

8400

"Position Follower" technology application
for 8400 TopLine C



Software manual

EN



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1

About this documentation

This documentation describes the software-based solution of a task. The transferability of the described solution to the respective application 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 "Position Follower" 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
Position Follower	1.0

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	 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".
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. Ein Funktionsbaustein (kurz: "FB") kann mit einer integrierten Schaltung verglichen werden, die eine bestimmte Steuerungslogik enthält und bei der Ausführung einen oder mehrere Werte liefert. 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 "Position Follower" technology application represents a configuration for a slave drive and is used in applications in which one or several 8400 TopLine inverters have to be traversed synchronously to each other in terms of their position.

The axis bus (X10) is used as transmission medium. If required, a modification to "CAN on board" system bus (X1) or digital frequency coupling (X8) can be effected without high cost. ▶ [Master value selection options for the slave position follower](#) (□ 27)

The core function comprises a slave drive which follows a master drive with accuracy in terms of position. In addition to the "Electrical shaft" function, the application contains a function for positioning to the master position ("Lock to master") as well as all basic drive functions required (homing, manual jog, position follower, holding brake control).

The "Position Follower" technology application is primarily aimed at master/slave systems with limited traversing ranges like for example lifting platforms and Gantry axes, since these systems require absolute position synchronism.



Note!

Systems with modulo measuring systems such as printing units, cross cutters, draw rollers, chain conveyors, etc. are currently not supported by the technology application. Use the "Electrical Shaft Master" and "Electrical Shaft Slave" technology applications for applications of these types.



Tip!

Each master drive is provided with the "Position Sequencer" and "Electrical Shaft Master" technology applications.

2.1

Functional overview

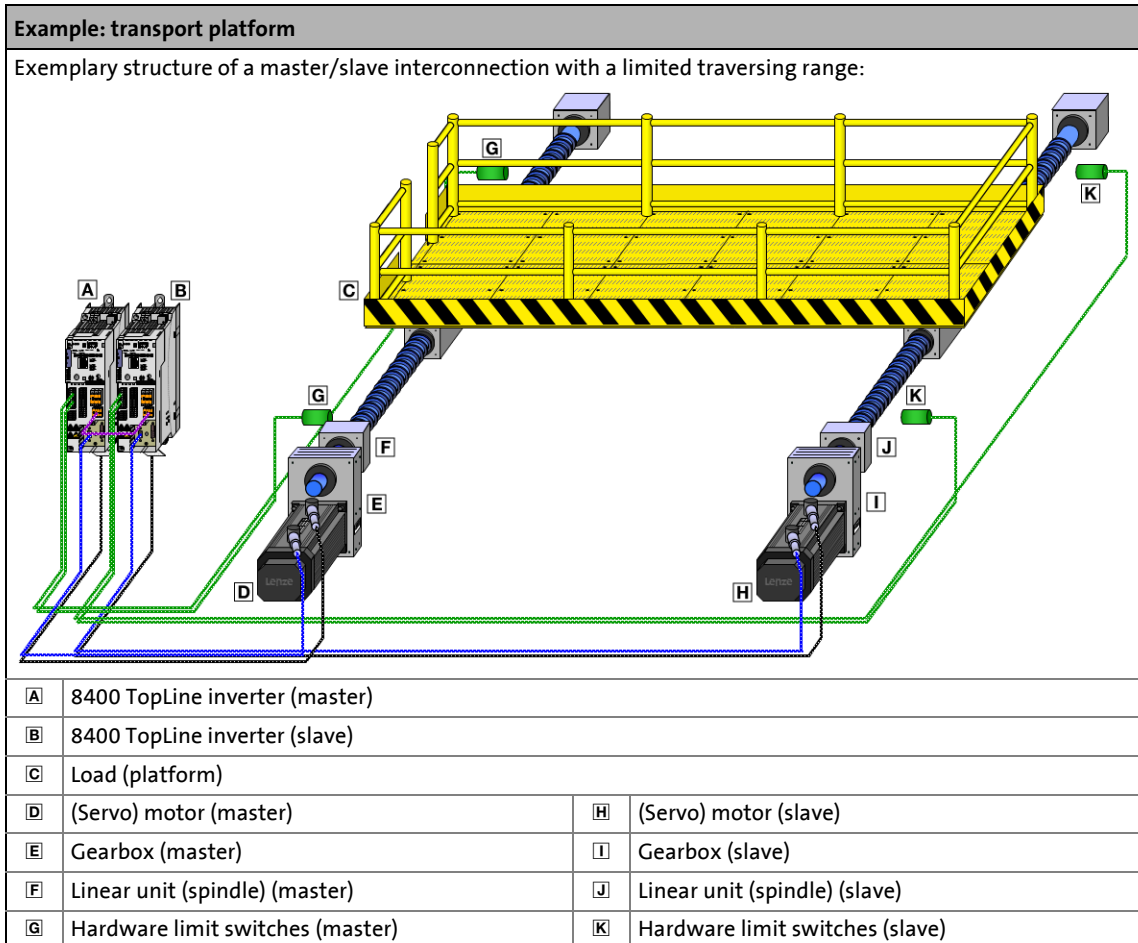
- Electrical shaft in line topology (all slave drives receive the same master position)
- Transfer of the master position via axis bus
- 1 master drive and up to 61 slave drives
- Adjustable synchronism factor
- "Lock to master" function: automatic straightening of the slave axis when position follower mode is selected
- Superimposition of a position offset with continuous coupling via ramp generator (Y offset)
- Use of the state machine of the Motion Control Kernel (MCK) and the following basic drive functions:
 - Homing
 - Manual jog
 - Position follower
 - Holding brake control
- Limit position monitoring (hardware limit switches and software limit positions)
- Following error monitoring system
- Control/status signals optionally via digital terminals and fieldbus interface (MCI)

2 Features of the technology application

2.2 Application ranges

2.2 Application ranges

- Gantry cranes
- Gantry axes
- Lifting platforms
- ...



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

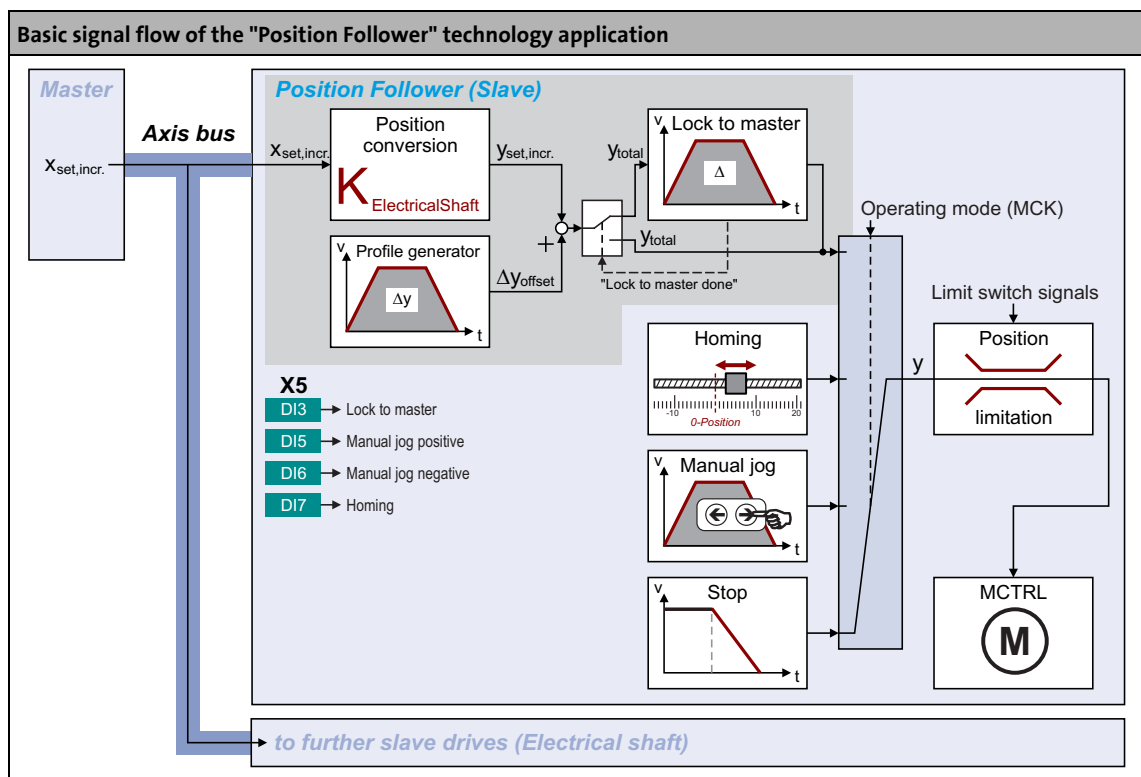
Product	Order designation	from hardware version	from software version
Inverter Drives 8400 TopLine C	E84AVTCxxxxx	VD	13.00

2.4

Basic signal flow

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

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



2.5

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".

2.6 Pre-assignment of the user interface

2.6.1 Pre-assignment of the I/O terminals

Terminal	Function		
Digital input terminals			
X5/RFR	Controller enable		
	RFR	Function	
	LOW	Inhibit drive	
	HIGH	Enable drive	
X5/DI1	- (reserved for HTL encoder)		
X5/DI2	- (reserved for HTL encoder)		
X5/DI3	Switch on position follower operation ("Lock to master") • Only possible when the controller is enabled and the home position is known.		
	DI3	Function	
	LOW	The drive unlocks from the electrical shaft and runs to a standstill ("Stop" state) along the stop ramp C01251/1.	
	HIGH	The drive positions to the master position (electrical shaft) and then follows it directly.	
	Note! The electrical shaft interconnection must only be cancelled at standstill and must be re-established before the drive axes are restarted. Otherwise the system runs askew. Provide for corresponding locking in the higher-level control!		
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	Start homing (only possible with controller enable)		
	DI7	Function	
	LOW	Interrupt/stop homing	
	LOW↗HIGH	Start homing	
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	HIGH $\equiv$ "Drive is ready" state
X4/DO2	HIGH $\equiv$ "Position follower operation active" state ("Lock to master done")
X4/DO3	HIGH $\equiv$ "Home position is known" state
X107/BD1, BD2	Control of a holding brake by the basic function "holding brake control"
X101/COM, NO	Relay contact closed $\equiv$ "An error is pending" state
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)

2.6.2 Process data input words

Fieldbus interface (MCI); LP_MciIn port block

Input words	Assignment
Words 1 ... 16	- (not preconfigured)

2.6.3 Process data output words

Fieldbus interface (MCI); LP_MciOut port block

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)
Words 3 ... 4	Actual position value • Scaling: 65536 [increments] $\equiv$ 1 encoder revolution (position encoder)
Word 5 ... 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	1 ≡ position follower operation switched on																																																																														
Bit 15	1 ≡ Home position is known																																																																														

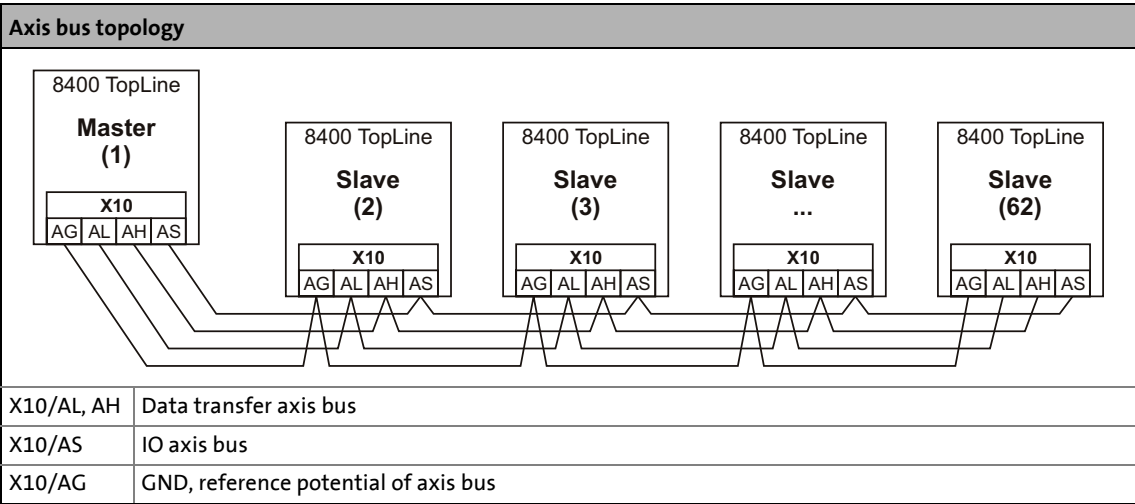
3 Short setup of the technology application

3.1 Hardware structure required

3 Short setup of the technology application

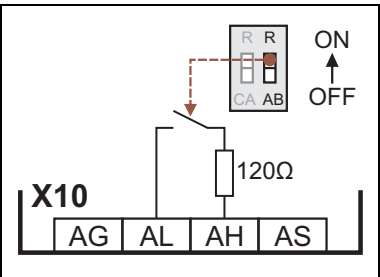
3.1 Hardware structure required

The "Position Follower" 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 switching on: Make sure that the inverter is inhibited (digitale input terminal X5/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.
 - Execute the commissioning wizard right to the end.
 - You can skip the "Control mode" step by clicking **Next** (only relevant for "Speed actuating drive" technology application).

3.3 Short setup of the master drive

Each master drive is provided with the "Position Sequencer" and "Electrical Shaft Master" technology applications.

- With the "Position Sequencer" technology application, the drive can execute parameterisable travel profiles. The program flow is defined on the basis of a sequence table.
- 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.



Note!

The commissioning process for the master drive is described in the documentation for the corresponding technology application and is not part of this documentation.

The following subchapters only contain notes regarding the commissioning of the master drive.

3.3.1 Configuration of the speed/position output in the master drive

For the speed/position output to the slave drives, the **LS_AxisBusOut** SB is provided in the two "technology applications Position Sequencer" and "Electrical Shaft Master".

- 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.
- For optimum interaction with a slave position follower, set the value "1" for the master in C00470/4. Then the current position instead of the integrated speed is output via the axis bus.



Stop!

If operation as master position follower is switched on in the master (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 are referencing the master!

If you are using an individual application in the master drive, provide for a suitable signal interconnection of the **LS_AxisBusOut** SB!

Configuration options of the speed/position output in the master drive

"Position Sequencer" technology application:

C00470/4		C00470/2		-	Axis bus output
Operation as position follower master		Selection setpoint/actual value			
0	Off	0	Setpoint	-	Line data words 1 & 2 = speed setpoint integrated to an angle (path) Line data word 3 = speed setpoint
		1	Actual value	-	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

"Electrical Shaft Master" technology application:

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

3.3.2 Setpoint retention in the master drive

In order to eliminate signal propagation delays of the electrical shaft via axis bus, a setpoint retention for the master drive can be set in C01239. The setpoint retention provides for a delay of the setpoints in the master drive.

If the setting in C01239 corresponds to the actual runtime of the signal from the master drive to the slave position follower, the setpoints in the master and slave are executed simultaneously, and no speed-dependent position offset will occur.

Parameter	Possible settings			Info
C01239	0	ms	32	Setpoint holding
	Lenze setting: 0 ms			

3 Short setup of the technology application

3.4 Short setup of the slave drive

3.4 Short setup of the slave drive

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

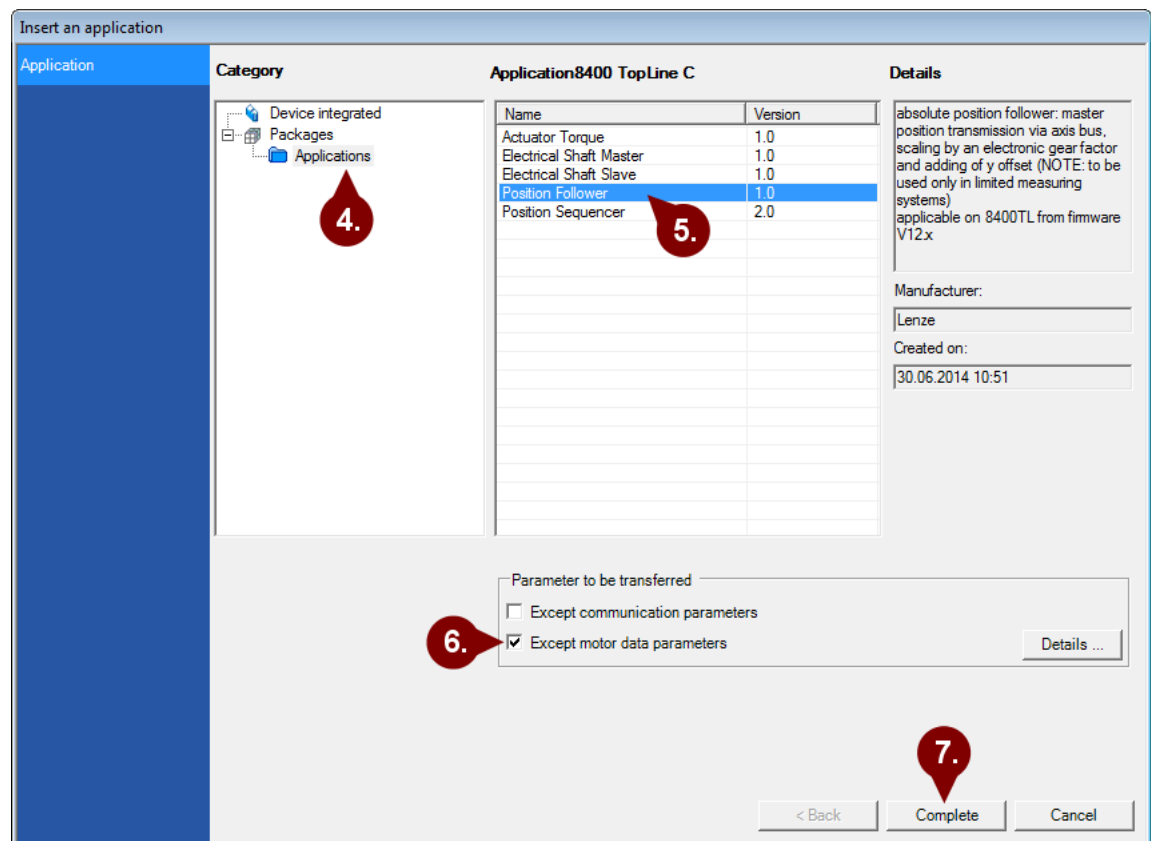
3.4.1 Step 1: Load "Position Follower" technology application

In the Lenze setting, the inverter uses the "Speed actuating drive" technology application integrated in the device. Execute the following steps to use the "Position Follower" 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. In the right field, select the "Position Follower" 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 prompt on whether the current application is to be replaced by the "Position Follower" application with **Yes**.

3.4.2 Step 2: Axis bus settings

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.



Note!

For synchronisation of the master and slave, the axis bus IO line is used.
The **LS_AxisBusIO** SB must therefore not be utilised by the user in the application!

3.4.3 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. If functions are to be controlled via the fieldbus interface (MCI), the user interface (area highlighted in turquoise) has 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.



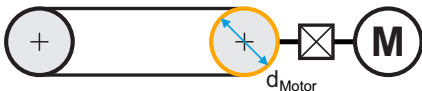
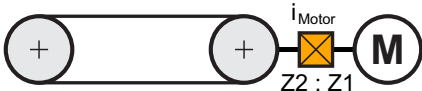
Tip!

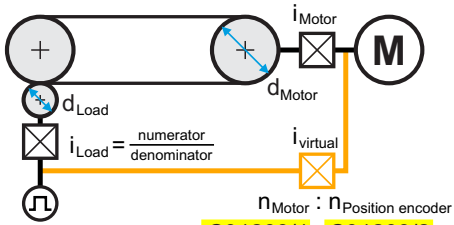
Control via the integrated CANopen interface ("CAN on board") can also be attained by means of simple interconnection changes. For this purpose, the **LP_CanIn** port block has to be inserted in the interconnection and connected to the corresponding inputs of the user interface.

3.4.4 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				
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: C01204 = π * d_{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) $i_{\text{Motor}} = \frac{\text{C01202/1}}{\text{C01202/2}} = \frac{Z2}{Z1}$ • Schematic diagram of a conveyor drive:  C01202/1 : 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 Lenze setting: 1:1	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:  $i_{\text{virtual}} = \frac{\text{C01203/1}}{\text{C01203/2}} = \frac{i_{\text{Motor}}}{i_{\text{load}}} \cdot \frac{\pi \cdot d_{\text{load}}}{\pi \cdot d_{\text{Motor}}}$ $i_{\text{virtual}} = \frac{\text{C01202/1}}{\text{C01202/2}} \cdot \frac{\text{denominator}}{\text{numerator}} \cdot \frac{\pi \cdot d_{\text{load}}}{\text{C01204}}$ - The "virtual" speed ratio can be calculated as follows:
Electrical shaft function (measuring system conversion)		
Use the following parameters to specify the electrical shaft factor $K_{\text{ElectricalShaft}}$ for the conversion of the incremental master position to an incremental setpoint position for the slave.		
Basics with regard to the calculation can be found in the "Electrical shaft function (measuring system conversion)" chapter. (38)		
C00471/3..4 (LS_ParFree)	0 Lenze setting: 1:1	Electrical shaft factor $K_{\text{ElectricalShaft}}$ - Set the factor with mathematical precision in the two subcodes: - Subcode 3: numerator term - Subcode 4: denominator term (is only evaluated in terms of value) Note: Values greater than 32767 are interpreted as negative values according to the so-called two's complement. The effective value is calculated on the basis of the formula $\text{C0471/x} - 2^{16}$. Example: The setting "65535" is internally considered as the value $65535 - 2^{16} = -1$.

Parameter (Block)	Possible settings (Lenze setting printed in bold)			Info
Y offset (shift of the slave position follower setpoint position with regard to the master position)				
C00475/1 (LS_ParFreeUnit_1)	-214748.3647	units	214748.3647	Y offset
	Lenze setting: 0.0000 units			
When the y offset is changed during position follower operation, the following parameters are to be set:				
C01060/2 (L_PosCtrlLin_1)	0.010	s	130.000	Acceleration ramp
	Lenze setting: 10 s			
C01060/3 (L_PosCtrlLin_1)	0.010	s	130.000	Deceleration ramp
	Lenze setting: 10 s			
C01061/1 (L_PosCtrlLin_1)	-15000	rpm	15000	Forward motion (positive speed) • The value is only evaluated with regard to its amount.
	Lenze setting: 50 min-1			
C01061/2 (L_PosCtrlLin_1)	-15000	rpm	15000	Return motion (negative speed) • The value is only evaluated with regard to its amount.
	Lenze setting: 50 min-1			
Following error monitoring system				
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: 500 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: 1000 units			
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			
Limit position monitoring				
C01229/1...2 (LS_MotionControl Kernel)	-214748.3647	units	214748.3647	Positive and negative software limit position for limiting the valid traversing range • Subcode 1: Positive software limit position • Subcode 2: Negative software limit position Note: The software limit positions are only evaluated if • the home position is known to the drive, and • the software limit positions for the respective operating mode have been activated, and • the positive software limit position is set to a greater value than the negative software limit position!
	Lenze setting: ±100000.0000 units			

3.4.5 Step 5 (optional): Connection of limit switch signals



Note!

In der "Position Follower" technology application, no evaluation of hardware limit switches is prepared by default yet. However, if required, an evaluation can be retrofitted by means of only a few steps.

► [Limit position monitoring](#) (📖 48)

3.4.6 Step 6: 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.

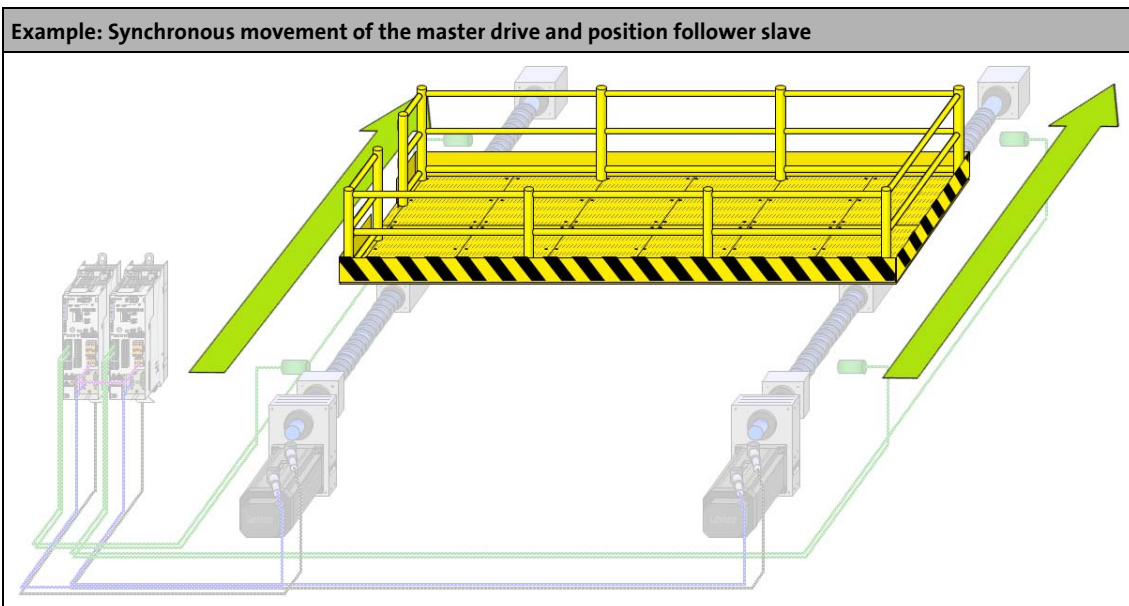
3.5 Approaching the drive system (terminal control)

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

► [Pre-assignment of the user interface](#) (11)

How to proceed:

1. Enable position follower slave (set X5/RFR to HIGH level).
2. If the home position in the position follower slave is not known:
reference position follower slave (set X5/DI7 to HIGH level).
3. After having completed the homing process (output X4/DO3 is set to HIGH level):
reset X5/DI7 to LOW level.
4. "Lock to master": position the position follower slave to the position of the master drive to correct an inclination (set X5/DI3 to HIGH level).
Note: During the correction movement of the position follower slave, the master drive must be at standstill.
5. After having completed the "Lock to master" function (output X4/DO2 is set to HIGH level):
reset X5/DI3 to LOW level.
6. Enable master drive and traverse as desired.
The position follower slave traverses accordingly.



3.6

(Optionally): Setting the optimisation parameters in the slave drive

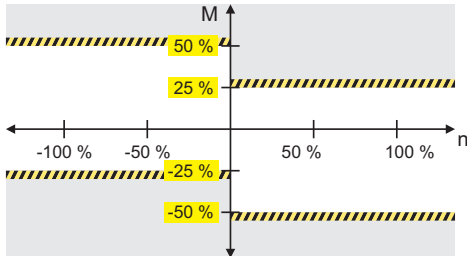
The following application-specific parameters are used for optimisation and can also be adapted during operation.

**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")

Parameter (Block)	Possible settings			Info
Position controller				
C00472/1 (LS_ParFree_a)	-199.99	%	199.99	Limitation of the position controller output
	Lenze setting: 100 % reference speed (C00011)			
C00472/2 (LS_ParFree_a)	-199.99	%	199.99	Adaptation of the position controller gain
	Lenze setting: 100 % Vp (C00254)			
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 %  The graph shows torque (M) on the vertical axis and speed (n) on the horizontal axis. The horizontal axis ranges from -100 % to 100 % with major ticks at -100 %, -50 %, 50 %, and 100 %. Four horizontal lines with yellow and black diagonal hatching represent torque limits: a top line at 50 %, a line at 25 %, a line at -25 %, and a bottom line at -50 %. The area between the 50 % and 25 % lines is shaded light gray, and the area between the -25 % and -50 % lines is also shaded light gray.
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)			

Parameter (Block)	Possible settings			Info
Profile parameters for positioning to master position ("Lock to master")				
C01236/1 (LS_MotionControl Kernel)	- 214748.3647	units/s	214748.3647	PosFollower: Sync. speed Synchronisation speed for approaching the setpoint position of the master.
	Lenze setting: 360.0000 units/s			
C01237/1 (LS_MotionControl Kernel)	- 214748.3647	units/s ²	214748.3647	Pos follower: Sync. accel. Acceleration for ramp-up to synchronisation speed
	Lenze setting: 3600.0000 units/s ²			
C01237/2 (LS_MotionControl Kernel)	- 214748.3647	units/s ²	214748.3647	Pos follower: Sync. decel. Deceleration for synchronisation speed ramp-down to standstill (to the setpoint position of the master).
	Lenze setting: 3600.0000 units/s ²			
C01238/1 (LS_MotionControl Kernel)	0.000	s	10.000	Pos follower: Sync. S-ramp time S-ramp time for the synchronisation speed ramps.
	Lenze setting: 0.000 s			
Following error monitoring system				
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			
Limit position monitoring				
C01218 - Bit 3 (LS_MotionControl Kernel)				Consideration of the software limit positions in MCK "Position follower" operating mode
	0	Software limit positions not active		
	1	Software limit positions active (if the home position is known)		
C01230 - Bit 3 (LS_MotionControl Kernel)				Consideration of the software limit positions in MCK "Manual jog" operating mode
	0	Software limit positions not active		
	1	Software limit positions active (if the home position is known)		
C00595/1...4 (LS_MotionControl Kernel)				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. • 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			

4

Detailed functions of the technology application

This chapter describes the functions implemented in the "Position Follower" 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

Master value selection options for the slave position follower

The master value for position follower operation can be obtained from different sources:

- Axis bus (X10)
- Digital frequency coupling (X8)
- "CAN on board" system bus (X1)

In the following subchapters, these sources are specified in detail.

4.1.1

Axis bus (X10)

In the default setting, the "Position Follower" technology application uses the master value selection via the axis bus. In this configuration only an 8400 TopLine can be used as master drive.

► [Hardware structure required](#) (14)

► [Step 2: Axis bus settings](#) (19)



Note!

Activate the time-out monitoring functions of the axis bus in both the master and the slave drive to prevent the master and slave from moving apart in the case of incorrect master value transmission! ► [Bus monitoring](#) (52)

For synchronisation of the master and slave, the axis bus IO line is used.
The LS_AxisBusIO SB must therefore not be utilised by the user in the application!

4.1.2 Digital frequency coupling (X8)

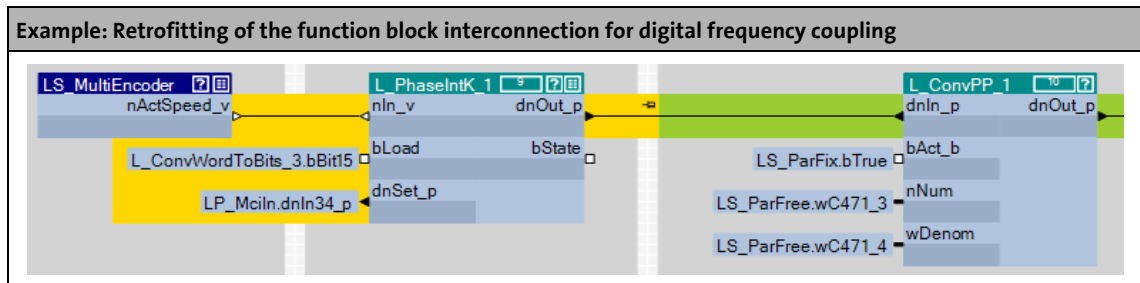
The "Position Follower" technology application can be refitted to a master value selection via digital frequency at low cost and effort. Therefore an 8400 TopLine is not absolutely required as master drive for the master value selection.



Note!

For a master value selection via digital frequency, the multi-encoder interface (X8) must not be occupied by a feedback system!

Since the digital frequency signal solely reflects the relative movement of the master (speed signal $V_{ElShaft}$), an integrator (**L_PhaseIntK_1**) is to be added to the main signal flow, integrating the master speed (in the example: $nActSpeed_v$) to a master position:

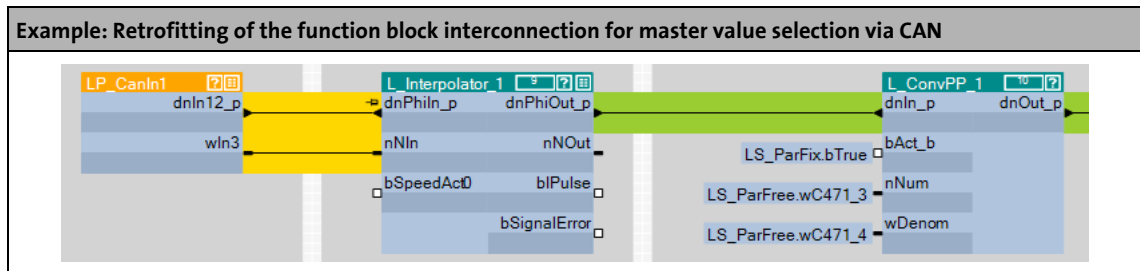


- The **L_PhaseIntK_1** integrator must be called in the processing order before the **L_ConvPP_1** FB.
 - The integrator must be pre-loaded once with a suitable starting position before position follower operation is started.
- In the example,
- the incremental starting position is preselected via the MCI process data input words 3 + 4.
 - the starting position is accepted via bit 15 of the application control word (**L_ConvBitsToWord_3** FB). The user must then interconnect this bit accordingly.

4.1.3 "CAN on board" system bus (X1)

The "Position Follower" technology application can be refitted to a master value selection via the "CAN on board" system bus at low cost and effort. Therefore an 8400 TopLine is not absolutely required as master drive for the master value selection.

Compared with the standard signal flow, the signal flow hardly changes at all. Instead of via the **LS_AxisBusIn** SB, the master value selection is effected via one of the CAN input ports (in the example **LP_CanIn1**):



- The telegram structure must be identical to that for the axis bus: The master position is transferred via CAN process data input words 1 + 2, and the master speed via CAN process data input word 3.
- If transmission cycles > 1 ms are used, the interpolation function (**L_Interpolator_1** FB) must be activated and parameterised.



Note!

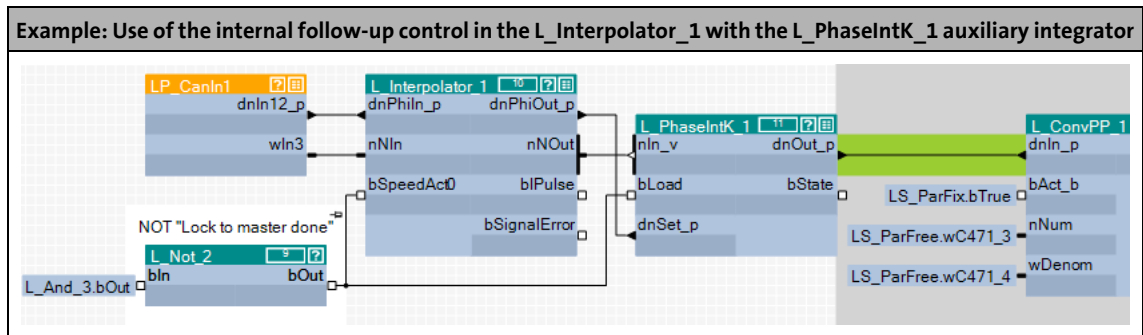
Compared with the real setpoint, the interpolation produces a dead time which complies with the duration of the interpolation cycles (plus possible transmission times on the data bus). In order to eliminate this dead time, a setpoint retention for the master drive can be set in C01239. ▶ [Setpoint retention in the master drive](#) (17)



Tip!

In the case of lower to medium demands to the dynamics, even a non-synchronised master value selection can be applied.

- For this purpose, the follow-up control contained in the **L_Interpolator_1** FB can be used, which outputs a smoothed speed setpoint at output *nNOut*.
- A downstream integrator (**L_PhaseIntK_1**) eventually converts the *nNOut* speed setpoint to a position setpoint.
- By means of the additional logic (**L_Not_2**), the set position with inactive position follower operation (**L_And_3.bOut** = FALSE) is directly loaded to the integrator (**L_PhaseIntK_1**).



4.2

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.

4.2.1

Operating mode selection

The operating mode selection by the user is carried out in the default setting via the digital inputs.

► [Pre-assignment of the I/O terminals](#) (11)

For internal mapping of the individual basic drive functions, the "Position Follower" technology application uses the state machine of the **Motion Control Kernel**. The desired operating mode is selected via the *wOperationMode* input of the **L_MckCtrlInterface_1** FB.

For a control bit-dependent selection, a corresponding interconnection logic is configured upstream to the *wOperationMode* input in the default setting (consisting of the **L_DigitalLogic5_1**, **L_And_1**, and **L_FixSet_w_1** FBs).

**Note!**

If more than one operating mode is selected at the same time, a change-over to the "[Stop \(STOP\)](#)" operating mode is carried out. The drive is braked to a standstill from its movement.

**Tip!**

- C00137 displays the current device state.
- C01243 shows the active operating mode of the **Motion Control Kernel**.

4.2.2 Stop (STOP)

Similar to the 9400 device series, the so-called "Stop" mode is also provided for 8400 HighLine/TopLine inverters, braking the drive to a standstill from its movement when a basic drive function is deselected.

The "Stop" mode differs from quick stop as follows:

Stop (STOP)	Quick stop (QSP)
Is triggered via Motion Control Kernel .	Is triggered directly in the motor control. The Motion Control Kernel changes to the "Standby" state immediately.
Deceleration ramp adjustable in C01251/1 in application units [units/s ²].	Deceleration ramp adjustable in C00105 in [s] with reference to the reference speed (C00011).
S-ramp time adjustable in C01252/1 in [s].	Only linear ramp.
Braking process is executed in a position-controlled manner.	Braking process is executed in a speed- or position-controlled manner (can be selected via bit 1 in C00104/1).
Standstill is executed in position-controlled manner.	Standstill is executed in speed- or position-control (can be selected via bit 0 in C00104/1).

"Stop" is defined as an individual operating mode in the Motion Control Kernel. When another operating mode is deselected, the drive is braked to a standstill from the current movement with the profile parameters of "Stop". The following setting parameters are provided:

Parameter (Block)	Possible settings	Info
C01251/1 (LS_MotionControl Kernel)	-214748.3647 units/s ² 214748.3647 Lenze setting: 3600.0000 units/s ²	MCK: Stop: Decel. Deceleration for setpoint speed ramp-down to standstill.
C01251/2 (LS_MotionControl Kernel)	0.000 s 10.000 Lenze setting: 0.000 s	MCK: Stop: S-ramp time S-ramp time for setpoint speed ramp-down to standstill.



Stop!

In the case of the 8400 device series, both "Stop" and "Quick stop" (QSP) are executed with the torque that is specified at the **LS_MotorInterface** SB via the *nTorqueMotLimit_a* or *nTorqueGenLimit_a* input (difference to the 9300, ECS, and 9400 device series).

4.2.3 Homing

In order to be able to actuate the drive in a reasonable fashion, the position of the zero position within the physically possible travel range must be known. The zero position, also called the "reference", can be defined by homing or reference setting. This so-called "homing" is usually carried out after the mains is switched on. Furthermore homing is required after an encoder error has been eliminated.

- "Manually" starting/stopping the homing process is executed via bit 6 of the application control word (**L_ConvBitsToWord_3** FB). In the default setting, bit 6 is linked with digital input DI7.
- 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.



Note!

Positioning operation and position follower operation can only be executed if the home position is known to the drive (**LS_MotionControlKernel.bHomePosAvailable** = TRUE). The monitoring of software limit positions can also only be carried out with a known reference!



Note!

The "Position Follower" technology application is typically used on following axes that are coupled to a master axis and further following axes via the mechanics and which can therefore be traversed against each other in any way. Thus the homing processes cannot be executed independently on each axis.

The following procedure has proved of value:

- Mount the reference-determining sensors (e.g. touch probe sensor) to the same position for all axes.
- Set the feed constant (C01204) and motor mounting position (C01206/1) on all axes of the interconnection so that an identical length scaling and counting direction results on all axes.
- Be sure to parameterise all homing profile and position parameters in all axes in an identical manner (see the following parameter list).
- Start the homing process simultaneously on all axes involved and only reset the homing command when all axes in the interconnection have completed the homing process successfully!

Like this, the homing process produces identical traversing profiles for all axes and the mechanics are not pulled askew.



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.

The screenshot shows the 'Block Parameters List: LS_MotionControlKernel' dialog box, 'Application Parameters' tab, 'Homing' section. The 'Homing' dropdown is selected. The 'Ref. TP signal source' is set to 'No TP'. The 'Homing mode' is set to 'SetRef'. The 'Ref. home position' is -240.0000 unit. The 'Ref. reference offset' is -20.0000 unit. The 'Ref. sequence profile' is 0. The 'System of measurement setti..' is 0x0. The 'Actual MCTRL position obtained at power off' checkbox is unchecked. The 'Dist. Ref-Mark to Ref-TP' is 0.0000 units. The 'Actual position' is -0.0109 units. The 'Homing active', 'Homing done', and 'Home position available' status indicators are shown. Below the parameters, there are two diagrams: 1. Sensor mark (TP, MP) - home position in machine measuring system, and 2. Reference target position. At the bottom, there are parameters for 'Ref. S-ramp time', 'Ref. M-Limit mode 14/15', 'Ref. waiting time mode 14/15', 'Ref. start speed', 'Ref. start acceleration', 'Positive SW limit position', 'Ref. search speed', 'Ref. search acceleration', and 'Negative SW limit position'.



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	100	SetRef
C01224/1	MCK: Ref. initial speed	360.0000	unit/s
C01225/1	MCK: Ref. initial acceleration	3600.0000	unit/s ²
C01224/2	MCK: Ref. search speed	360.0000	unit/s
C01225/2	MCK: Ref. search acceleration	3600.0000	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	-20.0000	unit
C01227/2	MCK: Ref. home position	-240.0000	unit
C01228	MCK: Ref. sequence profile	0	
C01229/1	MCK: Positive SW limit position	1000000	units
C01229/2	MCK: Negative SW limit position	1000000	units
C01246/1	MCK: Ref. TP signal source	0: No TP	

4.2.4 Manual jog

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

- The basic function "Manual jog" is activated via bit 12 and bit 13 of the application control word (**L_ConvBitsToWord_3** FB). In the default setting, bit 12 and bit 13 are linked to 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 3 \(optional\): Set up control system via the fieldbus interface \(MCI\)](#). (19)



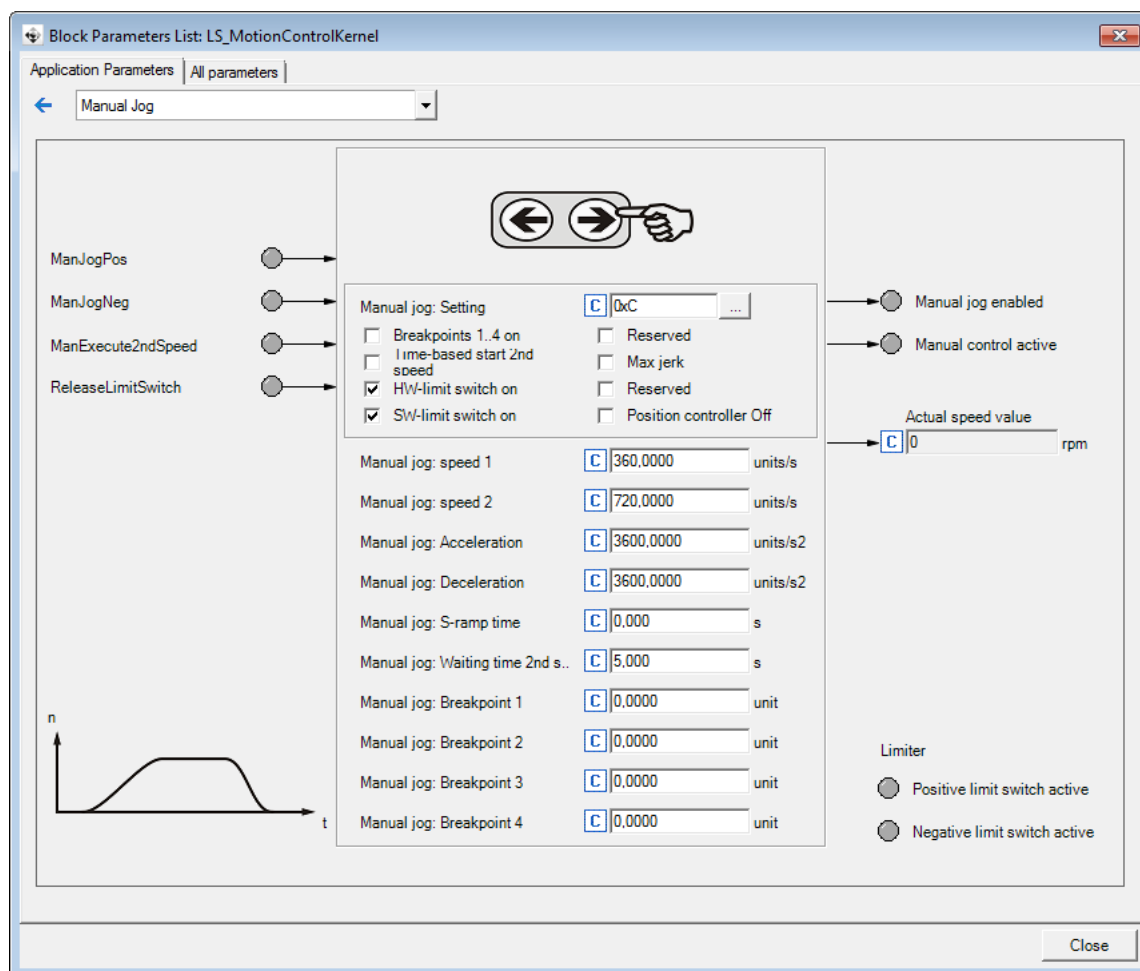
Note!

In the Lenze setting, the software limit positions parameterised are active for manual jog if the home position is known. ▶ [Limit position monitoring](#) (48)



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

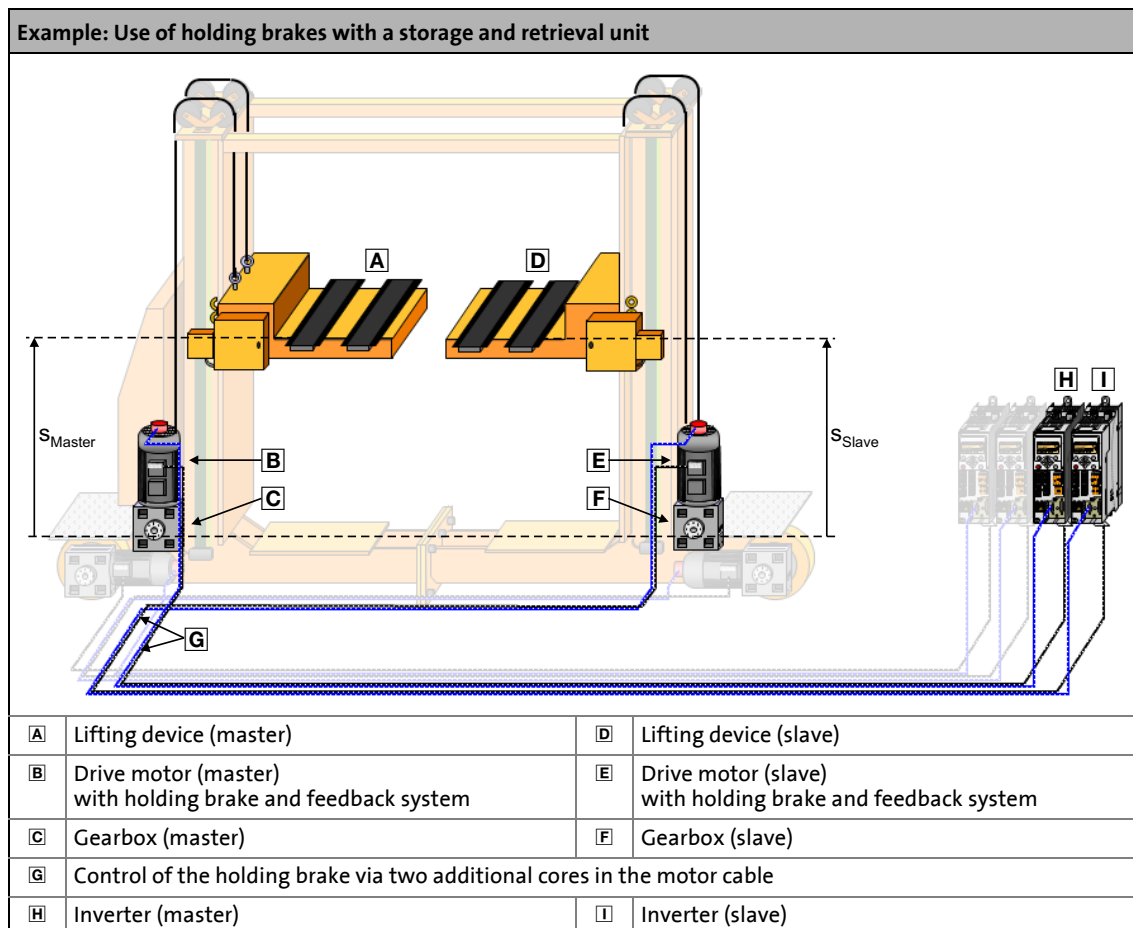
1.  Open the parameter list for the **LS_MotionControlKernel** SB.
2. In the *Block Parameters List...* dialog box on the **Application parameters** tab, select the "Manual Jog" entry in the upper list field.



Parameter	Info	Lenze setting	
		Value	Unit
C01230	MCK: Manual jog setting	Bit coded	
C01231/1	Manual jog: speed 1	360.0000	units/s
C01231/2	Manual jog: Speed 2	720.0000	units/s
C01232/1	Manual jog: Acceleration	3600.0000	units/s²
C01232/2	Manual jog: Deceleration	3600.0000	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

4.2.5 Holding brake control

For hoisting axes with floating loads, drives are often equipped with holding brakes making it possible to inhibit the drives without the load sagging.



The 8400 TopLine inverter is already equipped with an automatic holding brake control.



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:

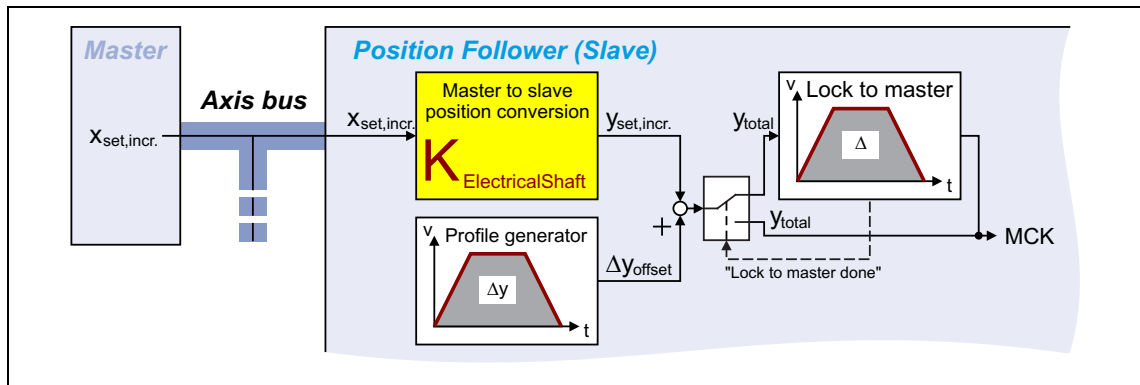
- In the Lenze setting, the mode 0 (brake control off) is preset in C02580.
- The technology application is prepared for the control of a 24 V holding brake via the high current output (terminal strip X107).
- The application of the holding brake effects a controller inhibit, and with an inhibited inverter, the following error is reset. [Starting from version 14.00.00](#), a following error value can be set in C01215/3, which also remains stored when the controller is inhibited.
- In mode 12 (controlled automatically), the forced release is executed on the holding brake when position follower operation is active ("Lock to master done"), so that the slave drive follows each of the master drive's movements without the holding brake being applied whilst the master value is fixed. For the implementation of this function, the "Lock to master done" signal in the application (**L_And_3.bOut**) is linked with the *bMBrakeRelease* input of the **LS_MotionControlKernel** SB.

4.3 Position follower functions

4.3.1 Electrical shaft function (measuring system conversion)

In order to enable the slave position follower to follow the master in a position-synchronous fashion, the position of the master must be provided in the slave. For this purpose, various transmission paths from the master to the slave drive are provided, as described in the "[Master value selection options for the slave position follower](#)" chapter.

Then a measuring system conversion is carried out in the slave position follower: The incremental master position $x_{\text{set,incr.}}$ is converted to an incremental setpoint position $y_{\text{set,incr.}}$ for the slave.



[4-1] Measuring system conversion (excerpt from the [basic signal flow](#))

Basics for the calculation	
Formula for the conversion of the master position to a set position for the slave position follower	
$y_{\text{set,incr.}} = K_{\text{ElectricalShaft}} \cdot x_{\text{set,incr.}} = \frac{i_{\text{Slave}}}{i_{\text{Master}}} \cdot \frac{FC_{\text{Master}}}{FC_{\text{Slave}}} \cdot K_{\text{User}} \cdot x_{\text{set,incr.}}$	
Formula for the calculation of the electrical shaft factor $K_{\text{ElectricalShaft}}$	
Solving for the electrical shaft factor $K_{\text{ElectricalShaft}}$ from the first formula yields the following:	
$K_{\text{ElectricalShaft}} = \frac{y_{\text{set,incr.}}}{x_{\text{set,incr.}}} = \frac{i_{\text{Slave}}}{i_{\text{Master}}} \cdot \frac{FC_{\text{Master}}}{FC_{\text{Slave}}} \cdot K_{\text{User}} = \frac{C00471/3}{C00471/4}$	
$K_{\text{ElectricalShaft}}$	Electrical shaft factor
$y_{\text{set,incr.}}$	Incremental set position (y position)
$x_{\text{set,incr.}}$	Incremental master position (x position)
i_{Slave}	Gearbox ratio of slave position follower
i_{Master}	Gearbox ratio of master drive
FC_{Master}	Feed constant of master drive
FC_{Slave}	Feed constant of slave position follower
K_{User}	User proportionality factor (in the case of position synchronism, set to "1")

The electrical shaft factor $K_{\text{ElectricalShaft}}$ is preselected via the following parameters in the "Position Follower" technology application:

Parameter (Block)	Possible settings (Lenze setting printed in bold)	Info
C00471/3..4 (LS_ParFree)	0 Lenze setting: 1:1	Electrical shaft factor $K_{\text{ElectricalShaft}}$ - Set the factor with mathematical precision in the two subcodes: - Subcode 3: numerator term - Subcode 4: denominator term (is only evaluated in terms of value) Note: Values greater than 32767 are interpreted as negative values according to the so-called two's complement. The effective value is calculated on the basis of the formula $C0471/x - 2^{16}$. Example: The setting "65535" is internally considered as the value $65535 - 2^{16} = -1$.

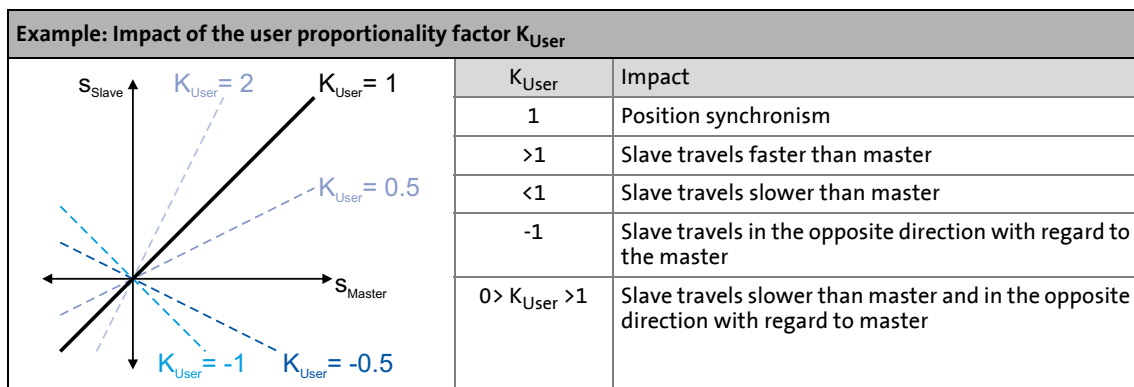
For the conversion of the position, the **L_ConvPP_1** FB is used in the application.



Tip!

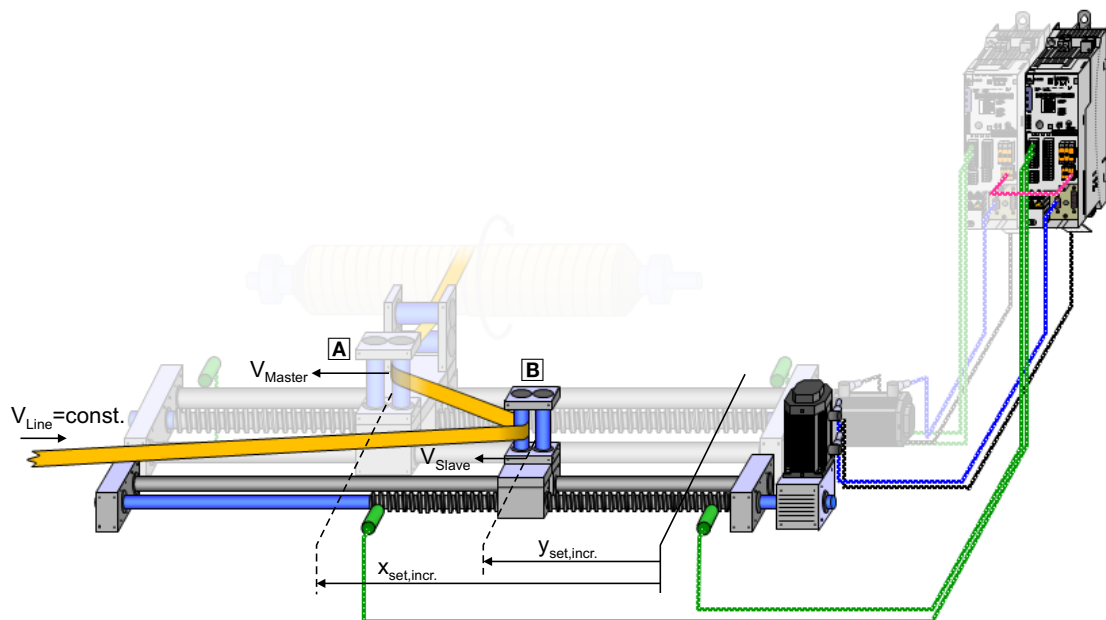
Most applications require an exact position synchronism. The user proportionality factor K_{User} in these cases must always be set to "1".

- With $K_{\text{User}} \neq 1$, absolute stretching/compression of the set position, similar to that in the electronic cam technology, can be obtained.
- $K_{\text{User}} < 0$ produces a movement in the opposite direction with regard to the master.



Example: Speed compensation for traversing control

In order to keep the machine material speed V_{Line} exactly constant, a compensation process is to be executed via an additional control system (slave), which is to move in the ratio $K_{User} = s_{Slave} : s_{Master} = 1 : 2$ to the traversing support (master).



A Traversing support (master):	B Additional control system (slave):
$i_{Master} = 1 : 1$	$i_{Slave} = 39 : 17$
$FC_{Master} = 10.0000 \text{ [mm/rev.]}$	$FC_{Slave} = 7.5000 \text{ [mm/rev.]}$
	$K_{User} = 1 : 2$

Calculation of the electrical shaft factor $K_{ElectricalShaft}$

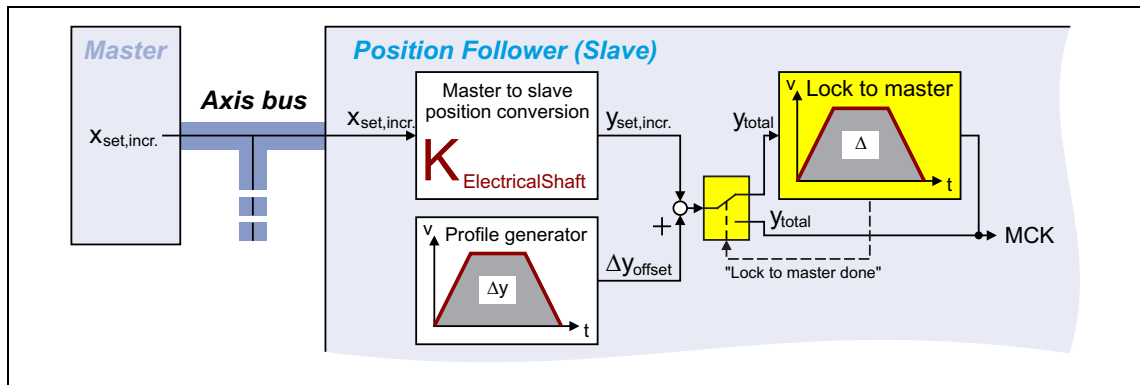
$$K_{ElectricalShaft} = \frac{i_{Slave}}{i_{Master}} \cdot \frac{FC_{Master}}{FC_{Slave}} \cdot K_{User} = \frac{39}{17} \cdot \frac{10.0000 \text{ [mm/rev.]}}{7.5000 \text{ [mm/rev.]}} \cdot \frac{1}{2} = \frac{390.0000}{255.0000} = \frac{26}{17}$$

Setting of the electrical shaft factor $K_{ElectricalShaft}$

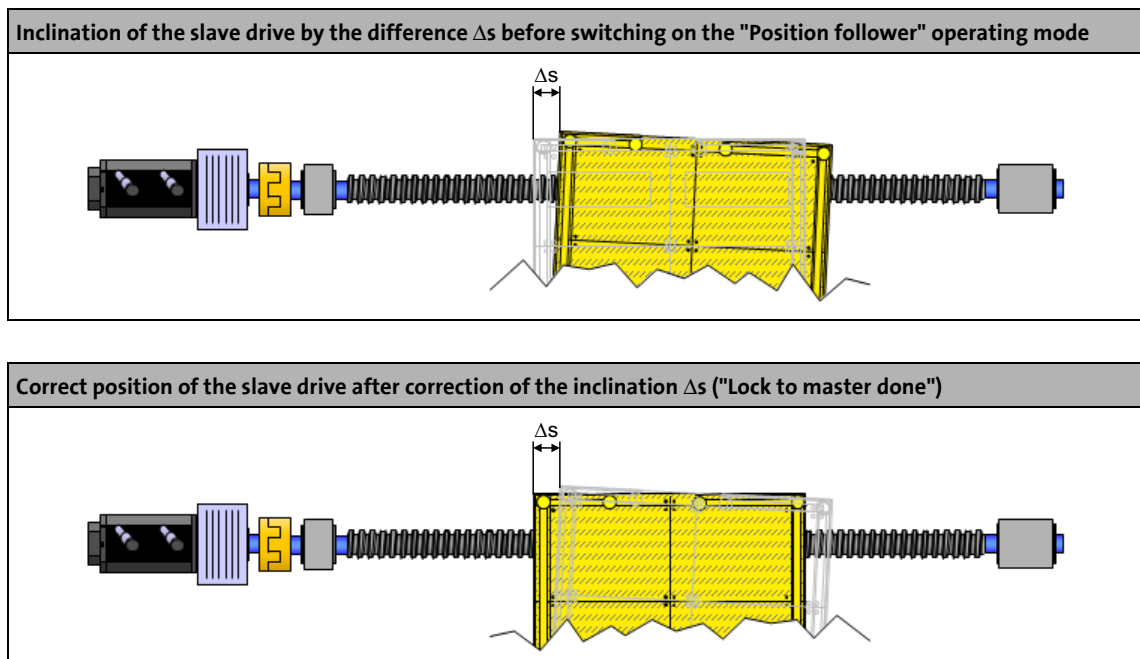
C00471/3 = 26	Numerator term
C00471/4 = 17	Denominator term (is only evaluated in terms of value)

4.3.2 Positioning to master position ("Lock to master")

Before the master/slave interconnection can be reasonably actuated in electrical shaft mode, a potential inclination of the slave drive with regard to the master drive must be corrected. This correction can be mapped by means of a positioning process. The functionality that is referred to as "Lock to master" here is known by the designation "Lock to cam" from the field of electronic cam technology.



[4-2] "Lock to master" function (excerpt from the [basic signal flow](#))



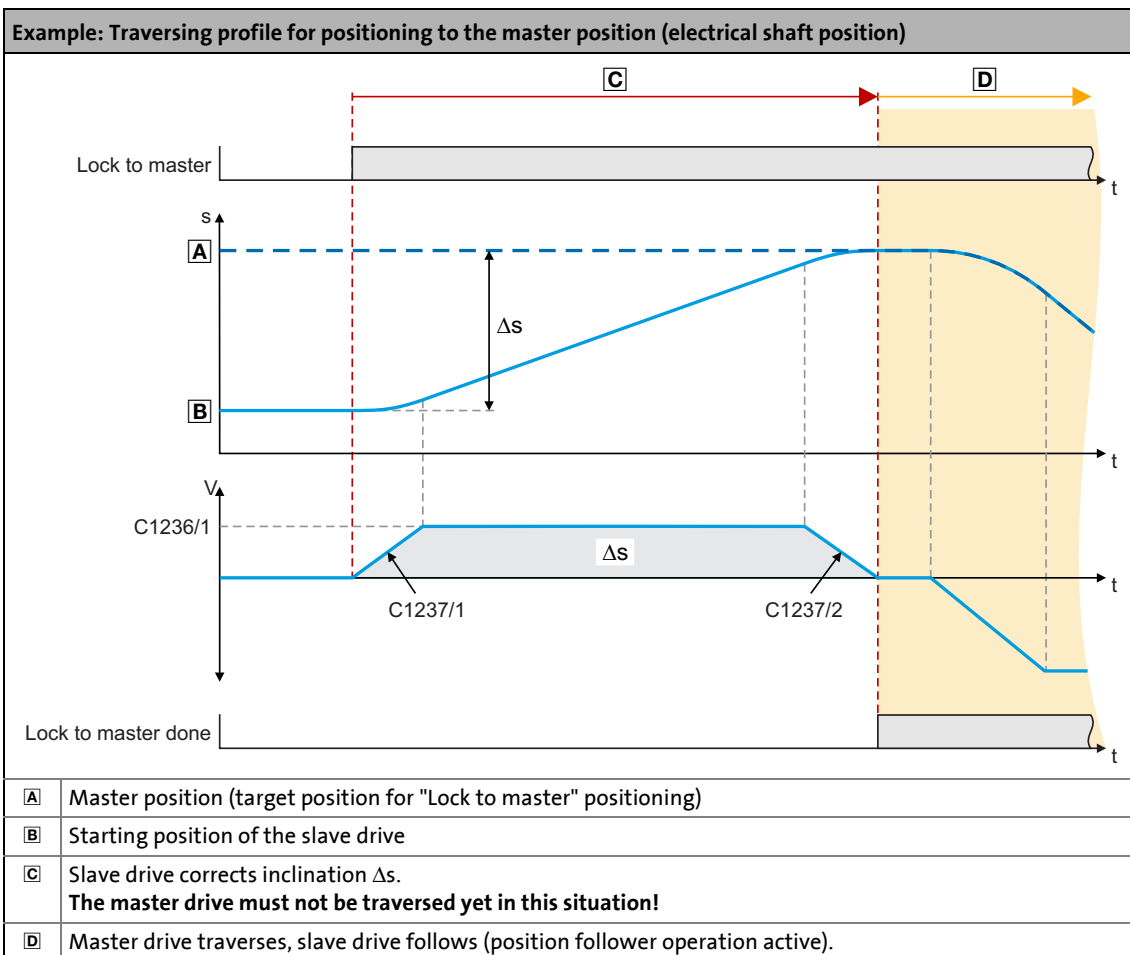
In the "Position Follower" technology application, the basic function "position follower" of the **Motion Control Kernel (MCK)** is used for the correction of the inclination. The correction is automatically executed if position follower operation is switched on.

- Position follower operation is switched on via bit 9 of the application control word (**L_ConvBitsToWord_3 FB**). In the default setting, bit 9 is linked with digital input DI3.
- Positioning to the master position can only be executed when the home position is known.
- When positioning to the master position (correction of the inclination) has been completed ("Lock to master done"), feedback is given via digital output DO2 and bit 14 of the MCI process data output word 1.



Stop!

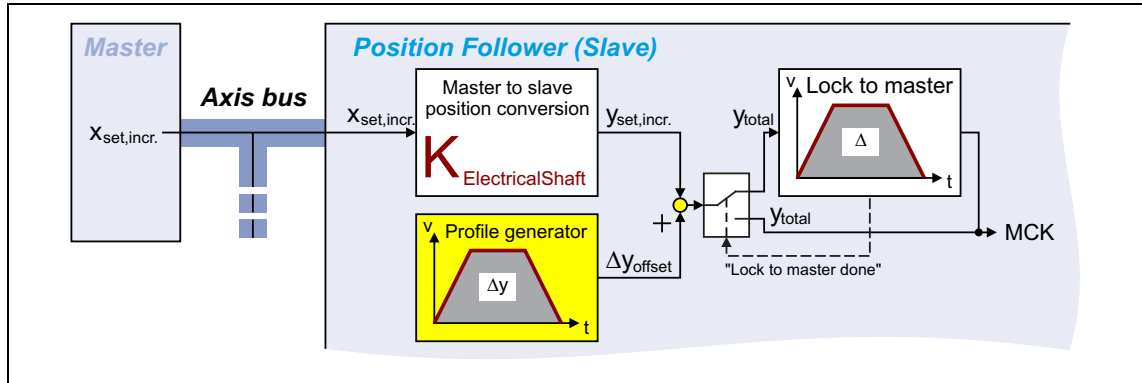
Only start the master drive when all slave drives have carried out the correction of the inclination successfully and reported the "Lock to master done" status! Otherwise a following error message will be output in position follower operation.



Parameter (Block)	Possible settings			Info
C01236/1 (LS_MotionControl Kernel)	-214748.3647	units/s	214748.3647	PosFollower: Sync. speed Synchronisation speed for approaching the setpoint position of the master.
	Lenze setting: 360.0000 units/s			
C01237/1 (LS_MotionControl Kernel)	-214748.3647	units/s ²	214748.3647	Pos follower: Sync. accel. Acceleration for ramp-up to synchronisation speed
	Lenze setting: 3600.0000 units/s ²			
C01237/2 (LS_MotionControl Kernel)	-214748.3647	units/s ²	214748.3647	Pos follower: Sync. decel. Deceleration for synchronisation speed ramp-down to standstill (to the setpoint position of the master).
	Lenze setting: 3600.0000 units/s ²			
C01238/1 (LS_MotionControl Kernel)	0.000	s	10.000	Pos follower: Sync. S-ramp time S-ramp time for the synchronisation speed ramps.
	Lenze setting: 0.000 s			

4.3.3 Shifting the set position (y offset)

In addition to stretching/compression the master position, the set position of the slave can be shifted by an offset distance with regard to the master position. In the signal flow, this offset couples in downstream of the electrical shaft function (measuring system conversion), so that this is also referred to as an y offset.



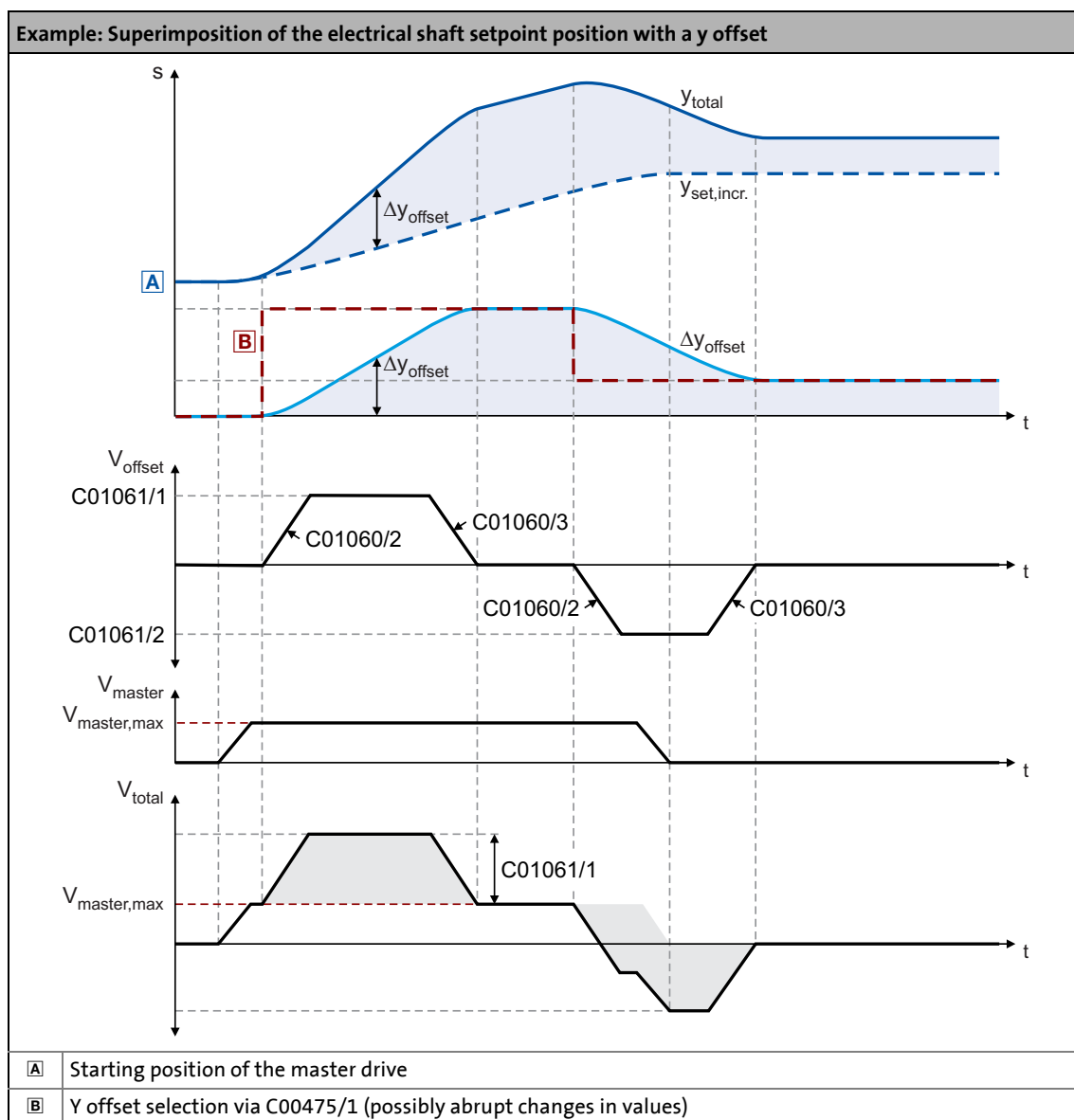
[4-3] y offset (excerpt from the [basic signal flow](#))

- The y offset (Δy) is selected via C00475/1 in application units.
- The y offset (Δy) is controlled via a profile generator (**L_PosCtrlLin_1** FB), in order to provide for constant setpoint characteristics even if the offset is changed in a discontinuous manner. Like this, the y offset can also be changed during position follower operation.
- The overall setpoint y_{total} is composed of the electrical shaft setpoint position $y_{set,incr.}$ and the offset value Δy_{offset} .
- In terms of function, the y offset causes a shift of the slave setpoint position compared with the master position (also see the following illustration).



Stop!

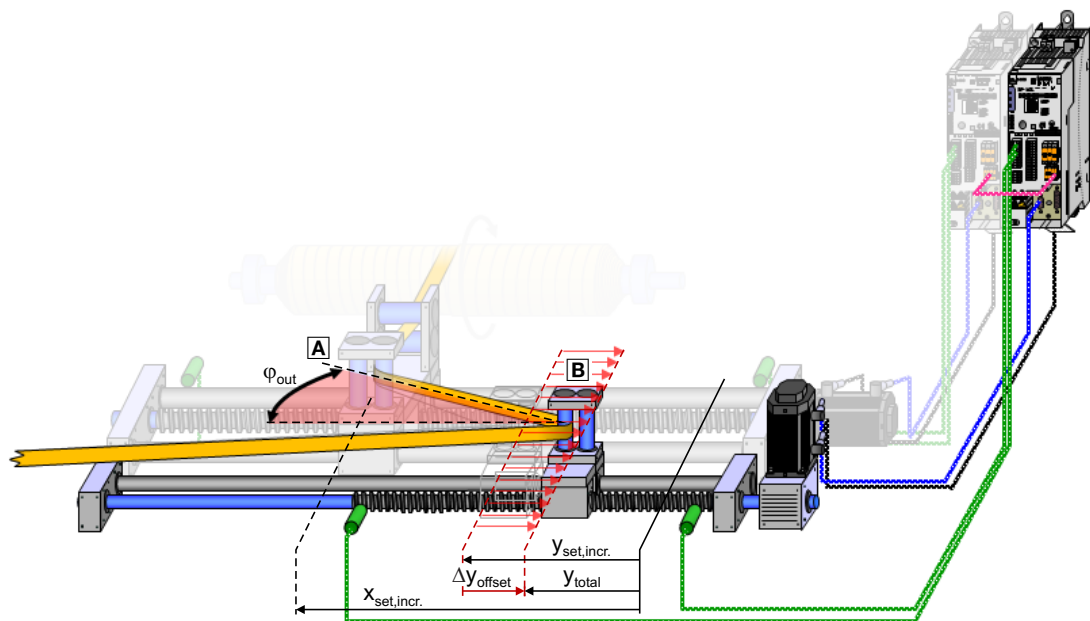
When the master and slave axis are mechanically coupled to each other (like for example the traversing platform shown in the "[Application ranges](#)" chapter), the y offset function in the slave drive must not be used, because otherwise an inclination in the machine mechanics will occur!



Parameter (Block)	Possible settings (Lenze setting printed in bold)			Info
Y offset (shift of the slave position follower setpoint position with regard to the master position)				
C00475/1 (LS_ParFreeUnit_1)	-214748.3647	units	214748.3647	Y offset
	Lenze setting: 0.0000 units			
When the y offset is changed during position follower operation, the following parameters are to be set:				
C01060/2 (L_PosCtrlLin_1)	0.010	s	130.000	Acceleration ramp
	Lenze setting: 10 s			
C01060/3 (L_PosCtrlLin_1)	0.010	s	130.000	Deceleration ramp
	Lenze setting: 10 s			
C01061/1 (L_PosCtrlLin_1)	-15000	rpm	15000	Forward motion (positive speed) • The value is only evaluated with regard to its amount.
	Lenze setting: 50 min-1			
C01061/2 (L_PosCtrlLin_1)	-15000	rpm	15000	Return motion (negative speed) • The value is only evaluated with regard to its amount.
	Lenze setting: 50 min-1			

Example: Shift of the additional guide (slave) for a traversing control

In order to keep the discharge angle of the material φ_{out} low at the additional guide, the additional guide is to act as far back as possible in the traversing range. This state can be achieved by a correspondingly negative Δy_{offset} :



A	Traversing support (master)	B	Additional guide (slave)
----------	-----------------------------	----------	--------------------------

Calculation of the overall setpoint for the slave drive

$$y_{total} = x_{set,incr.} \cdot K_{ElectricalShaft} + \Delta y_{offset} = y_{set,incr.} + \Delta y_{offset}$$

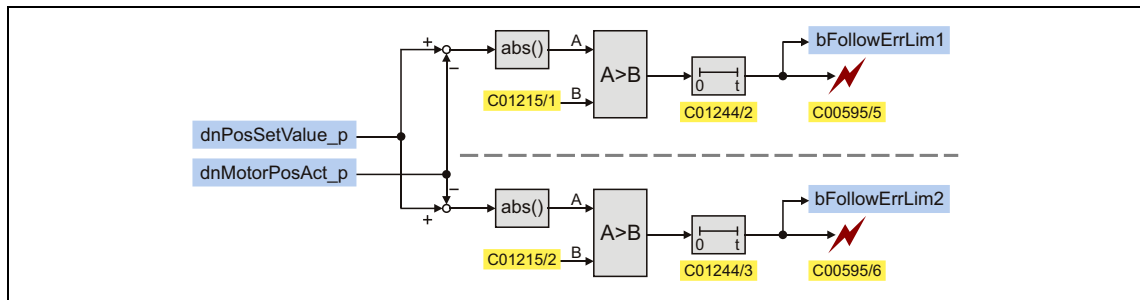
4.4 Monitoring functions

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. The following error is always compensated dynamically. If the position control is adjusted optimally, only a minimum following error occurs which does not increase continuously.

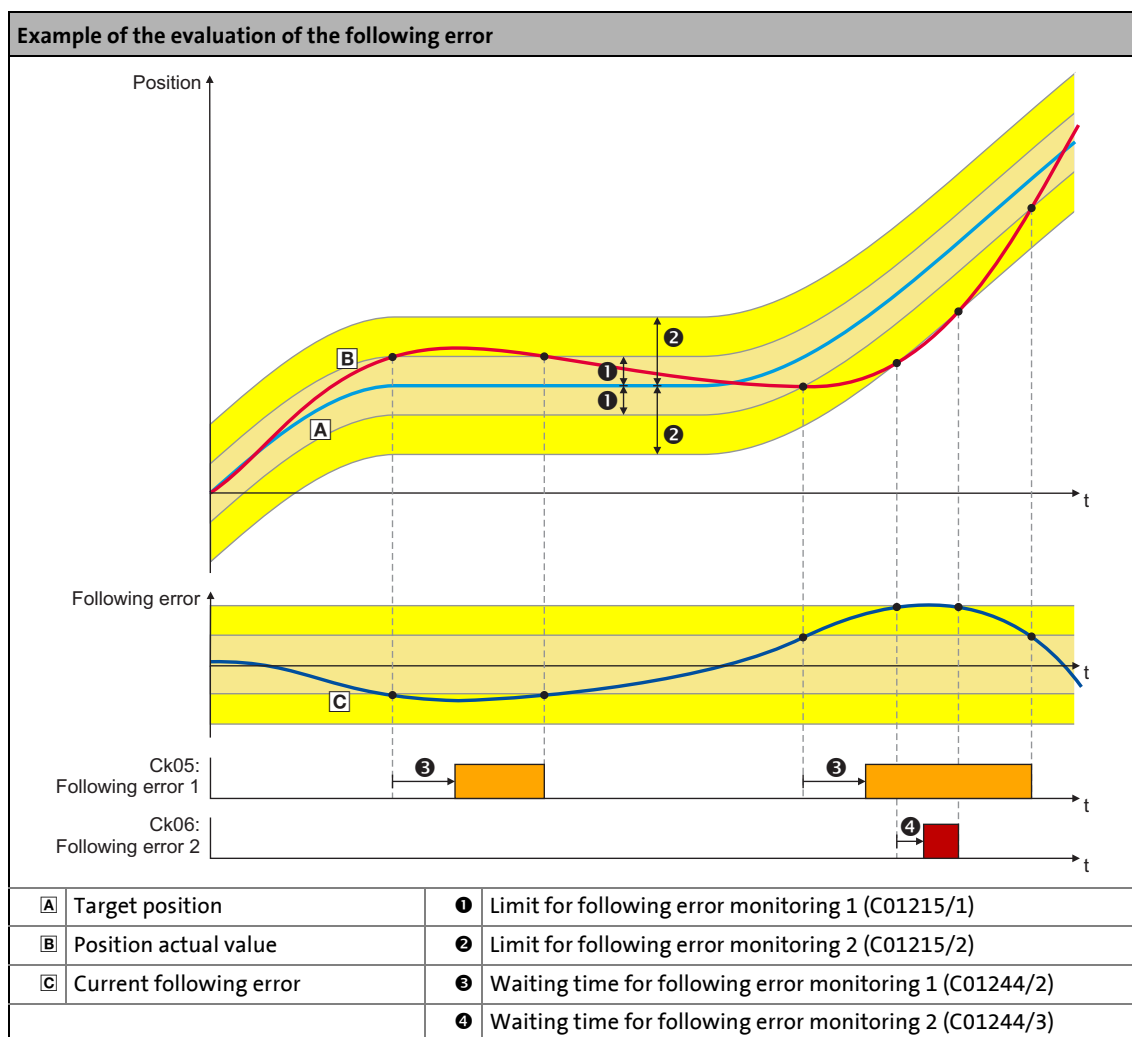
Certain processes, however, require that a defined limit as a difference between set position and actual position is not exceeded. If it is exceeded, it may have been caused by a mechanical blocking in the machine and the system part is not situated at the position defined at that time. In such a case, 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:



[4-4] 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	60000	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

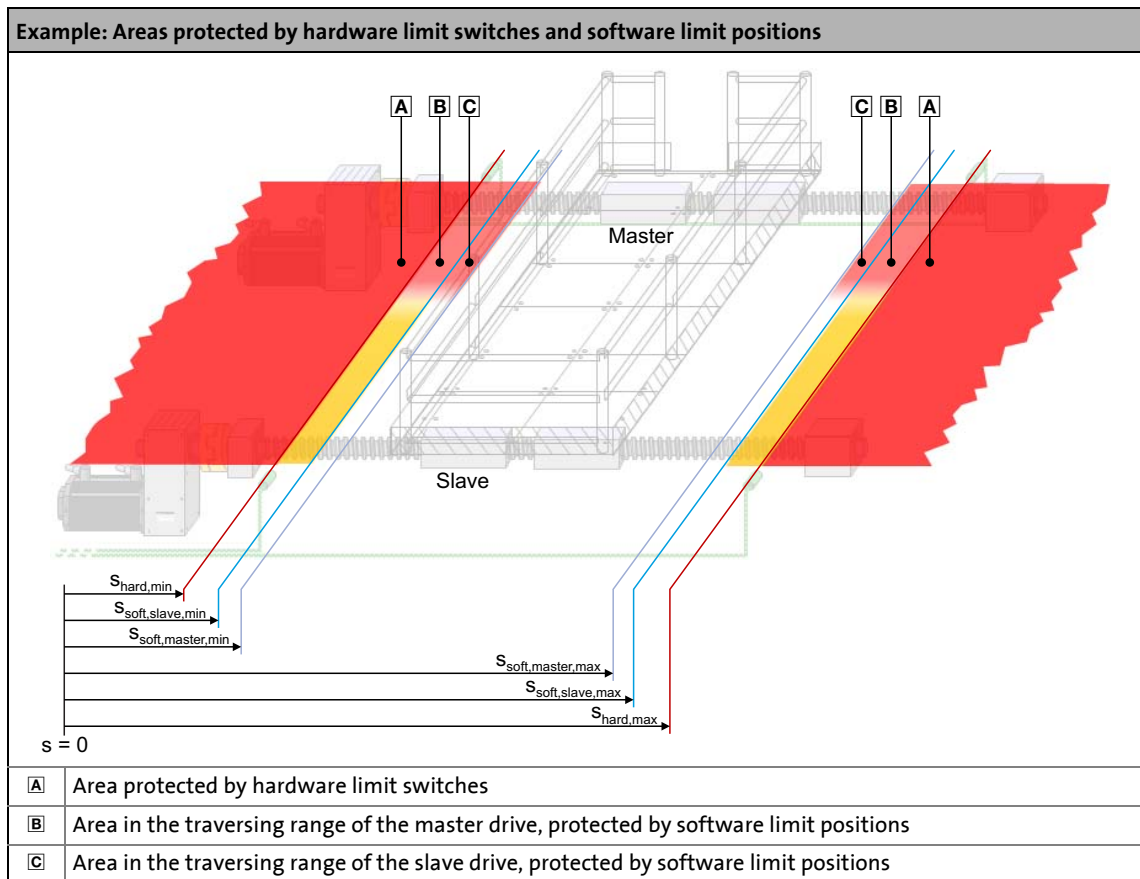
For safety reasons, drives with a limited traversing range must always be made safe using corresponding safety mechanisms. These are firstly the hardware limit switches, which must effect a standstill of the axes as quickly as possible during the approaching process. In addition, the parameterisable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



Note!

In der "Position Follower" technology application, no evaluation of hardware limit switches is prepared by default. However, if required, an evaluation can be retrofitted by means of only a few steps (see "[Hardware limit switch](#)" subchapter).

In practice, the software limit positions are always placed within a safety distance from the limit switches (see the following example).



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 of the slave position follower 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.
- The software limit positions of the master must take effect earlier than the software limit positions of the slaves. Like this, error activation by approaching the software limit positions of a slave is prevented.

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 connection of the hardware limit switches have to be connected to the *bLimitSwitchNeg* and *bLimitSwitchPos* monitoring inputs 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)

For this switching logic, the level inversion for the two digital inputs to which the limit switches are connected is to be activated in C00114.

(If DI1 and DI2 are used, bit 1 and bit 2 are to be set to "1" 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
Homing	Depending on the homing mode selected (see description of the homing modes in the reference manual/online help of the inverter)
Manual jog	Yes (adjustable in C01230 - bit 2)
Position follower	Yes (adjustable in C01218 - bit 2)
Positioning	Yes

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.



Note!

Hardware limit switches approached in the case of the 8400 TopLine inverter can only be retracted via the "[Manual jog](#)" operating mode.

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)!

If the drive is stopped at a high deceleration, depending on the mass inertia and friction, an overvoltage in the DC bus may occur, and pulse inhibit is set as error response. The use of a brake resistor can prevent this response.

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

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 • Subcode 1: Positive software limit position • Subcode 2: Negative software limit position Note: The positive software limit position must be set to a greater value than the negative software limit position!
	Lenze setting: ±100000.0000 units			
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

If an "Electrical shaft" is operated via axis bus, or generally via a bus system, data transmission errors, for example due to EMC interference, must always be expected. In order to prevent a mechanical offset of the drives in the event of a fault that is only temporary, the **L_Interpolator_1** FB is used in the slave application. This FB is equipped with an internal correction mechanism, which, in the case of a missing data telegram, provides for an automatic offset correction. If transmission cycles >1 ms are used, the interpolation function must be activated and parameterised.

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		
C02431/3	0	ms	65000	Axis bus monitoring time • Tolerance time before the data error is triggered • For systems that are coupled in a mechanically rigid fashion, enter a value that is as small as possible.
	Lenze setting: 100 ms			



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

@ 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