Application Note

FESTO

EHMD - Application Example

Application note for application example for the EHMD-40 to be used for a decapping and recapping.

EHMD-40-RE-GE

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1 Components/Software used

Description	Type/Name	Date of manufacture
Rotation-gripping-module	EHMD-40-RE-GE	--
Adapter with z-compensation	EHAM-E20-40-Z	--
Adapter	EHAM-E20-40-E19-25	--
Z-axis	EGSC-BS-KF-32-75-8P	--
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	--
Motor controller for Z-axis	CMMO-ST-C5-1-LKP	--
Sensor for z-compensation	SIES-8M-...	--
PLC	--	--
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

1.1 Passive z-compensation

With the passive z compensation treads can be screwed up and down without the need of a synchronized movement of z-axis and rotation axis.

There are several advantages:

- No need for path interpolation in PLC
- No need for real time capable bus connection between motor controller and PLC
- Low requirements for electrical hard- and software
- Pitch of thread doesn't matter (needn't be known)
- Angle position of beginning of thread needn't be known or can easily be detected
- No jamming if cap or vial is slipping a little bit

1 inductive switch (SIES- 8M-...)
2 switch lug
3 weight compensation
4 slide for z compensation

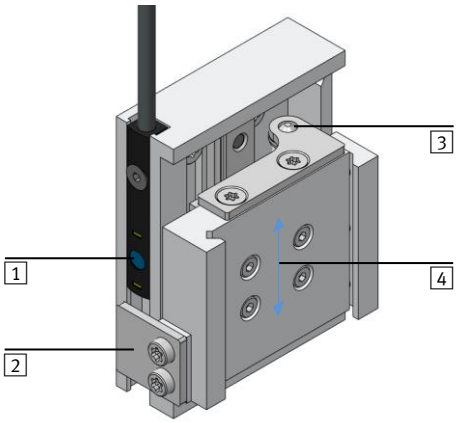

Fig. 1.1: Adapter with passive z-compensation (EHAM-E20-40-Z)

1.1.1 Weight compensation

There is a spring which pushes the slider upward to partially compensate the weight of EHMD.
This ensures that only low forces act on the tread of the vial.

1.1.2 Sensor

There is a T-slot for an inductive switch sensor to detect a defined travel of the slider of the z-compensation.
This signal can be used to compensate tolerances of the height of vials or to find the angular beginning of the Thread. The switch position of the sensor can be adjusted by the clamping position within the t-slot. For most applications it can be adjusted to the middle of the stroke.

2 Application description

This application note describes how you can execute a decapping and recapping process with the EHMD-40-RE-GE on a vial with thread cap.

The required torque to open must be smaller than 0,3 Nm.
Such vials are for example used in medical automation. They typical have a cap diameter smaller than 22 mm.

1 cap
2 vial

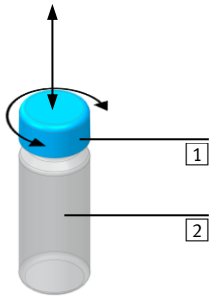

Fig. 2.1: Vial

Decapping

- Open cap of the vial
- Lift cap off the vial

Recapping

- Put cap on vial
- Look for beginning of thread by left hand rotation
- Screw cap on vial with limited torque

3 Commissioning

3.1 Mechanical commissioning

1. Attach z-axis to structure of application
2. Attach adapter plate to slider of z-axis
3. Attach assembly kit with z-compensation to adapter
4. Plug in flexible flat cable to rotation-gripping module
5. Attach rotation-gripping module to slider of z-compensation
6. Attach gripper fingers to gripper. The Fingers must be manufactured suitable for the caps of the vials.
7. Attach device for clamping the vial while decapping (for example pneumatic gripper with special gripper fingers)

For detailed assembly information (torque for screws ...) see customer documentation of particular component.

[1] z-axis
[2] adapter plate
[3] sensor for z-compensation
[4] assembly kit with z-compensation
[5] rotation-gripper-module EHMD
[6] gripper fingers
[7] clamping device for vial

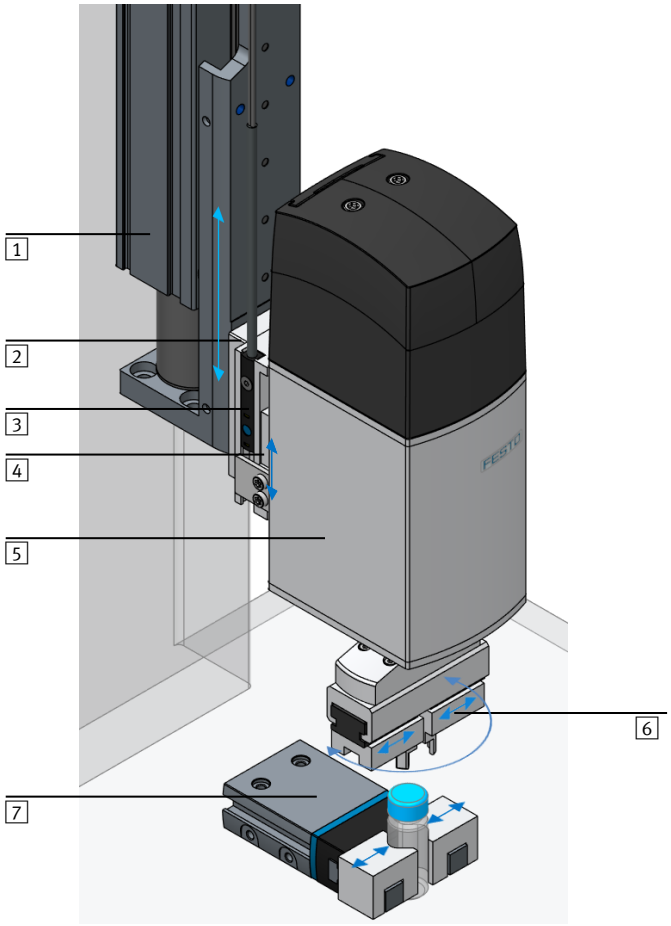

Fig. 3.1: Mechanical assembly

3.2 Electrical commissioning

1. Attach the motor cable with adapter so 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.

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

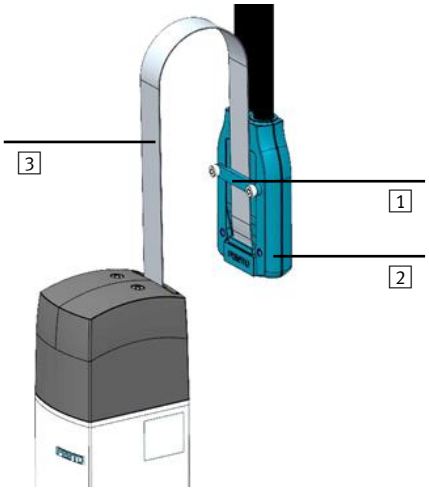

Fig. 3.2: Motor cable

1. Connect the motor cable to the motor controllers.
2. Connect the motor controllers to the PLC.
3. Clamp the sensor for the z-compensation in the t-slot and connect it to the PLC. Adjust the switching position to roughly the middle of the stroke.
4. Connect GND and power for motor controllers and PLC.

See documentation of EHMD, CMMO and PLC for details

3.3 Configuration

See ‘AppNote EHMD – Commissioning’ for configuration of motor controllers.
See documentation of CMMO to configure interface to PLC.

4 Application example decapping/recapping

4.1 Application process decapping

Operation Mode

For decapping the rotation axis can be controlled in position mode. Force mode is not necessary. It is even possible to drive the motor open loop.

Start situation

The vial with cap has been positioned in the clamping device manually or by an additional handling system.

1. Open the gripper.
2. Lower the z-axis slowly until the sensor of the z-compensation device is activated.

   When the gripper fingers hit the cap of the vial the z-axis carries on moving while the z-compensation travels until the sensor is activated.

   If the height of the vial is always the same, the z-axis can be positioned to an absolute position independent from the sensor signal.

3. Close the gripper fingers in force mode.

   The force has to be set high enough to transfer the necessary torque to the cap without slipping. If it is chosen to high the cap is deformed and the friction between cap and vial increases.

4. Rotate the gripper counterclockwise a few degrees to untighten the cap.
5. If the cap is soft, the gripping force should now be decreased before the rotation is continued. Otherwise the cap might be deformed once it isn't supported by the vial any more.

   Reducing gripping force without opening the gripper isn't possible in force mode with the CMMO controller. In force mode you have to open the gripper a little bit and close it again with a reduced force.

   In positioning mode the gripping force can directly be reduced without opening the gripper first. The force is reduced by turning the gripper motor backwards some degrees to release the spring in the gripper drive a little bit and thereby reducing the gripping force.

6. Continue the rotation to open the cap.

   The z-axis is standing still while screwing. The z-movement is done by the z-compensation device.

   The cap should be turned a little further than necessary to reliably unlock the thread.

7. Move the z-axis upward to lift off the cap from the vial.

   The distance until the sensor signal changes can be monitored while moving the z-axis. If the process is successful this distance should always be the same within a typical tolerance.

4.2 Application process recapping

Operation mode

For recapping the torque of the rotation motor must be limited. Therefore the motor controller is setup to closed loop mode. The torque limit can be applied by a torque limit in position mode or by using the force mode.

Start situation

A vial that has been decapped is still clamped inside the clamping device while the cap is securely held between the gripper fingers.

1. Lower the z-axis slowly until the sensor of the z-compensation device is activated.
2. Look for the beginning of the thread if necessary (see next chapter).
3. Begin screwing by rotating the gripper clockwise.

The z-axis is not moved while screwing. The z-movement is done by the z-compensation device.

4. Just before the end the rotation is stopped and the gripping force is increased to the value needed for transferring the necessary torque to tighten the cap.

If the cap doesn't deform easily the whole process can be done with the high gripping force.

5. Continue screwing to tighten the cap.

This can either be done in positioning mode with a reduced torque limit or in force mode with a force (torque) limit. The target position must be set to a position where the necessary torque is higher than the set torque limit to guarantee that the torque limit is reached.

Positioning mode

If a normal 'motion complete' occurs the target position (not torque) has been reached. In This case the cap slipped in the gripper fingers or the vial slipped in the clamping device or the thread didn't catch.

If the rotation is stopped by the torque limit a contouring error occurs which must be acknowledged.

If the contouring error is configured as a warning the positioning command has to be stopped additionally.

Force mode

If the torque increases the rotation stops and a 'motion complete' occurs while the torque is kept constant.

The force command has to be stopped by the PLC. The reached position should be verified to see if the process was successful.

4.3 Finding the beginning of the thread

For soft caps variable gripping force can be necessary. Therefore the beginning of the tread must be known in order to also now the final position to increase the force just before the cap is completely closed.

Some threads have a critical zone where the beginning of the treads of vial and cap overlap only a little bit. If screwing is started from this position the cap might get jammed.

Normally the beginning of the thread is known if the vial was decapped just before.
If it is not known it can be found by the following sequence.

1. Lower the z-axis slowly until the sensor signal of the z-compensation device is activated.

When the cap hits the vial the z-axis carries on moving while the z-compensation device travels until the sensor is activated.

Due to the braking ramp the z-axis moves a short distance into the “high” area of the sensor. Depending on the rotation angle there are different positions of the z-axis where the sensor becomes high.

If the tolerance of the height of vials is low the z-axis could always be driven to the same absolute position independent of the signal of the sensor.

2. Slowly rotate the gripper counterclockwise until the sensor signal becomes low -› the beginning of the thread is found

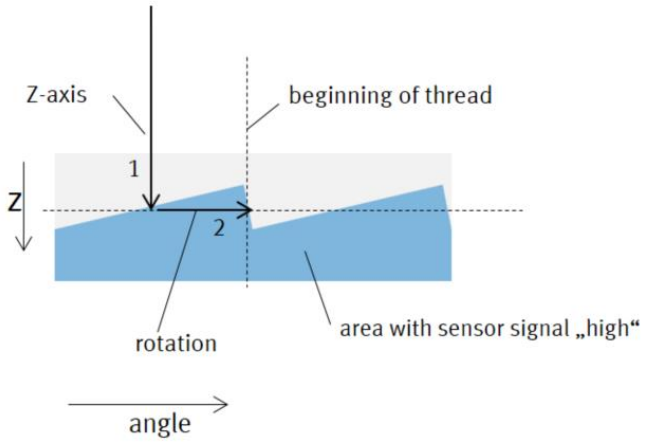

Fig. 4.1: finding the beginning of the thread

3. If the signal doesn’t become low within one turn of the gripper, the z-axis is moved up by the amount of about half the thread-pitch. Then step 2 is repeated.

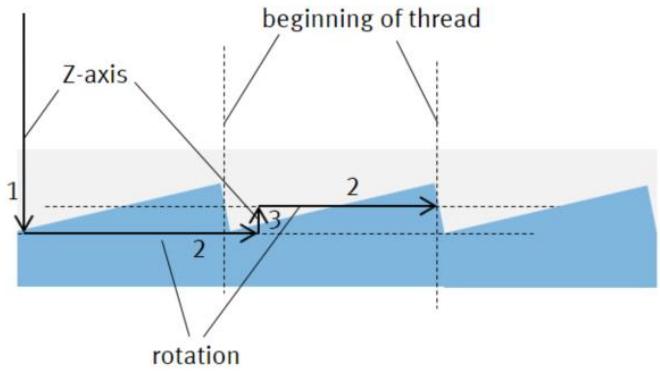

Fig. 4.2: finding the beginning of the thread if first trial failed