BUCHER automation

Application-oriented Manual



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2-phase stepper motor and regulated 2-phase stepper motor on the JetMove 100x

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1 Possible application

The 2-phase stepper motor and the regulated 2-phase stepper motor are available via the JetMove 100x with EtherCAT® controllers:

– JC-440EXT
– JC-965EXT
– JC-975EXT

1.1 System configuration

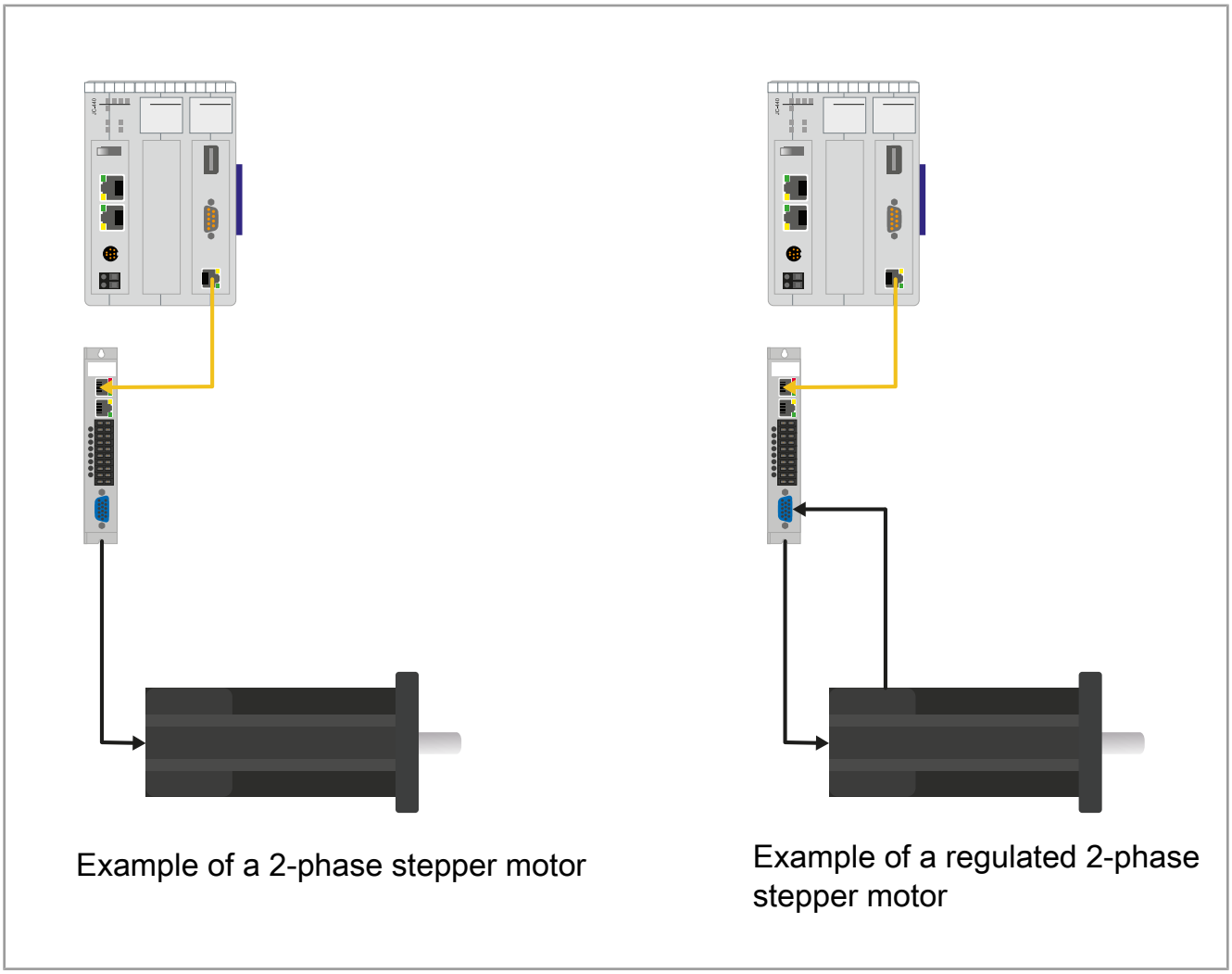


Fig. 1: Examples of system configuration

2 System requirements

The following hardware and software requirements must be met in order to use the 2-phase stepper motors.

2.1 Hardware

The EtherCAT 3rd-Party can be operated on the following controllers from Bucher Automation AG.

Type	Minimum OS version
JC-440EXT	1.11.0.41
JC-965EXT	1.21.0.6
JC-975EXT	1.27.0.33
JetMove 100x	001.0043

Tab. 1: Hardware

2.2 Software

Operating system

Please refer to the hardware requirements for the minimum operating system version (min. OS) of your controller.

License

To use JetMove 100x, a valid license for the JCF4-C_ETHERCAT_MASTER operating system function must be available on the controller for at least one axis.

Software development environment

You need at least JetSym 5.7.0.

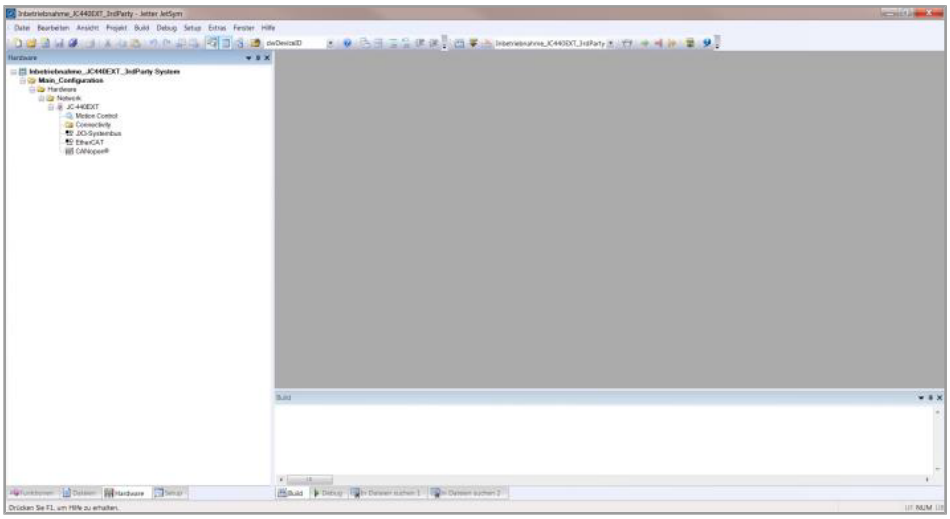
Programming

Programming is carried out using the JetSym hardware manager and the STX user program.

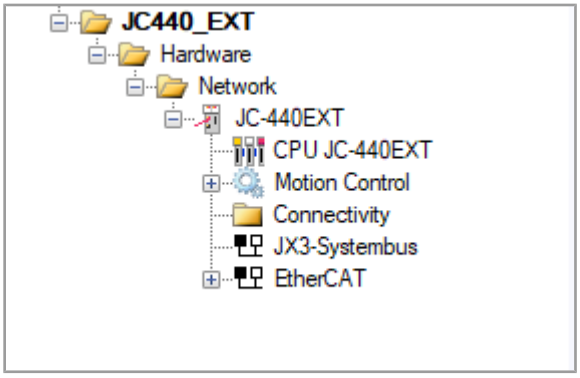
3 Integrate JetMove 100x

To set up the JetMove 100x in JetSym, follow these steps (the screenshots show the configuration using a JC-440EXT as an example):

1. Start the JetSym programming environment.
2. Create a new project.

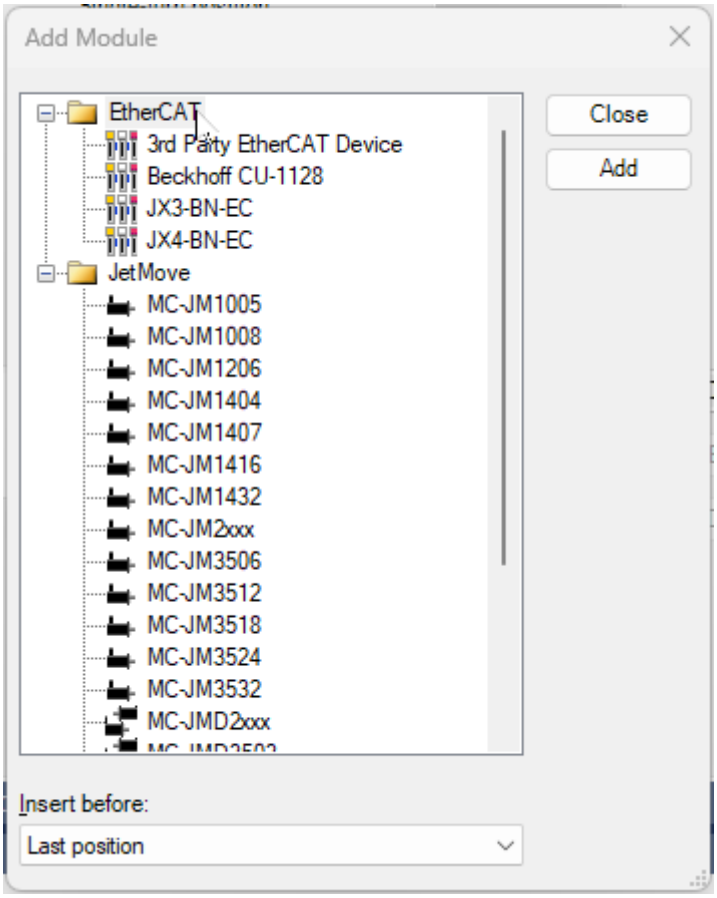


3. In JetSym, open the Hardware Manager by clicking on the Hardware tab with the mouse or pressing Alt + 5 on the keyboard.



4. Click on EtherCAT® in the hardware manager. Open the context menu by clicking the right mouse button and select Add Device.

   ⇨ The Add Device dialog box opens.



This dialog box contains 3rd Party EtherCAT® Device, JX3-BN-EC and 3 types of drives:

1. Drives with single axes, e.g., MC-JM-2xxx
2. Drives with dual axes, e.g., MC-JMD3503 (2 axes per drive)
3. Drives with triple axes, e.g., MC-JMT3503 (3 axes per drive)

► Select the **MC-JM1005** or **MC-JM1008** by double-clicking or clicking the Add button.

⇨ The JetMove 100x is integrated into the system.

NOTICE! The EtherCAT® devices must be integrated into the hardware manager in the order in which they are physically connected to the controller.

4 Start up the motor

4.1 Encoder

The encoder is defined in the Motion Setup under *Encoder*.

4.1.1 Set encoder for 2-phase stepper motor

► Set the encoder resolution to 1 and the encoder type must be set to "not active".

⇨ In this case, when a stepper motor is selected in the motor data, a position proportional to the number of steps driven is simulated. This simulated position is displayed in the actual axis position.

4.1.2 Set encoder for regulated 2-phase stepper motor

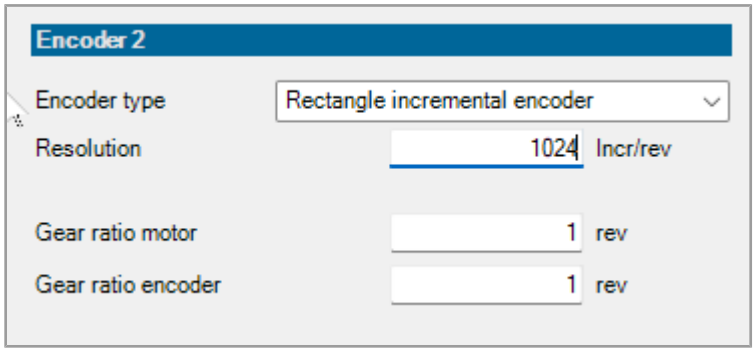


Fig. 2: Example: Encoder

► Select the encoder type and set the encoder resolution.

In the example:

– Encoder type: Rectangular incremental encoder

– Encoder resolution: 1024 Ink./ revol.

The number of lines of the incremental encoder must be entered. The drive performs a 4-fold evaluation of the encoder signals, thereby generating a position resolution that is four times higher than the value entered here.

4.2 Check counting direction for regulated 2-phase stepper motor

1. Look at the motor shaft and when the motor is turned to the right, the actual position must be displayed in ascending order.
2. If this is not the case, you must swap channels A and B on the encoder plug.

4.3 Motor data

4.3.1 Motor data for 2-phase stepper motor

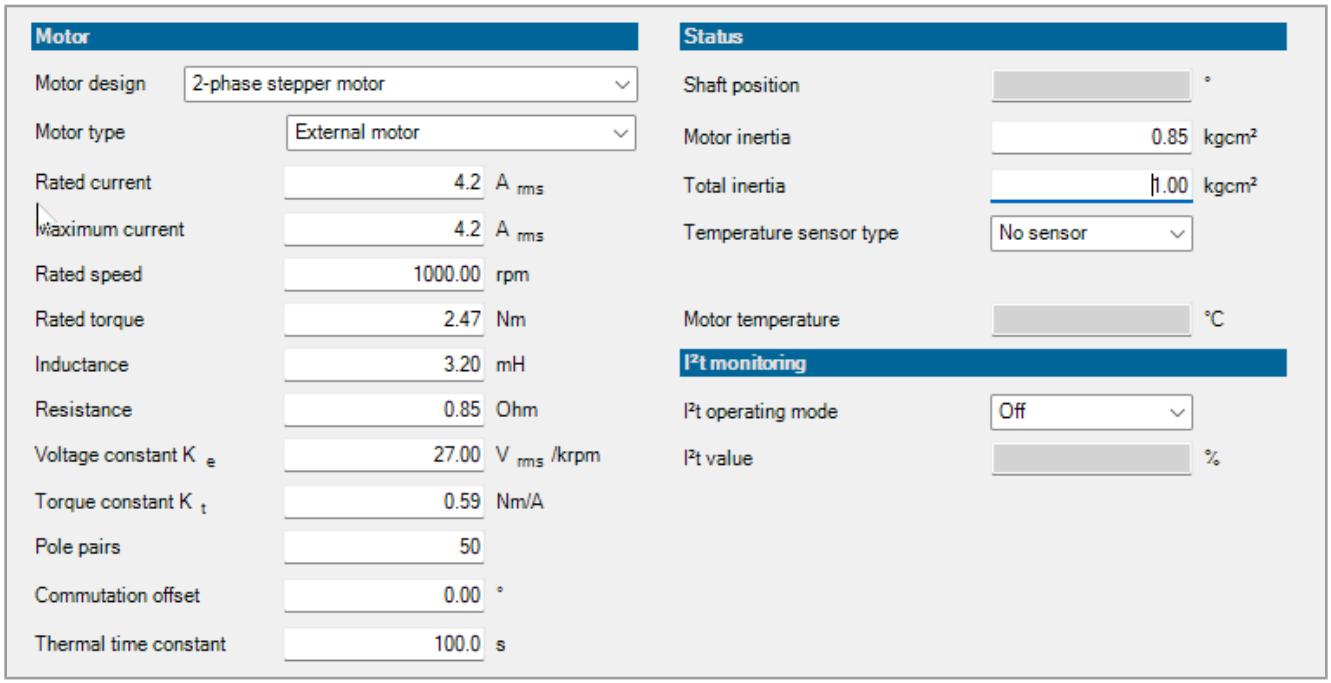


Fig. 3: Motor data 2-phase stepper motor

Design of the motor

1. Select 2-phase stepper motor.
2. Refer to the motor data sheet and torque/speed diagram for values.

Motor rated current

- Refer to the data sheet for the holding current data.

If this is not listed, it can be estimated from the torque/speed diagram.

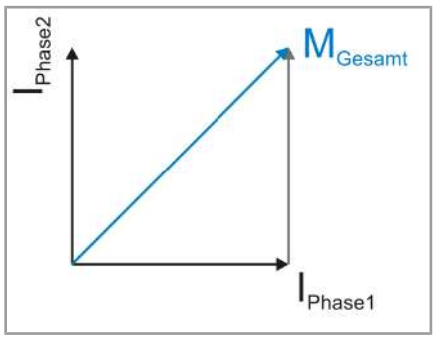
Maximum motor current

- Set it to the same value as the motor rated current.

Motor rated speed

- You must estimate these from the torque/speed diagram.

Motor rated torque



- Check the data sheet to see whether the specified holding torque is specified for one coil or both coils.

If both coils are supplied with the rated current specified in the data sheet, the resulting torque is the vector between the two "phase torques". Since these phases are at right angles to each other, the value for the "phase torque" must be 1/√2 of the holding torque.

1 coil: Holding torque from the data sheet

2 coils: Holding torque /√2

Motor inductance and motor resistance

- Refer to the data sheet for the phase values.

Torque constant

Rated torque / rated current

Voltage constant

at 48V → 27 V/rated speed

at 24 V → 17 V/rated speed

Number of pole pairs

Typically 50 (for stepper motors with a step angle of 1.8).

Thermal time constant

- This is required for I²t monitoring of the motor, and you must determine the value by testing the machine.

4.3.2 Motor data for regulated 2-phase stepper motor

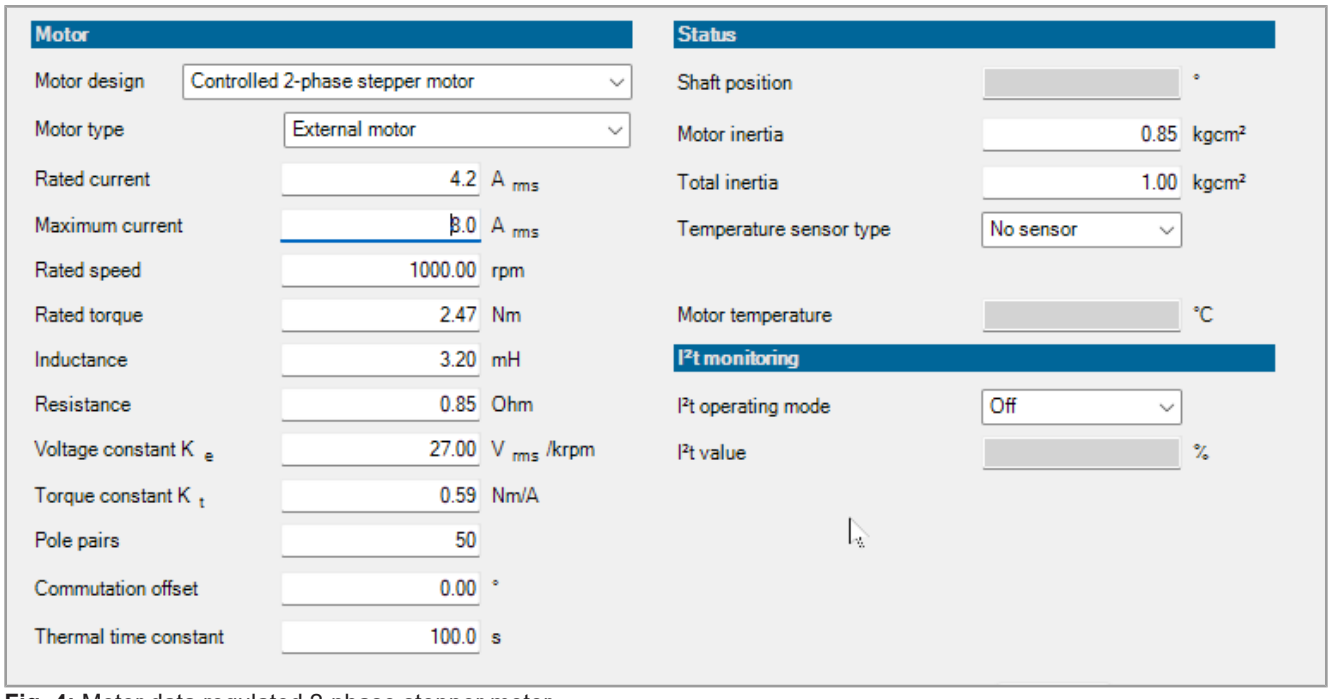


Fig. 4: Motor data regulated 2-phase stepper motor

Design of the motor

1. Select Regulated 2-phase stepper motor.
2. Refer to the motor data sheet and torque/speed diagram for values.

Motor rated current

- Refer to the data sheet for the holding current data.

If this is not listed, it can be estimated from the torque/speed diagram.

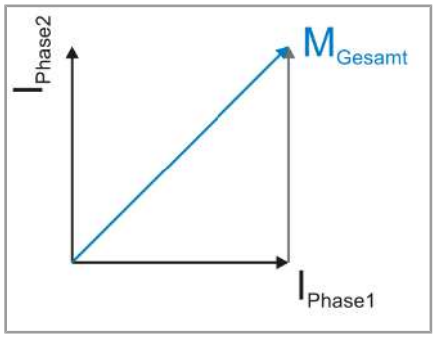
Maximum motor current

Approx. 2 * rated current (if this overload is used)

Motor rated speed

► You must estimate these from the torque/speed diagram.

Motor rated torque



► Check the data sheet to see whether the specified holding torque is specified for one coil or both coils.

If both coils are supplied with the rated current specified in the data sheet, the resulting torque is the vector between the two "phase torques". Since these phases are at right angles to each other, the value for the "phase torque" must be 1/√2 of the holding torque.

1 coil: Holding torque from the data sheet

2 coils: Holding torque /√2

Motor inductance and motor resistance

► Refer to the data sheet for the phase values.

Torque constant

Rated torque / rated current

Voltage constant

at 48 V → 27 V/rated speed

at 24 V → 17 V/rated speed

Number of pole pairs

Typically 50 (for stepper motors with a step angle of 1.8).

Thermal time constant

► This is required for the I²t and you must determine the value by testing the machine.

4.4 Adjusting the current regulator

2-phase stepper motor

1. Press the Current Controller Optimization button under *Current/Torque*.
2. Turn on the axis and
3. adjust the KP so that a slight whistling sound can be heard.
4. Then reduce the KP value by 20%.
5. Check the TN to see if the axle runs smoothly later on.

6. Check that the direction of rotation of the axis is correct.
   Positioning in the positive direction causes the shaft to rotate clockwise when viewed from the motor shaft. If this is not the case, swap the two connections of one motor phase.
7. Operate the axes in reverse mode.
8. Switch off the axis when everything is running satisfactorily.

Regulated 2-phase stepper motor

For motor

► Select 2-phase stepper motor under *Design of the motor*.

For encoder

1. Specify the *encoder resolution* with **1**.
2. Select **Not active** for *Encoder type* (this changes the operating mode to unregulated stepper motor operation).
3. Press the Current Controller Optimization button under *Current/Torque*.
4. Turn on the axis and
5. adjust the KP so that a slight whistling sound can be heard.
6. Then reduce the KP value by 20%.
7. Check the TN to see if the axle runs smoothly later on.
8. Check that the direction of rotation of the axis matches the counting direction.
   Positioning in the positive direction causes the shaft to rotate clockwise when viewed from the motor shaft. If this is not the case, swap the two connections of one motor phase.
9. Operate the axes in reverse mode.
10. Switch off the axis when everything is running satisfactorily.
11. Reactivate the encoder and select the regulated 2-phase stepper motor.
12. Briefly release the drive and lock it again (to change the motor and encoder operating mode).

4.5 Commutation search for regulated 2-phase stepper motor

✓ The motor shaft must be able to move freely.

► Perform the commutation search.

– This must also be executed later in the program before the first positioning after booting the controller.
– The drive uses the commutation search to find the assignment of the encoder position to the magnetic poles of the rotor.
– If this assignment is incorrect, no torque or insufficient torque can be applied, or the motor may stall.
– If errors occur during the commutation search, there are several options:
  – The motor shafts oscillate at the end of the function. In this case, it is often helpful to reduce the torque limit during commutation search and/or increase the filter time Tf in the speed controller.
  – The motor shaft cannot move sufficiently because there is insufficient torque. To give the shaft more torque, the motor rated current and motor rated torque can be increased by the same factor. However, it must not be set higher than the motor maximum current.

4.6 Adjust speed controller

2-phase stepper motor

Nothing can be adjusted on the speed controller, as the motor is only operated via the current controller.

Regulated 2-phase stepper motor

Reverse the drive, achieving the desired ramp slope and speed.

KP:

- ► Increase the value until you hear a humming noise, then reduce it again by approx. 20%.

TN:

- ► Reduce the value until a humming noise can be heard, then increase it again by approx. 20%.

Tf:

This value filters the encoder signals, which can lead to smoother operation as the values increase. However, higher values also mean greater dead time in the control system and thus also lower stiffness.

4.7 Adjust position controller

Kv:

- ► Increase the value until the motor starts to vibrate, then reduce it again by approx. 20%.

4.8 Pre-control

1. Leave the value for torque pre-control scaling at 0.
2. Leave the value for the speed pre-control scaling at 100%.

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