a conveyor drive:  $n_{\text{Motor}} : n_{\text{Position encoder}}$ C01203/1 : C01203/2 - The "virtual" speed ratio can be calculated as follows: $i_{\text{virtual}} = \frac{\text{C01203/1}}{\text{C01203/2}} = \frac{i_{\text{Motor}}}{i_{\text{load}}} \cdot \frac{\pi \cdot d_{\text{load}}}{\pi \cdot d_{\text{Motor}}}$$i_{\text{virtual}} = \frac{\text{C01202/1}}{\text{C01202/2}} \cdot \frac{\text{denominator}}{\text{numerator}} \cdot \frac{\pi \cdot d_{\text{load}}}{\text{C01204}}$
Error handling				
C00470/4 (LS_ParFree_b)				Error message to the master
	0	deactivated		For commissioning of the slave drive, the error message to the master via the IO axis bus is deactivated at first.
	1	activated		
Selection of the speed setpoint for the application				
C00470/1 (LS_ParFree_b)				Selection of the source for the speed setpoint
	0	Axis bus		Master drive
	1	Multi encoder		Multi-Encoder at X8
Stretch factor				
C00471/1..2 (LS_ParFree)	0		65535	Stretch factor
	Lenze setting: 1000:1000			- Subcode 1: numerator term - Subcode 2: denominator term
Gearbox factor				
C00471/3..4 (LS_ParFree)	0		65535	Gearbox factor
	Lenze setting: 1000:1000			- Subcode 1: numerator term - Subcode 2: denominator term
Speed trimming				
C00476/1 (LS_ParFree_a_2)	-199.99	%	199.99	Speed trimming positive
	Lenze setting: 3 %			Scaling: 100 % $\equiv$ reference speed (C00011)
C00476/2 (LS_ParFree_a_2)	-199.99	%	199.99	Speed trimming negative
	Lenze setting: -3 %			Scaling: 100 % $\equiv$ reference speed (C00011)

Parameter (Block)	Possible settings (Lenze setting printed in bold)			Info
Position offset (angular adjustment)				
C00475/1 (LS_ParFreeUnit)	-214748.3647	units	214748.3647	Position offset (X offset) The angular adjustment is retained as long as the position offset is present and the slave is running in electrical shaft operation.
	Lenze setting: 0.0000 units			
C01060/2 (L_PosCtrlLin_1)	0.010	s	130.000	Acceleration ramp for the higher-level positioning of the X axis via the position offset set in C00475/1.
	Lenze setting: 1.000 s			
C01060/3 (L_PosCtrlLin_1)	0.010	s	130.000	Deceleration ramp for the higher-level positioning of the X axis via the position offset set in C00475/1.
	Lenze setting: 1.000 s			
Mark synchronisation/TP correction				
C00470/3 (LS_ParFree_b)				Mark synchronisation/TP correction
	0	Off		
	1	On		Permanent zero pulse/touch probe synchronisation. The correction is carried out by the shortest path. (Other synchronisation modes can be selected in C01075/1)
C01069/2 (L_DFSET_1)	0	Incr./ms	32767	Correction width (ramp for angle compensation) The increments for the angle compensation in the case of mark synchronisation are specified in the Lenze setting with downstream 3rd-order polynomial.
	Lenze setting: 100 incr./ms			

3.4.5

Step 5: Go online and transfer parameter set to the inverter

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.

3.5

Enabling the interconnection and specifying the speed setpoint

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

- ▶ [Pre-assignment of the user interface for the master drive \(14\)](#)
- ▶ [Pre-assignment of the user interface for the slave drive \(17\)](#)

3.6 (Optionally): Setting the 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 parameter changes carried out with mains failure protection in the memory module implemented! (C00002/11 = "1: on/start")

3.6.1 Optimisation parameters for the master drive

The following parameters have already been set in step 4. However, depending on the application it may be required to change the settings again during operation:

Parameter (Block)	Possible settings			Info
Settings for main setpoint via MCI interface or analog input 1				
C00012 (L_NSet_1)	0.000	s	999.999	Acceleration time - main setpoint • Not relevant if multi-encoder is set as speed setpoint source in C00470/2.
	Lenze setting: 2.000 s			
C00013 (L_NSet_1)	0.000	s	999.999	Deceleration time - main setpoint • Not relevant if multi-encoder is set as speed setpoint source in C00470/2.
	Lenze setting: 2.000 s			
"Electrical shaft STOP" function				
C01040/1 (L_SRFG_1)	0.001	s	999.999	Linear ramp time for Electrical Shaft STOP • $t_{\text{ramp}} = C01040/1 * \text{speed} [\%] + C01041/1$
	Lenze setting: 0.5 s			
C01041/1 (L_SRFG_1)	0.001	s	50.000	S-ramp time for Electrical Shaft STOP
	Lenze setting: 0.1 s			

3.6.2 Optimisation parameters for the slave drive

Parameter (Block)	Possible settings			Info
Following error monitoring system				
C00254 (LS_MotorInterface)	0.00	1/s	500.00	Kp position controller • Gain for following error compensation
	Lenze setting: 5.00/s			
C01215/1 (LS_MotionControl Kernel)	0.0001	units	214748.3647	Limit for following error monitoring 1 • The setting "0" deactivates following error monitoring 1
	Lenze setting: 5.0000 units			
C01215/2 (LS_MotionControl Kernel)	0.0001	units	214748.3647	Limit for following error monitoring 2 • The setting "0" deactivates following error monitoring 2
	Lenze setting: 10.0000 units			

4

Detailed functions of the technology application

4.1

Basic drive functions (MCK)

**Danger!**

During homing, manual jog, and positioning, specially assigned profile parameters are active. If they have not been set correctly, the drive may carry out an unexpected movement!



Detailed information relating to the basic drive functions and the corresponding parameters can be found in the reference manual/online help of the inverter in the "Basic drive functions (MCK)" chapter.

4.1.1

Homing

In some applications it is required that the master and slave drive are aligned with each other before the actual synchronous operation starts. This can for instance be effected by homing or a reference search. This so-called "homing" is usually carried out after mains connection. Furthermore, homing after the elimination of an encoder error is required.

**Note!**

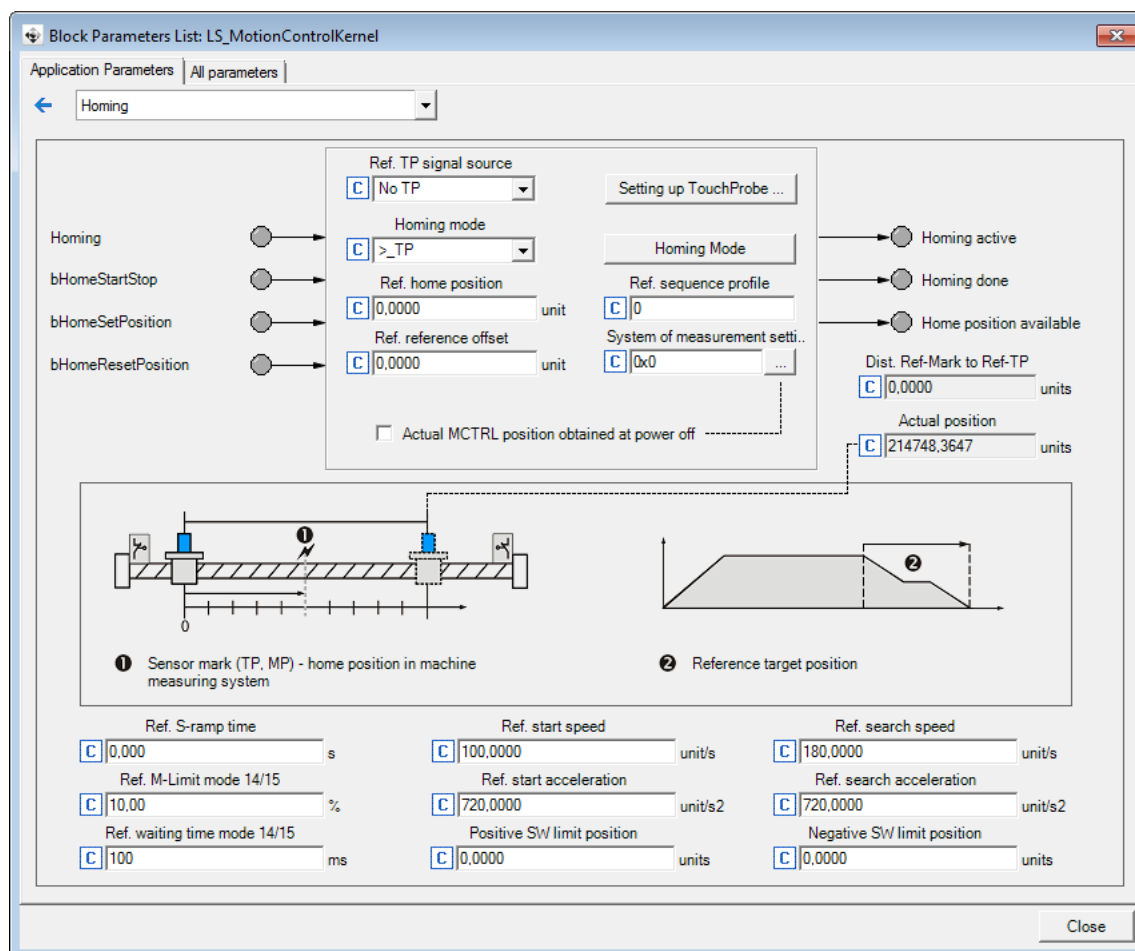
Depending on the configuration of the master drive, the slave will follow the master during a homing process, or it won't. Therefore it depends on the application whether it is reasonable to, for example, first reference the master and then the slave. If the slave is not to follow the master during the homing process, quick stop (QSP) is to be activated for the slave.

- "Manual" start/stop of the homing process is executed via bit 6 of the application control word (FB `L_ConvBitsToWord_1`).
 - In the case of the master, this bit is linked with digital input DI1 in the default setting.
 - In the case of the slave, this bit is linked with digital input DI6 in the default setting.
- Homing is to be configured according to the requirement of the application, as described in the reference manual/online help of the inverter.
- If the home position is known to the drive, a response is sent via digital output DO3 and bit 15 of the MCI process data output word 1.



How to go to the parameterisation dialog of the basic "Homing" function:

1. Open the parameter list for the **LS_MotionControlKernel** SB.
2. In the *Block Parameters List...* dialog box on the **Application Parameters** tab, select the "Homing" entry in the upper list field.



Note!

For a reference search with touch probe detection:

If the reference signal is to follow a real touch probe, the touch probe interface must be configured accordingly via the **Setting up TouchProbe...** button!

Parameter	Info	Lenze setting	
		Value	Unit
C01221	MCK: Homing mode	8: >_TP	
C01224/1	MCK: Ref. initial speed	100.0000	unit/s
C01225/1	MCK: Ref. initial acceleration	720.0000	unit/s ²
C01224/2	MCK: Ref. search speed	180.0000	unit/s
C01225/2	MCK: Ref. search acceleration	720.0000	unit/s ²
C01226/1	MCK: Ref. S-ramp time	0.000	s

Parameter	Info	Lenze setting	
		Value	Unit
C01222	MCK: Ref. M limit mode 14/15	10.00	%
C01223	MCK: Ref. waiting time mode 14/15	100	ms
C01227/1	MCK: Ref. offset reference degree	0.0000	unit
C01227/2	MCK: Ref. home position	0.0000	unit
C01228	MCK: Ref. sequence profile	0	
C01229/1	MCK: Positive SW limit position	0.0000	units
C01229/2	MCK: Negative SW limit position	0.0000	units
C01246/1	MCK: Ref. TP signal source	0: No TP	

4.1.2 Manual jog

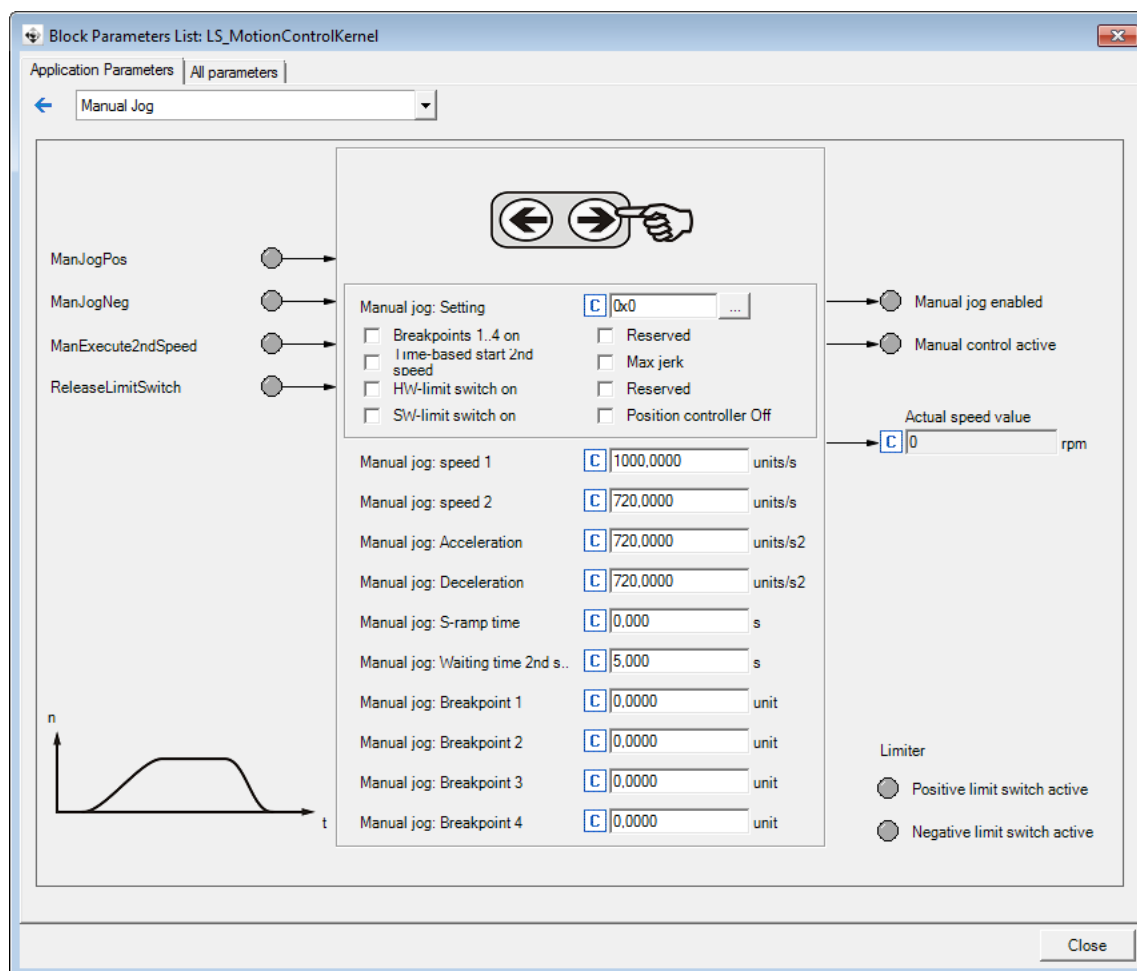
In this operating mode, the drive can be traversed manually in a clockwise or anticlockwise direction ("jogging mode").

- The basic "Manual jog" function is activated via bit 12 and bit 13 of the application control word (FB **L_ConvBitsToWord_1**).
 - In the case of the master, these two bits are linked with digital inputs DI5 and DI6 in the default setting.
 - In the case of the slave, these two bits are linked bit 12 and bit 13 of the MCI process data input word 1 in the default setting.



How to go to the parameterisation dialog of the basic "Manual jog" function:

1. Open the parameter list for the **LS_MotionControlKernel** SB.
2. In the *Block Parameters List...* dialog box on the **Application Parameters** tab, select the "Manual Jog" entry in the upper list field.



Parameter	Info	Lenze setting	
		Value	Unit
C01230	MCK: Manual jog setting	Bit coded	
C01231/1	Manual jog: speed 1	1000.0000	units/s
C01231/2	Manual jog: Speed 2	720.0000	units/s
C01232/1	Manual jog: Acceleration	720.0000	units/s²
C01232/2	Manual jog: Deceleration	720.0000	units/s²
C01233/1	Manual jog: S-ramp time	0.000	s
C01235/1	Waiting time 2nd speed	5.000	s
C01234/1	Manual jog: Breakpoint 1	0.0000	unit
C01234/2	Manual jog: Breakpoint 2	0.0000	unit
C01234/3	Manual jog: Breakpoint 3	0.0000	unit
C01234/4	Manual jog: Breakpoint 4	0.0000	unit

4.1.3 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!

In order to ensure that the brake is not released unintentionally while the application is transferred to the inverter, we recommend unplugging the brake connector X107 during the transfer.



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.
- In the "Homing" and "Manual jog" operating modes, the holding brake is released automatically by the MCK. In the "Speed follower" operating mode, release of the brake is effected by the application. For the master by the **L_DigitalLogic5_1** FB, for the slave by FBs **L_Or5_2** and **L_Not_2**.
- For the slave drive, the switching threshold for releasing the brake is set in C02581/1.

4.2 Functions in the master drive

4.2.1 Selection of the setpoint signal for the slave drives

For the speed/position output to the slave drives, SB **LS_AxisBusOut** is provided in the master application.

- In the default setting, the speed setpoint integrated to an angle (path) is output via line data words 1 & 2, and the speed setpoint is output via line data word 3.
- A slave drive connected via axis bus with the "Electrical Shaft Slave" technology application is executable immediately after the initialisation of the axis bus if no fault is pending.
 - If a fault is pending in the slave drive, the cause of which, however, has been eliminated, this error can be reset via reset of the master.
- If the drive is to be used as master for a slave drive with the "Position Follower" technology application, set the value "1" in C00470/4. Then, instead of the speed integrated, the current position is output via axis bus.



Stop!

If operation as master position follower is switched on (C00470/4 = "1"), homing of the master causes a step for the slave position follower if the current position is set to the home position!

Remedy: Inhibit the slave position follower when you reference the master!

The signal to be output via axis bus is selected using C00470/4...6:

C00470/4		C00470/6		C00470/5		Axis bus output
Operation as position follower master		Selection of master value/ actual speed		Selection of mere master value		
0	Off	0	Master value	0	Mere master value	Line data words 1 & 2 = speed setpoint integrated to an angle (path) Line data word 3 = speed setpoint
				1	Master value	Line data words 1 & 2 = speed setpoint integrated to an angle (path) from the MCK Line data word 3 = speed setpoint from the MCK
		1	Actual speed			Line data words 1 & 2 = current speed integrated to an angle (path) Line data word 3 = current speed
1	On					Line data words 1 & 2 = current position Line data word 3 = current speed

Details on the signal flow

Switch-over between the different setpoint signals for the slave drives is effected via FBs **L_SignalSwitch_2...4**.

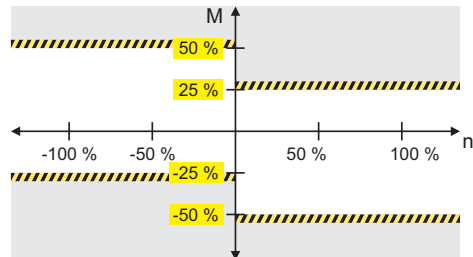
In the default setting C00470/4 = 0, the position value for SB **LS_AxisBusOut** is generated with the **L_PhaseIntK_1** FB. Loading or a reset is not required, since in the slave drive merely consistency with the speed value is compared without attaching importance to the absolute value.

With the setting C00470/4 = 1 (operation as master position follower), as position value for SB **LS_AxisBusOut** the current position *dnMotorPosAct_p* is used by the **LS_MotorInterface** SB.

4.2.2 "Electrical shaft STOP" function

When the "Electrical shaft STOP" function is activated in the master, all slave drives enabled remain synchronous, since this function has a direct impact on the master value path. When the "Quick stop (QSP)" function is activated in the master, however, it depends on the setting in C00104/1 whether the drive is brought to a standstill in an angle-controlled manner or not.

A further characteristic of the "Electrical shaft STOP" function is that a torque limitation which is possibly set via the following parameters is continued to be taken into consideration:

Parameter (Block)	Possible settings			Info
Torque limitation in motor mode/in generator mode				
The torque limitation set is always active.				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)			



Tip!

Depending on the application, the "Electrical Shaft Stop" function can be used for an operation stop, and the "quick stop (QSP)" function for an emergency stop.

4.3 Functions in the slave drive

4.3.1 Mark synchronisation/TP correction

For a mark synchronisation/TP correction, FB **L_DFSET_1** is provided to the slave application. This FB enables the slave drives to synchronise to the master in a "flying" manner.

Preconditions for a mark synchronisation

- The mark synchronisation is switched on (C00470/3 = "1: True").
- The touch probe sensor for the mark synchronisation of the slave drive is connected to digital input DI4.
- The master pulse for the mark synchronisation is connected to digital input DI5.

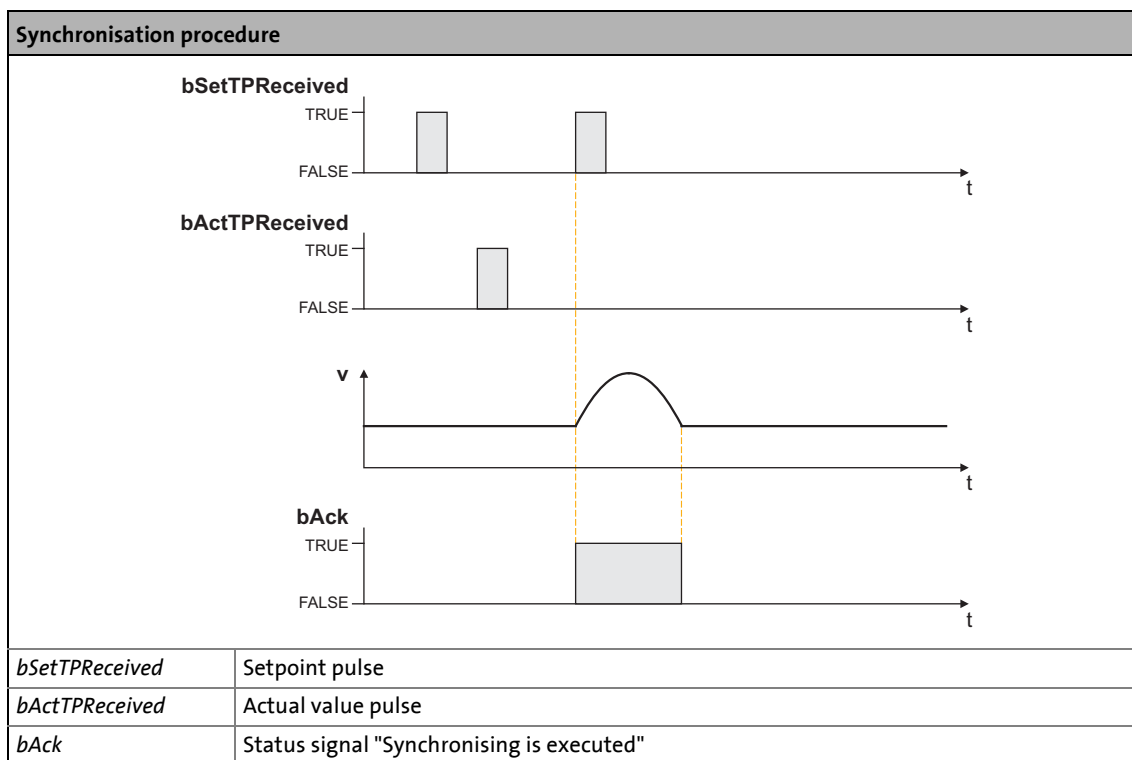
Operating mode

For the synchronisation, the slave drive needs a cyclic or one-time pulse generated by the master drive and provided by digital input DI5. This "setpoint pulse" is either the zero pulse of the master feedback, or the edge of a touch probe sensor. Via the setpoint pulse, the drive position of the master drive is communicated to the slave drive.

In addition, digital input DI4 must provide the slave drive with an "actual value pulse" from a touch probe sensor, recording the marks.

Only if FB **L_DFSET_1** receives both signals, it can execute a synchronisation!

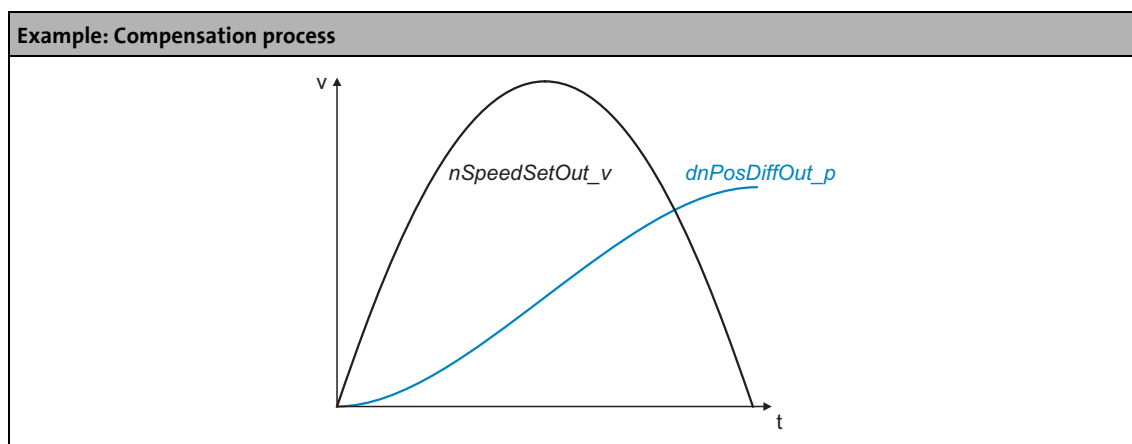
In the synchronisation mode "2" that is preset in C01075/1, a full synchronisation including a correction by the shortest path is executed when the mark synchronisation is switched on (C00470/3 = "1: True"). The synchronisation is only carried out when two setpoint pulses have been received (pulse sequence required: setpoint - actual - setpoint):



Compensation process

At the input of the second setpoint or actual value pulse, the difference between the master and slave position is determined. This difference is then transferred via the speed output *nSpeedSetOut_v* as an additive offset to the **Motion Control Kernel**. The compensating movement is smoothened by means of a polynomial.

The following illustration shows a compensating process after the marks have been detected. The speed is added here as a parabola to the line speed. (The scaling in this diagram does not correspond to reality)



Detailed information about the **L_DFSET_1** FB can be found in the reference manual/online help of the inverter in the "Function library" chapter.

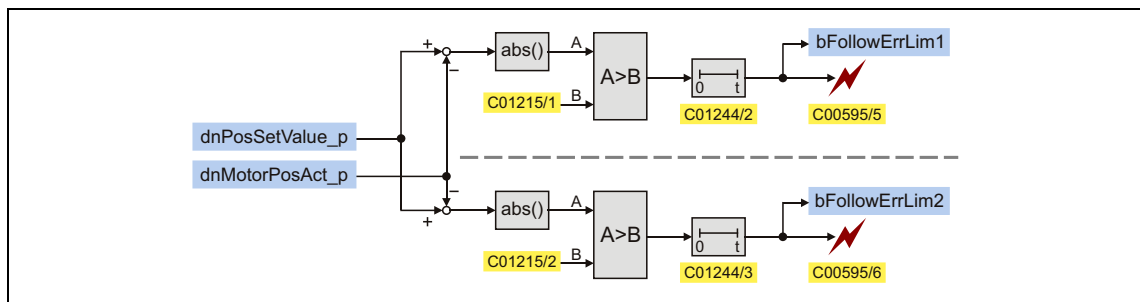
4.4 Monitoring functions

4.4.1 Following error monitoring system

The difference between set position and actual position is called the following error. Ideally, the following error should be "0". The set position is created by the internal definition of the traversing profiles of the **Motion Control Kernel**. The actual position is created by the integration of the speed supplied by the position encoder. If the position control is adjusted optimally, only a minimum following error arises which is always compensated dynamically and not increases continuously.

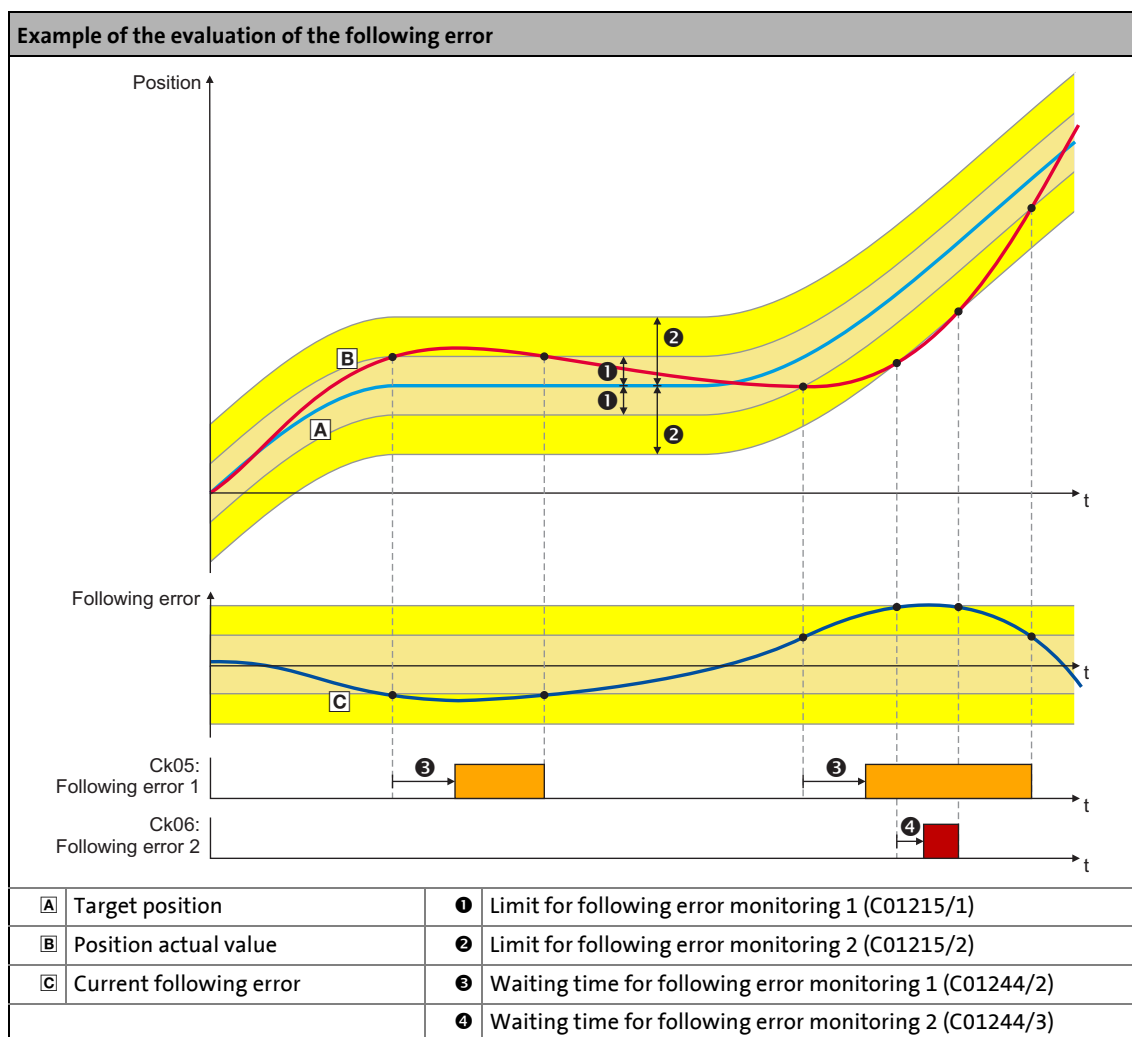
Certain processes, however, require that a defined limit as a difference between set position and actual position is not exceeded. If it is exceeded, it may have been caused by a mechanical blocking in the machine and the system part is not situated at the position defined at that time. In such a case, it makes sense to activate the "Fault" error response to make the motor torqueless.

In the 8400 TopLine controller, two independent following error monitoring systems can be parameterised:



[4-1] Two-channel following error monitoring system

Parameter (Block)	Possible settings			Info
C01215/1 (LS_MotionControl Kernel)	0.0001	units	214748.3647	Limit for following error monitoring 1 • The setting "0" deactivates following error monitoring 1
	Lenze setting: 5.0000 units			
C01215/2 (LS_MotionControl Kernel)	0.0001	units	214748.3647	Limit for following error monitoring 2 • The setting "0" deactivates following error monitoring 2
	Lenze setting: 10.0000 units			
C01244/2...3 (LS_MotionControl Kernel)	0	ms	600000	Waiting time for following error monitoring 1 & 2 • In order to avoid that an error is triggered by acceleration and a narrow tolerance limit can be nevertheless monitored at standstill in the target, the response of the following error monitoring system can be delayed by setting a waiting time.
	Lenze setting: 0 ms			
C00595/5...6 (LS_SetError_1)				Response at the activation of following error monitoring • Subcode 5: response at the activation of following error monitoring 1. • Subcode 6: response at the activation of following error monitoring 2.
	0	No Reaction		
	1	Fault		
	3	TroubleQuickStop		
	4	WarningLocked		
	5	Warning		
	6	Information		



The above example clearly shows that there are two monitoring functions acting independently of each other. Normally, one following error monitoring function with a low tolerance is set as warning, and the other with a higher tolerance is set as TroubleQuickStop.

By means of the waiting times (C1244/2 and C1244/3), the error responses can be delayed, so that disconnection does not result immediately when the following error limits are temporarily exceeded. This "switch-on delay" makes it possible to effectively distinguish between dynamic processes and actual error states such as mechanical obstacles or sluggishness.

4.4.2 Limit position monitoring

For safety reasons, drives with a limited traversing range must always be made safe using corresponding safety mechanisms. These are firstly the hardware limit switches, which must effect a standstill of the axes as quickly as possible during the approaching process. In addition, the parameterisable software limit positions are to inhibit all travel commands which would entail an exit of the permissible travel range.



Note!

In the two technology applications "Electrical Shaft Master" and "Electrical Shaft Slave", an evaluation of hardware limit switches is not prepared by default yet, but it can be retrofitted in a few steps if required (see "[Hardware limit switch](#)" subchapter).

Take the following items into consideration for placing the limit positions:

- The hardware limit switches must be mounted with a sufficient clearance in front of the mechanical limit positions of the linear axis. The clearance to the mechanical limit position should be calculated for a quick stop (QSP) from maximum speed, so that in the event of an error, standstill is attained safely before the mechanical limit position is reached.
- The software limit positions must be placed with a sufficient distance from the hardware limit switch positions. The distance should be calculated for a quick stop (QSP) from maximum speed without the hardware limit switches being approached.

4.4.2.1 Hardware limit switch

For an evaluation of hardware limit switches, the two digital inputs in the function block editor that are used for the connection of the hardware limit switches have to be connected to the monitoring inputs *bLimitSwitchNeg* and *bLimitSwitchPos* of the **LS_MotionControlKernel** system block.

The following example exemplarily shows the connections required if the negative limit switch is connected to digital input DI1 and the positive limit switch is connected to digital input DI2:

1. **LS_DigitalInput.bIn1** → **LS_MotionControlKernel.bLimitSwitchNeg**
2. **LS_DigitalInput.bIn2** → **LS_MotionControlKernel.bLimitSwitchPos**



Stop!

The connection of the limit switch signals must be executed in a fail-safe fashion:

- LOW level = limit switch approached (activated)
- HIGH level = limit switch not approached (not activated)

To obtain this switching logic, the level inversion for the two digital inputs to which the limit switches are connected has to be activated in C00114!

The limit switches are only evaluated if the limit switches for the respective operating mode have been activated (see the following table)!

Operating mode	Hardware limit switch effective
Speed follower	Yes (adjustable in C01219 - bit 2)
Homing	Depending on the homing mode selected (see description of the homing modes in the reference manual/online help of the inverter)
Manual jog	No (adjustable in C01230 - bit 2)

Operating mode	Hardware limit switch effective
Positioning	Yes
Stop	Yes
Position follower	Yes (adjustable in C01218 - bit 2)

Parameter (Block)	Possible settings	Info
C00595/1...2 (LS_MotionControl Kernel)	0 No Reaction	Response at the activation of limit position monitoring • Subcode 1: response at the approach of the positive limit switch. • Subcode 2: response at the approach of the negative limit switch.
	1 Fault	
	3 TroubleQuickStop	
	4 WarningLocked	
	5 Warning	
	6 Information	

Behaviour when hardware limit switches are active

If one of the two monitoring inputs is set to TRUE, in the Lenze setting the "TroubleQuickStop" error response is triggered: Irrespective of the setpoint selection, the drive is brought to a standstill in the deceleration time set for the quick stop function. Depending on the error response parameterised, the drive can then only be traversed again after the error has been acknowledged.

4.4.2.2 Software limit positions

The parameterisable limit positions are used by the software to limit the traversing range.



Stop!

The software limit positions are only evaluated and monitored if the home position is known to the drive and the software limit positions for the respective operating mode have been activated (see following table)!

Operating mode	Software limit positions active (if home position is known)
Speed follower	Yes (adjustable in C01219 - bit 3)
Homing	Yes
Manual jog	Yes (adjustable in C01230 - bit 3)
Positioning	Yes
Position follower	Yes (adjustable in C01218 - bit 3)

Parameter (Block)	Possible settings	Info
C01229/1...2 (LS_MotionControl Kernel)	-214748.3647 units 214748.3647	Positive and negative software limit position for limiting the valid traversing range • The positive software limit position must be set to a greater value than the negative software limit position!
	Lenze setting: 0.0000 units	

Parameter (Block)	Possible settings	Info
C00595/3...4 (LS_MotionControl Kernel)		Response at the activation of limit position monitoring • Subcode 3: response at overtravelling the positive software limit position (C01229/1). • Subcode 4: response at overtravelling the negative software limit position (C01229/2).
	0 No Reaction	
	1 Fault	
	3 TroubleQuickStop	
	4 WarningLocked	
	5 Warning	
	6 Information	

Behaviour in the case of active software limit positions



Note!

The "travel commands" mentioned in the following description are no speed setpoint selections. In the "Speed follower" and "Position follower" operating modes, an acknowledged software limit position error ensures that traversing to the impermissible travel range remains possible afterwards. This is because in these two operating modes, there is no preview of whether a software limit position is approached with a setpoint selection.

If the software limit positions are active, travelling commands that would result in the exit from the permissible travel range can no longer be executed.

If the drive is already outside the permissible travel range and the software limit positions have been activated, only travel commands that result in the drive moving back into the permissible travel range can be executed.

If the software limit positions are active, and one of the software limit positions is overtravelled, in the Lenze setting the "TroubleQuickStop" error response is triggered: Irrespective of the setpoint selection, the drive is brought to a standstill in the deceleration time set for the quick stop function. Depending on the error response parameterised, the drive can then only be traversed again after the error has been acknowledged.

4.4.3 Bus monitoring

When an "electrical shaft" is executed via axis bus, or generally via a bus system, one always has to expect data transmission errors, for example due to EMC interference. In order to prevent a mechanical offset of the drives in the case of even a temporary fault, the **L_Interpolator_1** FB is used in the slave application. This FB is provided with an internal correction mechanism which arranges for an automatic offset correction if a data telegram is missing. Like this, the axis bus monitoring time (C02431/3) can be set to an insensitive value, so that a very robust transmission system is created.

Parameterisation of the error handling:

Parameter	Possible settings			Info
C00591/1				Resp. to axis bus data error • Response in the case of an accumulation of data errors
	0	No Reaction		
	1	Fault		
	2	Trouble		
	3	TroubleQuickStop		
	4	WarningLocked		
	5	Warning		
	6	Information		
C00591/2				Resp. to axis bus IO error • Response in the case of an I/O error ("release cord" function)
	0	No Reaction		
	1	Fault		
	2	Trouble		
	3	TroubleQuickStop		
	4	WarningLocked		
	5	Warning		
	6	Information		
C02431/3	0	ms	65000	Axis bus monitoring time
	Lenze setting: 1000 ms			Tolerance time before the data error is triggered
C02444/1				Axis bus configuration
	Bit 0	Edge detection SetFail		1 ≡ input <i>bSetFail_DigOut</i> is edge-sensitive. 0 ≡ input <i>bSetFail_DigOut</i> is level-sensitive.
	Bit 1	Reserved		Not relevant for bus monitoring
	...	Reserved		
	Bit 13	Reserved		
	Bit 14	same CobId for all Cas		
	Bit 15	500 kbps		



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:

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Thank you for your support.

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