Application Note

FESTO

AppNote - Commissioning

Application note for commissioning the EHMD-40 and connectivity to the costumer system

EHMD-40-RE-GE,
EHMD-40-RE-GP

100275

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Table of contents

1 Components/Software used 5

2 Application description 6

3 Electrical commissioning 7

4 Festo Configuration Tool (FCT) 8

4.1 Installation of FCT 8

4.2 Allocation of EHMD axis to Motor Controllers 8

4.3 Setting up communication 10

5 Gripping axis 11

5.1 Homing 11

5.2 Positioning 12

5.3 Gripping with limited motor torque 12

5.4 Gripping with defined force in position mode 13

5.5 Influences on gripper force 16

5.6 Changing force while gripping 17

6 Rotation axis 18

6.1 Homing 18

6.2 Different moments of inertia 18

6.3 Acceleration 19

6.4 Limited torque 20

Table of contents

1 Components/Software used

Description	Type/Name	Date of manufacture
Rotation-gripping-module	EHMD-40-RE-GE	--
Motor cable	NEBM-SF1W31-EH-2.6-Q15N-LE-28	--
Flat flex cable	NEBM-F1W31-EC-0.3-F1N-DF1W31	--
Motor controller for rotation	CMMO-ST-C5-1-LKP	--
Motor controller for gripping	CMMO-ST-C5-1-LKP	--
Power Supply	24 VDC	--

Table 1.1: 1 components

Type/Name	Version Software/Firmware	Date of manufacture
Firmware for CMMO-ST-...	--	--
Festo Configuration Tool (FCT)	--	--
CMMO-ST Plugin for FCT	--	--

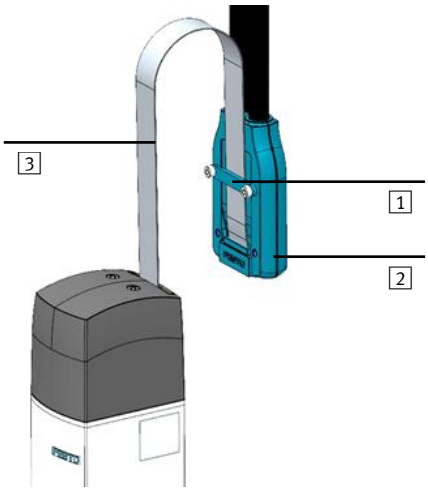
Table 1.2: 1 Software used

2 Application description

This application note describes the commissioning of the rotation-gripping-unit EHMD.

- Electrical commissioning
- Configuration of motor controller CMMO-ST via FCT

3 Electrical commissioning



[1] motor cable with adapter
[2] strain-relief
[3] flat flex cable

Fig. 3.1: Motor cable

1. Attach the motor cable with adapter. If there is a z-axis it has to be placed in a way that the flexible flat cable can do a rolling motion with a radius bigger than 25 mm within the whole travel of the z-axis.
2. Plug the flat cable into the adapter and clamp it with the strain-relief.
3. Connect the motor cable to the motor controllers.
4. Connect the motor controllers to the PLC.
5. Connect GND and power for motor controllers and PLC.

See documentation of EHMD, cable, CMMO and PLC for details.

4 Festo Configuration Tool (FCT)

The Festo Configuration Tool is used to set up the Festo Motor Controllers.

4.1 Installation of FCT

1. Download FCT with Plugin for CMMO-ST from Support Portal
2. Unzip and install configuration package

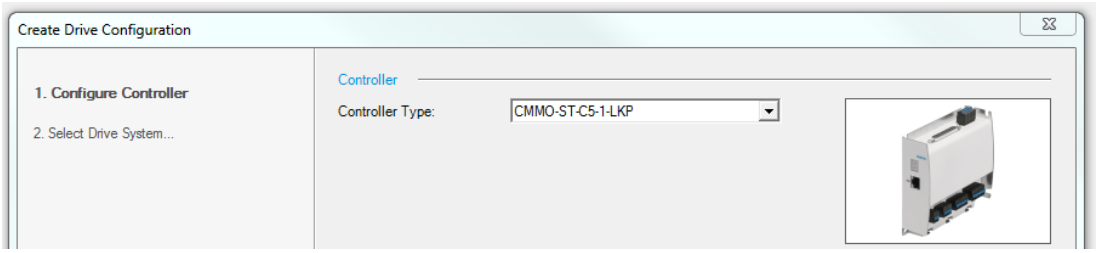
If FCT is already installed but without plugin for CMMO-ST. You only have to install the CMMO-ST plugin.

4.2 Allocation of EHMD axis to Motor Controllers

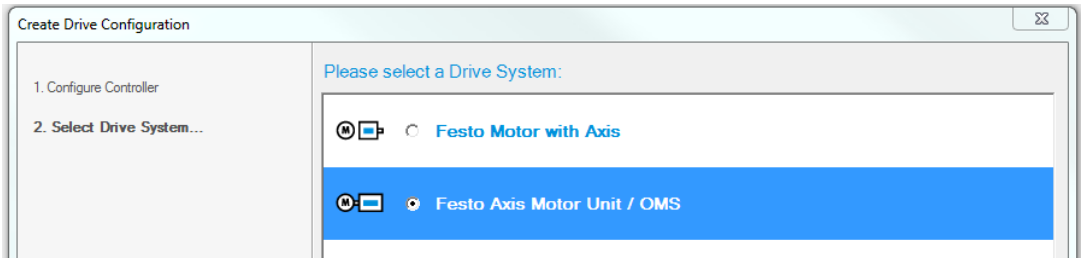
Rotation-gripping-unit	function	Axis motor unit in FCT
EHMD-40-RE-GE	rotation	EHMD-40-RE
	gripping	EHMD-40-...-GE
EHMD-40-RE-GP	rotation	EHMD-40-RE-GP
	gripping	-

Table 4.1: Axis motor units in FCT

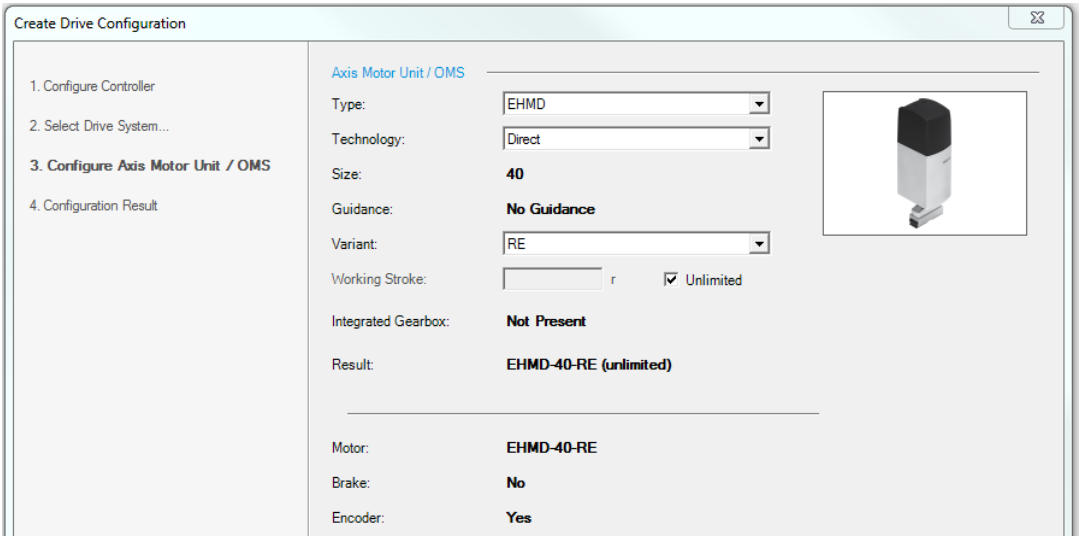
1. Open FCT
2. Create a new project (name for example ”EHMD”)
3. Add component (Controller for rotation axis)
   - Select CMMO-ST
   - Name for axis for example “Rotation”
   - Create new configuration
   - Select controller type



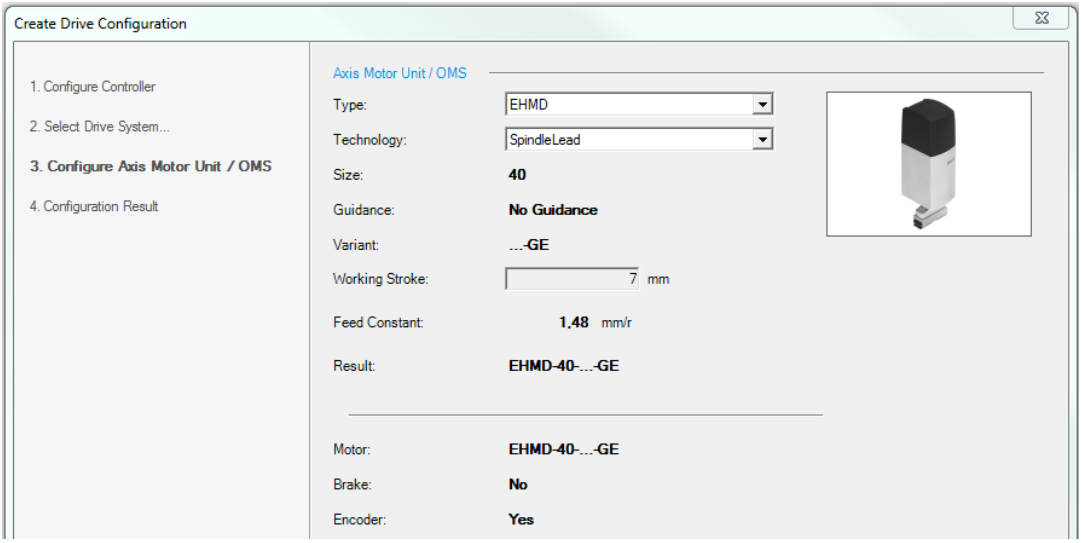
   - Select drive system [Festo Axis Motor Unit]



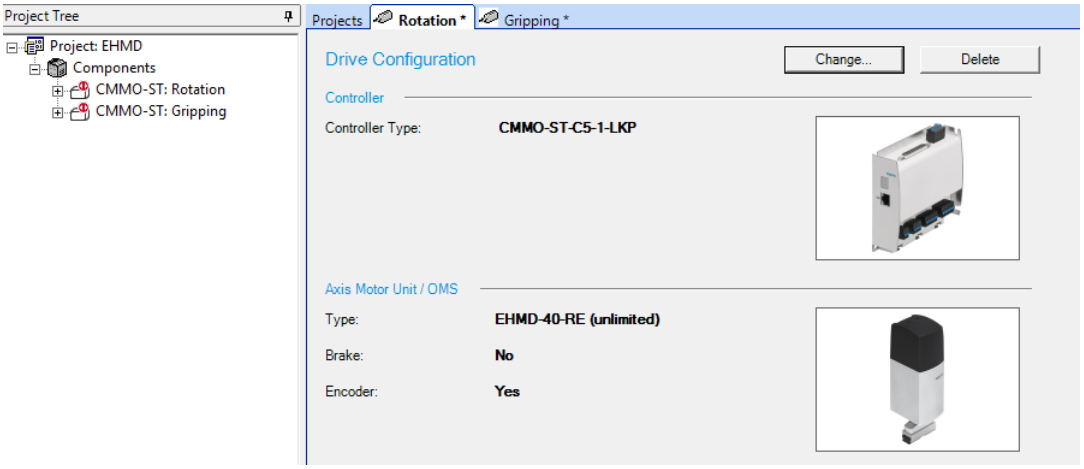
   - Select Configuration for rotation axis
     Select Type: [EHMD]
     Select Technology: [Direct] for rotation
     Select Variant: [EHMD-40-RE] or [EHMD-40-RE-GP] for rotation (both are identical)



4. Add new component (for gripping axis)
   Same procedure as for rotation axis but different configuration in last step:
   - Select configuration for gripping axis
     Select Type: [EHMD]
     Select Technology: [SpindleLead]



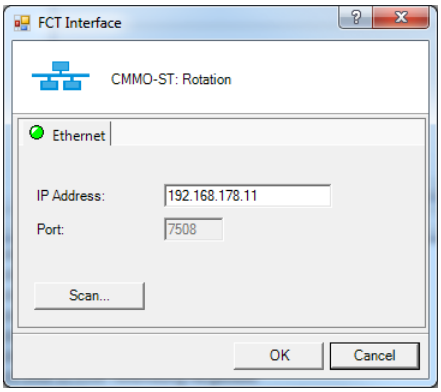
In the project tree on the left you can see a project with two components. One with CMMO-ST for rotation and one with CMMO-ST for gripping.



4.3 Setting up communication

Communication has to be set up for each Component

1. Select component in project tree
2. Select Menu -› Component -› FCT Interface



1. Type in the IP address if known or press [Scan...] to open “Festo Field Device Tool” to scan for connected controllers.

5 Gripping axis

Caution

Gripper drive might be damaged

The gripper is designed only to grip in closing direction. In the electrical gripper drive there is a spring which is deflected when the gripping force acts. This spring can only deflect in one direction.

5.1 Homing

There is no end switch for homing the gripper jaw position.

The gripper can slowly be opened until block for homing.

Homing in close direction is not possible because there is a spring and no hard stop.

Caution

Gripper drive might be damaged

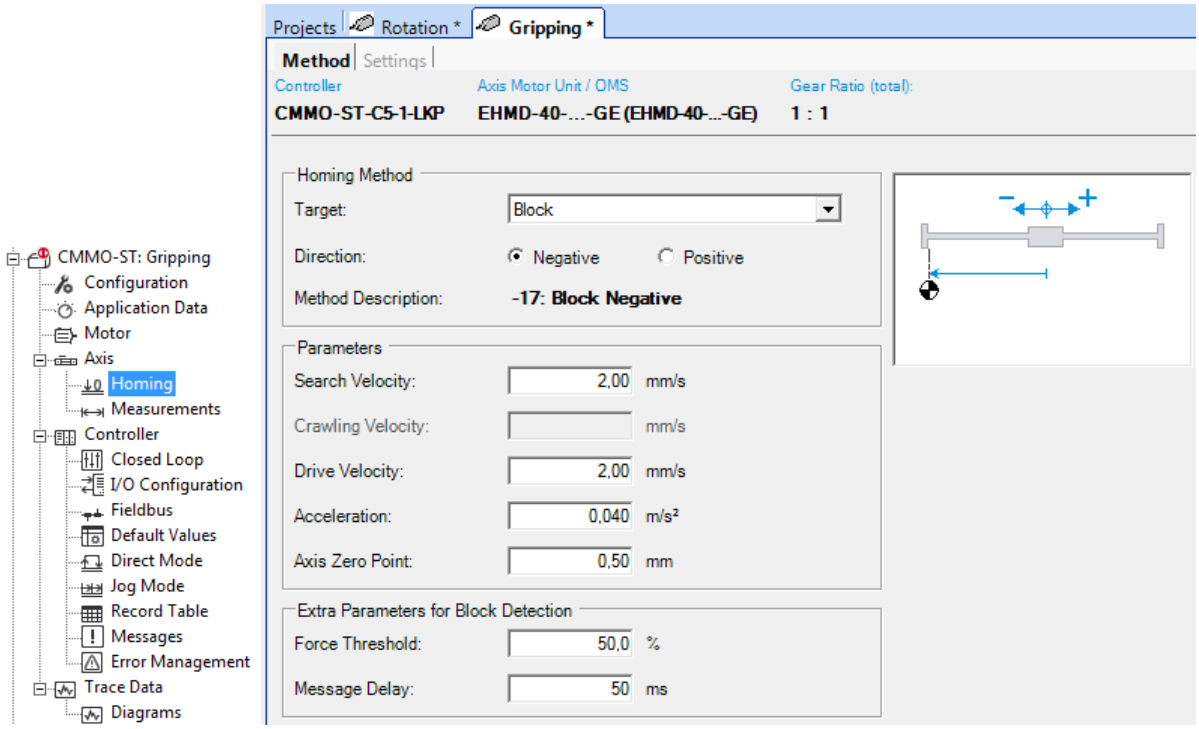
The velocity for homing to block mustn't exceed 2 mm/s (per jaw). Otherwise the EHMD could be damaged.

With CMMO-ST there is no possibility to do homing to block in open loop mode so use closed loop mode.

Closed Loop

1. Select Homing Method [Block] and direction [negative]
2. Ensure, that search velocity is not higher than 2 mm/s.
3. Torque limit can be reduced to for example 50 %.
4. Define axis zero point to for example 0,5 mm.
5. Start homing

Gripper will open till mechanical stop and then close a little bit to the configured zero point.



Open loop

If using an open loop controller the gripper can be opened to block with reduced current and low velocity (e.g. I = 150 mA , v = 2 mm/s).

1. Set the target position to a value which can't be reached (behind the block) and start the motion.
2. The motor will lose steps if the block is reached until it arrives at the target position.
   This will produce strange sounds.
3. Set position counter = current position - offset for 0 position.
4. Move to 0 position

5.2 Positioning

Gripper jaws can be positioned within the whole stroke.

Due to the play in the gripper kinematic there is a hysteresis of about 0,3 mm when changing direction.

When a gripping force is acting a part of the travel is used to deflect a spring within the gripper drive which means there is a force dependent deviation between the jaw position in the motor controller and the actual position of the jaws.

5.3 Gripping with limited motor torque

The gripping force can be controlled by the torque of the motor.

Ensure to set the nominal current to 0,5 A. Otherwise the %-values in the diagrams don't match the force values.

Closed Loop

Use one of the following record types.

T-Title	
FSL	Force Control – stroke limit active
F	Force Control – stroke limit off

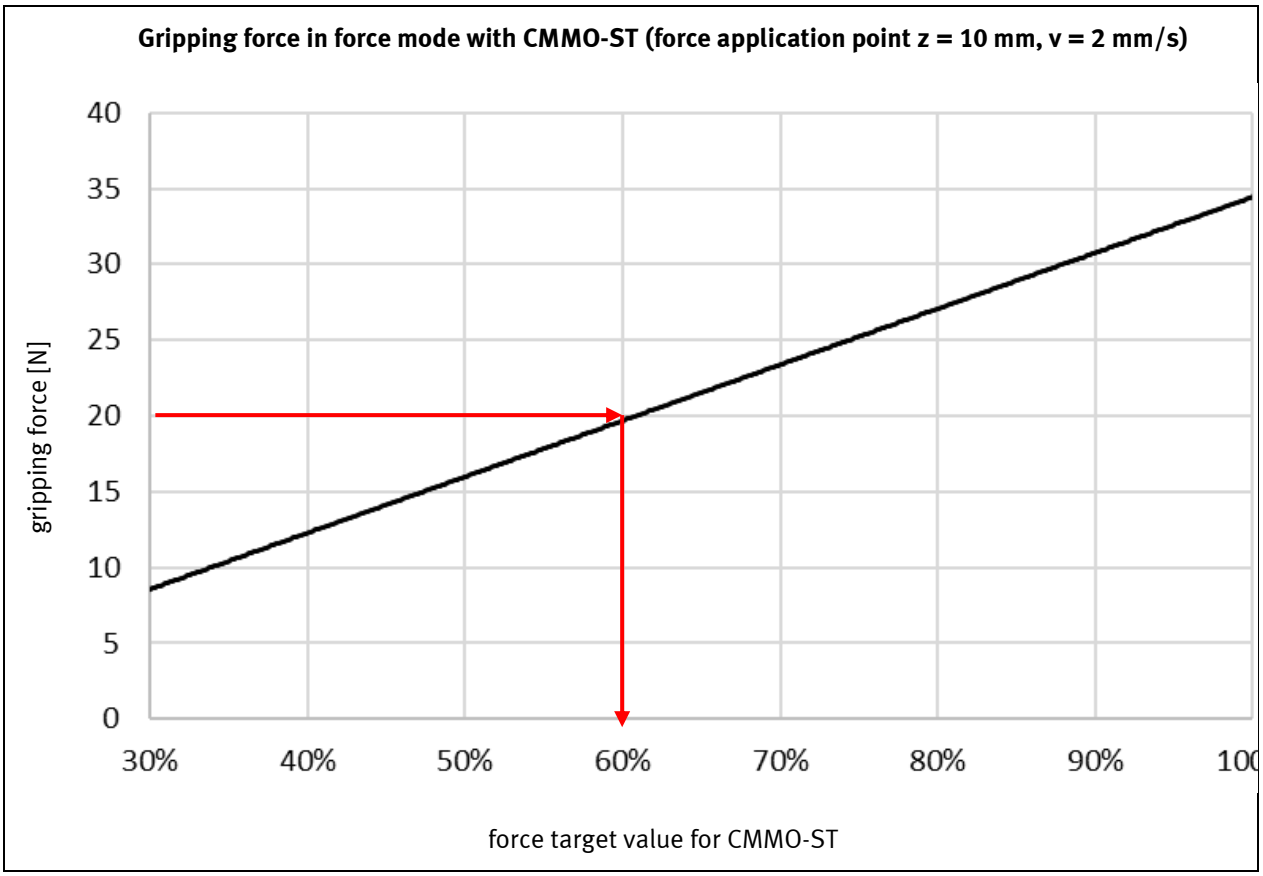
Table 5.1: Table force modes

The motor will turn position controlled with the configured parameters until the force limit is reached. Then it changes to torque control and a "motion complete" is reported. The force is held until the next position command is initiated.

In FSL-mode the motor also stops if the configured stroke limit is reached.

Example

A workpiece has to be gripped with a force of 20 N.



➔ Motor torque has to be set to 60 % (based on nominal current of 0,5 A)

Open loop

Another method to limit the motor torque is to limit the motor current in open loop mode and to turn until steps are lost.

Some controllers can detect loss of steps without encoder, others need an encoder to do that. If steps are lost you might have to repeat homing if an exact positioning of the gripper jaws is important for your application.

5.4 Gripping with defined force in position mode

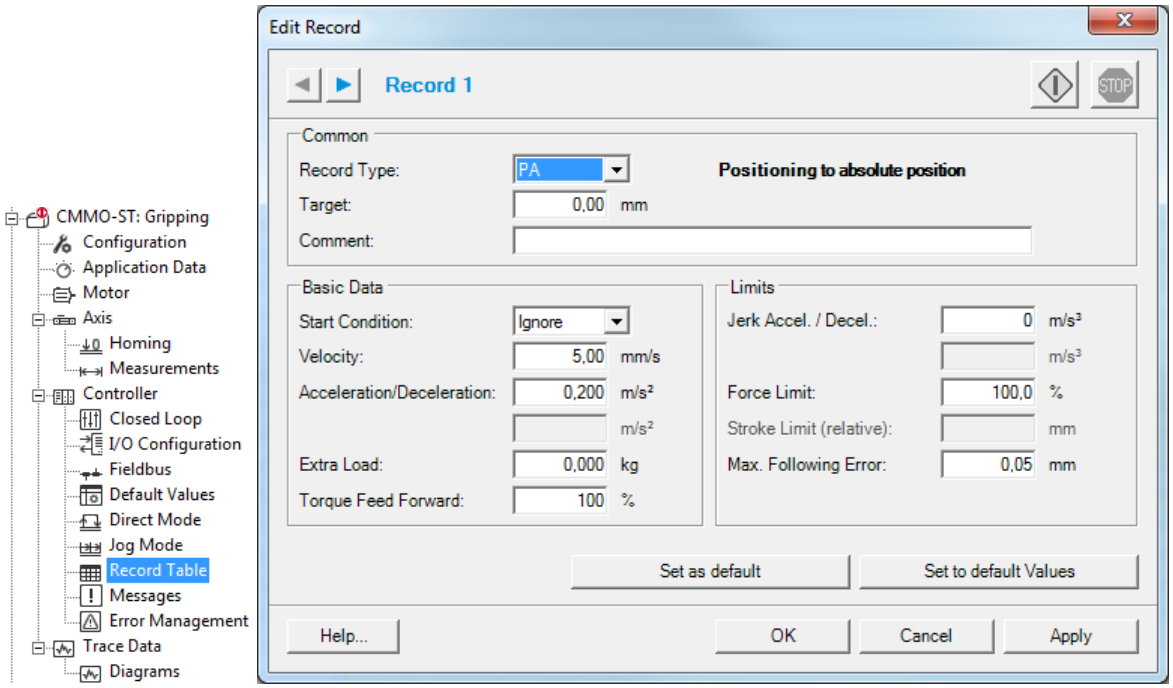
There is a spring within the gripper drive. Gripping force can be controlled by a defined deflection of this spring. Therefore the motor can be driven in position mode without torque control. So it doesn't matter whether open or closed loop mode is used.

Use one of the following record types.

T-Title	
PA	Positioning to absolute position
PRN	Positioning relative to nominal position
PRA	Positioning relative to actual position

Table 5.3: Table positioning modes

Gripping axis



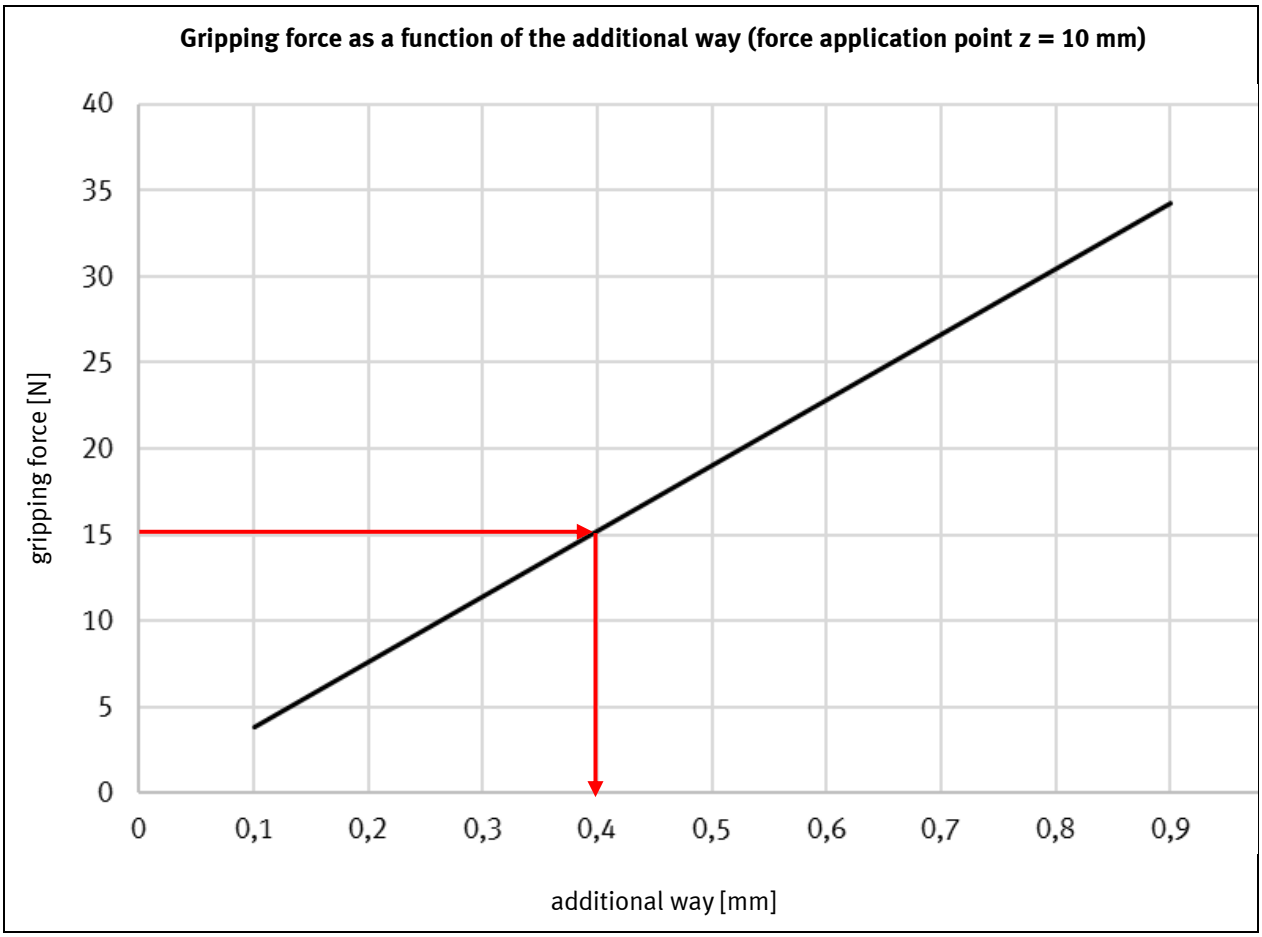
To grip with a defined force in position mode the size of the workpiece has to be known.

When the gripper jaws touch the part the target position is increased by a value according to the desired force.

Example

Yaws touch workpiece at position 3,2 mm.

Workpiece hast to be gripped with a force of 15 N.

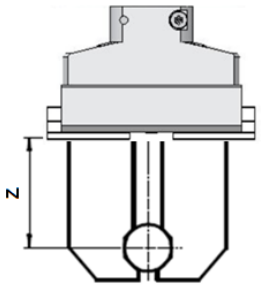


Target position should be set to 3,2 mm + 0,4 mm = 3,6 mm

5.5 Influences on gripper force

Position of force / length of gripper fingers

The gripping force is reduced by friction in the jaw guides. The friction increases with the distance between the gripper and part in z direction. So gripping fingers should be as short as possible.

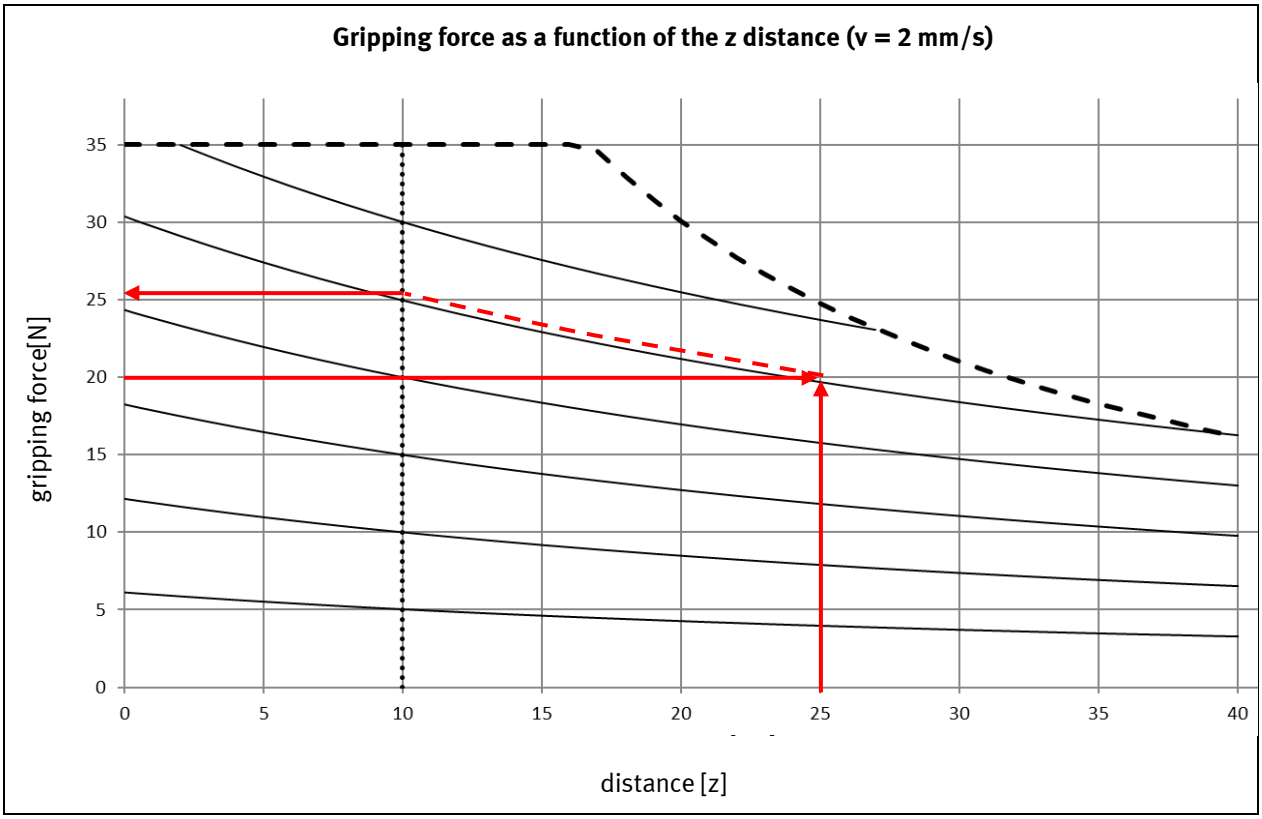


Force values in most tables and diagrams of technical data are valid for a z distance of 10 mm. If the distance differs from 10 mm you have to determine an equivalent force by the following diagram.

Example

A workpiece hast to be gripped with a force of 20 N.

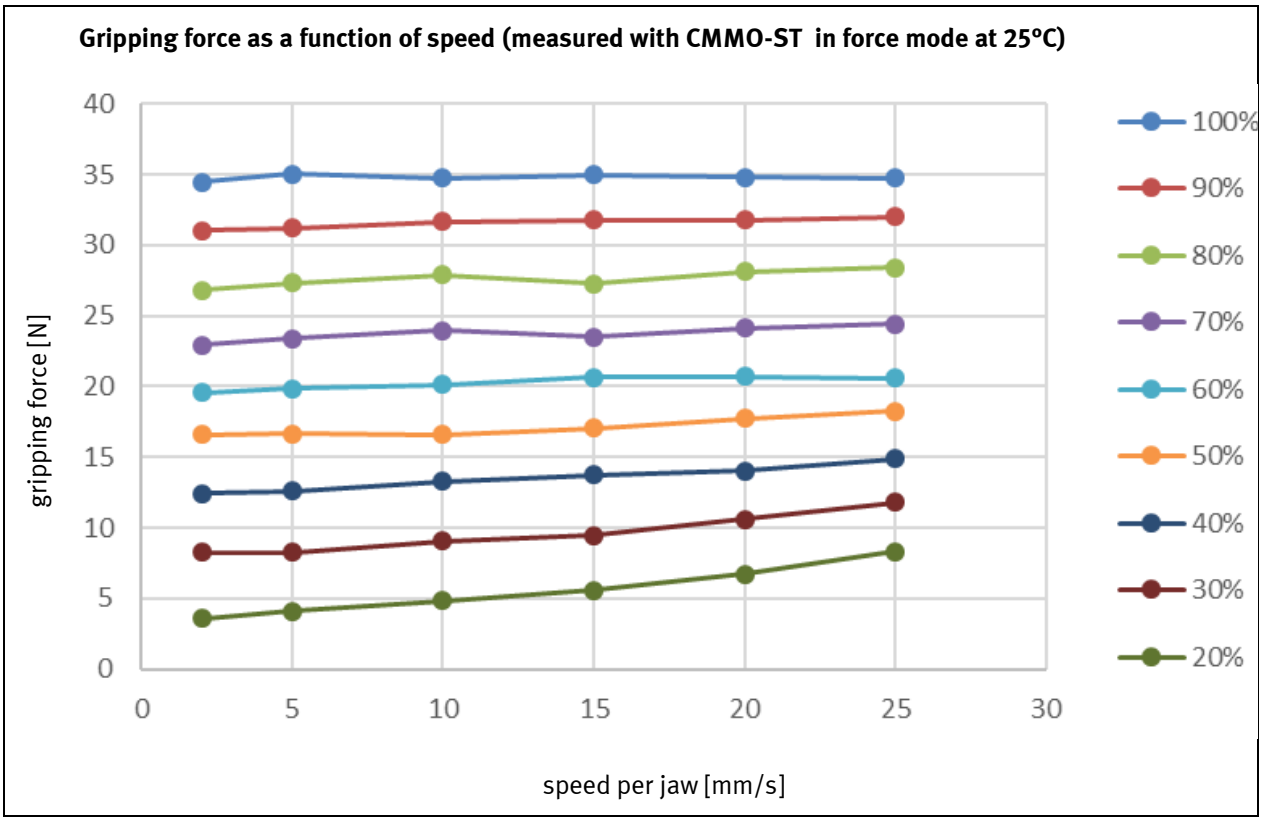
The gripping force acts at a distance of 25 mm in z direction.



➔ The equivalent force at a z distance of 10 mm is 26 N.

Velocity

When controlling the force by motor torque, there is a correlation between jaw velocity and gripping force.



For high forces this can be neglected. To achieve very low forces you have to drive slow.

5.6 Changing force while gripping

For decapping application (see application note ...) it can be necessary to change the gripping force while gripping.

In torque mode it is not possible to change the gripping force without opening it. You have to open the gripper a little bit and close it again with a lower torque. The reason is the large hysteresis because of friction in the lead screw mechanism.

To change the force without opening the gripper, the current position can be changed in positioning mode.

When changing the position the deflection of the spring is changed. There is no big hysteresis between the spring force and the gripping force so the gripping force can be increased or decreased in this way.

6 Rotation axis

T gripper can be rotated endlessly while gripping. This is realized by a direct drive with a stepper motor.

Information

Due to torque ripple in the motor there is a ripple in rotation velocity.

Depending on the used motor controller, the drive mode (open loop or closed loop) and the rotation speed this ripple can be higher or lower.

At low speeds (< 50 rpm) it is normally not noticed.

There are parts in the gripper which have play if the gripper is open. At speeds between 80 rpm and 150 rpm these parts can lead to rattling sounds.

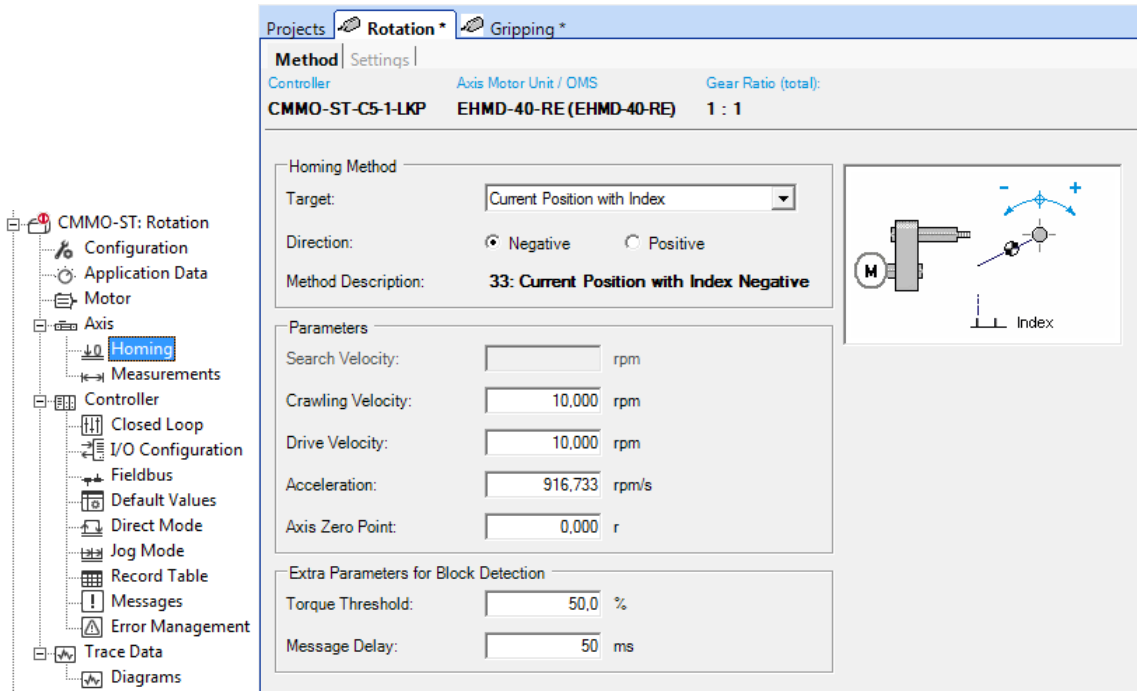
The sound disappears almost completely when the gripper is closed.

There is no increased wear or reduction in lifetime if this sound appears.

6.1 Homing

There is one encoder index per revolution of the gripper. This encoder index is mechanically adjusted to the angle of the gripper and can be used for homing of the rotation axis. This homing method is possible in closed and open loop mode.

1. Select homing method [Current Position with Index]
2. Set search velocity (for example 10 rpm)
3. The torque limit can be reduced if closed loop mode is selected (for example 50%)
4. Define axis zero point (angular offset to adjust Gripper angle at zero position).



5. Start homing to test parameters

As mentioned above, in closed loop mode the velocity is not very smooth especially with low velocities.
For homing the velocity mustn't be too high. About 10 rpm are a good value.

6.2 Different moments of inertia

The default parameters work for the gripper without an additional moment of inertia. When big gripper fingers are mounted the moment of inertia of the rotation axis is increased. It can be necessary to adjust the parameters of velocity loop.

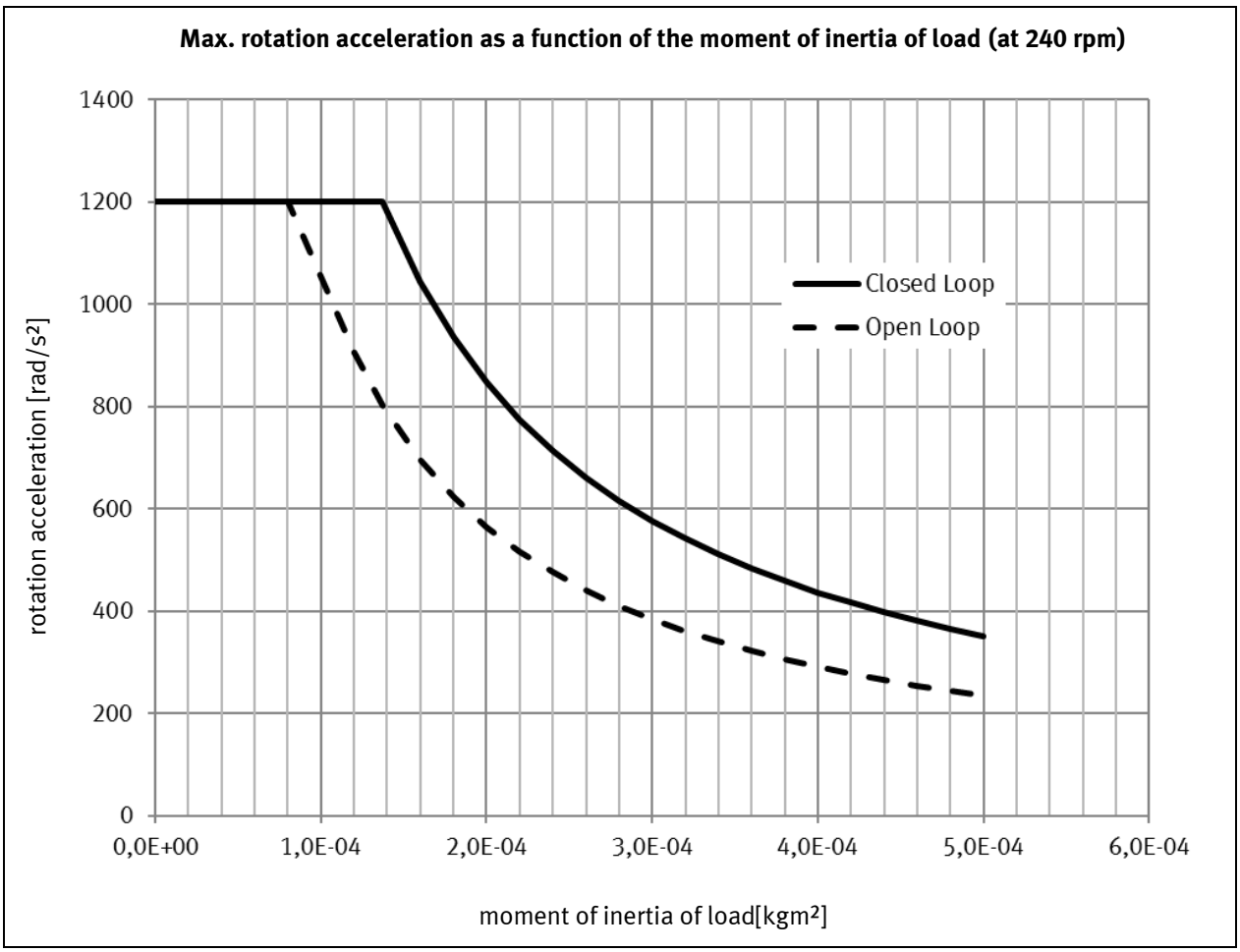
If big workpieces are handled, the moment of inertia changes within one application. In closed loop mode this can be a problem because the parameters of closed loop can't be optimised both for small and large moments of inertia. With CMMO-ST switching between different parameters is not possible.

In this case open loop mode should be selected.

6.3 Acceleration

The required motor torque depends on the moment of inertia and the acceleration of the rotation. So acceleration should not be chosen unnecessary high.

Especially with high moments of inertia and in open loop mode it is important not to accelerate too fast.



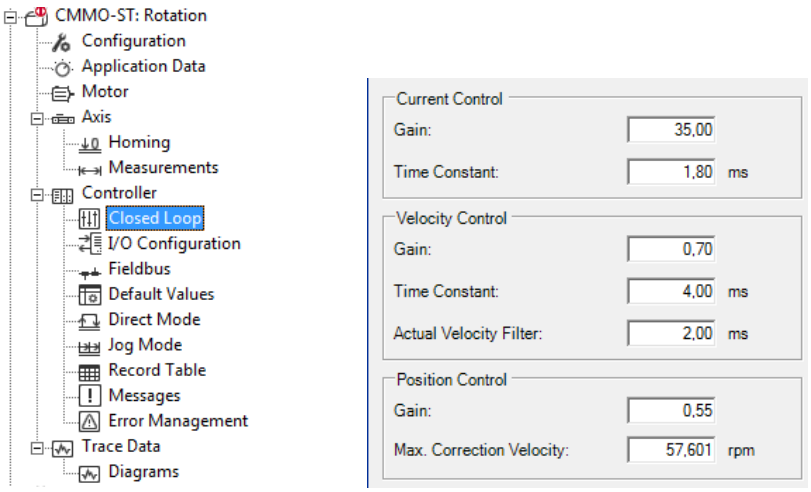
Closed Loop

In closed loop mode controller parameters have to be adjusted for different moments of inertia.

If handling different moments of inertia in one application there might be problems with closed loop control.

Due to low encoder resolution and torque ripple of the motor it is difficult to find a configuration which moves smooth and precise.

There is no automatic calculation of parameters for additional moments of inertia in FCT, so parameters have to be adjusted manually.



Current control is independent from moment of inertia of load. -> no changes necessary

Especially gain and time constant of the velocity control loop have to be adjusted.

The gain of position control usually doesn't have to be changed.

If no good configuration can be found it might be better to drive open loop.

Open Loop

In open loop mode there are no parameters which must be adjusted as a function of inertia.

In this mode the motor can lose steps if the torque gets too high. So ensure to have enough torque reserve to minimize the danger of step loss. Especially with high moments of inertia it is important not to accelerate to fast.

After each motion the encoder position should be checked to ensure, that no steps were lost or to compensate lost steps.

6.4 Limited torque

For closing screw caps with a defined torque the torque of the rotation axis has to be limited. Limiting torque is possible by limiting motor current.

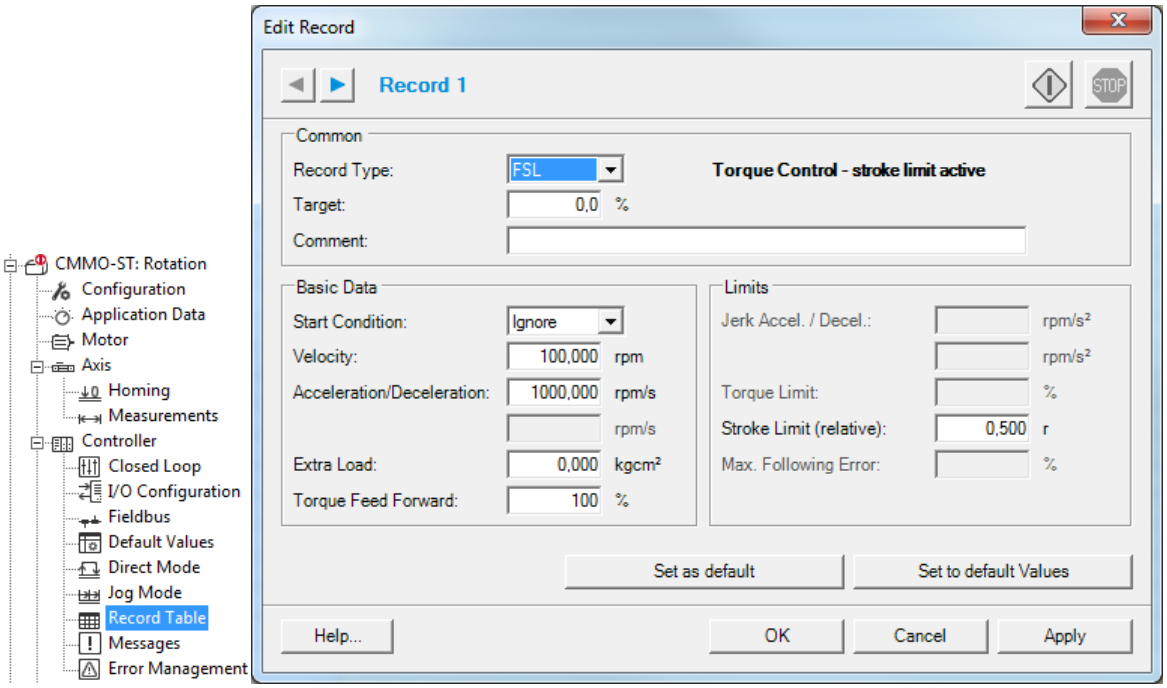
Ensure to set the nominal current to 0,9 A. Otherwise the %-values in the diagrams don't match the force values.

Closed Loop

Use one of the following record types.

T-Title	
FSL	Torque Control – stroke limit active
F	Torque Control – stroke limit off

Table 6.1: Torque modes



The motor will turn position controlled with the configured parameters until the torque limit is reached. Then it changes to torque control and a “motion complete” is reported. Torque is held until a next move is initiated.

In FSL-mode the drive also stops if a configured stroke limit is reached.

Open loop

In open loop mode the torque can also be limited by the motor current. If the torque according to the motor current is reached the motor stops and steps are lost. If the controller can recognize the step loss movement should be immediately stopped to avoid the sound of losing steps (not possible with CMMO-ST). If there is no encoder it might be necessary to do a homing after that.