Parallel kinematic system

EXPT-45-...

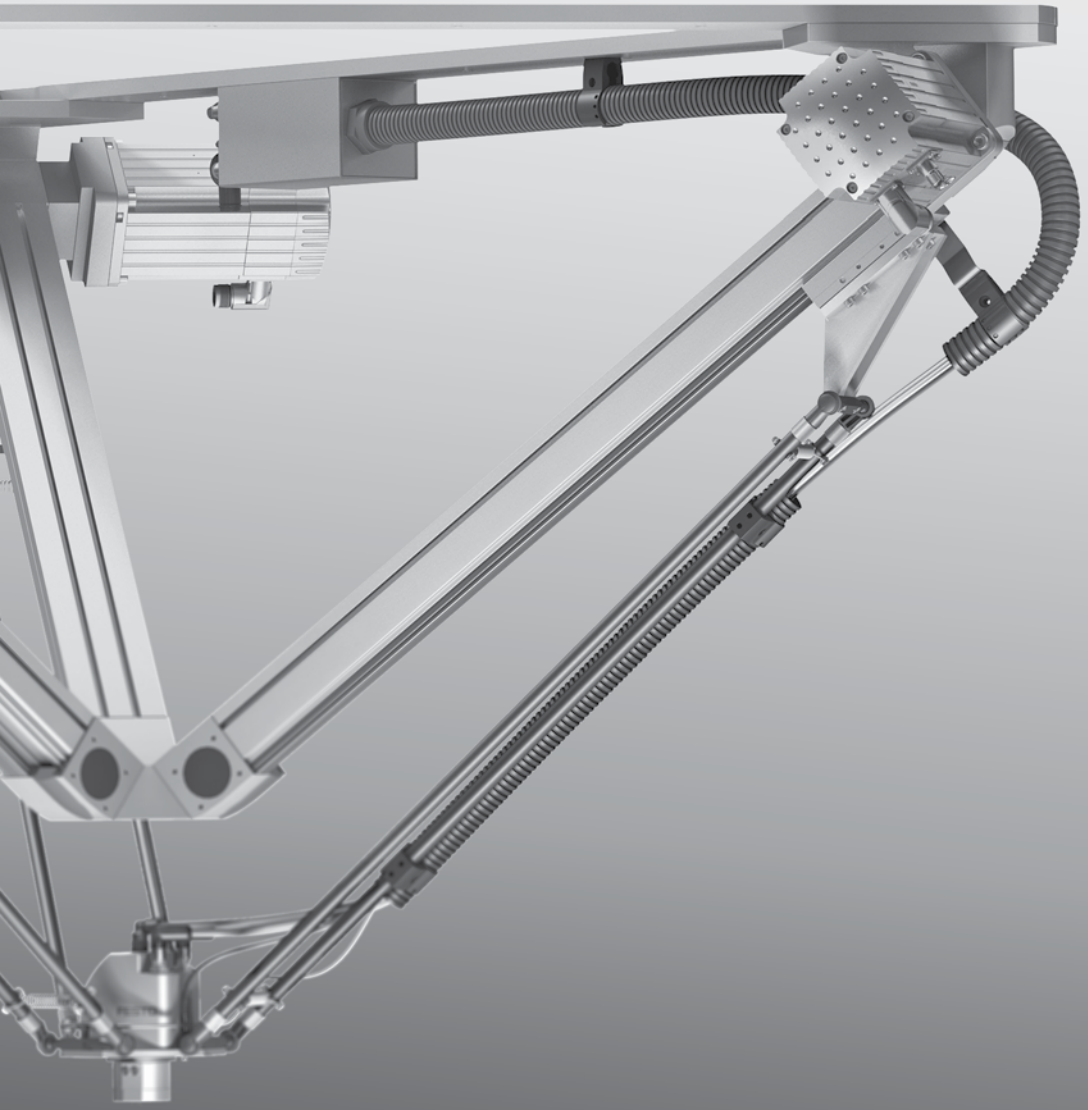
EXPT-70-...

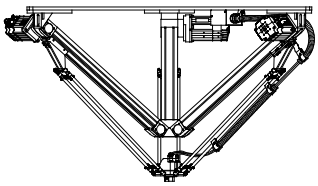
EXPT-95-...

EXPT-120-...

FESTO

Repair instructions (en)





7EXPTa_en

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7EXPTa_en (02.2015)

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Foreword

These repair instructions are valid for the parallel kinematic systems EXPT listed on the title page to the exclusion of any liability claims.

Deviations compared to the descriptions in these repair instructions may arise depending on the design and/or modification status of the specific parallel kinematic system. The user must check this prior to carrying out the repair and take the deviations into consideration if necessary.

These repair instructions have been prepared with care.

Festo AG & Co. KG does not, however, accept liability for any errors in these repair instructions or their consequences. Likewise, no liability is accepted for direct or consequential damage resulting from incorrect use of the products.

More detailed information on this can be found in section 12 “Liability”.

The relevant regulations on protection of labour, safety engineering and interference suppression as well as the stipulations contained in these repair instructions must be observed when working on the products.

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Table of contents

FESTO

Table of contents

FESTO

Table of contents

FESTO

Table of contents

1 Important information

1.1 About these repair instructions

The EXPT is referred to in these repair instructions as the **parallel kinematic system**.

This document contains important information about the professional repair of the parallel kinematic system.

Before carrying out a repair, the relevant section in these instructions must be read in full and followed consistently.

For reasons of clarity, these repair instructions do not contain complete detailed information. The following documents should therefore also be available while performing repair work on the parallel kinematic system:

- **Description – parallel kinematic system EXPT, mechanical installation**
  Contains information about installing and removing the parallel kinematic system, installing and removing the motor, the axial kit with coupling and coupling housing and the toothed belt axis, as well as information about the function, structure, application, installation, commissioning, care and maintenance, etc. Can be found on the Festo website (www.festo.com).
- **Description – commissioning the parallel kinematic system with control system EXPT-...-C...**
  Describes the functions, the electrical installation, the commissioning using the FCT, the operation, the control principle and the procedure for fault clearance for the parallel kinematic system. This can be found on the Festo website (www.festo.com).
- **Spare parts documentation**
  Contains an overview of the spare and wearing parts as well as information on their installation. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com).
- **Information brochure – accessories, equipment and tools**
  Contains an overview of available assembly aids such as lubricants, screw locking agent, maintenance tools, accessories for assembly and maintenance, etc. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

1.2 Pictograms used in these repair instructions

Danger categories

This description includes instructions on the possible dangers that can occur if the product is used incorrectly.
These instructions are marked with a signal word (Warning, Caution, etc.), printed on a shaded background and marked additionally with a pictogram. A distinction is made between the following danger warnings:

Warning
... means that non-observance may result in serious personal injury or damage to property.

Caution
... means that non-observance may result in personal injury and damage to property.

Note
... means that non-observance may result in damage to property.

Marking special information

The following pictograms mark passages in the text which contain special information.

Information:
Recommendations, tips and references to other sources of information.

Environment:
Information on the environmentally-friendly use of Festo products.

1.3 Text markings used in these repair instructions

- Indicates activities that can be carried out in any sequence.

1. Indicates activities that should be carried out in the specified sequence.

– Indicates a general list.

[...] Indicates menu options in a software program.

“ ” Indicates writing in windows and on buttons.

1.4 Safety instructions

1.4.1 General safety information

Warning

Risk of fatal injury due to electric shock and uncontrolled movement of components.

– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.

– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Caution

Lifting large loads can lead to permanent injury.

– Depending on size and weight, the parallel kinematic system should be lifted and turned over by 2 to 3 persons. An additional person is required for attachment to the mounting frame.

Caution

Crushing of body parts and damage to the system. Unintended activation can trigger unexpected movements.

– Before any conversion or maintenance work or inspections of the plant, ensure that the plant is secured to prevent restarting. Detached parts could fall or execute unexpected movements.

– Secure the parts to prevent accidental movement or bring them into a safe end position.

Note

The removal of mechanical components (e.g. motor, axis, parallel kinematic system) causes homing and calibration to be lost, and thus results in a reduction in absolute positioning accuracy. Prior to commissioning, homing or calibration must be carried out (see section 8 “Homing, setting feed constants and calibration”).

Note

Carrying out repair work without consulting the necessary technical documentation is dangerous, and thus not permissible. Repairs must always be carried out in conjunction with these repair instructions as well as the respective operating instructions for the device, as well as the documents listed in section 1.1 “About these repair instructions”.

In the event of damage caused by unauthorised manipulation, improper use or use of non-original spare parts, the warranty is invalidated and the manufacturer is not liable for damages.

Instead of carrying out the repair yourself, your local Festo sales office offers the option of having the repair carried out by Festo.

Components and equipment replaced as part of a repair must be disposed of in accordance with the locally valid environmental protection regulations.

1.4.2 Intended use

The parallel kinematic system EXPT and the control system CMCA are intended for installation in machines and automation systems for moving an end-effector in the kinematics working space.

1.4.3 Technical requirements

Note

The following instructions for the correct and safe use of the product must be observed:

- Comply with the connection and ambient conditions of the products and all connected components specified in the technical data of the parallel kinematic system EXPT and control system CMCA. The parallel kinematic system can only be operated in compliance with the relevant safety regulations if you comply with the limit values and load limits (see all documentation enclosed with the parallel kinematic system).
- The parallel kinematic system must be in faultless technical condition.
- The parallel kinematic system must be operated in its original status, without unauthorised modifications.
- The parallel kinematic system is designed for industrial use.
- The safety circuit of the control system CMCA is only one part of the safety concept for a machine; the overall safety concept must be based on a risk assessment of the entire machine performed by the machine manufacturer.
- Observe all the warnings and instructions in this documentation.

1.4.4 Qualification of specialised personnel

Caution

The parallel kinematic system must only be repaired by authorised or trained personnel in accordance with the specifications in the technical documentation and using original spare parts. Installation and repair work carried out by unauthorised and untrained personnel is dangerous, and therefore not permissible.

Furthermore, repair and installation staff must possess knowledge of the following areas:

- Automation technology
- Installation and operation of electrical control systems
- The applicable regulations for operating safety-engineering systems
- The applicable regulations for accident prevention and occupational safety
- The motor controller CMMP; the multi-axis controller CMXR
- The software CoDeSys for use with the multi-axis controller CMXR-C2
- Working with robotics systems

1.4.5 Range of application and certifications

Standards and test values that the products must comply with and fulfil can be found in the “Technical data” sections of the accompanying documentation.

2 General product description for the parallel kinematic system

2.1 Functional description

The parallel kinematic system with robotic functionality has four degrees of freedom for path and positioning applications in space, with additional position control. The parallel kinematic system's range of movement is characterised by the pyramid-shaped arrangement of three standard linear drives. The front panel is connected to the drives by parallel carbon-fibre rods, which reduce the moving mass to a minimum.

The driving force can almost be used entirely for the introduction of dynamic response. Vibrations are simultaneously minimised.

Optional front unit

The high-performance and extremely precise rotary drive which is mounted on the front panel completes the parallel kinematic system and allows it to function as a 4-axis system.

1 Mounting frame
2 Interface housing
3 Motor
4 Toothed belt axis
5 Parallel kinematic system module
6 Front unit for attaching a gripper, etc.

Types and part numbers

Type	Part number
EXPT-45	569797
EXPT-70	569798
EXPT-95	569799
EXPT-120	569800

The complete overview of features, accessories, type codes, technical data and dimensions for the parallel kinematic system can be found in the product catalogue or on the Festo website (www.festo.com).

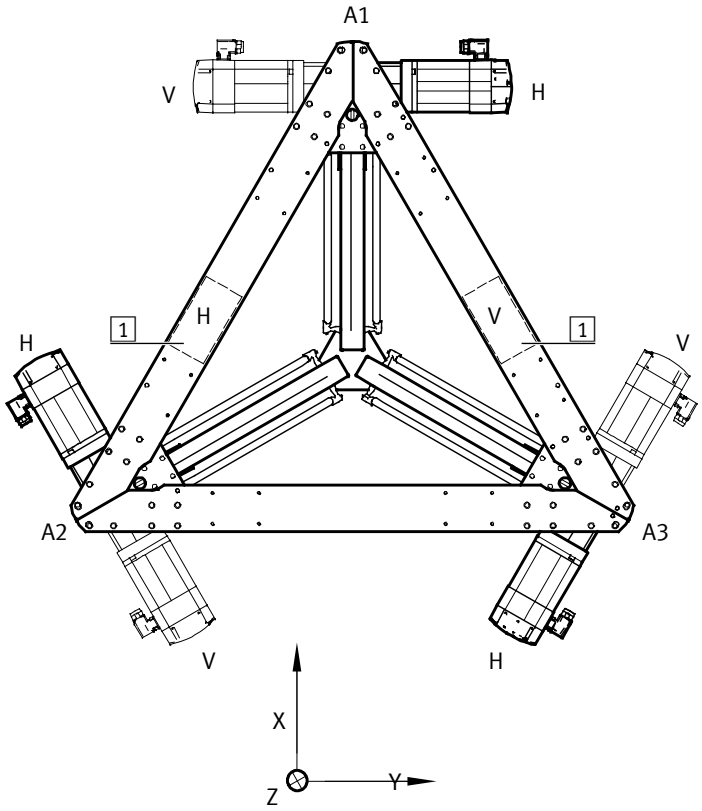
2.2 Features of the parallel kinematic system

Parallel kinematic system feature	Code	Specification
Type/working space	45	Ø 450 mm, height 100 mm
	70	Ø 700 mm, height 100 mm
	95	Ø 950 mm, height 100 mm
	120	Ø 1200 mm, height 100 mm
Drive	E1	DGE-25
	E4	EGC-80
Attachment components	T0	Front unit without attachment component
	T1	Front unit with rotary drive, size 8
	T2	Front unit with rotary drive, size 8 with pneumatic rotary through-feed
	T3	Front unit with rotary drive, size 11
	T4	Front unit with rotary drive, size 11 with pneumatic rotary through-feed
Attachment position of motors (See section 2.2.1 “Motor attachment variants”)	HHH	Motor axis A1, A2, A3 rear
	HHV	Motor axis A1 rear, motor axis A2 rear, motor axis A3 front
	HVH	Motor axis A1 rear, motor axis A2 front, motor axis A3 rear
	HVV	Motor axis A1 rear, motor axis A2 front, motor axis A3 front
	VHH	Motor axis A1 front, motor axis A2 rear, motor axis A3 rear
	VHV	Motor axis A1 front, motor axis A2 rear, motor axis A3 front
	VVH	Motor axis A1 front, motor axis A2 front, motor axis A3 rear
	VVV	Motor axis A1, A2, A3 front
Protection against particles	–	Standard
	P8	Protected version

Accessories feature	Code	Specification
Control system	–	Without control system
	C	Control system on a mounting plate for installation in a control cabinet
	CC	Complete control system with control cabinet
Multi-axis controller	–	Without control system
	C1	Control system with multi-axis controller CMXR-C1
	C2	Control system with multi-axis controller CMXR-C2 and integrated PLC
Operator terminal	–	Without operator unit
	B	With operator unit CDSA
Cable length	–	No cables or tubing included
	5	Connecting cable and 5 m long tubing included
	10	Connecting cable and 10 m long tubing included
	15	Connecting cable and 15 m long tubing included
Calibration	–	Standard
	S	With calibration
Document language	DE	German
	EN	English
	ES	Spanish
	FR	French
	IT	Italian
	RU	Russian
	SV	Swedish
	ZH	Chinese

2.2.1 Motor attachment variants

This illustration provides an overview of the attachment positions for the parallel kinematic system motors.



Versions:

The attachment position of the motors can be individually configured using the modular product system.

The standard motor attachment position corresponds to code HHH (cf. illustration, left). This means: A1/A2/A3 rear.

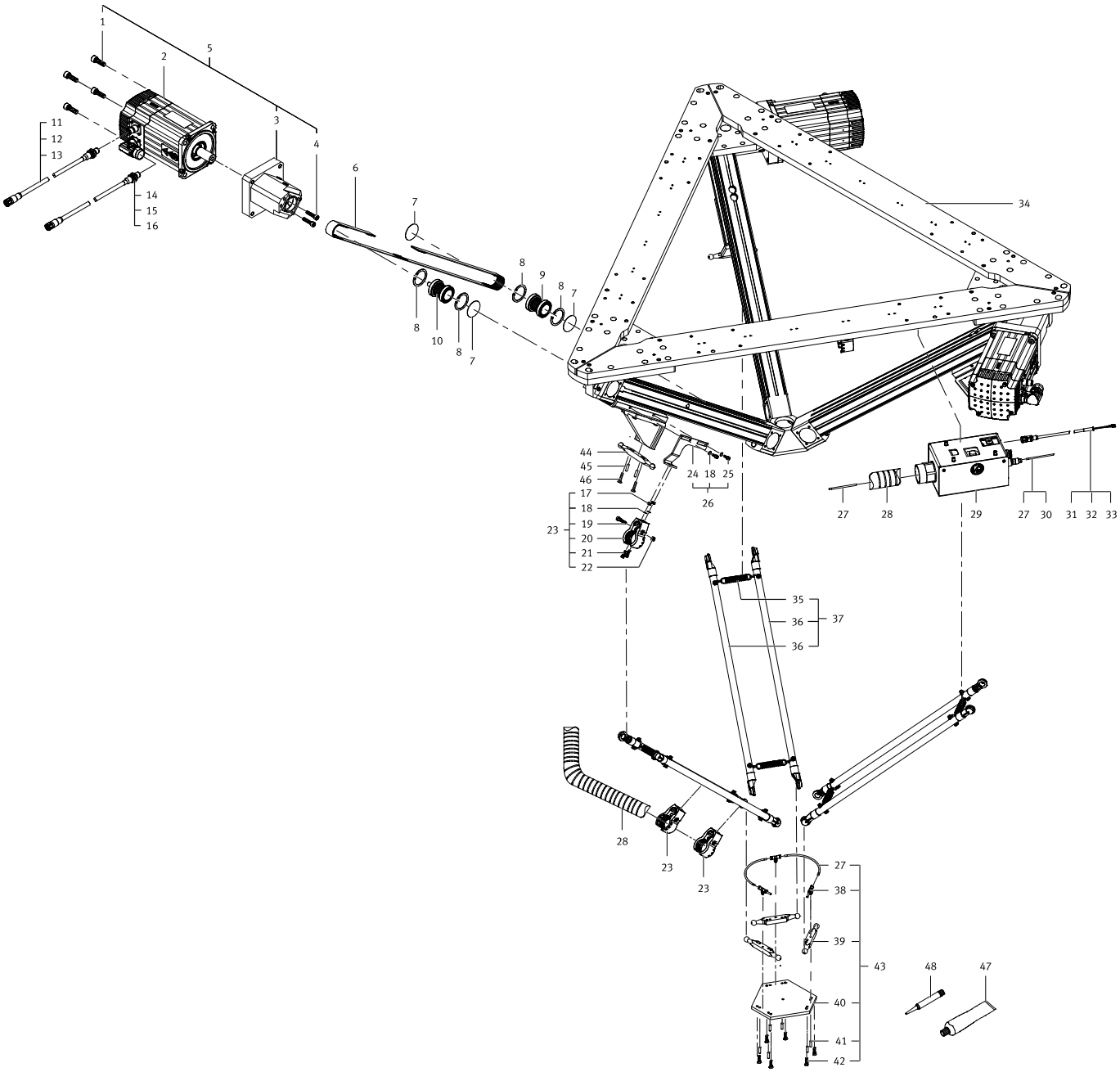
The position of the interface housing [1] depends on the position of the motor (V or H) on axis A1.

Orientation of motor attachment variants:

HHH: A1/A2/A3 rear
HHV: A3 front; A1/A2 rear
HVH: A2 front; A1/A3 rear
HVV: A2/A3 front; A1 rear
VHH: A1 front; A2/A3 rear
VHV: A1/A3 front; A2 rear
VVH: A1/A2 front; A3 rear
VVV: A1/A2/A3 front

2.3 Components list

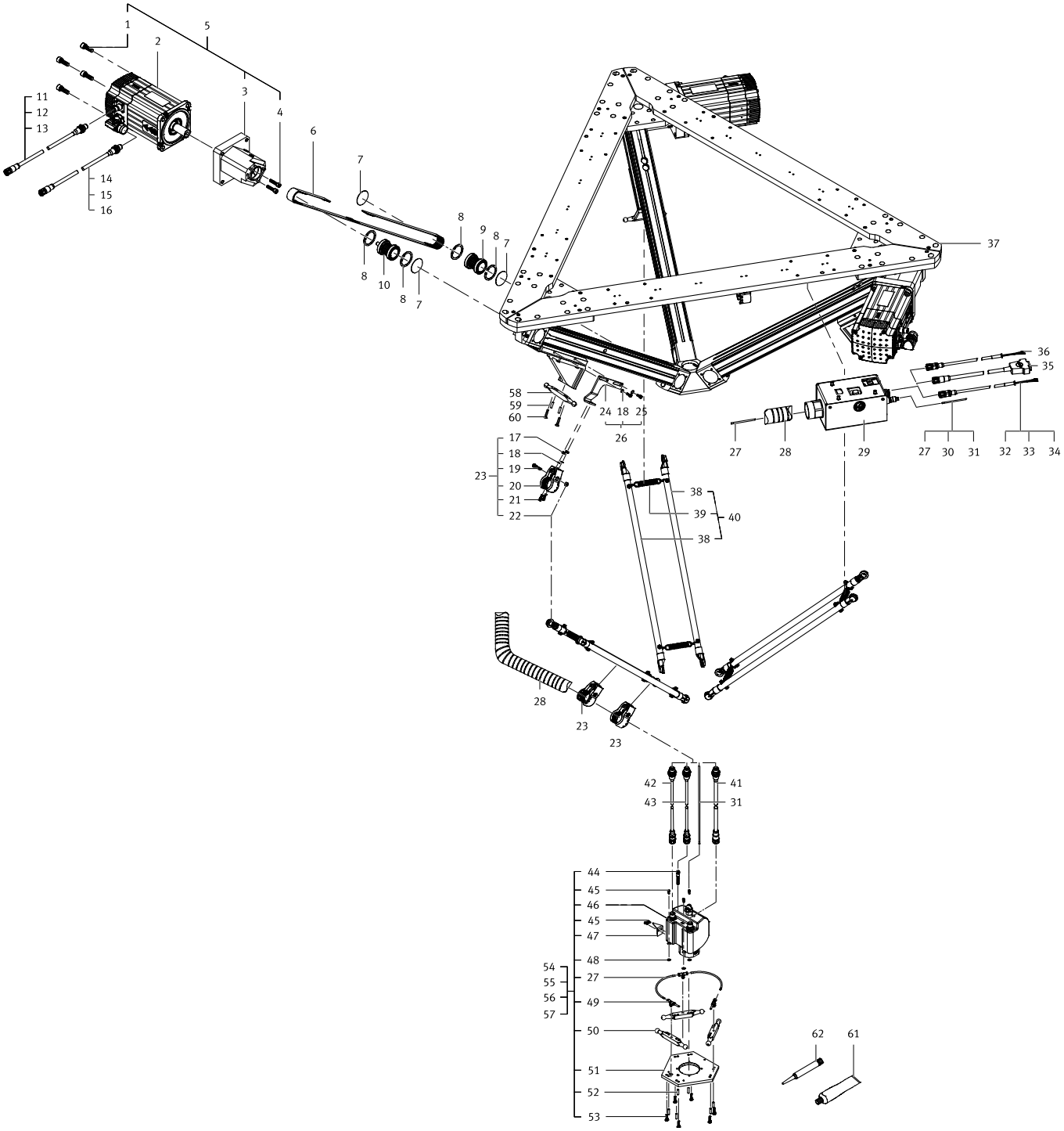
2.3.1 EXPT-45 / 70-E1-T0



This diagram is intended to provide an overview of the individual components and an aid when ordering. For a more detailed overview, please refer to the online spare parts catalogue on the Festo website (http://spareparts.festo.com).

	EXPT-45-E1-T0			EXPT-70-E1-T0		
No.	Part no.	Designation	Type	Part no.	Designation	Type
1	200693	Socket head screw	DIN 912-M8×25-10.9	200693	Socket head screw	DIN 912-M8×25-10.9
2	550125	Servo motor		550125	Servo motor	
3		Coupling housing			Coupling housing	
4	200128	Socket head screw	DIN 912-M6×25-10.9	200128	Socket head screw	DIN 912-M6×25-10.9
5	569805	Axial kit		569805	Axial kit	
6	8003454	Toothed belt		8003455	Toothed belt	
7	666475	Sealing disc		666475	Sealing disc	
8	664723	Retaining ring	DIN 472-37×1.5	664723	Retaining ring	DIN 472-37×1.5
9	665595	Drive		665595	Drive	
10	665598	Drive		665598	Drive	
11	550318	Encoder cable		550318	Encoder cable	
12	550319	Encoder cable		550319	Encoder cable	
13	550320	Encoder cable		550320	Encoder cable	
14	550310	Motor cable		550310	Motor cable	
15	550311	Motor cable		550311	Motor cable	
16	550312	Motor cable		550312	Motor cable	
17		Hex nut	DIN 934-M4-10		Hex nut	DIN 934-M4-10
18		Washer	DIN 433-4.3		Washer	DIN 433-4.3
19		Socket head screw	DIN 6912-M5×20-8.8		Socket head screw	DIN 6912-M5×20-8.8
20		EXPT retaining clip			EXPT retaining clip	
21		Socket head screw	DIN 6912-M4×12-8.8		Socket head screw	DIN 6912-M4×10-8.8
22		Hex nut	DIN 934-M5-6		Hex nut	DIN 934-M5-6
23	1574902	Tubing holder		1574902	Tubing holder	
24		EXPT mounting bracket			EXPT mounting bracket	
25	204482	Socket head screw	DIN 912-M5×8-8.8	204482	Socket head screw	DIN 912-M5×8-8.8
26	2075203	Angle kit		2075203	Angle kit	
27	558277	Plastic tubing	PUN-H-3×0.5-SI	558277	Plastic tubing	PUN-H-3×0.5-SI
28	177589	Protective conduit		177589	Protective conduit	
29		EXPT cover			EXPT cover	
30	558278	Plastic tubing	PUN-H-4×0.75-SI	558278	Plastic tubing	PUN-H-4×0.75-SI
31	541334	Connecting cable		541334	Connecting cable	
32	541332	Connecting cable		541332	Connecting cable	
33	575986	Connecting cable		575986	Connecting cable	
34		EXPT-45-E1 basic kit			EXPT-70-E1 basic kit	
35	727290	EXPT tension spring		727290	EXPT tension spring	
36		EXPT-45 rod			EXPT-70 rod	
37	748293	Parallel kinematic system module		748294	Parallel kinematic system module	
38	153351	Push-in T-fitting		153351	Push-in T-fitting	
39	727285	EXPT ball stud		727285	EXPT ball stud	
40	745220	EXPT plate		745220	EXPT plate	
41	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
42	352252	Countersunk screw	DIN 7991-M4×16-8.8	352252	Countersunk screw	DIN 7991-M4×16-8.8
43	1714815	EXPT front unit		1714815	EXPT front unit	
44	727286	EXPT ball stud		727286	EXPT ball stud	
45	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
46	657784	Countersunk screw	DIN 7991-M4×20-8.8	657784	Countersunk screw	DIN 7991-M4×20-8.8
47	684474	Lubricating grease	LUB-KC1, silicone-free	684474	Lubricating grease	LUB-KC1, silicone-free
48	247891	Locking agent	LOCTITE 243	247891	Locking agent	LOCTITE 243

2.3.2 EXPT-45 / 70-E1-T1 / T2 / T3 / T4



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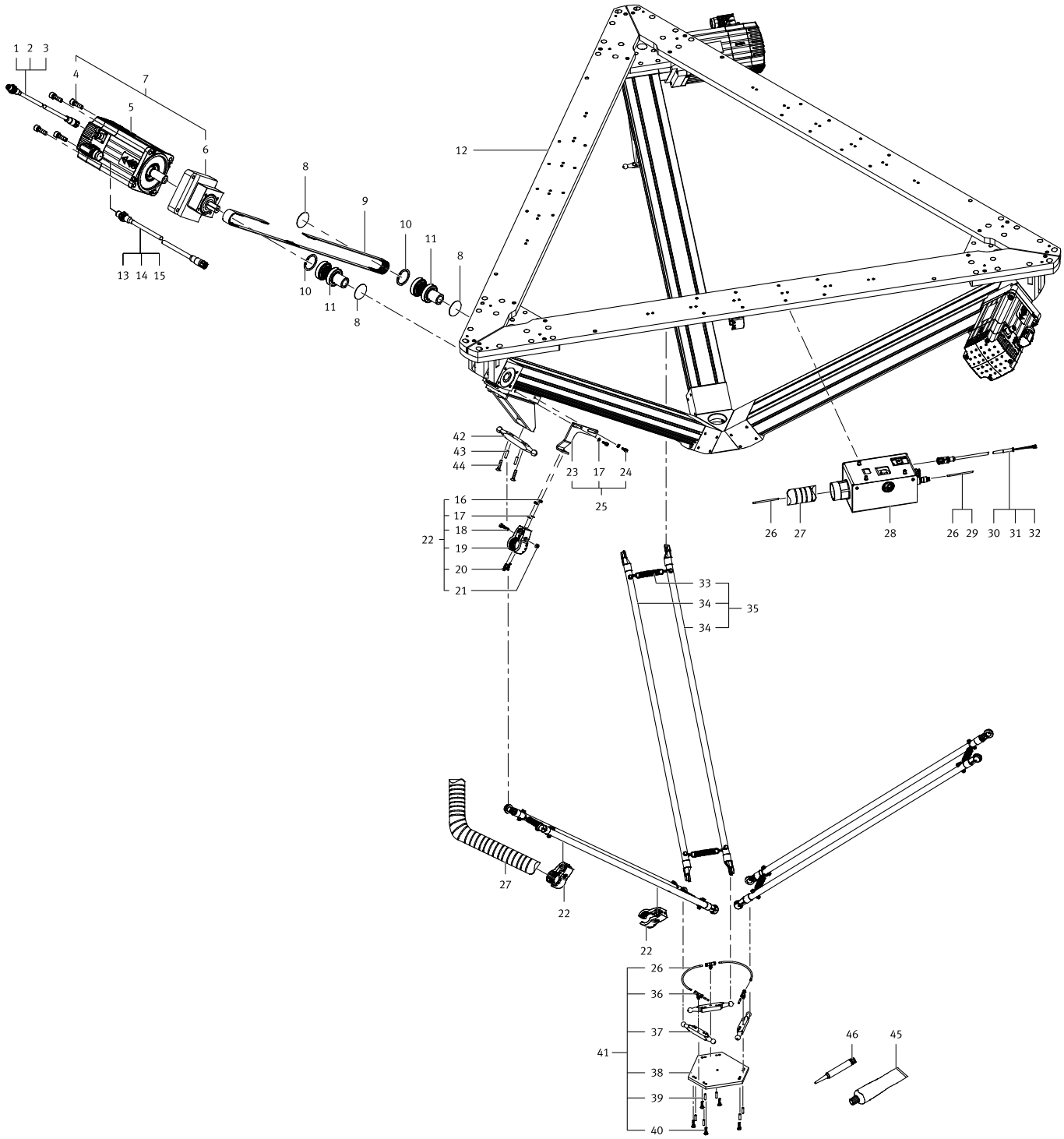
	EXPT-45-E1-T1 / T2 / T3 / T4			EXPT-70-E1-T1 / T2 / T3 / T4		
No.	Part no.	Designation	Type	Part no.	Designation	Type
1	200693	Socket head screw	DIN 912-M8×25-10.9	200693	Socket head screw	DIN 912-M8×25-10.9
2	550125	Servo motor		550125	Servo motor	
3		Coupling housing			Coupling housing	
4	200128	Socket head screw	DIN 912-M6×25-10.9	200128	Socket head screw	DIN 912-M6×25-10.9
5	569805	Axial kit		569805	Axial kit	
6	8003454	Toothed belt		8003455	Toothed belt	
7	666475	Sealing disc		666475	Sealing disc	
8	664723	Retaining ring	DIN 472-37×1.5	664723	Retaining ring	DIN 472-37×1.5
9	665595	Drive		665595	Drive	
10	665598	Drive		665598	Drive	
11	550318	Encoder cable		550318	Encoder cable	
12	550319	Encoder cable		550319	Encoder cable	
13	550320	Encoder cable		550320	Encoder cable	
14	550310	Motor cable		550310	Motor cable	
15	550311	Motor cable		550311	Motor cable	
16	550312	Motor cable		550312	Motor cable	
17		Hex nut	DIN 934-M4-10		Hex nut	DIN 934-M4-10
18		Washer	DIN 433-4.3		Washer	DIN 433-4.3
19		Socket head screw	DIN 6912-M5×20-8.8		Socket head screw	DIN 6912-M5×20-8.8
20		EXPT retaining clip			EXPT retaining clip	
21		Socket head screw	DIN 6912-M4×10-8.8		Socket head screw	DIN 6912-M4×10-8.8
22		Hex nut	DIN 934-M5-6		Hex nut	DIN 934-M5-6
23	1574902	Tubing holder		1574902	Tubing holder	
24		EXPT mounting bracket			EXPT mounting bracket	
25	204482	Socket head screw	DIN 912-M5×8-8.8	204482	Socket head screw	DIN 912-M5×8-8.8
26	2075203	Angle kit		2075203	Angle kit	
27	558277	Plastic tubing	PUN-H-3×0.5-SI	558277	Plastic tubing	PUN-H-3×0.5-SI
28	177589	Protective conduit		177589	Protective conduit	
29		EXPT cover			EXPT cover	
30	558278	Plastic tubing	PUN-H-4×0.75-SI	558278	Plastic tubing	PUN-H-4×0.75-SI
31	558280	Plastic tubing	PUN-H-8×1.25-SI	558280	Plastic tubing	PUN-H-8×1.25-SI
32	541334	Connecting cable		541334	Connecting cable	
33	541332	Connecting cable		541332	Connecting cable	
34	575986	Connecting cable		575986	Connecting cable	
35	571915	Encoder cable		571915	Encoder cable	
36	571907	Motor cable		571907	Motor cable	
37		EXPT-45-E1 basic kit			EXPT-70-E1 basic kit	
38		EXPT-45 rod			EXPT-70 rod	
39	727290	EXPT tension spring		727290	EXPT tension spring	
40	748293	Parallel kinematic system module		748294	Parallel kinematic system module	
41	571899	Motor cable		571900	Motor cable	
42	571901	Encoder cable		571902	Encoder cable	
43	575984	Connecting cable		575985	Connecting cable	
44	150371	Proximity sensor		150371	Proximity sensor	
45		Socket head screw	DIN 912-M3×6-8.8		Socket head screw	DIN 912-M3×6-8.8
46		Cover			Cover	
47	1465344	Switch lug		1465344	Switch lug	
48		Toothed disc	DIN 6797-A-3.2		Toothed disc	DIN 6797-A-3.2
49	153351	Push-in T-fitting		153351	Push-in T-fitting	
50	727285	EXPT ball stud		727285	EXPT ball stud	
51		EXPT-D49 plate			EXPT plate	
52	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
53	352252	Countersunk screw	DIN 7991-M4×16-8.8	352252	Countersunk screw	DIN 7991-M4×16-8.8
54	1234379	Front unit	ERMH-8	1234379	Front unit	ERMH-8
55	1557788	Front unit	ERMH-8-P	1557788	Front unit	ERMH-8-P
56	1234366	Front unit	ERMH-11	1234366	Front unit	ERMH-11
57	1234378	Front unit	ERMH-11-P	1234378	Front unit	ERMH-11-P
58	727286	EXPT ball stud		727286	EXPT ball stud	
59	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
60	657784	Countersunk screw	DIN 7991-M4×20-8.8	657784	Countersunk screw	DIN 7991-M4×20-8.8
61	684474	Lubricating grease	LUB-KC1, silicone-free	684474	Lubricating grease	LUB-KC1, silicone-free
62	247891	Locking agent	LOCTITE 243	247891	Locking agent	LOCTITE 243

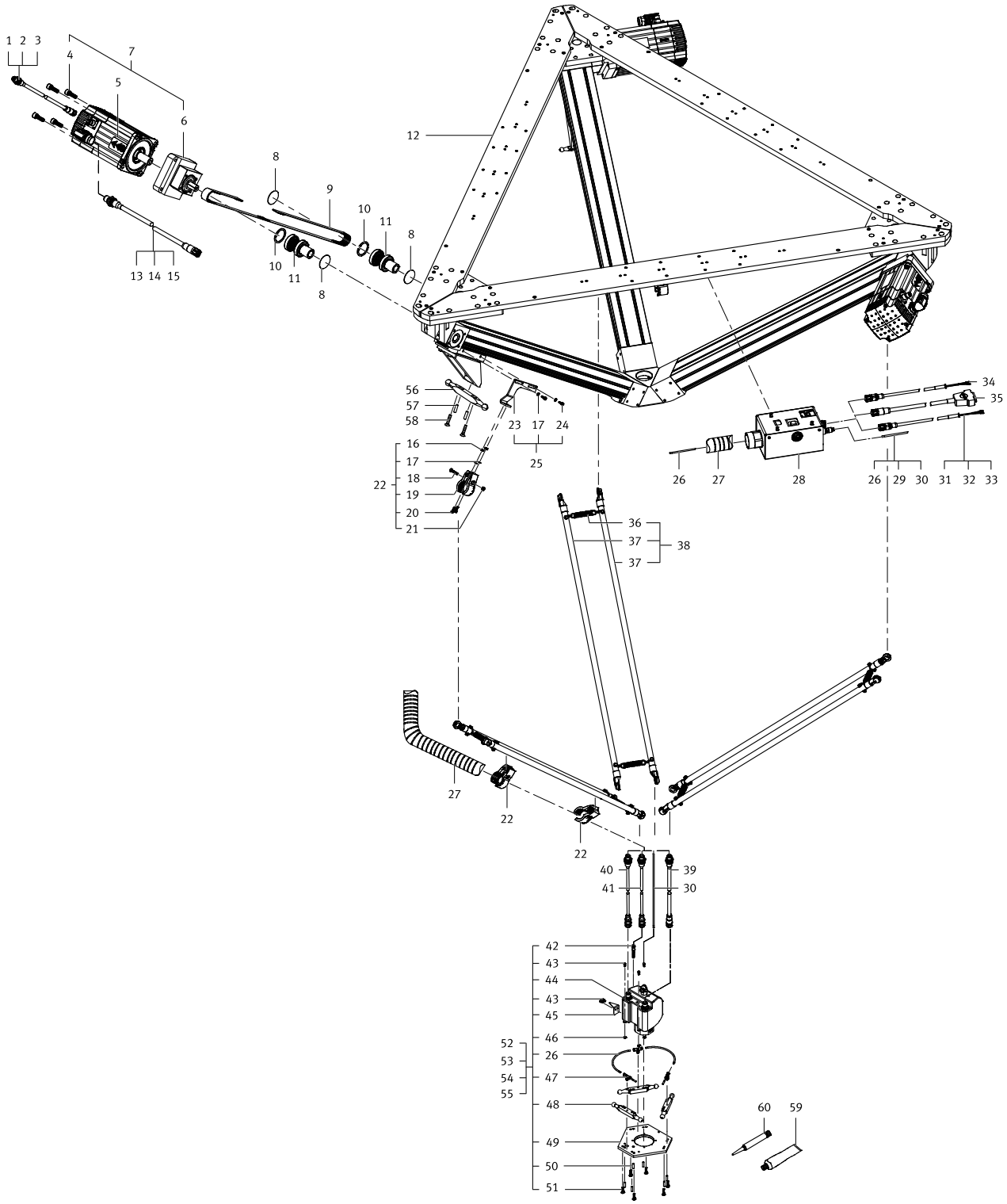
2.3.3 EXPT-95 / 120-E4-T0



This diagram is intended to provide an overview of the individual components and an aid when ordering. For a more detailed overview, please refer to the online spare parts catalogue on the Festo website (http://spareparts.festo.com).

	EXPT-95-E4-T0			EXPT-120-E4-T0		
No.	Part no.	Designation	Type	Part no.	Designation	Type
1	550318	Encoder cable		550318	Encoder cable	
2	550319	Encoder cable		550319	Encoder cable	
3	550320	Encoder cable		550320	Encoder cable	
4	200693	Socket head screw	DIN 912-M8×25-10.9	200693	Socket head screw	DIN 912-M8×25-10.9
5	550125	Servo motor		550125	Servo motor	
6		Motor flange			Motor flange	
7	557984	Axial kit		557984	Axial kit	
8	716453	Sealing disc		716453	Sealing disc	
9	8003453	Toothed belt		8003452	Toothed belt	
10	201030	Retaining ring	DIN 472-42×1.75	201030	Retaining ring	DIN 472-42×1.75
11	723109	Toothed belt pulley module		723109	Toothed belt pulley module	
12		EXPT-95-E4 basic kit			EXPT-120-E4 basic kit	
13	550310	Motor cable		550310	Motor cable	
14	550311	Motor cable		550311	Motor cable	
15	550312	Motor cable		550312	Motor cable	
16		Hex nut	DIN 934-M4-10		Hex nut	DIN 934-M4-10
17		Washer	DIN 433-4.3		Washer	DIN 433-4.3
18		Socket head screw	DIN 6912-M5×20-8.8		Socket head screw	DIN 6912-M5×20-8.8
19		EXPT retaining clip			EXPT retaining clip	
20		Socket head screw	DIN 6912-M4×10-8.8		Socket head screw	DIN 6912-M4×10-8.8
21		Hex nut	DIN 934-M5-6		Hex nut	DIN 934-M5-6
22	1574902	Tubing holder		1574902	Tubing holder	
23		EXPT mounting bracket			EXPT mounting bracket	
24	207734	Socket head screw	DIN 912-M4×10-8.8	207734	Socket head screw	DIN 912-M4×10-8.8
25	2075203	Angle kit		2075203	Angle kit	
26	558277	Plastic tubing	PUN-H-3×0.5-SI	558277	Plastic tubing	PUN-H-3×0.5-SI
27	177589	Protective conduit		177589	Protective conduit	
28		EXPT cover			EXPT cover	
29	558278	Plastic tubing	PUN-H-4×0.75-SI	558278	Plastic tubing	PUN-H-4×0.75-SI
30	541334	Connecting cable		541334	Connecting cable	
31	541332	Connecting cable		541332	Connecting cable	
32	575986	Connecting cable		575986	Connecting cable	
33	727290	EXPT tension spring		727290	EXPT tension spring	
34		EXPT-95 rod			EXPT-120 rod	
35	748295	Parallel kinematic system module		748296	Parallel kinematic system module	
36	153351	Push-in T-fitting		153351	Push-in T-fitting	
37	727285	EXPT ball stud		727285	EXPT ball stud	
38	745220	EXPT plate		745220	EXPT plate	
39	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
40	352252	Countersunk screw	DIN 7991-M4×16-8.8	352252	Countersunk screw	DIN 7991-M4×16-8.8
41	1714815	EXPT front unit		1714815	EXPT front unit	
42	727286	EXPT ball stud		727286	EXPT ball stud	
43	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
44	657784	Countersunk screw	DIN 7991-M4×20-8.8	657784	Countersunk screw	DIN 7991-M4×20-8.8
45	684474	Lubricating grease	LUB-KC1, silicone-free	684474	Lubricating grease	LUB-KC1, silicone-free
46	247891	Locking agent	LOCTITE 243	247891	Locking agent	LOCTITE 243

2.3.4 EXPT-95 / 120-E4-T1 / T2 / T3 / T4



This diagram is intended to provide an overview of the individual components and an aid when ordering. For a more detailed overview, please refer to the online spare parts catalogue on the Festo website (http://spareparts.festo.com).

	EXPT-95-E4-T1 / T2 / T3 / T4			EXPT-120-E4-T1 / T2 / T3 / T4		
No.	Part no.	Designation	Type	Part no.	Designation	Type
1	550318	Encoder cable		550318	Encoder cable	
2	550319	Encoder cable		550319	Encoder cable	
3	550320	Encoder cable		550320	Encoder cable	
4	200693	Socket head screw	DIN 912-M8×25-10.9	200693	Socket head screw	DIN 912-M8×25-10.9
5	550125	Servo motor		550125	Servo motor	
6		Motor flange			Motor flange	
7	557984	Axial kit		557984	Axial kit	
8	716453	Sealing disc		716453	Sealing disc	
9	8003453	Toothed belt		8003452	Toothed belt	
10	201030	Retaining ring	DIN 472-42×1.75	201030	Retaining ring	DIN 472-42×1.75
11	723109	Toothed belt pulley module		723109	Toothed belt pulley module	
12		EXPT-95-E4 basic kit			EXPT-120-E4 basic kit	
13	550310	Motor cable		550310	Motor cable	
14	550311	Motor cable		550311	Motor cable	
15	550312	Motor cable		550312	Motor cable	
16		Hex nut	DIN 934-M4-10		Hex nut	DIN 934-M4-10
17		Washer	DIN 433-4.3		Washer	DIN 433-4.3
18		Socket head screw	DIN 6912-M5×20-8.8		Socket head screw	DIN 6912-M5×20-8.8
19		EXPT retaining clip			EXPT retaining clip	
20		Socket head screw	DIN 6912-M4×10-8.8		Socket head screw	DIN 6912-M4×10-8.8
21		Hex nut	DIN 934-M5-6		Hex nut	DIN 934-M5-6
22	1574902	Tubing holder		1574902	Tubing holder	
23		EXPT mounting bracket			EXPT mounting bracket	
24	207734	Socket head screw	DIN 912-M4×10-8.8	207734	Socket head screw	DIN 912-M4×10-8.8
25	2075203	Angle kit		2075203	Angle kit	
26	558277	Plastic tubing	PUN-H-3×0.5-SI	558277	Plastic tubing	PUN-H-3×0.5-SI
27	177589	Protective conduit		177589	Protective conduit	
28		EXPT cover			EXPT cover	
29	558278	Plastic tubing	PUN-H-4×0.75-SI	558278	Plastic tubing	PUN-H-4×0.75-SI
30	558280	Plastic tubing	PUN-H-8×1.25-SI	558280	Plastic tubing	PUN-H-8×1.25-SI
31	541334	Connecting cable		541334	Connecting cable	
32	541332	Connecting cable		541332	Connecting cable	
33	575986	Connecting cable		575986	Connecting cable	
34	571907	Motor cable		571907	Motor cable	
35	571915	Encoder cable		571915	Encoder cable	
36	727290	EXPT tension spring		727290	EXPT tension spring	
37		EXPT-95 rod			EXPT-120 rod	
38	748294	Parallel kinematic system module		748296	Parallel kinematic system module	
39	571899	Motor cable		571900	Motor cable	
40	571901	Encoder cable		571902	Encoder cable	
41	575984	Connecting cable		575985	Connecting cable	
42	150371	Proximity sensor		150371	Proximity sensor	
43		Socket head screw	DIN 912-M3×6-8.8		Socket head screw	DIN 912-M3×6-8.8
44		Cover			ERMH cover	
45	1465344	Switch lug		1465344	ERMH switch lug	
46		Toothed disc	DIN 6797-A-3.2		Toothed disc	DIN 6797-A-3.2
47	153351	Push-in T-fitting		153351	Push-in fitting	
48	727285	EXPT ball stud		727285	EXPT ball stud	
49		EXPT plate			EXPT plate	
50	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
51	352252	Countersunk screw	DIN 7991-M4×16-8.8	352252	Countersunk screw	DIN 7991-M4×16-8.8
52	1234379	Front unit	ERMH-8	1234379	Front unit	ERMH-8
53	1557788	Front unit	ERMH-8-P	1557788	Front unit	ERMH-8-P
54	1234366	Front unit	ERMH-11	1234366	Front unit	ERMH-11
55	1234378	Front unit	ERMH-11-P	1234378	Front unit	ERMH-11-P
56	727286	EXPT ball stud		727286	EXPT ball stud	
57	770073	Cylindrical dowel pin	DIN 7-4M6×14	770073	Cylindrical dowel pin	DIN 7-4M6×14
58	657784	Countersunk screw	DIN 7991-M4×20-8.8	657784	Countersunk screw	DIN 7991-M4×20-8.8
59	684474	Lubricating grease	LUB-KC1, silicone-free	684474	Lubricating grease	LUB-KC1, silicone-free
60	247891	Locking agent	LOCTITE 243	247891	Locking agent	LOCTITE 243

3 Overview of the sequence of individual repair steps

Repair step	Parallel kinematic system	Servo motor	Axial kit	Parallel kinematic system module	Ball stud	Axis removal	Toothed belt	Toothed belt pulley module	Stop buffer	Homing required	Calibration required	Feed constant	Teach position
Servo motor replacement	EXPT-45-E1 EXPT-70-E1	**1.** ➔ Sec. 6.1	–	–	–	–	–	–	–	**2.** ➔ Sec. 8.1	–	–	–
	EXPT-95-E4 EXPT-120-E4	**1.** ➔ Sec. 7.1	–	–	–	–	–	–	–	**2.** ➔ Sec. 8.1	–	–	–
Axial kit replacement	EXPT-45-E1 EXPT-70-E1	**1.** ➔ Sec. 6.1	**2.** ➔ Sec. 6.2	–	–	–	–	–	–	**3.** ➔ Sec. 8.1	–	–	–
	EXPT-95-E4 EXPT-120-E4	**1.** ➔ Sec. 7.1	**2.** ➔ Sec. 7.2	–	–	–	–	–	–	**3.** ➔ Sec. 8.1	–	–	–
Parallel kinematic system module replacement	EXPT-45 / 70-E1 EXPT-95 / 120-E4	–	–	**1.** ➔ Sec. 5		–	–	–	–	–	–	–	–
Ball stud replacement	EXPT-45 / 70-E1 EXPT-95 / 120-E4	–	–	**1.** ➔ Sec. 5	**2.** ➔ Sec. 5.1.1.1 ➔ Sec. 5.1.1.2	–	–	–	–	–	Yes, for calibrated version	–	–
Toothed belt axis, complete replacement	EXPT-45-E1 EXPT-70-E1	**2.** ➔ Sec. 6.1	**3.** ➔ Sec. 6.2	**1.** ➔ Sec. 5	–	**4.** ➔ Sec. 6.3	–	–	–	**5.** ➔ Sec. 8.1	Yes, for calibrated version	**6.** ➔ Sec. 8.2	Yes
	EXPT-95-E4 EXPT-120-E4	**2.** ➔ Sec. 7.1	**3.** ➔ Sec. 7.2	**1.** ➔ Sec. 5	–	**4.** ➔ Sec. 7.3	–	–	–	**5.** ➔ Sec. 8.1	Yes, for calibrated version	**6.** ➔ Sec. 8.2	Yes
Replacing the toothed belt	EXPT-45-E1 EXPT-70-E1	**2.** ➔ Sec. 6.1	**3.** ➔ Sec. 6.2	**1.** ➔ Sec. 5	–	–	**4.** ➔ Sec. 6.4.1	**5.** ➔ Sec. 6.4.1.2	–	**6.** ➔ Sec. 8.1	Yes, for calibrated version	**7.** ➔ Sec. 8.2	Yes
	EXPT-95-E4 EXPT-120-E4	**2.** ➔ Sec. 7.1	**3.** ➔ Sec. 7.2	**1.** ➔ Sec. 5	–	–	**4.** ➔ Sec. 7.4.1	**5.** ➔ Sec. 7.4.1.2	–	**6.** ➔ Sec. 8.1	Yes, for calibrated version	**7.** ➔ Sec. 8.2	Yes
Toothed belt pulley module replacement	EXPT-45-E1 EXPT-70-E1	**2.** ➔ Sec. 6.1	**3.** ➔ Sec. 6.2	**1.** ➔ Sec. 5	–	–	**4.** ➔ Sec. 6.4.1	**5.** ➔ Sec. 6.4.1.2	–	**6.** ➔ Sec. 8.1	–	**7.** ➔ Sec. 8.2	–
	EXPT-95-E4 EXPT-120-E4	**2.** ➔ Sec. 7.1	**3.** ➔ Sec. 7.2	**1.** ➔ Sec. 5	–	–	**4.** ➔ Sec. 7.4.1	**5.** ➔ Sec. 7.4.1.2	–	**6.** ➔ Sec. 8.1	–	**7.** ➔ Sec. 8.2	–
Replacing the stop buffers	EXPT-45-E1 EXPT-70-E1	–	–	–	–	–	–	–	**1.** ➔ Sec. 6.4.2	–	–	–	–
	EXPT-95-E4 EXPT-120-E4	–	–	–	–	–	–	–	**1.** ➔ Sec. 7.4.2	–	–	–	–

4 Removing the parallel kinematic system from the plant and re-installing it

This section describes how to remove the parallel kinematic system from the plant and re-install it. The parallel kinematic system needs to be removed from the plant in the following situations:

- If the parallel kinematic system mounting frame is defective, meaning that the entire parallel kinematic system needs replacing
- If the plant's mounting frame is defective and the required positional tolerances for flatness (0.05 mm) and parallelism (0.5 mm) can no longer be met
- If the parallel kinematic system needs to be sent to a Festo service point for calibration

Depending on the cause of the defect to be eliminated, it may be necessary to exchange several components. The cause of a defect must therefore always be determined before starting a repair.

Warning

Risk of fatal injury from electrical shock.

- The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Caution

Crushing of body parts.

In the event of stress on the joints of the parallel kinematic system module, the rods can break or the balls can spring out of the ball cups. This can cause the parallel kinematic system module to fall down or tilt over.

- The parallel kinematic system may only be held in the **motor**, **axis** and **mounting frame** areas.
- Only ever set the parallel kinematic system down on the mounting frame.
- When lifting the parallel kinematic system off a surface, always lift it far enough to allow it to be turned freely.

Caution

Lifting large loads can lead to permanent injury.

- As such, four people are required to remove and install the parallel kinematic system.

Note

Make sure that all the mounting screws used during mounting have a strength class of at least 8.8.

Note

Before removal work begins, make sure you have a safe, clean and even space on which to set down components, e.g. a Euro-pallet.

4.1 Removing the parallel kinematic system from the plant

In order to prevent the different lines getting mixed up during reconnection, we advise labelling them before removal.

Warning

Risk of fatal injury from electrical shock.

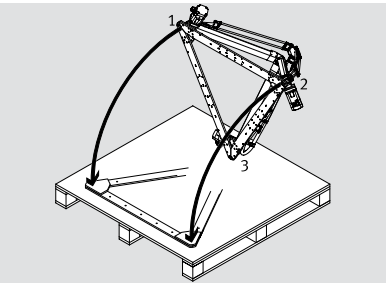
– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

1. Switch off the power and pressure to the parallel kinematic system and secure it using reliable methods to prevent it from unauthorised reactivation.
2. Remove the motor and encoder cables.
3. Remove pneumatic lines and tubing that connect the interface housing to external components or systems.

Note

Only ever set the parallel kinematic system down on the mounting frame. Once the parallel kinematic system has been removed from the plant, it must be turned over before being set down.

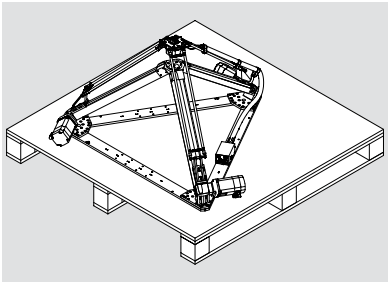
4. Have one person hold the parallel kinematic system at each of its three corners.
5. A fourth person must then unscrew the mounting screws that connect the parallel kinematic system mounting frame to that of the plant.
6. Carefully remove the parallel kinematic system from the plant.
7. Move the parallel kinematic system to the prepared surface to be set down.
8. Lower corner (3) of the parallel kinematic system.
9. With the corner lowered, set the parallel kinematic system down on the prepared surface.
10. Keep the top two corners (1) and (2) in the air be holding the parallel kinematic system in the motor, axis or mounting frame areas.



Note

Make sure that the corner that has been set down (3) is secure and cannot slip off the prepared surface.

11. Lower the parallel kinematic system until the mounting frame lies on the prepared surface.



Note

If you wish to transport the parallel kinematic system, it will need to be screwed onto the prepared surface using self-tapping screws in order to prevent it from slipping off the pallet.

12. Screw the parallel kinematic system onto the prepared surface using six self-tapping screws.

4.2 Installing the parallel kinematic system in the plant

The parallel kinematic system may only be re-installed in the plant's mounting frame in the area of the corner bracket of the mounting frame. There must be a torsionally rigid, flat mounting surface in the area of the corner bracket. In order for the parallel kinematic system to attain the positioning accuracy described in the technical data, the following minimum requirements apply to the mounting surface:

- Flatness: 0.05 mm
- Parallelism: 0.5 mm

Note

Deviations from the minimum requirements will lead to increased wear and/or inaccuracies in positioning during subsequent operation.

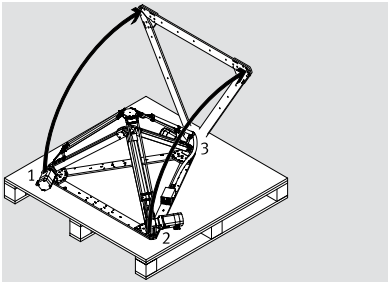
Other holes in the parallel kinematic system mounting frame may **only** be used as an assembly aid or for mounting additional installation elements, such as cable ducts.

Note

After being turned over, the parallel kinematic system cannot be set down without damaging it. Ensure that you have all the attachment materials required for mounting on the plant's mounting frame to hand before commencing the procedure.

More detailed information on installing the parallel kinematic system can be found in the description “Parallel kinematic system EXPT, mechanical installation” (www.festo.com).

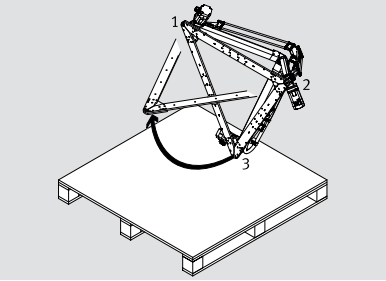
1. Unscrew any self-tapping screws in the surface on which the parallel kinematic system has been set down.
2. Have two to three people hold the parallel kinematic system in the areas around the motor, axis or mounting frame at corners (1) and (2).
3. Set the parallel kinematic system on end on corner (3).



Note

Make sure that the bottom corner is secure and cannot slip off.

4. Have a third person hold the parallel kinematic system in the area around the motor, axis or mounting frame at corner (3).
5. Turn the parallel kinematic system by pulling corner (3) upward.



6. Bring the parallel kinematic system to the plant.

Take care to ensure that the parallel kinematic system is positioned correctly in the plant.

7. Position the parallel kinematic system in the plant.

Note

The tightening torque for the mounting screws must always be observed. Excessive tightening torques will damage the thread.

A suitable screw length must be selected so that the motor and toothed belt axis do not need to be removed. If the screws are too long, the motor will need to be removed. As a result, homing/calibration will need to be carried out again.

8. Have a fourth person screw the parallel kinematic system onto the plant's mounting frame.
9. Tighten the parallel kinematic system mounting screws to the specified tightening torque.

Type of mounting	Tightening torque
Direct mounting using four M8 screws per corner	25 Nm
Direct mounting using one M20 screw per corner	425 Nm
Slot nut mounting	10 Nm ± 20 %

Note

The following points must be observed when laying lines and tubing:

– Lines and tubing must never dangle down into the working space. This could lead to them being damaged during commissioning or subsequent operation.
– Lines and tubing must never rub against edges or other sharp objects. This could lead to them being damaged and thus cause the parallel kinematic system to fail prematurely.

10. Connect the pneumatic lines and tubing that connect the interface housing to external components or systems.
11. Connect the motor and encoder cables.

4.2.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Prior to normal operation of the parallel kinematic system, a homing procedure must be carried out (see section 8.1 “Homing the parallel kinematic system”).

5 Repair steps for the parallel kinematic system module

The parallel kinematic system module comprises two carbon-fibre-reinforced plastic (CFRP) rods that care connected by two tension springs. Ball cups at the ends of the rods hold the balls of the ball stud. The balls of the ball studs form ball joints with the ball cups of the rod pairs.

The parallel kinematic system has three modules. These convert the linear movements of the three toothed belt axes into three-dimensional movement of the front unit.

5.1 Replacing a defective parallel kinematic system module, including replacement of the ball studs

Warning

Risk of fatal injury from electrical shock.

– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.

Note

Replacing the ball studs will cause the calibration to be lost, thus reducing the positioning accuracy. For calibrated parallel kinematic systems, calibration will have to be performed again (see section 8.3 “Calibration”).

If the balls of the ball stud are in perfect working condition with no signs of wear, such as scratches or grooves, they do not need to be replaced. As such, sections 5.1.1.1 “Replacing the ball stud on the toothed belt axis” and 5.1.1.2 “Replacing the ball stud on the front unit” can be skipped.

The sliding surfaces of the ball studs are made of ceramic material, and are almost completely resistant to wear. The ball studs will only have to be replaced very occasionally.

The parallel kinematic system module can be replaced separately from the ball studs.

5.1.1 Dismantling the parallel kinematic system module

If the parallel kinematic system module on which the protective conduit retainers are mounted is defective, the retainers will need to be removed first.

1. Unscrew the socket head screws from the protective conduit retainer.

2. Remove the socket head screws from the retainer together with the nuts.
3. Push the retainer down off the the protective conduit from above.

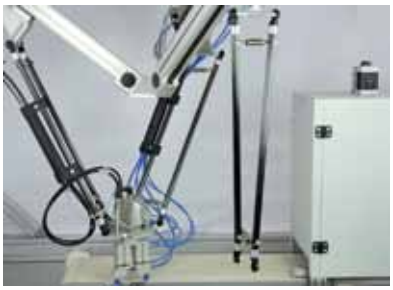
4. Bend the retainer slightly away open on the carbon-fibre rod.
5. Remove the retainer.

6. Remove the lower retainer in the same way as the upper one.

Caution

Risk of injury due to crushing.

– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.



7. Hold the front unit in place with one hand and pull the first rod of the defective parallel kinematic system module off the ball of the ball stud.
8. While still holding the front unit in place with one hand, pull the second rod of the defective parallel kinematic system module off the ball of the ball stud.
9. Move the front unit to a stable position.
10. Pull the defective parallel kinematic system module off the balls on the upper ball stud in the same way as for te lower ball stud.

5.1.1.1 Replacing the ball stud on the toothed belt axis

The sliding surfaces of the ball studs are made of ceramic material, and are thus almost completely resistant to wear. The ball studs will only have to be replaced very occasionally.

The ball studs need to be replaced if thy show signs of wear, such as scratches or grooves. If the ball studs do not need to be replaced, you can skip this section and go straight to the mounting of the new parallel kinematic system module (see section 5.1.2 “Assembling the parallel kinematic system module”).

The parallel kinematic system module can be replaced separately from the ball studs.

Note

Replacing the ball studs will cause the calibration to be lost, thus reducing the positioning accuracy. For calibrated parallel kinematic systems, calibration will have to be performed again (see section 8.3 “Calibration”).

Removing the ball studs from the toothed belt axis

1. Unscrew the two countersunk screws from the connection block on the toothed belt axis.

Note

Do not use sharp tools when pulling the ball stud off the connection block, and do not move between the connection block and the ball stud. This could damage the mounting surfaces, making it impossible for the ball stud to lie flat.

The ball stud and the connection block on the toothed belt axis are aligned with one another using cylindrical dowel pins. As such, a certain amount of force is required when pulling off the ball studs.

2. Pull the ball studs off the connection block.

Mounting the ball studs on the toothed belt axis

The ball studs are symmetrical. They do not need to be mounted in any particular direction to prevent the left and right sides from being mixed up.

3. Clean the screw locking agent off the countersunk screw threads.
4. Drive both cylindrical dowel pins into the ball studs until they are flush with the ball stud mounting surface.
5. Apply LOCTITE 243 to the threads of the countersunk screws.
6. Screw the ball studs onto the connection block, but do not tighten the countersunk screws yet.

7. Drive the cylindrical dowel pins into the connection block until they are flush with the ball studs.
8. Tighten the countersunk screws to a torque of 1.2 Nm.

5.1.1.2 Replacing the ball stud on the front unit

The sliding surfaces of the ball studs are made of ceramic material, and are thus almost completely resistant to wear. The ball studs will only have to be replaced very occasionally.

The ball studs need to be replaced if thy show signs of wear, such as scratches or grooves. If the ball studs do not need to be replaced, you can skip this section and go straight to the mounting of the new parallel kinematic system module (see section 5.1.2 “Assembling the parallel kinematic system module”).

The ball studs on the front unit should be replaced using the same method as when replacing the ball stud on the toothed belt axis (see section 5.1.1.1 “Replacing the ball stud on the toothed belt axis”).

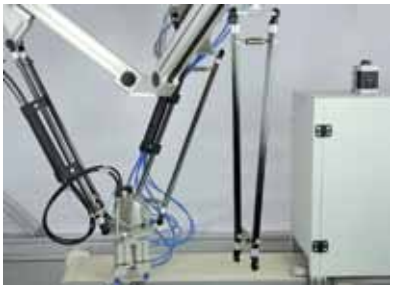
5.1.2 Assembling the parallel kinematic system module

Caution

Risk of injury due to crushing.

– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.

1. Lightly grease the balls of the ball studs and ball cups for the parallel kinematic system module with LUB-KC1 before assembly (see section 10.2 “Greasing”).
2. Place the ball cups of the parallel kinematic system module on the top balls of the ball stud on the toothed belt axis.



3. Hold the front unit in place and place the ball cups of the parallel kinematic system module on the lower balls of the ball stud on the front unit.

If the parallel kinematic system module to which the protective conduit retainers were attached has been replaced, the retainers will need to be re-mounted.

4. Bend the retainers slightly open and press onto the corresponding carbon-fibre rod.
5. Push the protective conduit into the retainers.
6. Apply Loctite 243 to the two socket head screws.
7. Insert both socket head screws into the cut-outs in the retainer, together with the nuts.
8. Tighten the retainer socket head screws to a tightening torque of 0.25 Nm ± 20%.

5.1.2.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Replacing the ball studs will cause the calibration to be lost, thus reducing the positioning accuracy. If they are replaced during repair work on calibrated parallel kinematic systems, calibration will have to be performed again (see section 8.3 “Calibration”).

6 Repair instructions for EXPT 45 and EXPT 70

6.1 Replacing the servo motor

The servo motor EMMS-AS is a permanently excited, electrodynamic, brushless servo motor. The encoder built into the motor supplies motor data, rotational speed and position signals to the higher-order controller. The controller functions in a closed-loop control circuit and regulates the motor to the specified setpoint values for current, rotational speed and position with a high degree of accuracy.

The motor must always be operated within its permitted characteristic curves.

The servo motor needs to be removed and mounted in the following circumstances:

- If the motor is covering a mounting drill hole that needs to be accessed in the basic kit
- If the motor is defective
- If the toothed belt pulley module (toothed belt drive shaft) for the axis needs to be turned or removed for a task such as changing the toothed belt, because the servo motor is fitted with a brake

6.1.1 Removing the servo motor

The servo motor is coupled to the toothed belt axis by the axial module EAMM-A-F37-100A.

Note

Homing will be lost if the motor is removed. Prior to normal operation of the parallel kinematic system, a homing procedure must be carried out (see section 8.1 “Homing the parallel kinematic system”).

At the beginning of the repair procedure, the clamping screw must be aligned to the transverse bore in the coupling housing. The motor brake will need to be released in order for you to do this (see section 8.2.2 “Releasing the brakes”). The motor brake can only be released if the motor and encoder cables are connected to the motor.

1. Carefully lever the cover cap off the transverse bore in the coupling housing using a screwdriver.
2. Release the motor brake.
3. Adjust the coupling clamping screw so that it is aligned with the transverse bore in the coupling housing.

The clamping screw can be aligned with the transverse bore by moving the slide.

Warning

Risk of fatal injury due to electrical shock.

- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

4. Switch off power to the parallel kinematic system and secure it using reliable methods to prevent it from unauthorised reactivation.
5. Remove the motor and encoder cables.

6. Undo the clamping screw on the motor side.

The coupling clamping screw must never be unscrewed completely, otherwise it could get stuck in the coupling housing.

7. Unscrew the motor mounting screws on the motor flange.

8. Remove the motor from the motor flange.
9. Pull the motor out of the coupling housing.

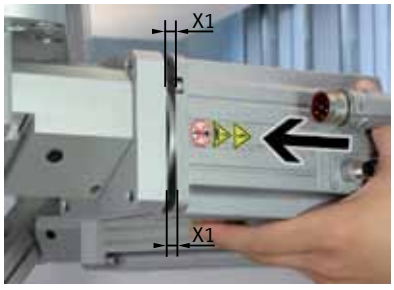
Take care not to tilt the motor when removing it. The motor must be kept straight at all times when pulling it out of the coupling housing.

6.1.2 Mounting the servo motor

Note

The motor shaft and coupling must be completely free of grease. Proper power transmission can only be ensured if the coupling can grip a clean motor and axis shaft.

1. Carefully push the motor into the drill hole in the coupling.



Take care not to tilt the motor when inserting it. The motor must be kept as straight as possible during installation, with dimension X1 equal on all sides.

2. Tighten the motor mounting screws with a tightening torque of 24 Nm ± 20%.

Note

Care must be taken to ensure that the motor mounting screws are tightened before the clamping screw. Failure to follow this sequence may cause tension between the toothed belt axis, coupling and motor.

The clamping screw's alignment to the transverse bore in the coupling housing can be adjusted by moving the slide.

3. Adjust the coupling clamping screw so that it is aligned with the transverse bore in the coupling housing.

4. Tighten the clamping screws in the coupling hub with a tightening torque of 10.5 Nm ± 20%.

5. Connect the motor and encoder cables.

6.1.2.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Prior to normal operation of the parallel kinematic system, a homing procedure must be carried out, as the position of the zero point will be lost when the motor is removed (see section 8.1 “Homing the parallel kinematic system”).

6.2 Replacing axial kit EAMM-A-F37-100A

The axial kit must be removed and re-mounted if the toothed belt pulley module (toothed belt drive shaft) for the axis needs to be removed, e.g. if the ball bearings or drive pinion are defective.

This section describes how to remove and install the axial kit EAMM-A-F37-100A. The following components must already have been removed before work can begin:

– The servo motor (see section 6.1.1 “Removing the servo motor”)

6.2.1 Removing the axial kit

Warning

Risk of fatal injury due to electrical shock.

– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Note

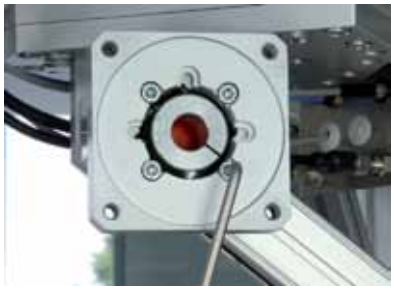
Homing will be lost if the motor or axial kit are removed. Prior to normal operation of the parallel kinematic axis, a homing procedure must be carried out (see section 8.1 “Homing the parallel kinematic system”).

1. Carefully lever the cover cap off the transverse bore in the coupling housing using a screwdriver.
2. Align the coupling clamping screw with the transverse bore.

The clamping screw can be aligned with the transverse bore by moving the slide.

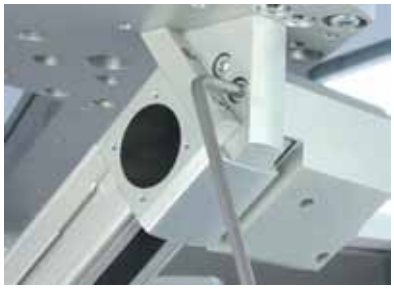
3. Undo the clamping screw on the axis side.

4. Unscrew the mounting screws from the motor flange.
5. Take the motor flange off the coupling housing.
6. Remove the coupling.



7. Unscrew the four mounting screws inside the coupling housing.

8. Unscrew the two mounting screws outside the coupling housing.



9. Take off the coupling housing.

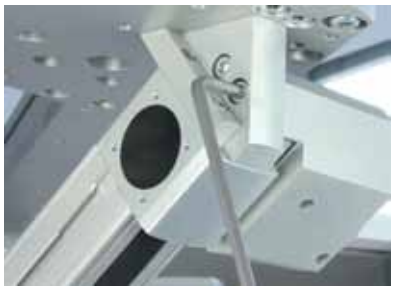
6.2.2 Mounting the axial kit

Note

The motor and axis shafts must be completely free of grease. Perfect power transmission can only be ensured if the coupling can grip a clean motor and axis shaft.

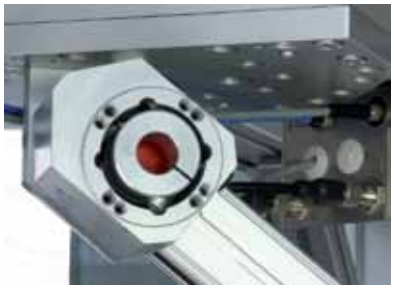
1. Clean the toothed belt axis shaft.

2. Place the coupling housing on the toothed belt axis.
3. Tighten the mounting screws on the outside of the coupling housing to a torque of 14 Nm ± 20%.



4. Tighten the mounting screws on the inside of the coupling housing to a torque of 4.1 Nm ± 20%.

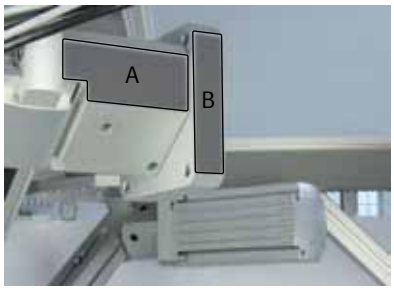
5. Push the coupling with the corresponding drill hole onto the shaft on the axis side. It should be possible to access each of the two coupling clamping screws through a transverse bore in the coupling housing.
6. Tighten the clamping screws on the axis-side shaft with a tightening torque of 10.5 Nm ± 20%.



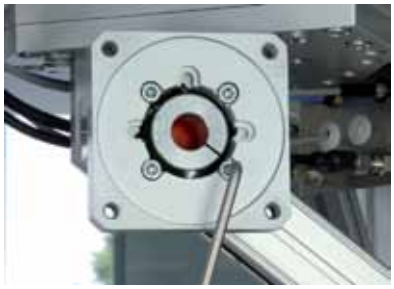
Note

The motor flange should be aligned with the left outside edge parallel to the left outside edge of the coupling housing.

7. Place the motor flange on the coupling housing so that surfaces A and B are parallel.



8. Tighten the mounting screws to a torque of 9.9 ±20% Nm.



6.2.3 Finishing repair work

The following components need to be re-mounted:

– The servo motor (see section 6.1.2 “Mounting the servo motor”)

6.2.3.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Prior to normal operation of the parallel kinematic axis, a homing procedure must be carried out, as the position of the zero point will be lost when the motor is removed (see section 8.1 “Homing the parallel kinematic system”).

6.3 Removing and installing the toothed belt axis DGE-25-...-ZR-RF with track roller pretension adjustment

This section describes how to remove and install the toothed belt axis DGE-25-...-ZR-RF. The following components must already have been removed before work can begin:

1. The servo motor (see section 6.1.1 “Removing the servo motor”)
2. The axial kit (see section 6.2.1 “Removing the axial kit”)

The axis needs to be removed from the parallel kinematic system in the following situations:

– If the drive cover is defective, meaning that the entire axis needs replacing
– If there is a suspicion that there is too much play in the track rollers is too great (increased slide running noise)
– If the cylinder barrel is defective, meaning that the entire axis needs replacing

Depending on the cause of the defect to be eliminated, it may be necessary to exchange several components. The cause of a defect must therefore always be determined before starting a repair.

6.3.1 Removing the toothed belt axis DGE-25-...-ZR-RF from the parallel kinematic system

Warning

Risk of fatal injury due to electrical shock.

– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Caution

Risk of injury due to crushing.

– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.

Note

The homing and calibration settings will be lost when the toothed belt axis is removed from the parallel kinematic system. Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 “Homing the parallel kinematic system”) and calibration (for calibrated parallel kinematic systems) must be performed (see section 8.3 “Calibration”).

1. Pull the parallel kinematic system module off the balls on the upper ball stud on the toothed belt axis.
2. Move the front unit with the parallel kinematic system module to a secure position.

3. Unscrew the lower toothed belt axis mounting screws on the foot mounting.

Note

When unscrewing the upper mounting screws, the toothed belt axis must be held in place with one hand to prevent it from falling.

4. Unscrew the upper toothed belt axis mounting screws on the mounting frame angle bracket.
5. Remove the toothed belt axis from the parallel kinematic system.

6.3.2 Checking and adjusting the track roller pretension

During operation of the parallel kinematic system, the eccentric screws in the slide may come loose. This will directly affect the operating behaviour of the parallel kinematic system. Increased running noise is a sign that the eccentric screws have not been set correctly. This can be checked by monitoring the displacement force of the slide.

The displacement force is measured across the entire stroke without the toothed belt attached.

The track roller pretension is set using the eccentric screws on the slide. To do this, the connection block must be removed from the slide.

6.3.2.1 Removing the connection block with ball stud

1. Unscrew the mounting screws from the connection block.
2. Take the connection block off the slide.

Take care to ensure that the slot nuts do not fall out of the guides.

6.3.2.2 Removing clamping components with the toothed belt

1. Unscrew the socket head screws in the clamping components on both sides of the slide.

A film of thread lock fluid is applied to the screw heads of the socket head screws. The Allen key can be driven carefully into the screw head with a hammer to ensure that it is seated securely.

Note

Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

2. Pull both clamping components out of the slide in the direction of the return housing.

3. Pull both clamping components through the cut-outs in the cylinder barrel and out of the axis.

6.3.2.3 Checking the displacement force of the slide

The displacement force can be determined using an electronic hand-held force-measuring device (pressure and tensile force meter).

In general, the mechanical understanding of the user is important when setting the linear guide. Poor operating behaviour is indicated by running noise. Excessive pretensioning is indicated by harsh, increased running noise.

Check the guide backlash and the displacement force by moving the slide a number of times. The slide must move smoothly and without jerking on the guide rail. The displacement force should be between 5 N and 12 N.

If the displacement force is outside the permissible range, it must be adjusted (see section 6.3.2.4 “Adjusting the track roller pretension”).

6.3.2.4 Adjusting the track roller pretension

The track rollers must be set using the eccentric screws so that the displacement resistance for the slide is as low as possible and it can move without backlash.

The track roller pretension is set using the two inner track rollers via eccentric screws. This requires a high degree of mechanical understanding.

The two track rollers are set one after the other.

1. Carefully lever both cover caps out of the slide using a screwdriver.

2. Unscrew the hex nuts on the eccentric screws and clean off the screw locking agent.
3. Apply LOCTITE 243 to the hex nuts.

4. Screw the hex nuts back onto the eccentric screws, but do not tighten them yet.

5. Place the socket with the milled spanner flat (see section 11.4 “Devices for in-house assembly”) on the hex nut.

6. Place the Allen socket on the eccentric screw through the socket.
7. Pretension the eccentric screw anticlockwise to 0.5 Nm using a torque spanner with drag indicator.

8. Tighten the hex nut slightly so that the pretension of the eccentric screw is maintained.

If the hex nuts are too tight, the pretension will change.

9. Place a rigid Allen key in the eccentric screw and hold it in position.
10. Tighten the hex nut to 2.9 Nm.

Set the second eccentric screw in the same way as the first.

6.3.2.5 Mounting clamping components with the toothed belt

Note

Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

1. Push the clamping components through the cut-out of the cylinder barrel and into the axis.

2. Push the clamping components into the guide in the slide.

Note

If the toothed belt is cut to the correct length, the clamping components should lie flush with the slide unit.

If the clamping components protrude beyond this point, the socket head screws will not reach the minimum screw-in depth and could be torn out.

The clamping components must not touch the slide when they are being screwed in, otherwise the toothed belt could become overstretched, reducing its service life. Slowly increase the toothed belt pretensioning to the correct value.

3. Steadily screw the socket head screws through the clamping components into the slide.
4. Pretension the toothed belt by steadily tightening the socket head screws by feel.

6.3.2.6 Setting the toothed belt pretension

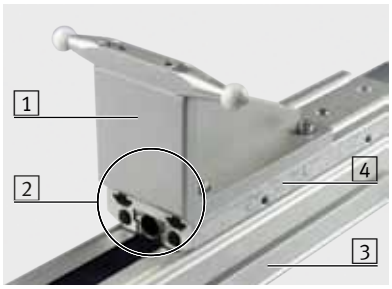
Set the toothed belt pretension (see section 6.4.1.5 “Checking the toothed belt pretension”).

6.3.2.7 Mounting the connection block with ball stud

1. Place the connection block on the slide.

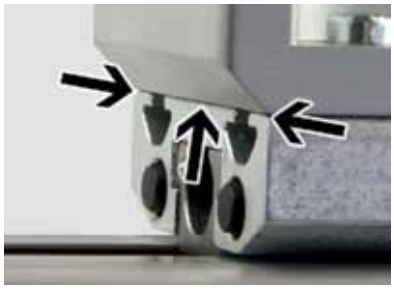
The ball stud should be facing towards the front unit.

2. Apply LOCTITE 243 to the connection block mounting screws.
3. Screw the mounting screws into the slot nuts. Do not tighten the mounting screws yet.



[1] Connection block
[2] Detailed view of slide/connection block (see figure below)
[3] Toothed belt axis
[4] Slide

4. Align the connection block so that the chamfers are flush with the slide.



5. Tighten the connection block mounting screws to a torque of 5.9 ±20% Nm.

6.3.3 Installing the toothed belt axis DGE-25-...-ZR-RF in the parallel kinematic system

Caution

Risk of injury due to crushing.

– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.

Note

The tightening torque for the mounting screws must always be observed. An excessively high tightening torque will damage the threads in the drive cover and on the screws. If the drive cover si damaged, the whole toothed belt axis will need to be replaced.

1. Clean the screw locking fluid off the mounting screws.
2. Apply LOCTITE 243 to the mounting screws.
3. Make sure you have the appropriate Allen key to hand.
4. Insert the toothed belt axis into the parallel kinematic system.
5. Tighten the mounting screws to a torque of 2.9 ±20% Nm.

6. Clean the screw locking fluid off the mounting screws.
7. Apply LOCTITE 243 to the mounting screws.
8. Tighten the mounting screws to a torque of 2.9 ±20% Nm.

9. Place the top ball cup of the parallel kinematic system module on the balls of the ball stud on the toothed belt axis.

6.3.4 Finishing repair work

The following components need to be re-mounted:

1. The axial kit (see section 6.2.2 “Mounting the axial kit”)
2. The servo motor (see section 6.1.2 “Mounting the servo motor”)

6.3.4.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

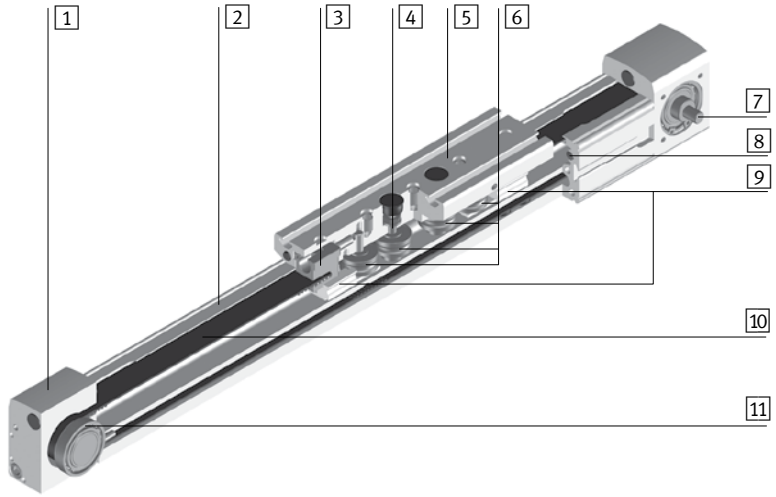
Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 “Homing the parallel kinematic system”), setting of the feed constants (see section 8.2 “Setting the feed constant”) and calibration (for calibrated models) must be performed (see section 8.3 “Calibration”).

6.4 Repairs to the toothed belt axis DGE-25-...-ZR-RF when installed

The following components must be removed before these repair instructions can be carried out:

1. The parallel kinematic system module on the upper ball stud (see section 5.1.1 “Dismantling the parallel kinematic system module”)
2. The servo motor (see section 6.1.1 “Removing the servo motor”)
3. The axial kit (see section 6.2.1 “Removing the axial kit”)

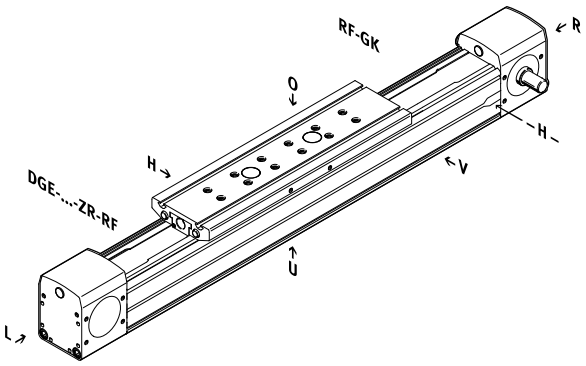
Description of the toothed belt axis DGE-25-...-ZR-RF



1 Drive cover with corner pulley
2 Cylinder barrel
3 Clamping component for clamping the toothed belt
4 Eccentric screw for adjusting the guide backlash of the slide
5 Slide
6 Track rollers
7 Toothed belt pulley with drive trunnion
8 Guide rods
9 Scraper for lubricating the guide rods
10 Toothed belt
11 Deep-groove ball bearing

Mounting directions

This illustration provides an overview of the mounting directions for the toothed belt axis.

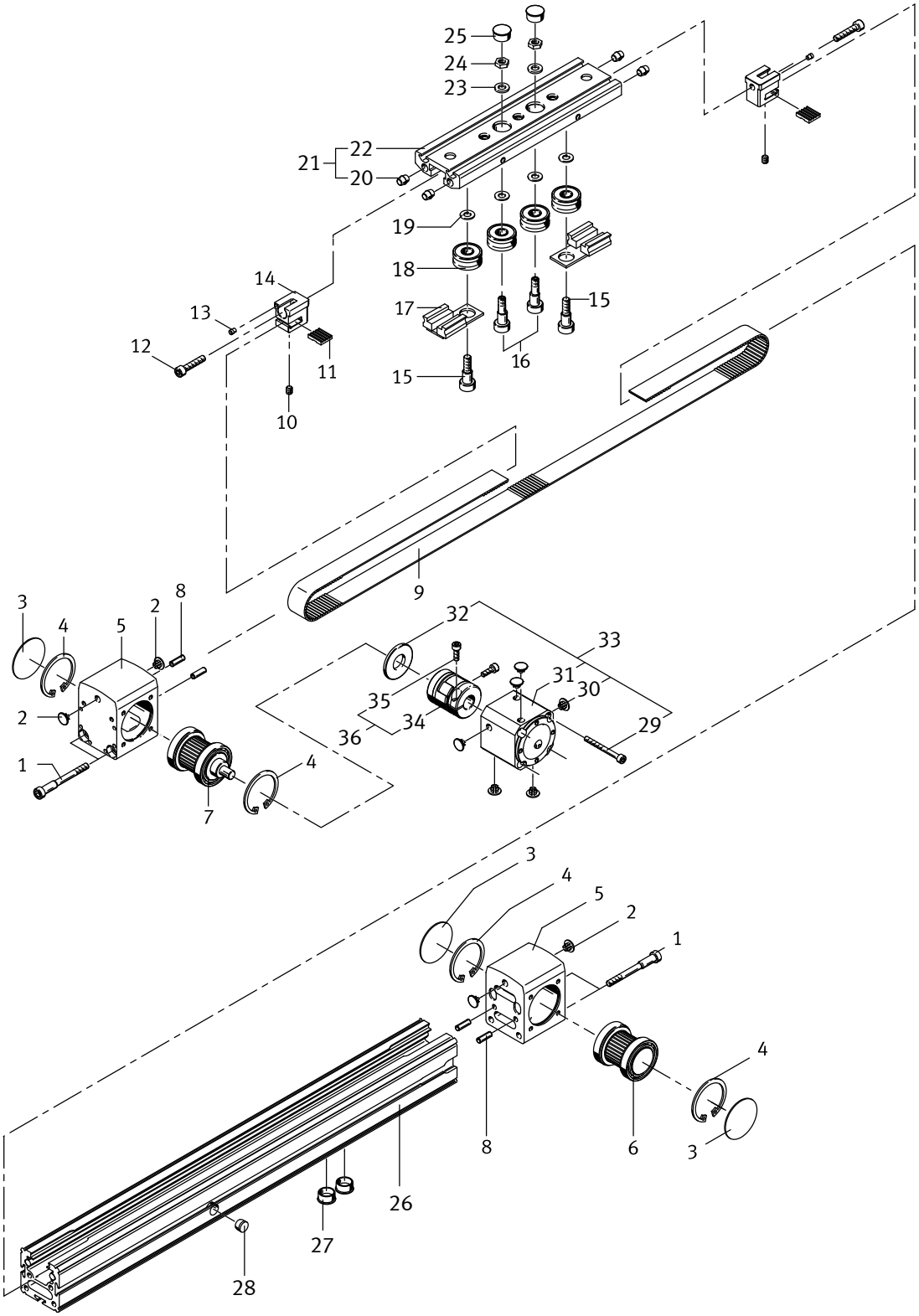


Orientation:

O = top
U = Underneath
R = Right
L = Left
V = Front
H = rear

-H- = Position of the insertion points for slot nuts

Component overview for DGE-25-...-ZR-RF



This diagram is intended only to provide an overview of the individual components. To order spare and wearing parts, please use the online spare parts catalogue on the Festo website (http://spareparts.festo.com).

No.	Part no.	Designation	Type
1	349219	Flange screw	M5×58
2	349347	End cap	
3	666475	Sealing disc	
4	664723	Retaining ring	DIN 472-37×1.5
5		Drive cover	
6	665595	Toothed drive shafts	
7	665598	Toothed drive shafts	
8	353300	Spring pin	DIN 7346-4.5×14
9	664701	Toothed belt	
10	204481	Threaded pin	DIN 913-M5×6-45H
11	745675	Clamping plate	
12	200048	Socket head screw	DIN 912-M5×25-10.9
13	369367	Lubrication nipple	
14	664727	Clamping component	
15	745672	Centring screw	
16	745669	Eccentric screw	
17	664730	Scraper kit	Soaked with oil
18	664736	Track roller	
19	666471	Adjusting washer	
20	371075	Buffer	
21	666468	Slide module	
22		Slide	
23	237071	Washer	DIN 125-A-6.4-A2
24	200601	Hex nut	DIN 439 B-M6
25	665592	Cover cap	
26		Cylinder barrel	
27	665592	Cover cap	
28	669296	Cover cap	
29	200667	Socket head screw	DIN 912-M4×40-8.8
30	349347	End cap	
31		Coupling housing	
32		Centring ring	
33	534394	Coupling housing module	
34		Coupling module	
35	200663	Socket head screw	DIN 912-M4×12-8.8
36		Coupling	

6.4.1 Repair steps for toothed belt axis DGE-25-...-ZR-RF

The following repair steps are described in this section:

- Changing the toothed belt – toothed belt axis remains in parallel kinematic system
- Changing the toothed belt pulley module – toothed belt axis remains in parallel kinematic system

Should it be necessary to change the toothed belt, the cause of the failure must be investigated in order to prevent premature and repeated failure. A toothed belt axis that has been used as intended and sized correctly will not normally exhibit any premature signs of failure.

This investigation is not necessary in the case of non-premature failure (fatigue time). However, the condition of the toothed belt pulley module (wear of the tooth surface/geometry, radial play of the bearing inner raceway with respect to the bearing seat – when new, it should fit tightly) and also the condition of the deep-groove ball bearings (e.g. perceptible bearing clearance, impaired roll-off behaviour and increased operating noise, etc.) should always be checked. In case of uncertainty, we recommend replacing all the components mentioned so as to rule out reciprocal effects during subsequent operation.

Possible visible signs of wear on the toothed belt:

- Cracks on the back of the toothed belt are signs of wear. These can be caused by operation outside the permitted temperature range, impermissible chemical influences or fatigue, for example.
- Wear of the nylon fabric (fabric coating) on the tooth side of the belt. This is indicated by lint formation and bobbling, for example, and constitutes primary wear (abrasion of the fabric).
- Visible individual glass fibre tensile strands in the tooth base are secondary signs of wear due to primary wear to the nylon fabric. If these occur, the toothed belt pulley module must be examined carefully for wear, since visible glass fibre tensile strands may have had a severe abrasive effect on the tooth tip sides of the toothed belt pulleys.

A description of how to replace the toothed belt pulley module together with the corresponding deep-groove ball bearings can be found in section 6.4.1.2 “Checking and replacing the toothed belt pulley module”.

If the toothed belt suffers premature failure, the operating conditions should be observed more closely.

The following possibilities should be considered, among others:

- **Overloading**

  The elasticity of the toothed belt retards the acceleration and braking behaviour of the toothed belt axis and results in greater acceleration and deceleration than set in the controller (spring effect).

  Block-shaped acceleration and deceleration profiles (no jerk limitation) cause high peaks in the drive force that can lead to overloading of the drive. Positions outside of the permissible range can also occur. An acceleration and deceleration specification with jerk limitation reduces oscillations in the entire system and has a positive effect on the stresses to which the mechanical system is subjected.

  - Check which closed-loop controller settings can be adapted (e.g. jerk limitation, smoothing of the acceleration profile).
  - Check the settings for all braking ramps in your controller or the higher-order control system (deceleration values and jerk).
  - Make sure that the deceleration values (braking deceleration, deceleration times) for payload and the installation position (horizontal/vertical) correspond to the permissible values for the toothed belt axis you are using.
  - Use the Festo “PositioningDrives” design software, available via the Festo website (www.festo.com), to configure the toothed belt axis.

- **Ambient conditions/material resistance**
  - Check whether the ambient temperature is within the permissible range.
  - Check the chemical and physical ambient conditions for hazardous substances, such as dust, abrasive particles, cooling lubricants, solvents, ozone, radiation, water-soluble substances, greases and oils, etc.

Note

Festo recommends always checking the following points for each repair step:

- Check the toothed belt pulley module for wear (see section 6.4.1.2 “Checking and replacing the toothed belt pulley module”).
- Check the track roller pretension and adjust if necessary (see section 6.3.2 “Checking and adjusting the track roller pretension”). There should be no discernible play between the track rollers and the guide rods (negative operating clearance).
- Check the displacement force of the slide (see section 6.3.2 “Checking and adjusting the track roller pretension”). The slide must move smoothly and without jerking along the entire length of the axis.

6.4.1.1 Removing defective toothed belts

If the toothed belt is only cracked or damaged, the toothed belt axis remains in the parallel kinematic system during repair work.

The following components must have been removed before the toothed belt is replaced:

1. The parallel kinematic system module on the upper ball stud (see section 5.1.1 “Dismantling the parallel kinematic system module”)
2. The servo motor (see section 6.1.1 “Removing the servo motor”)
3. The axial kit (see section 6.2.1 “Removing the axial kit”)

Warning

Risk of fatal injury due to electrical shock.

- The parallel kinematic system must be de-energised and depressurised and reliably secured against unauthorised activation before the axial kit is replaced.
- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Note

When one toothed belt is cracked, Festo always recommends replacing the toothed belts on the other two axes as well.

If a toothed belt is cracked, the toothed belt pulley module should be checked once the defective toothed belt has been replaced. When doing this, check the following points:

- Signs of wear on the belt pulley (burr or damaged teeth).
- Play and operating behaviour of the two ball bearings. It should be possible to turn the ball bearings smoothly and noiselessly without any discernible scratching.

For instructions on how to remove the toothed belt pulley module, see section 6.4.1.2 “Checking and replacing the toothed belt pulley module”.

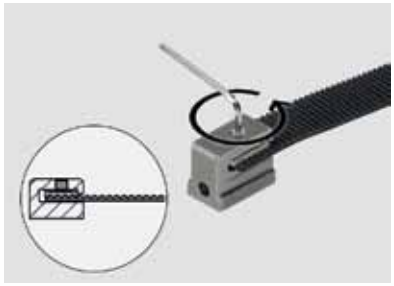
A film of thread lock fluid is applied to the screw heads of the socket head screws. The Allen key can be driven carefully into the screw head to ensure that it is seated securely.

4. Unscrew the socket head screws in the clamping components.

5. Move the slide up and down to loosen the clamping components from the slide.

6. Push both clamping components through the cut-outs in the cylinder barrel and out of the axis.

7. Unscrew the threaded pins in the clamping components at both ends of the toothed belt.



Take care to ensure that the clamping plate in the clamping component does not fall out.

8. Pull the clamping components sideways away from the toothed belt.
9. Remove the clamping plates from the toothed belt.
10. Remove the clamping components on the second side of the toothed belt in the same way as for the first.

11. Carefully pull the toothed belt out of the axis.

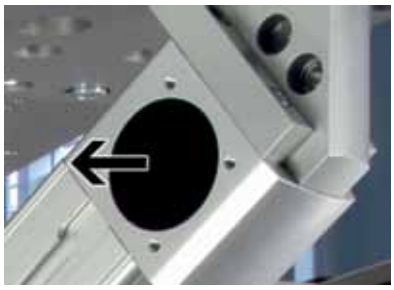
6.4.1.2 Checking and replacing the toothed belt pulley module

The toothed belt pulley module sits in a clearance fit in the drive cover with two pressed-on deep-groove ball bearings, and is secured by a retaining ring to prevent axial movement.

The toothed belt pulley module should be checked each time the toothed belt is replaced.

Removing the toothed belt pulley module

1. Lever the sealing disc out of the drive cover.



2. Remove the left and right retaining rings.

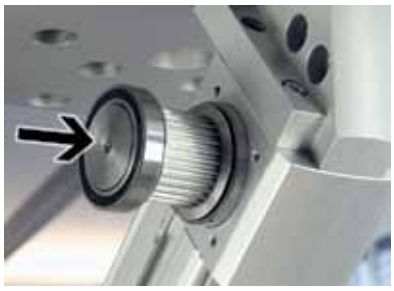
3. Carefully drive the toothed belt pulley module out of the drive cover using a plastic hammer.

You do not need to pull off the deep-groove ball bearings, as the spare part comprises the two bearings and the shaft, and is already pre-assembled.

4. Check that the deep-groove ball bearings are seated securely on the toothed belt drive shaft.
5. Check the roll-off behaviour of the deep-groove ball bearings.
6. Check the toothed belt drive shaft for damage.
7. If the deep-groove ball bearing is not seated securely, the roll-off behaviour is uneven or the toothed belt drive shaft shows signs of damage, the toothed belt pulley module must be replaced.
8. Remove and check the second toothed belt pulley module in the same way as the first.
9. Clean both drive covers and the cylinder barrel.

Installing the toothed belt pulley module

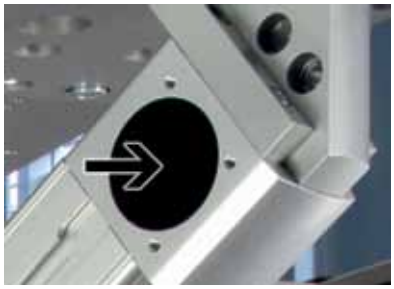
1. Apply a light coating of grease to the outside of the deep-groove ball bearings.
2. Carefully drive the toothed belt pulley module into the drive cover using a plastic hammer, with the drive trunnion pointing towards the motor.
3. Install the second toothed belt pulley module in the same way.



4. Insert all the retaining rings.

Check that the retaining rings are positioned correctly.

5. Press the sealing discs into the drive cover so that the deep-groove ball bearings have extra protection from contamination.



6.4.1.3 Installing a new toothed belt

General ordering information

Note

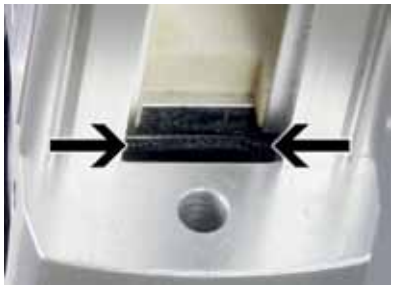
Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

The toothed belt supplied as a spare part is cut to the precise tooth if the part number, stroke and slide type are specified correctly. It does not need to be shortened.

The toothed belt is ordered from the online spare parts catalogue (http://spareparts.festo.com) using the corresponding part number (dependent on the size and version of the parallel kinematic system; see sections 2.3.1 “EXPT-45 / 70-E1-T0” and 2.3.2 “EXPT-45 / 70-E1-T1 / T2 / T3 / T4”).

1. Feed the toothed belt behind the top toothed belt pulley with the teeth facing down.
2. Carefully push the toothed belt through the toothed belt axis.

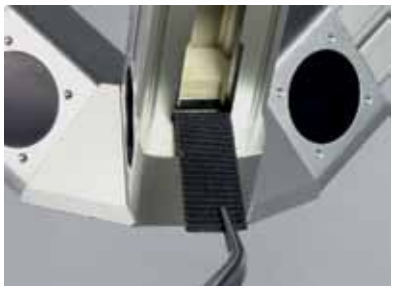
3. Feed the toothed belt behind the bottom toothed belt pulley with the teeth facing down.



The toothed belt will catch slightly where the drive cover meets the cylinder barrel.

4. Grip the toothed belt carefully with a pair of flat pliers.

5. Pull the toothed belt a little way out of the axis.

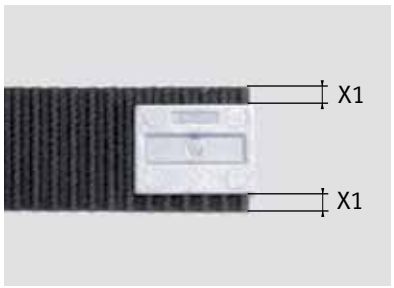


6. Place the clamping plate on the end of the new toothed belt.

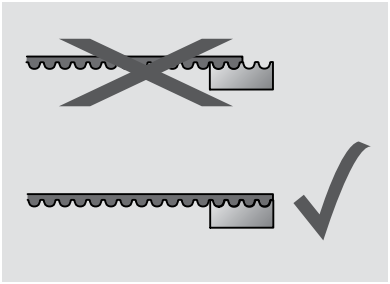
Note

To prevent the toothed belt from getting damaged during operation, the clamping plate must be axially centred in relation to the toothed belt.

7. Position the clamping plate centrally in relation to the toothed belt axis. Dimension X1 must be equal on both sides.



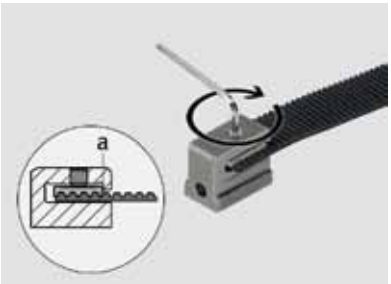
The toothed belt must be placed flush on the clamping plate. It must not protrude and must make contact with four teeth.



Note

The threads of the clamping components must be recut before the threaded pins are screwed in. Residues from the old locking agent on and in the thread result in uneven and increased torques for the threaded pins, which means they may not be correctly tightened.

8. Recut the threads in the clamping components.
9. Remove any residue of the old screw locking agent.
10. Insert the end of the toothed belt into the clamping component together with the clamping plate.
11. Position the toothed belt centrally in relation to the clamping component's axis.
12. Apply Loctite 243 to the threaded pin.
13. Screw the threaded pin into the clamping component.
14. Push the clamping plate against the stop (a) on the clamping component.



Note

The clamping plate must make contact with the stop (a), otherwise the toothed belt pretension will diminish during operation.

Note

The tightening torque must always be observed. Excessive tightening torques will bend the clamping component.

15. Tighten the threaded pin to a torque of 0.5 Nm.
16. Insert the second clamping component in the same way as the first.

Note

Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

17. Insert the clamping component into the groove in the cylinder barrel through the cut-out in the drive cover.

18. Pull the clamping component in the direction of the slide, or vice versa.

19. Push the clamping component into the guide of the slide.

Threaded inserts with SCREWLOCK® are screwed into the slides. These have a screw-clamping area that serves as a locking agent. Multiple windings have a clamping effect on the edges of the screwed-in adjusting screws for the toothed belt pretension. The result is flexible frictional locking. This keeps the setting for the toothed belt pretension from being changed (automatic unscrewing).

Note

The clamping components must not touch the slide when they are being screwed in, otherwise the toothed belt could become overstretched, reducing its service life. Slowly increase the toothed belt pretensioning to the correct value.

The use of threaded inserts with SCREWLOCK® and the dynamic loads on the adjusting screw mean that only original spare parts from Festo with the appropriate strength class may be used. Otherwise, the screws can break prematurely.

The clamping effect can damage the thread profile of the adjusting screw. As such, we recommend using **new** adjusting screws for assembly.

20. Steadily screw the socket head screws through the clamping components into the slide.
21. Repeat the steps at the other end of the axis to insert the second clamping component.
22. Pretension the toothed belt by steadily tightening the socket head screws by feel.

Note

If the toothed belt is the correct length, the clamping components should lie at least flush with the slide unit.

If the clamping components protrude beyond this point, the socket head screws will not reach the minimum screw-in depth and could be torn out.

Check the toothed belt pretensioning (see section 6.4.1.5 “Checking the toothed belt pretension”) and adjust if necessary (see section 6.4.1.6 “Adjusting the toothed belt pretension”).

6.4.1.4 General information on the toothed belt pretension

A pulse is applied to the toothed belt to make it oscillate. The resulting natural frequency of the toothed belt is recorded using a meter and displayed as a frequency value in hertz.

Note

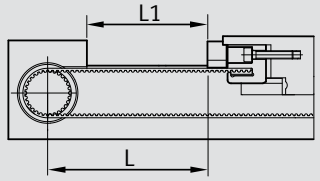
The correct toothed belt pretension is of critical importance for the service life of the toothed belt, as well as the positioning accuracy and performance of the toothed belt axis. Extreme care must therefore be taken when checking it.

The conventional method for measuring the toothed belt pretension using the deflection force is too inaccurate, and therefore cannot be used. Accurate results are achieved by measuring the oscillation frequency. The natural frequency of a belt depends on its tension (strand force), mass and strand length.

The strand length (L) is the oscillating length of a belt.

Since the freely oscillating strand length (L) cannot be measured directly, the distance from the piston to one of the drive covers (L1) is set by moving the slide.

The toothed belt pretension is determined by measuring the basic oscillation (natural frequency) of the toothed belt with a fixed and freely oscillating strand length (L).



The frequency value is calculated using the specified values for strand force (pretension force), belt mass and length of the free belt strand according to the following formula:

$$f = \frac{1}{2 \cdot L} \cdot \sqrt{\frac{F_V}{m}}$$

f	Natural frequency of the freely oscillating strand [Hz]
L	Strand length [m]
F_V	Pretension force [N]
m	Weight per metre of the toothed belt [kg / m]

The frequency that needs to be set can be calculated using the data from the following table:

Type	Weight per metre m	Freely oscillating strand length L	Pretension force F_V
DGE-25	0.0459 kg / m	24 mm + L1[1)]	267 – 282 N

[1)] See section 6.4.1.5 “Checking the toothed belt pretension”.

Note on measurement using the acoustic frequency meter:

If the toothed belt is excited by means of a force stimulus, the strand oscillates with its natural frequency; this dies down reasonably quickly depending on the cushioning.

The frequency meter measures the natural frequency generated (transverse oscillation) using the acoustic operating principle. In addition to the basic oscillation (natural frequency), harmonic oscillation can also occur. From experience it is always the first harmonic oscillation. In other words, a further oscillation node is generated and therefore, in addition to the basic oscillation frequency, values that are twice the natural frequency can also be measured.

For this reason, several measurements should always be carried out to differentiate the necessary basic oscillation (natural frequency) from the harmonic oscillation. Only this frequency can be used to extrapolate the force acting along the strand.

6.4.1.5 Checking the toothed belt pretension

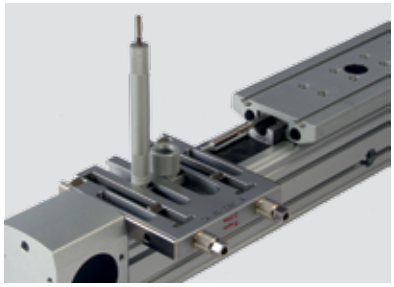
Before the toothed belt pretension can be measured, the slide must be moved back and forth a number of times to allow the toothed belt to fully settle and differences in tension to be equalised.

The easiest way to check the toothed belt pretension is using the test device (see section 11.3 “Equipment and meters”).

Measuring the toothed belt pretension with a test device

The distance between the drive cover and piston does not need to be set when measuring the toothed belt pretension using the test device (see 11.3 “Equipment and meters”). The correct strand length is attained using the supplied spacers.

The exact procedure for checking the toothed belt pretension can be found in the operating instructions **“Test device for toothed belt pretension TB-TE-EQ12”** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ12_en.pdf) or **“Test device for toothed belt pretension TB-TE-EQ02”** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ02_en.pdf).



Measuring the toothed belt pretension without a test device

The end clamp (see section 11.4 “Devices for in-house assembly”) allows the toothed belt to oscillate freely without hitting the cylinder barrel.

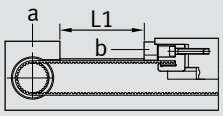
1. Push the end clamp through the cut-out in the cylinder barrel between the toothed belt and the cylinder barrel.

2. Push the end clamp onto the clamping component.

Note

The end clamp must lie against the clamping component.

3. Set the distance (L1) between the drive cover (a) and end clamp (b) to 50 mm.



4. Align the acoustic frequency meter centrally on the toothed belt as described in the associated operating instructions.
5. Make the toothed belt oscillate by striking it with a thin, heavy object, such as an Allen key or punch.

Several measurements should be taken to compensate for measurement tolerances.

The toothed belt must be able to oscillate freely.

6. When distance L1 is 50 mm, the measurement result should be 515^{+14} Hz.

6.4.1.6 Adjusting the toothed belt pretension

Note

The pretension of the toothed belt is not an indicator of wear!

The specified value applies for a new toothed belt.

The toothed belt is set to the specified value in the factory, and is thus maintenance-free for its entire service life.

The pretension of the toothed belt diminishes during storage and operation. This is not an indication of wear; it is a normal process that must not be changed by increasing the tension of the toothed belt.

The toothed belt pretension must therefore only be set after replacing the toothed belt.

If the measured natural frequency of the toothed belt is outside the specified range, the toothed belt pretension must be adjusted as follows:

1. Adjust the toothed belt pretension by turning the socket head screws.
2. Before you measure the toothed belt pretension again, the slide must be moved back and forth a number of times so that the toothed belt can fully settle and differences in tension are compensated.

Turning the socket head screw clockwise increases the tension in the toothed belt, and thus its oscillation frequency.

Turning the socket head screw anticlockwise decreases the tension in the toothed belt, and thus its oscillation frequency.

6.4.1.7 Functional test

After completing the assembly work on the toothed belt axis, check that all the components function correctly:

No-load torque

It must be possible to move the slide unit without much resistance or jerking when it is idle and has no drive attached or load connected.

This check is based on the installation technician's instinct and experience. It is not possible to specify precise test values.

6.4.2 Replacing the stop buffers

You can replace the stop buffers without dismantling the slide.

1. Lever the stop buffers out of the front sides of the slide.
2. Replace the stop buffers.

6.4.3 Finishing repair work

The following components need to be re-mounted:

1. The axial kit (see section 6.2.2 "Mounting the axial kit")
2. The servo motor (see section 6.1.2 "Mounting the servo motor")
3. The parallel kinematic system module (see section 5.1.2 "Assembling the parallel kinematic system module")

6.4.3.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 "Homing the parallel kinematic system"), setting of the feed constants (see section 8.2 "Setting the feed constant") and calibration (for calibrated models) must be performed (see section 8.3 "Calibration").

7 Repair instructions for EXPT 95 and EXPT 120

7.1 Replacing the servo motor

The servo motor EMMS-AS is a permanently excited, electrodynamic, brushless servo motor. The encoder built into the motor supplies motor data, rotational speed and position signals to the higher-order controller. The controller functions in a closed-loop control circuit and regulates the motor to the specified setpoint values for current, rotational speed and position with a high degree of accuracy.

The motor must always be operated within its permitted characteristic curves.

The servo motor needs to be removed and mounted in the following circumstances:

- If the motor is covering a mounting drill hole that needs to be accessed in the basic kit
- If the motor is defective
- If the toothed belt pulley module (toothed belt drive shaft) for the axis needs to be turned or removed for a task such as changing the toothed belt, (servo motor is fitted with a brake)

7.1.1 Removing the servo motor

The servo motor is coupled to the toothed belt axis by the axial module EAMM-A-L48-100A.

Warning

Risk of fatal injury from electrical shock.

- The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Note

Homing will be lost if the motor is removed. Prior to normal operation of the parallel kinematic system, a homing procedure must be carried out (see section 8.1 “Homing the parallel kinematic system”).

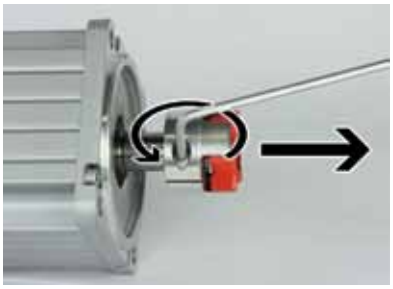
1. Detach the motor and encoder cables.

2. Unscrew the motor mounting screws on the motor flange.

3. Remove the motor from the motor flange.
4. Pull the motor out of the coupling housing.

A certain amount of force is required to pull the motor out of the coupling housing, as the two coupling hubs need to be pulled apart.

5. Undo the clamping screw on the motor shaft coupling hub.
6. Pull the coupling hub off the motor shaft.

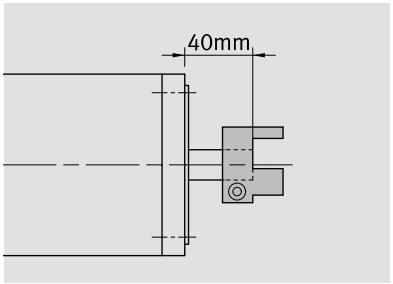


7.1.2 Mounting the servo motor

Note

The motor shaft and coupling must be completely free of grease. Proper power transmission can only be ensured if the coupling can grip a clean motor and axis shaft.

1. Push the motor-side coupling hub onto the motor shaft. A clearance of 40 mm (see illustration) must be observed when doing this.
2. Tighten the clamping screws in the coupling hub with a tightening torque of 8 Nm ± 20%.



3. Carefully place the motor with the coupling hub attached in the other coupling hub. This brings the two coupling halves back together. A certain amount of force is required to do this.
4. Tighten the motor mounting screws with a tightening torque of 24 Nm ± 20%.

5. Re-connect the motor cable and encoder cable.

7.1.3 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Prior to normal operation of the parallel kinematic system, a homing procedure must be carried out, as the position of the zero point will be lost when the motor is removed (see section 8.1 “Homing the parallel kinematic system”).

7.2 Replacing axial kit EAMM-A-L48-100A

The axial kit must be removed and re-mounted if the toothed belt pulley module (toothed belt drive shaft) for the axis needs to be removed, e.g. if the ball bearings or drive pinion are defective.

This section describes how to remove and install the axial kit EAMM-A-L48-100A. The following components must already have been removed before work can begin:

– The servo motor (see section 7.1.1 “Removing the servo motor”)

7.2.1 Removing the axial kit

Warning

Risk of fatal injury due to electrical shock.

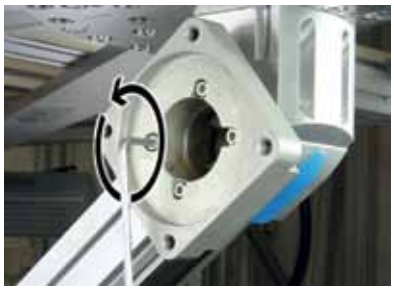
– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Note

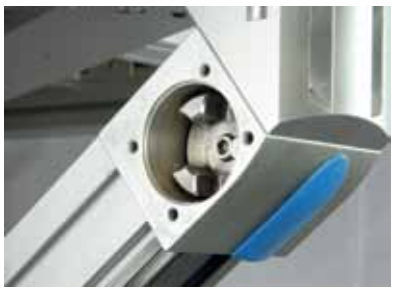
Homing will be lost if the motor or axial kit are removed. Prior to normal operation of the parallel kinematic axis, a homing procedure must be carried out (see section 8.1 “Homing the parallel kinematic system”).

A certain amount of force is required to detach the motor from the motor flange, as this procedure involves pulling the two coupling hubs apart.

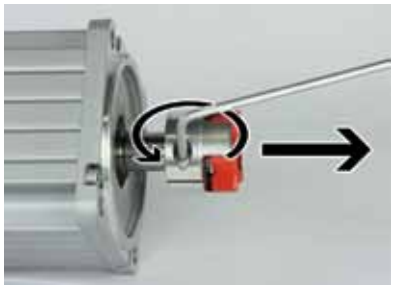
1. Unscrew the mounting screws from the motor flange.



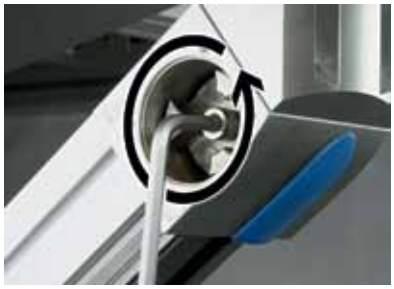
2. Take the motor flange off the axis.



3. Undo the clamping screw on the motor shaft coupling hub.
4. Pull the coupling hub off the shaft.



5. Undo the clamping screw on the toothed belt axis coupling hub.



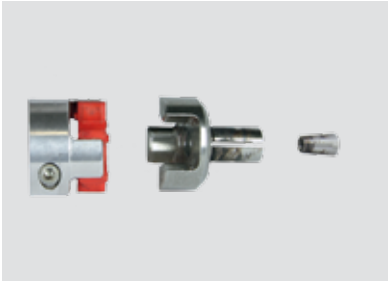
6. Pull the hub out of the toothed belt axis drive cover.

7.2.2 Mounting the axial kit

Note

The motor shaft and coupling must be completely free of grease. Perfect power transmission can only be ensured if the coupling can grip a clean motor and axis shaft.

1. Pull apart the two coupling hubs.
2. To do so, place the ring gear on one of the coupling hubs.



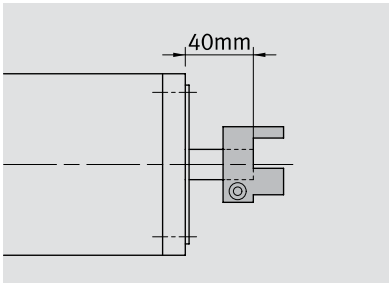
3. Push the coupling hub with the clamping spigot into the hollow shaft in the axis, until it is as far into the toothed belt axis drive cover as it will go.

4. Tighten the clamping screw with a tightening torque of 8.5 Nm ± 20%.

If the coupling hub with the clamping spigot cannot be moved, it cannot be mounted. An extraction thread can be used to loosen the component. To do this, screw a screw into the extraction thread and use this to push out the clamping spigot.

Note

A clearance of 40 mm must be observed when pushing the coupling hub onto the motor shaft; see illustration.



5. Push the coupling hub onto the motor shaft.

6. Tighten the clamping screw with a tightening torque of 8 Nm ± 20%.

7. Place the coupling housing with motor flange on the axis.
8. Tighten the four mounting screws to a torque of 6 Nm ± 20%.

7.2.3 Finishing repair work

The following components need to be re-mounted:

– The servo motor (see section 6.1.2 “Mounting the servo motor”)

7.2.3.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Prior to normal operation of the parallel kinematic axis, a homing procedure must be carried out, as the position of the zero point will be lost when the motor is removed (see section 8.1 “Homing the parallel kinematic system”).

7.3 Removing and installing the toothed belt axis EGC-80-...-TB-KF

This section describes how to remove and install the toothed belt axis EGC-80-...-TB-KF. The following components must already have been removed before work can begin:

1. The servo motor (see section 7.1.1 “Removing the servo motor”)
2. The axial kit (see section 7.2.1 “Removing the axial kit”)

The axis needs to be removed from the parallel kinematic system in the following situations:

– If the slide is defective, meaning that the entire axis needs replacing
– If the drive cover is defective, meaning that the entire axis needs replacing
– If one or more of the roller carriages are defective, meaning that the entire axis needs replacing
– If the roller carriage guide rail is defective, meaning that the entire axis needs replacing
– If the cylinder barrel is defective, meaning that the entire axis needs replacing

Depending on the cause of the defect to be eliminated, it may be necessary to exchange several components. The cause of a defect must therefore always be determined before starting a repair.

7.3.1 Removing the toothed belt axis EGC-80-...-TB-KF from the parallel kinematic system

Warning

Risk of fatal injury due to electrical shock.

– The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance and repair work begins.
– The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Caution

Risk of injury due to crushing.

– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.

Note

The homing and calibration settings will be lost when the toothed belt axis is removed from the parallel kinematic system. Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 “Homing the parallel kinematic system”) and calibration (for calibrated parallel kinematic systems) must be performed (see section 8.3 “Calibration”).

Dirt or abraded particles may fall into the operating area of the parallel kinematic system during removal of the toothed belt axis. Before removal, take the blue cover caps off the drive covers and dispose of any abraded particles.

1. Pull the parallel kinematic system module off the balls on the upper ball stud on the toothed belt axis.
2. Move the front unit with the parallel kinematic system module to a secure position.

3. Unscrew the lower toothed belt axis mounting screws on the foot mounting.

Note

When unscrewing the upper mounting screws, the toothed belt axis must be held in place with one hand to prevent it from falling.

4. Unscrew the upper toothed belt axis mounting screws on the mounting frame angle bracket.
5. Remove the toothed belt axis from the parallel kinematic system.

7.3.2 Installing the toothed belt axis EGC-80-...-TB-KF in the parallel kinematic system

Caution

Risk of injury due to crushing.

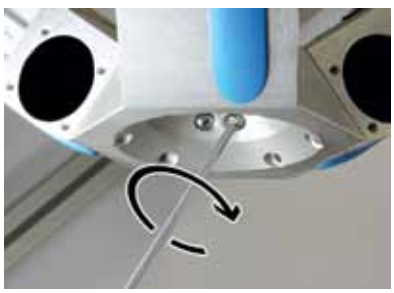
– Due to the tension of the springs in the parallel kinematic system module, a relatively large amount of force is required to undo the ball cups and place them on the ball heads. Take care not to put your fingers between the balls and the ball cups.

Note

The tightening torque for the mounting screws must always be observed. An excessively high tightening torque will damage the threads in the drive cover and on the screws. If the drive cover si damaged, the whole toothed belt axis will need to be replaced.

1. Clean the screw locking agent off the upper mounting screws.
2. Apply LOCTITE 243 to the upper mounting screws.
3. Make sure you have the appropriate Allen key to hand.
4. Insert the toothed belt axis into the parallel kinematic system.
5. Tighten the upper mounting screws to a torque of 8.3 ± 20% Nm.

6. Clean the screw locking agent off the lower mounting screws.
7. Apply LOCTITE 243 to the lower mounting screws.
8. Tighten the lower mounting screws to a torque of 8.3 ± 20% Nm.



9. Place the top ball cup of the parallel kinematic system module on the balls of the ball stud on the toothed belt axis.

7.3.3 Finishing repair work

The following components need to be re-mounted:

1. The axial kit (see section 7.2.2 “Mounting the axial kit”)
2. The servo motor (see section 7.1.2 “Mounting the servo motor”)

7.3.3.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

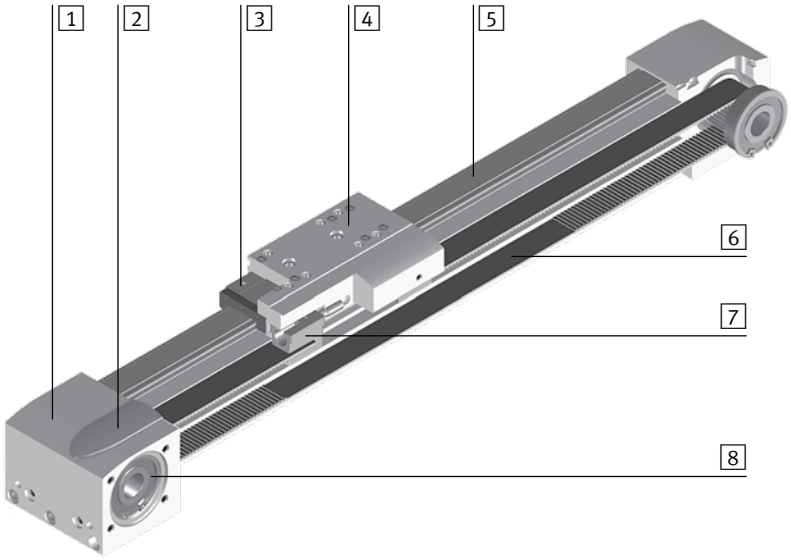
Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 “Homing the parallel kinematic system”), setting of the feed constants (see section 8.2 “Setting the feed constant”) and calibration (for calibrated models) must be performed (see section 8.3 “Calibration”).

7.4 Repairs to the toothed belt axis EGC-80-...-TB-KF when installed

The following components must be removed before these repair instructions can be carried out:

1. The parallel kinematic system module on the upper ball stud (see section 5.1.1 “Dismantling the parallel kinematic system module”)
2. The servo motor (see section 7.1.1 “Removing the servo motor”)
3. The axial kit (see section 7.2.1 “Removing the axial kit”)

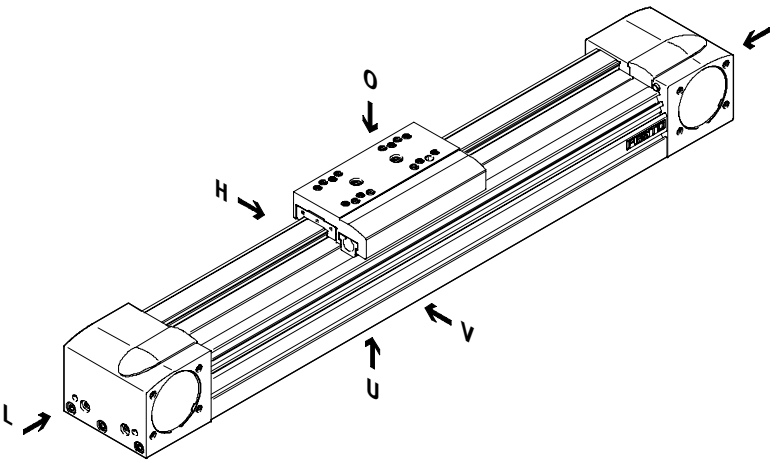
Description of the toothed belt axis EGC-80-...-TB-KF



1 Drive cover with corner pulley
2 Cover cap
3 Roller carriage
4 Slide
5 Guide rail
6 Toothed belt
7 Clamping component
8 Toothed belt pulley with deep-groove ball bearings

Mounting directions

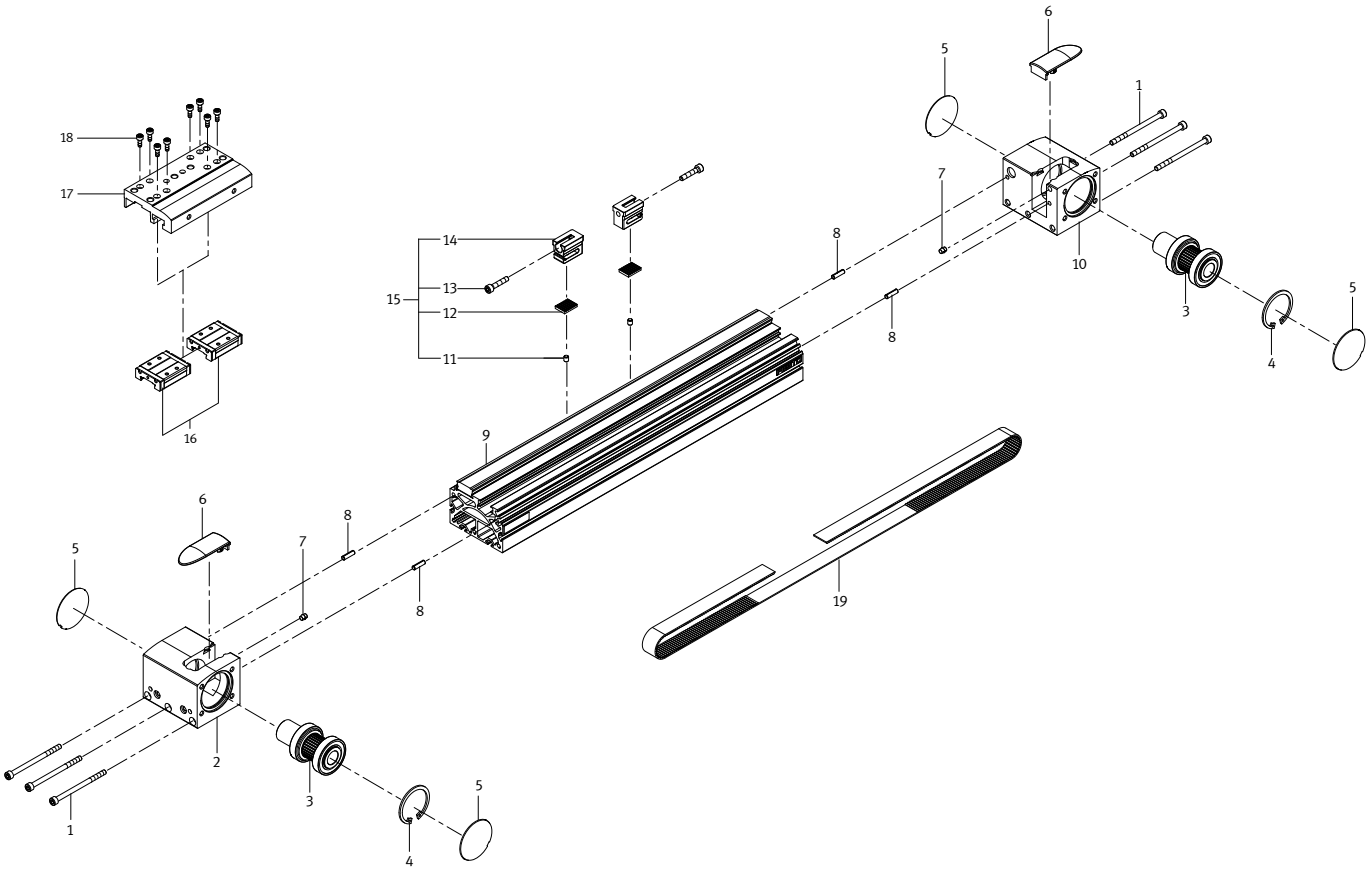
This illustration provides an overview of the mounting directions and slide variants for the toothed belt axis.



Orientation:

O = top
U = Underneath
R = Right
L = Left
V = Front
H = rear

Component overview for EGC-80-...-TB-KF



No.	Part no.	Designation	Type
1	255265	Socket head screw	DIN 912-M5×75-8.8
2	716437	Drive cover	
3	723109	Toothed belt pulley module	
4	201030	Retaining ring	DIN 472-42×1.75
5	716453	Sealing disc	
6	716447	Cover cap	
7	382090	Buffer element	
8	349184	Spring pin	DIN 7346-4.5×16
9		Cylinder barrel module	
10	716438	Drive cover	
11	204481	Threaded pin	DIN 913-M5×6-45H
12		Clamping plate	
13	200048	Socket head screw	DIN 912-M5×25-10.9
14		Clamping component	
15	739499	Clamping component module	
16	736905	Roller carriage	
17	716492	Slide	
18	396496	Socket head screw	DIN 912- M3×10-12.9
19	743150	Toothed belt	

This diagram is intended to provide a rough overview of the individual components and an aid when ordering. For a more detailed overview, please refer to the online spare parts catalogue on the Festo website (http://spareparts.festo.com).

7.4.1 Repair steps for toothed belt axis EGC-80-...-TB-KF

The following repair steps are described in this section:

- Changing the toothed belt – toothed belt axis remains in parallel kinematic system
- Changing the toothed belt module – toothed belt axis remains in parallel kinematic system

Should it be necessary to change the toothed belt, the cause of the failure must be investigated in order to prevent premature and repeated failure. A toothed belt axis that has been used as intended and sized correctly will not normally exhibit any premature signs of failure.

This investigation is not necessary in the case of non-premature failure (fatigue time). However, the condition of the toothed belt pulley module (wear of the tooth surface/geometry, radial play of the bearing inner raceway with respect to the bearing seat – when new, it should fit tightly) and also the condition of the deep-groove ball bearings (e.g. perceptible bearing clearance, impaired roll-off behaviour and increased operating noise, etc.) should always be checked. In case of uncertainty, we recommend replacing all the components mentioned so as to rule out reciprocal effects during subsequent operation.

Possible visible signs of wear of the toothed belt:

- Cracks on the back of the toothed belt are signs of wear. These can be caused by operation outside the permitted temperature range, impermissible chemical influences or fatigue, for example.
- Wear to the nylon fabric (fabric coating) on the tooth side of the belt. This is indicated by lint formation and bobbling, for example, and constitutes primary wear (abrasion of the fabric).
- Visible individual glass fibre tensile strands in the tooth base are secondary signs of wear due to primary wear to the nylon fabric. If these occur, the toothed belt pulley module must be examined carefully for wear, since visible glass fibre tensile strands may have had a severe abrasive effect on the tooth tip sides of the toothed belt pulleys.

A description of how to replace the toothed belt pulley module together with the corresponding deep-groove ball bearings can be found in section 7.4.1.2 “Checking and replacing the toothed belt pulley module”.

If the toothed belt suffers premature failure, the operating conditions should be observed more closely.

The following possibilities should be considered, among others:

- **Overloading**

  The elasticity of the toothed belt retards the acceleration and braking behaviour of the toothed belt axis and results in greater acceleration and deceleration than set in the controller (spring effect).

  Block-shaped acceleration and deceleration profiles (no jerk limitation) cause high peaks in the drive force that can lead to overloading of the drive. Positions outside of the permissible range can also occur. An acceleration and deceleration specification with jerk limitation reduces oscillations in the entire system and has a positive effect on the stresses to which the mechanical system is subjected.

  - Check which closed-loop controller settings can be adapted (e.g. jerk limitation, smoothing of the acceleration profile).
  - Incorrect set values for the braking ramp during STOP conditions (e.g. emergency stop, quick stop) result in overloading of the toothed belt axis and can destroy it or dramatically reduce its service life.
  - Check the settings for all braking ramps in your controller or the higher-order control system (deceleration values and jerk).
  - Make sure that the deceleration values (braking deceleration, deceleration times) for the speed, the load to be moved and the mounting position (horizontal/vertical) as well as the specified maximum driving torque or the feed force correspond to the permissible values for the toothed belt axis used.
  - Use the Festo “PositioningDrives” design software, available via the Festo website (www.festo.com), to configure the toothed belt axis.

- **Ambient conditions/material resistance**

  Make sure that the ambient temperature is within the permissible range.

  Check the chemical and physical ambient conditions for hazardous substances, such as dust, abrasive particles, cooling lubricants, solvents, ozone, radiation, water-soluble substances, greases and oils, etc.

Note

Festo recommends always checking the following points for each repair step:

- Check the toothed belt pulley module for wear (see section 7.4.1.2 “Checking and replacing the toothed belt pulley module”).
- There should be no discernible play between the roller carriage and the guide rails (negative operating clearance; see “Checking the roller carriage pretension”).
- The slide must move smoothly and without jerking along the entire length of the axis.

7.4.1.1 Removing defective toothed belts

Warning

Risk of fatal injury due to electrical shock.

- The parallel kinematic system must be de-energised and depressurised and reliably secured against unauthorised activation before the axial kit is replaced.
- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

Note

When one toothed belt is cracked, Festo always recommends replacing the toothed belts on the other two axes as well.

If a toothed belt is cracked, the toothed belt pulley module should be checked once the defective toothed belt has been replaced. When doing this, check the following points:

- Signs of wear on the belt pulley (burr or damaged teeth).
- Play and operating behaviour of the two ball bearings. It should be possible to turn the ball bearings smoothly and noiselessly without any discernible scratching.

For instructions on how to remove the toothed belt pulley module, see section 7.4.1.2 “Checking and replacing the toothed belt pulley module”.

Remove the cover cap, as abraded particles from the toothed belt could fall into the working space when you do so.

1. Lever the cover caps off both ends of the toothed belt axis using a screwdriver.

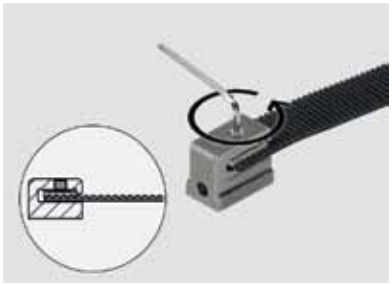
A film of thread lock fluid is applied to the screw heads of the socket head screws. The Allen key can be driven carefully into the screw head to ensure that it is seated securely.

2. Unscrew the socket head screws in the clamping components.

3. Move the slide up and down to loosen the clamping components from the slide.

4. Push the clamping components out of the cylinder barrel through the cut-outs in the drive covers.

5. Unscrew the threaded pins in the clamping components at both ends of the toothed belt.



Take care to ensure that the clamping plate in the clamping component does not fall out.

6. Pull the clamping components sideways away from the toothed belt.
7. Remove the clamping plates from the toothed belt.
8. Remove the clamping components on the second side of the toothed belt in the same way as for the first.

9. Carefully pull the toothed belt out of the axis.

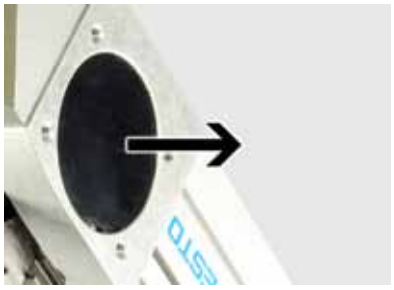
7.4.1.2 Checking and replacing the toothed belt pulley module

The toothed belt pulley module sits in a clearance fit in the drive cover with two pressed-on deep-groove ball bearings, and is secured by a retaining ring to prevent axial movement.

The toothed belt pulley module should be checked each time the toothed belt is replaced.

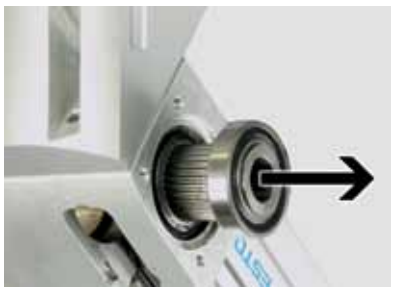
Removing the toothed belt pulley module

1. Lever the sealing discs out of the drive cover.



2. Remove the retaining ring.

3. Push the toothed belt pulley module with the two deep-groove ball bearings out of the drive cover.

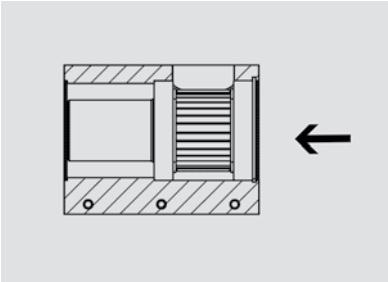


You do not need to pull off the deep-groove ball bearings, as the spare part comprises the two bearings and the shaft.

4. Check that the deep-groove ball bearings are seated securely on the toothed belt drive shaft.
5. Check the roll-off behaviour of the deep-groove ball bearings.
6. Check the toothed belt pulley for damage.
7. If the deep-groove ball bearing is not seated securely, the roll-off behaviour is uneven or the toothed belt pulley shows signs of damage, the toothed belt pulley module must be replaced.
8. Remove and check the second toothed belt pulley module in the same way as the first.
9. Clean both drive covers and the cylinder barrel using compressed air.

Installing the toothed belt pulley module

10. Apply a light coating of grease to the outside of the deep-groove ball bearings.
11. Push the toothed belt pulley module into the drive cover as shown, with the long end of the shaft in front.



12. Insert the retaining ring.

Check that the retaining ring is positioned correctly.

13. Press the sealing discs into the drive cover so that the deep-groove ball bearings have extra protection from contamination.

Checking the roller carriage pretension

Linear recirculating ball bearing guide system

The linear recirculating ball bearing guide system consists of a guide rail and the associated four rows of recirculating ball bearing units (roller carriages) with caged ball guide. The guide system has negative operating clearance, i.e. it is pretensioned and therefore has no mechanical play. This results in high rigidity and load bearing capacity in all system directions, as well as more precise guiding. The specified pretension is achieved using the individual components and their manufacturing tolerances.

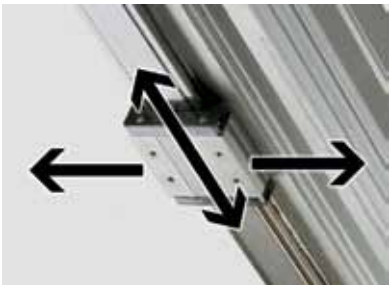
In order to perform the check, the clamping components must be pulled out of the slide together with the toothed belt.

1. Unscrew the mounting screws from the connection block.
2. Take the connection block off the slide.

3. Unscrew the mounting screws from the slide.
4. Take the slide off the roller carriages.

The following steps must be performed in order to check for negative operating clearance:

5. Move the roller carriage forwards and backwards, and press it back perpendicular to the guide rail.
6. Move the roller carriage forwards and backwards, and press it forward perpendicular to the guide rail.



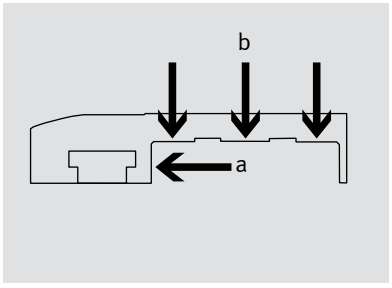
If there is a discernible positive operating clearance when doing this, the toothed belt axis must be removed from the parallel kinematic system and replaced with a new one. It is **not** possible to replace only the roller carriage.

7. Place the slide on the roller carriages.
8. Apply Loctite 243 to the socket head screws.
9. Screw the socket head screws into the roller carriage through the slide and tighten slightly.

The stop side (a) and the mounting surface (b) of the slide for the roller carriages must not show any surface defects such as burr, chips, blemishes etc. or any residue from screw locking agents.

a = Stop side

b = Mounting surface



10. Press the slide against the roller carriages.
11. Tighten the socket head screws to a tightening torque of 2.5 Nm.

12. Clean the screw locking agent off the connection block mounting screws.
13. Apply LOCTITE 243 to the mounting screws.
14. Place the connection block on the slide.
15. Tighten the mounting screws to a torque of 8.3 ±20% Nm.

7.4.1.3 Installing a new toothed belt

General ordering information

Note

Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

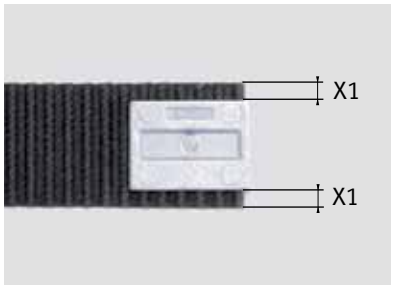
The toothed belt supplied as a spare part is cut to the precise tooth if the part number, stroke and slide type are specified correctly. It does not need to be shortened.

The toothed belt is ordered from the online spare parts catalogue (http://spareparts.festo.com) using the corresponding part number (dependent on the size and version of the parallel kinematic system; see sections 2.3.3 “EXPT-95 / 120-E4-T0” and 2.3.4 “EXPT-95 / 120-E4-T1 / T2 / T3 / T4”).

1. Feed the toothed belt behind the top toothed belt pulley with the teeth facing down.
2. Carefully push the toothed belt through the toothed belt axis.

3. Feed the toothed belt behind the bottom toothed belt pulley with the teeth facing down.
4. Pull the toothed belt a little way out of the axis.

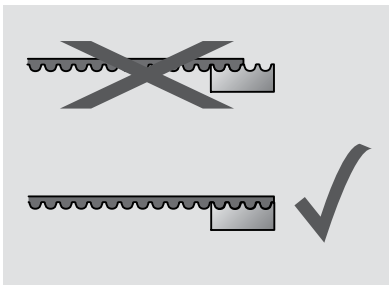
5. Place the clamping plate on the left end of the new toothed belt.



Note

To prevent the toothed belt from getting damaged during operation, the clamping plate must be axially centred in relation to the toothed belt.

6. Position the clamping plate centrally in relation to the toothed belt axis. Dimension X1 must be equal on both sides.

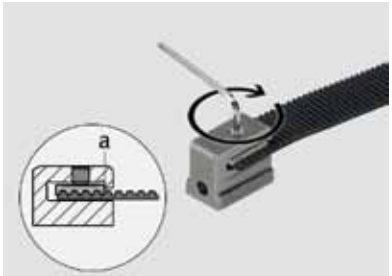


The toothed belt must be placed flush on the clamping plate. It must not protrude and must make contact with four teeth.

Note

The threads of the clamping components must be recut before the threaded pins are screwed in. Residues from the old locking agent in the thread result in uneven and increased torques for the threaded pins, which means they may not be correctly tightened.

7. Recut the threads in the clamping components.
8. Remove any residue of the old screw locking agent.
9. Insert the end of the toothed belt into the clamping component together with the clamping plate.
10. Position the toothed belt centrally in relation to the clamping component's axis.



11. Apply Loctite 243 to the threaded pin.
12. Screw the threaded pin into the clamping component.
13. Push the clamping plate against the stop (a) on the clamping component.

Note

The clamping plate must make contact with the stop, otherwise the toothed belt pretension will diminish during operation.

Note

The tightening torque must always be observed. Excessive tightening torques will bend the clamping component.

14. Tighten the threaded pin to a torque of 0.5 Nm.
15. Insert the second clamping component in the same way as the first.

Note

Do not bend or fold the toothed belt, as this can result in damage to the tensile bodies and shorten its service life by tearing it. Note the minimum bending radius R_{min} = 6 mm for assembly and storage.

16. Insert the clamping component into the groove in the cylinder barrel through the cut-out in the drive cover.

17. Pull the clamping component in the direction of the slide, or vice versa.
18. Push the clamping component into the guide of the slide.

Threaded inserts with SCREWLOCK® are screwed into the slides. These have a screw-clamping area that serves as a locking agent. Multiple windings have a clamping effect on the edges of the screwed-in adjusting screws for the toothed belt pretension. The result is flexible frictional locking. This prevents adjustment of the set toothed belt pretension (automatic unscrewing).

Note

The clamping components must not touch the slide when they are being screwed in, otherwise the toothed belt could become overstretched, reducing its service life. Slowly increase the toothed belt pretensioning to the correct value.

The use of threaded inserts with SCREWLOCK® and the dynamic loads on the adjusting screw mean that only original spare parts from Festo with the appropriate strength class may be used. Otherwise, the screws can break prematurely.

The clamping effect can damage the thread profile of the adjusting screw. As such, we recommend using **new** adjusting screws for assembly.

19. Steadily screw the socket head screws through the clamping components and into the slide.
20. Repeat the steps at the other end of the axis to insert the second clamping component.
21. Pretension the toothed belt by steadily tightening the socket head screws by feel.

Note

If the toothed belt is the correct length, the clamping components should lie at least flush with the slide unit.

If the clamping components protrude beyond this point, the socket head screws will not reach the minimum screw-in depth and could be torn out.

Check the toothed belt pretension as described in section 7.4.1.5 “Checking the toothed belt pretension”.

7.4.1.4 General information on the toothed belt pretension

A pulse is applied to the toothed belt to make it oscillate. The resulting natural frequency of the toothed belt is recorded using a meter and displayed as a frequency value in hertz.

Note

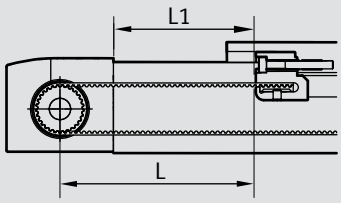
The correct toothed belt pretension is of critical importance for the service life of the toothed belt, as well as the positioning accuracy and performance of the toothed belt axis. Extreme care must therefore be taken when checking it.

The conventional method for measuring the toothed belt pretension using the deflection force is too inaccurate, and therefore cannot be used. Accurate results are achieved by measuring the oscillation frequency. The natural frequency of a belt is based on its tension (strand force), mass and strand length.

The strand length is the oscillating length of a belt.

Since the freely oscillating strand length (L) cannot be measured directly, the distance from the clamping component to one of the drive covers (L1) is set by moving the slide.

The toothed belt pretension is determined by measuring the basic oscillation (natural frequency) of the toothed belt with a fixed and freely oscillating strand length (L).



The frequency value is calculated using the specified values for strand force (pretension force), belt mass and length of the free belt strand according to the following formula:

$$f = \frac{1}{2 \cdot L} \cdot \sqrt{\frac{F_V}{m}}$$

f	Natural frequency of the freely oscillating strand [Hz]
L	Strand length [m]
F_V	Pretension force [N]
m	Weight per metre of the toothed belt [kg / m]

The frequency that needs to be set can be calculated using the data from the following table:

Type	Weight per metre m	Freely oscillating strand length L	Pretension force F_V
EGC-80	0.0459 kg / m	35 mm + L1[1]	408 - 426 N

[1] See section 7.4.1.5 “Checking the toothed belt pretension”.

Note on measurement using the acoustic frequency meter

If the toothed belt is excited by means of a force stimulus, the strand oscillates with its natural frequency; this dies down reasonably quickly depending on the cushioning.

The frequency meter measures the natural frequency generated (transverse oscillation) using the acoustic operating principle. In addition to the basic oscillation (natural frequency), harmonic oscillation may also occur. From experience it is always the first harmonic oscillation. In other words, a further oscillation node is generated and therefore, in addition to the basic oscillation frequency, values that are twice the natural frequency can also be measured.

For this reason, several measurements should always be carried out to differentiate the necessary basic oscillation (natural frequency) from the harmonic oscillation. Only this frequency can be used to extrapolate the force acting along the strand.

7.4.1.5 Checking the toothed belt pretension

Before the toothed belt pretension can be measured, the slide must be moved back and forth a number of times so that the toothed belt can fully settle and differences in tension can be compensated.

The easiest way to check the toothed belt pretension is using the test device (see section 11.3 “Equipment and meters”).

Measuring the toothed belt pretension using the test device

The distance between the drive cover and clamping component does not need to be set when measuring the toothed belt pretension using the test device (see 11.3 “Equipment and meters”). The correct strand length is attained using the supplied spacers.

The exact procedure for checking the toothed belt pretension can be found in the operating instructions **“Test device for toothed belt pretension TB-TE-EQ12”** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ12_en.pdf) or **“Test device for toothed belt pretension TB-TE-EQ02”** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ02_en.pdf).

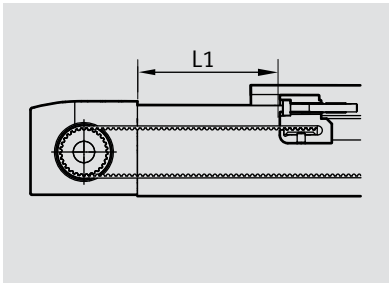
Measuring the toothed belt pretension without a test device

1. Place the toothed belt axis on the work surface as shown, with the slide unit facing upwards.
2. Lever off the cover cap from the drive cover.

3. Set the distance (L1) between the drive cover and clamping component (see table).

Type	Distance L1
EGC-80	222 mm / 50 mm[1)]

[1)] Alternatives for toothed belt axes with very short strokes.



The larger strand length should be set if possible. A longer, freely oscillating strand length reduces the variation of the measurement results.

4. Align the acoustic frequency meter centrally on the toothed belt as described in the associated operating instructions.
5. Make the toothed belt oscillate by striking it with a thin, heavy object, such as an Allen key or punch.

Several measurements should be taken to compensate for measurement tolerances.

The toothed belt must be able to oscillate freely.

6. Compare the measurement with the corresponding value (see table).

Type	Frequency (f) If distance L1 = 222 mm	Frequency (f) If distance L1 = 50 mm[1)]
EGC-80	183^{+4} Hz	555^{+11} Hz

7.4.1.6 Setting the toothed belt pretension

Note

The pretension of the toothed belt is not an indicator of wear!

The specified value applies for a new toothed belt.

The toothed belt is set to the specified value in the factory, and is thus maintenance-free for its entire service life.

The pretension of the toothed belt diminishes during storage and operation. This is not an indication of wear; it is a normal process that must not be changed by increasing the tension of the toothed belt.

The toothed belt pretension must therefore only be set after replacing the toothed belt.

If the measured natural frequency of the toothed belt is outside the specified range, the toothed belt pretension must be adjusted as follows:

1. Adjust the toothed belt pretension by turning the socket head screws.
2. Before you measure the toothed belt pretension again, the slide must be moved back and forth a number of times so that the toothed belt can fully settle and differences in tension are compensated.

Turning the socket head screw clockwise increases the tension in the toothed belt, and thus its oscillation frequency.

Turning the socket head screw anticlockwise decreases the tension in the toothed belt, and thus its oscillation frequency.

3. Place the cover cap in the drive cover.

7.4.1.7 Functional test

After completing the assembly work on the toothed belt axis, check that all the components function correctly:

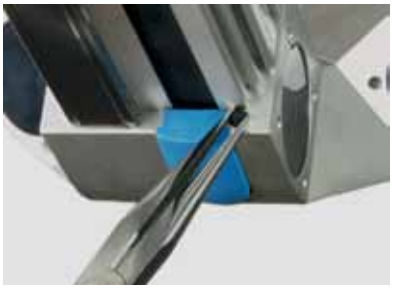
No-load torque

It must be possible to move the slide unit without much resistance or jerking when idle without a drive attached or load connected.

This check is based on the technician's instinct and experience. It is not possible to specify precise test values.

7.4.2 Replacing the stop buffers

1. Lever the stop buffers out of the front sides of the return housing.
2. Replace the stop buffers.



7.4.3 Finishing repair work

The following components need to be re-mounted once repairs are complete:

1. The axial kit (see section 7.2.2 “Mounting the axial kit”)
2. The servo motor (see section 7.1.2 “Mounting the servo motor”)
3. The parallel kinematic system module on the upper ball stud (see section 5.1.2 “Assembling the parallel kinematic system module”)

7.4.3.1 Restart

Perform a restart in accordance with the **Commissioning description– parallel kinematic system with control system EXPT-...-C...** This can be found on the Festo website (www.festo.com).

Note

Before commencing normal operation of the parallel kinematic system, homing (see section 8.1 “Homing the parallel kinematic system”), setting of the feed constants (see section 8.2 “Setting the feed constant”) and calibration (for calibrated models) must be performed (see section 8.3 “Calibration”).

8 Homing, setting feed constants and calibration

This section describes the work steps for:

- Homing the parallel kinematic system
- Calculating and setting the feed constants

It also provides information on the procedure to follow when calibrating the parallel kinematic system.

The axes cannot be operated if homing has not been carried out.

8.1 Homing the parallel kinematic system

Homing serves the purpose of setting the parallel kinematic system controller to a defined zero point. This is 4 mm from the metallic stop between the slide and the axis return housing in the upper end position (motor side). Homing achieves a high degree of relative positioning accuracy.

Homing is required in the following circumstances:

- If one or more servo motors have been replaced or removed
- If one or more axial kits have been replaced or removed
- If the front unit has been removed (in this case, calibration is also required; see section 8.3 “Calibration”)
- If one or more toothed belts have been replaced

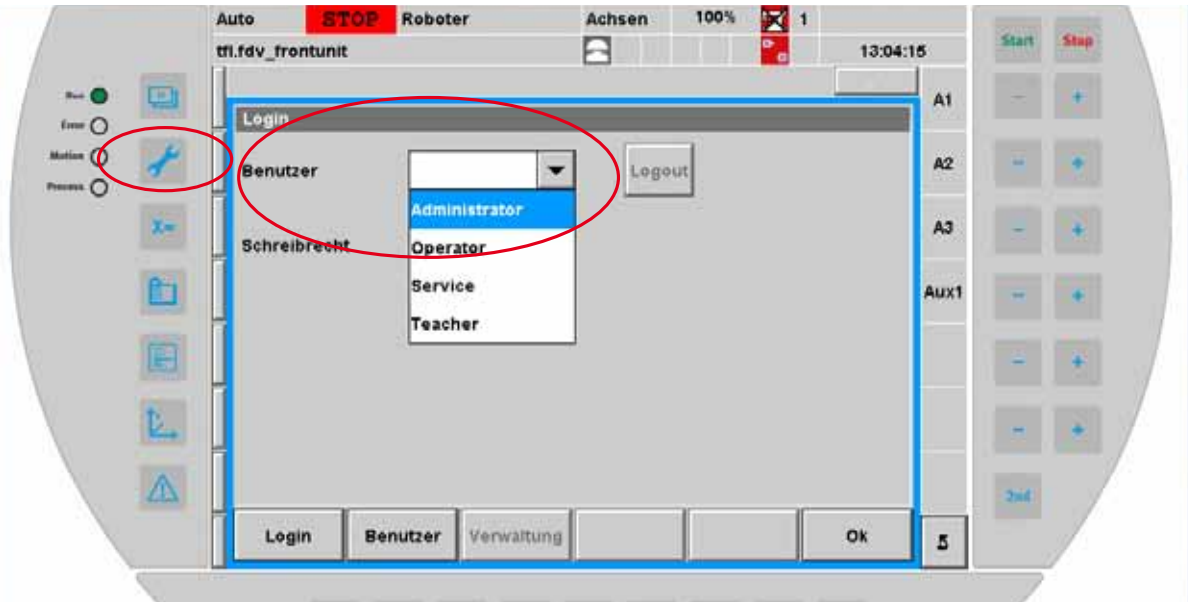
Note

This description of the homing procedure is intended for situations where the basic project has already been set up. The controller type, motor type and axis type must already be defined and set up. More detailed information on this can be found in the Commissioning instruction.

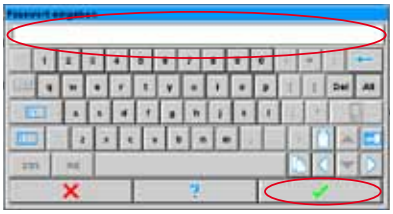
Before homing begins, the emergency off switch must be acknowledged so that the motor can be activated.

8.1.1 Establishing a connection to the CDSA

1. On the display, click on the blue spanner.
2. Click on the black arrow to select the “Administrator” user account.

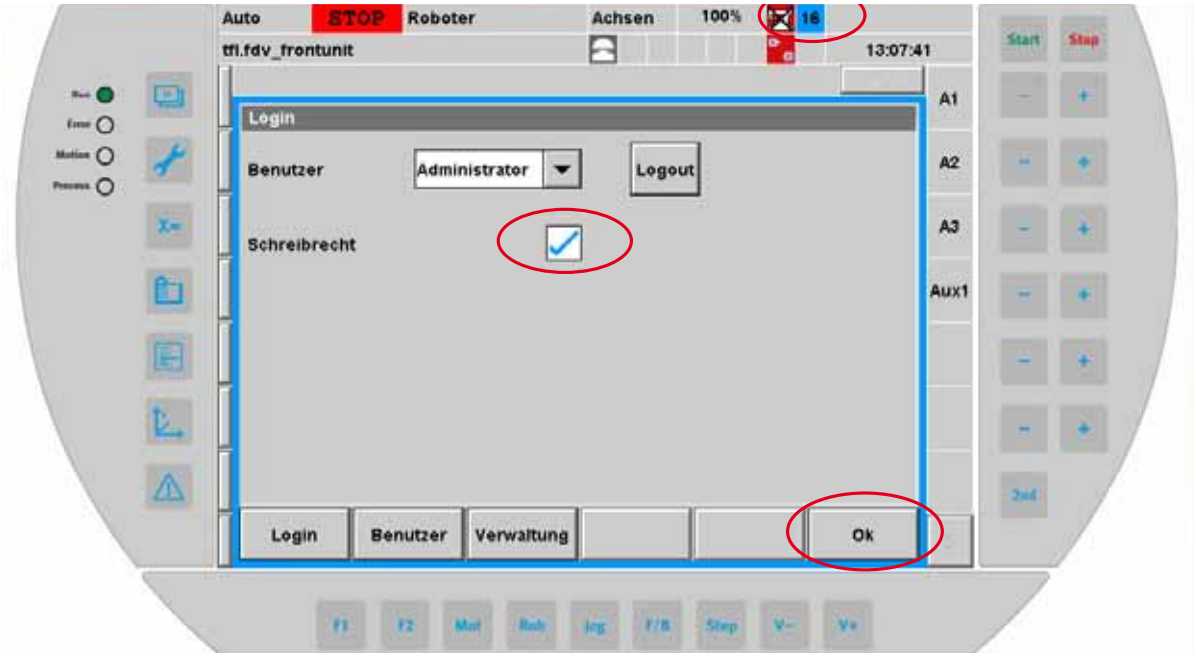


3. Once you have chosen to log in as an administrator, you will need to enter the password in the box that appears and click on the green tick to proceed.



4. Click on the “Permission to write” box so that a blue cross appears in it.
5. Press “OK” to confirm.

The [blue 16] confirms that you have successfully logged in as an administrator.



8.1.2 Releasing the brakes

Warning

Releasing the brakes can lead to uncontrolled axial movements. This can be prevented by unhooking the rods on the slide unit.
Dismantling the parallel kinematic system module (see section 5.1.1 “Dismantling the parallel kinematic system module”).

Before work begins, the corresponding motor brake must be released. There are two ways of doing this:

– At the control cabinet itself using a key switch, or using the FCT

8.1.2.1 Releasing the motor brakes using the control cabinet

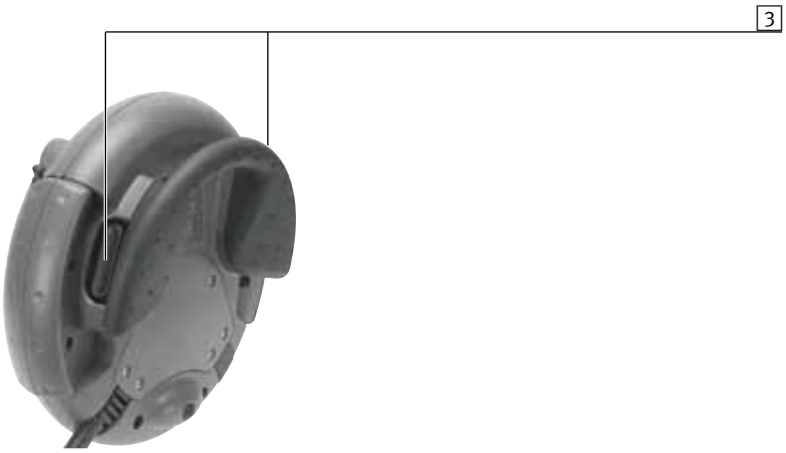
Caution

When the motor brakes are released using the control cabinet, the brakes of all three axes are released at the same time. Get a second person to help by supporting the front unit.

If you have the control cabinet, the brakes can be released using the key switch together with an enabling button.

1. Turn the key switch into the right-hand position as shown.
2. Press the enabling button on the CDSA to confirm the action and release the motor brakes for the three axes.

1 Emergency off switch
2 Emergency off acknowledgement button
3 Release brake key actuator
4 Power switch



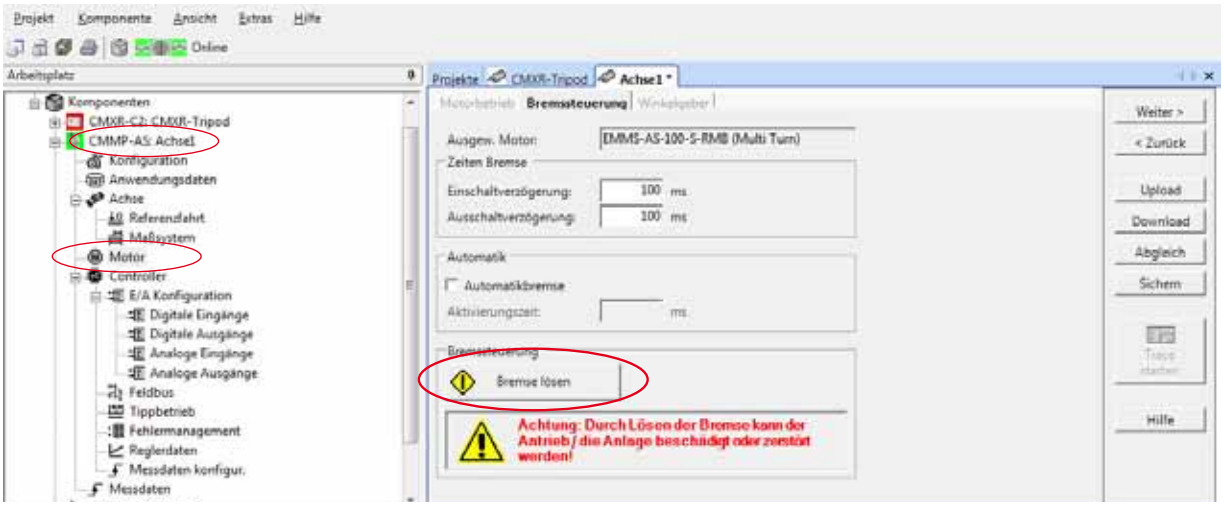
3 Enabling button

8.1.2.2 Releasing the motor brakes using the FCT

1. In the bar on the left, select the [CMXR-C2:CMXR parallel kinematic system] tab under the [Components] option.
2. Under the option [CMMP axis 1], select the [Axis] tab.

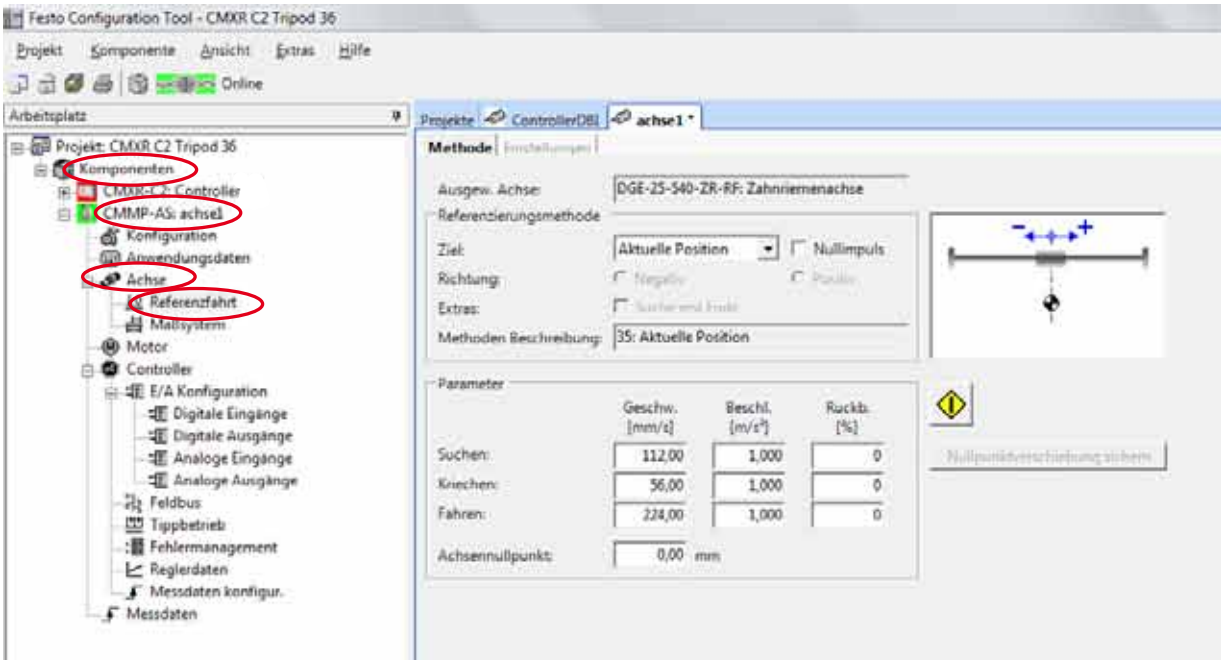
If you wish to release the motor brake for axis 2 or 3, [CMMP axis 2] or [CMMP axis 3] must be selected accordingly.

3. Select the [Motor] sub-option.
4. Press the “Release brakes” button.



8.1.3 Preparing for and carrying out homing

1. In the bar on the left, select the [CMMP-AS: axis 1] tab under the [Components] option.
2. Under the option [Axis], select the [Homing] tab.



Note

When homing the axes, care must be taken to ensure that the distance piece is not touching a rubber cushion. If this is the case, the slide must be moved out of the homing position by a few millimetres before homing can be carried out again. There must be metallic contact between the slide/distance piece and distance piece/return housing.

Please refer to the CMXR documentation for information on the procedure for moving individual axes manually.

3. Move the slide to a position that allows you to insert the distance piece.

The distance piece can be ordered from Festo (see section 11.2 “Special tools”).

4. Insert the distance piece with the semi-circular cut-out and “motor side” lettering pointing in the direction of the motor. The flat edge should be flush with the slide.
5. **Toothed belt axis only**

   Manually tighten the distance piece using the clamping screw on the guide rail.

DGE-25-...-ZR-RF:

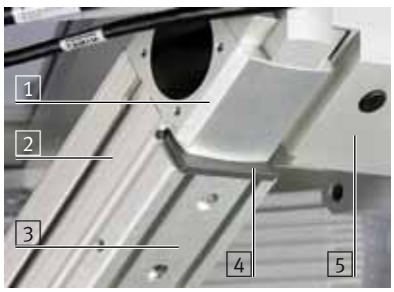
6. Push the slide with distance piece up onto the return housing by hand.
7. Activate the motor brake.

EGC-80-...-TB-KF:

1. Push the slide with distance piece up onto the return housing by hand.
2. Activate the motor brake.

DGE-25-...-ZR-RF:

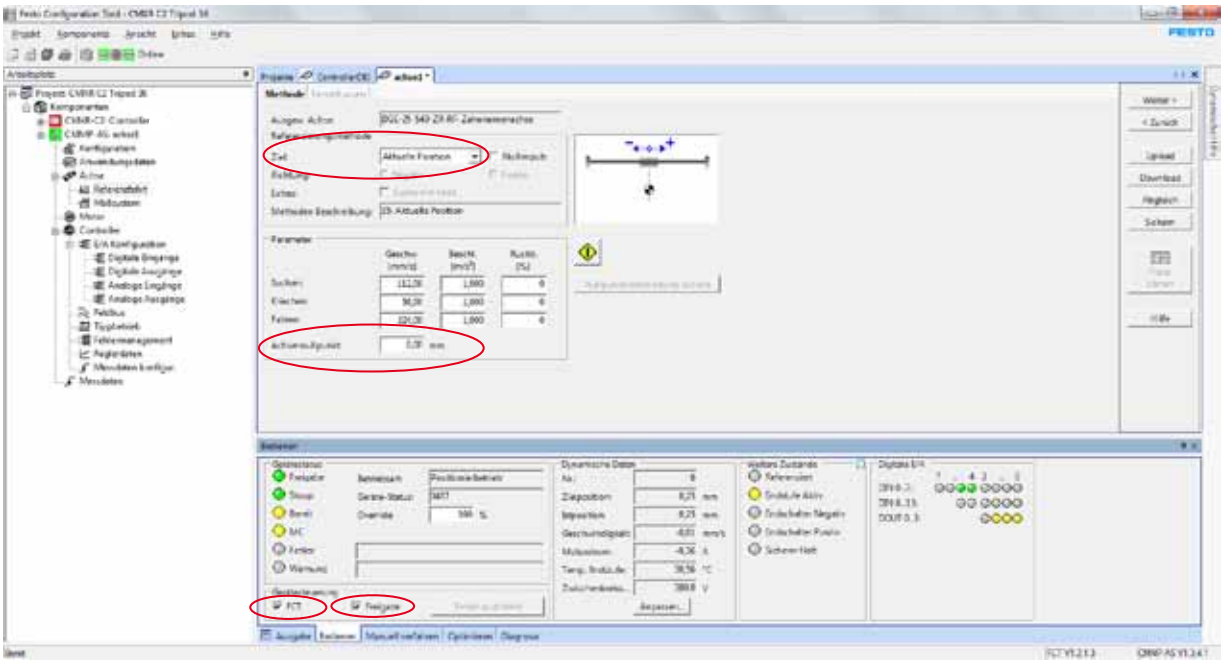
1 Return housing
2 Toothed belt axis
3 Slide
4 Distance piece (4 mm)
5 Axial kit



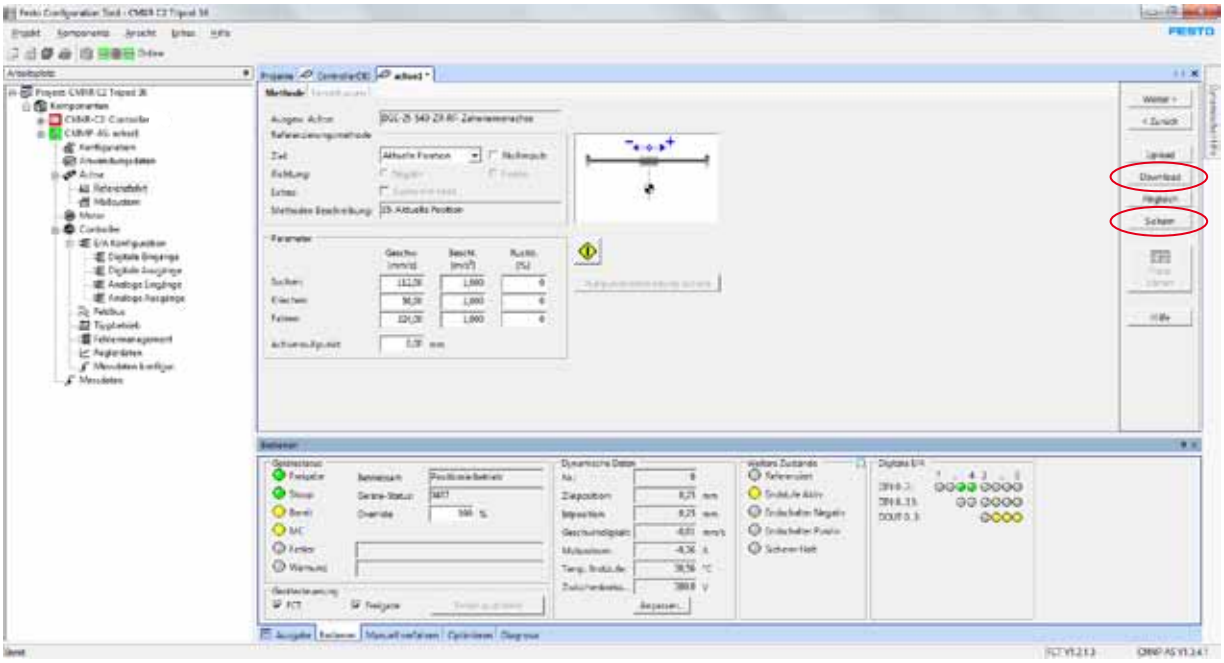
EGC-80-...-TB-KF:

1 Return housing
2 Distance piece (4 mm)
3 Slide

8. Under “Target” select [Current position]
9. Enter “0.00 mm” as the “Axis zero point”
10. Select the device control “FCT” and “Enable” by clicking on the empty box so that a tick appears in it.

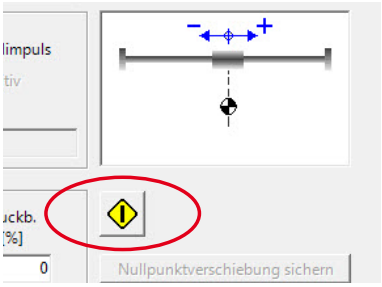


11. Press the “Download” button.
12. Press the “Save” button.

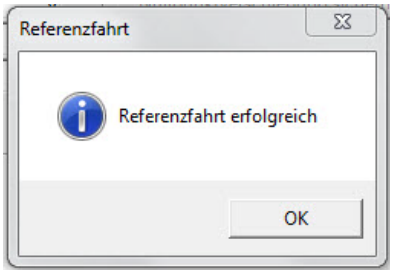


8.1.4 Carrying out homing

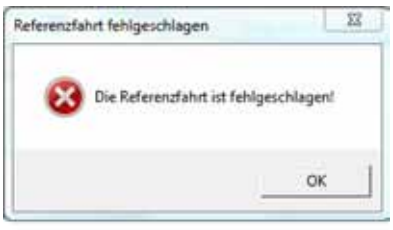
1. Press the button to start homing.



2. Once homing has been completed successfully, the following window appears:



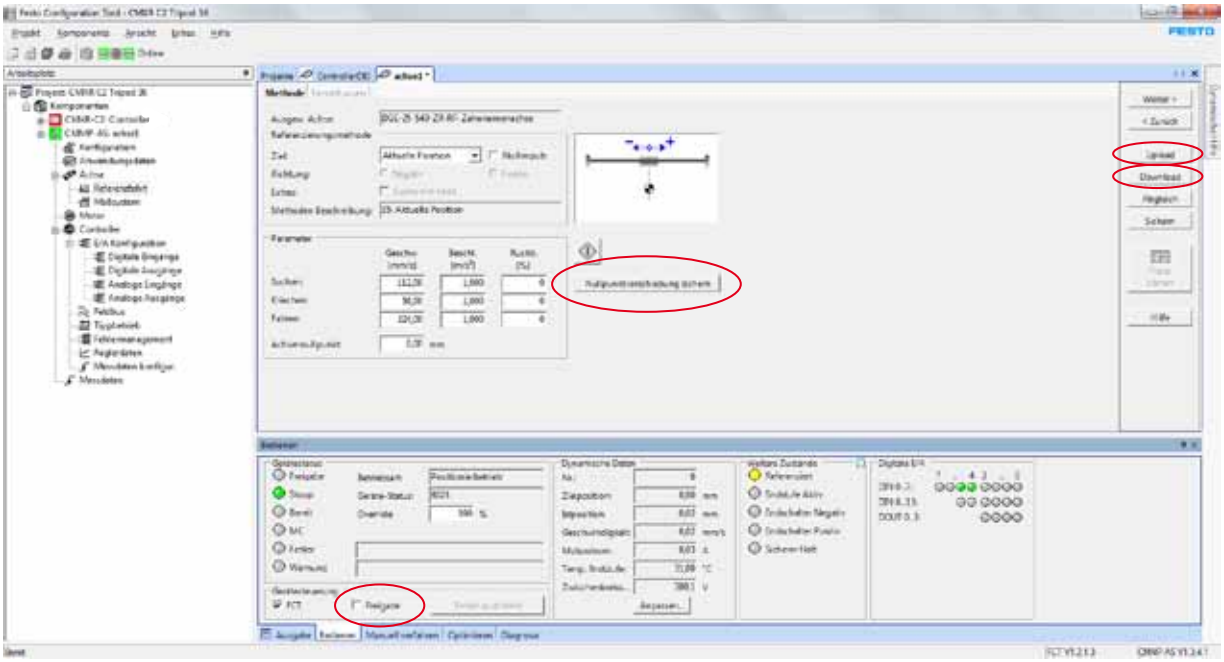
3. If the homing attempt is **not** successful, the following window appears:
4. Restart the homing procedure (see section 8.1.3 “Preparing for and carrying out homing” et seq.).



8.1.5 Saving the values in the encoder

In the following work steps, the values are saved in the encoder. These work steps must be carried out for each of the three axes.

1. Press the “Download” button.
2. Press the “Save” button.
3. Uncheck “Enable”.
4. Press the “Save null shift” button.



5. When the “Save null shift” button is pressed, the following window appears. This message must only be confirmed if the homing procedure was completed successfully.

If the homing procedure was not successful, it must be carried out again.

8.2 Setting the feed constant

Parallel kinematic system homing must be complete before the feed constants can be set (see 8.1 “Homing the parallel kinematic system”).

This section describes the work steps for setting the feed constants.

If the system is calibrated, the feed constants of the three main axes always need to be adjusted. The specifications required to do this can be found in the enclosed calibration report.

The feed constants also need to be set for non-calibrated systems in the following situations:

- If one or more toothed belts have been replaced
- If one or more toothed belt axes have been replaced
- If one or more toothed belt pulley kits have been replaced or removed

8.2.1 Tools and fundamentals

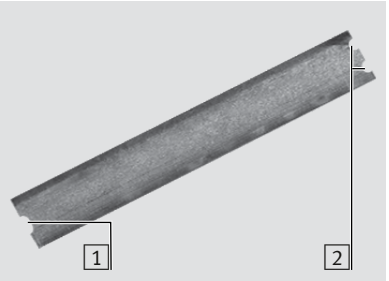
Before setting work begins, the direction of rotation and zero point of the motor controllers must be parameterised correctly and the basic project must already be set up.

The following tools are required for the setting work:

- Distance plate with known, precisely measured length. The distance plate must be produced by the customer (see section 11.4 “Devices for in-house assembly”).
- CDSA or emulation of CDSA in the FCT.

The distance plate design must include cut-outs that guarantee metallic contact between the distance plate and the housing and slide. The distance plate must not lie on the rubber cushions of the axis.

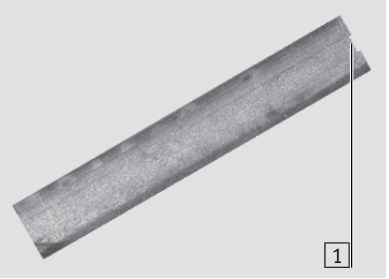
Distance plate for parallel kinematic system EXPT 45 / 70



1 Cut-out for rubber cushion on drive cover

2 Cut-outs for rubber cushions on slide

Distance plate for parallel kinematic system EXPT 95 / 120



1 Cut-out for roller carriage on slide

8.2.2 Releasing the brakes

Warning

Releasing the brakes can lead to uncontrolled axial movements. This can be prevented by unhooking the rods on the slide unit.
Dismantling the parallel kinematic system module (see section 5.1.1 “Dismantling the parallel kinematic system module”).

Releasing the brakes (see section 8.1.2 “Releasing the brakes”).

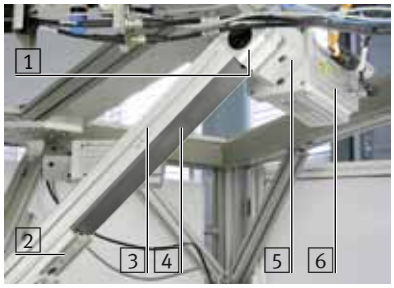
8.2.3 Determining the exact intermediate position as a reference

Note

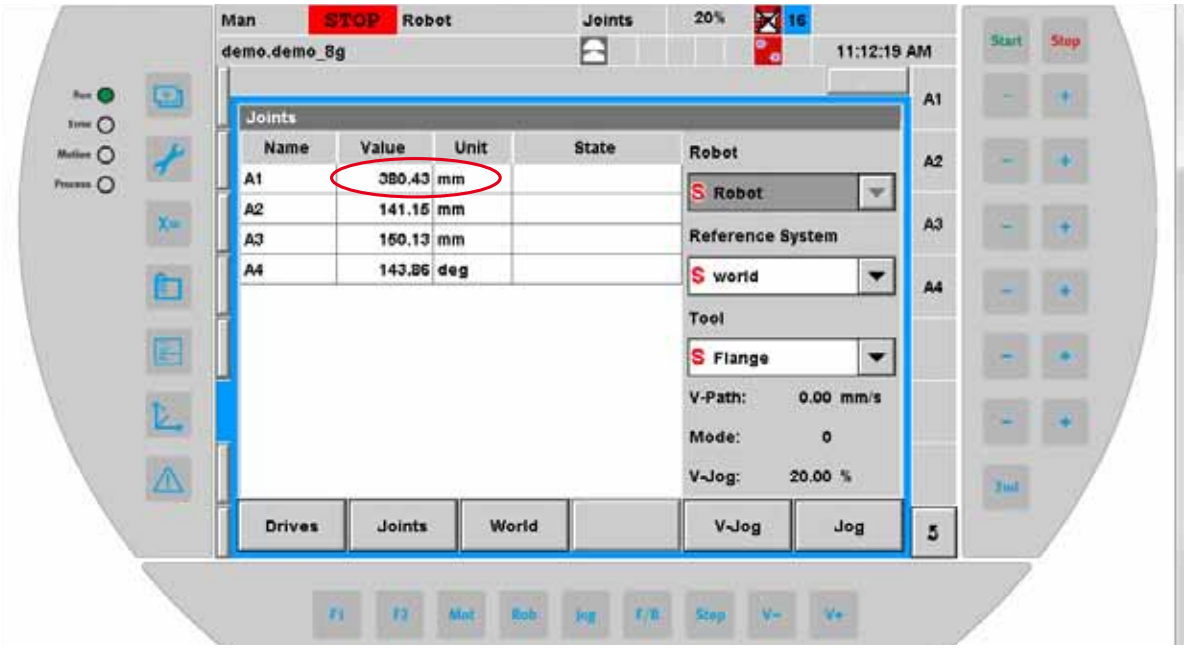
The distance plate must not be touching the rubber cushions on the drive housing or slide. Metallic contact between the slide/distance plate and the distance plate/return housing must be guaranteed.

1. Position the distance plate between the slide and the drive housing as shown in the figure below.

[1] Toothed belt axis drive housing
[2] Slide
[3] Toothed belt axis
[4] Distance plate
[5] Axial kit
[6] Servo motor



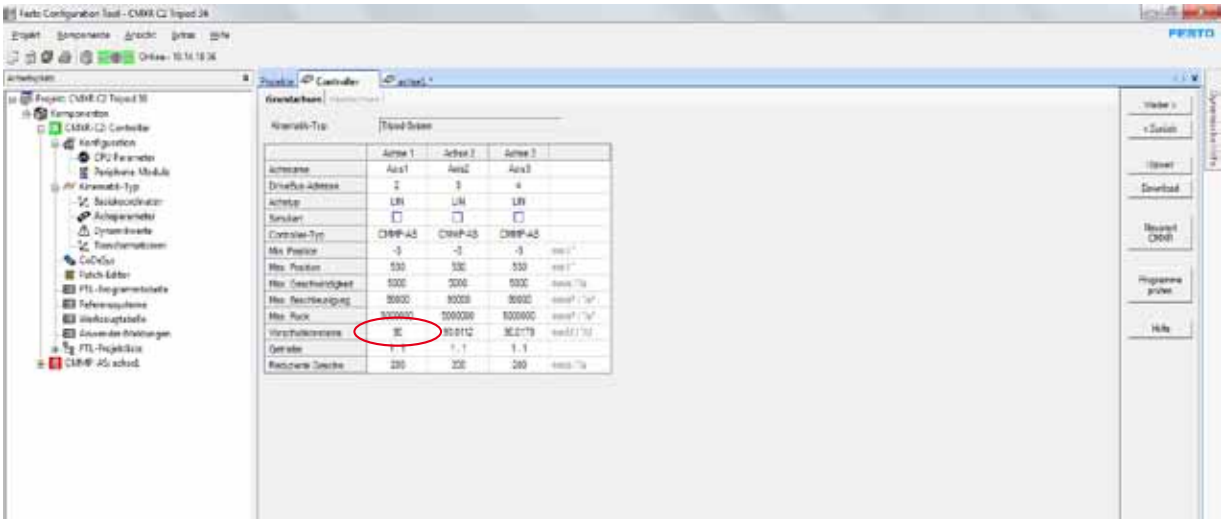
2. Push the slide in the direction of the drive housing so that the distance plate is held in place between the slide and the drive housing.
3. Read the current value for the slide intermediate position in the CDSA as shown in the following figure.



8.2.4 Determining the current feed constants

IN order to calculate the actual feed constants, the current feed constant must be read off the FCT. This requires the following steps:

1. In the bar on the left, select the [CMXR-CS: Controller] tab under the [Components] option.
2. Under the option [Kinematics type], select the [Axis parameters] tab.
3. The current feed constant can now be read from the field circled below.



8.2.5 Calculating the feed constants Vk_{new}

To calculate the actual feed constants Vk_{new}, the following variables must be used and substituted into the formula:

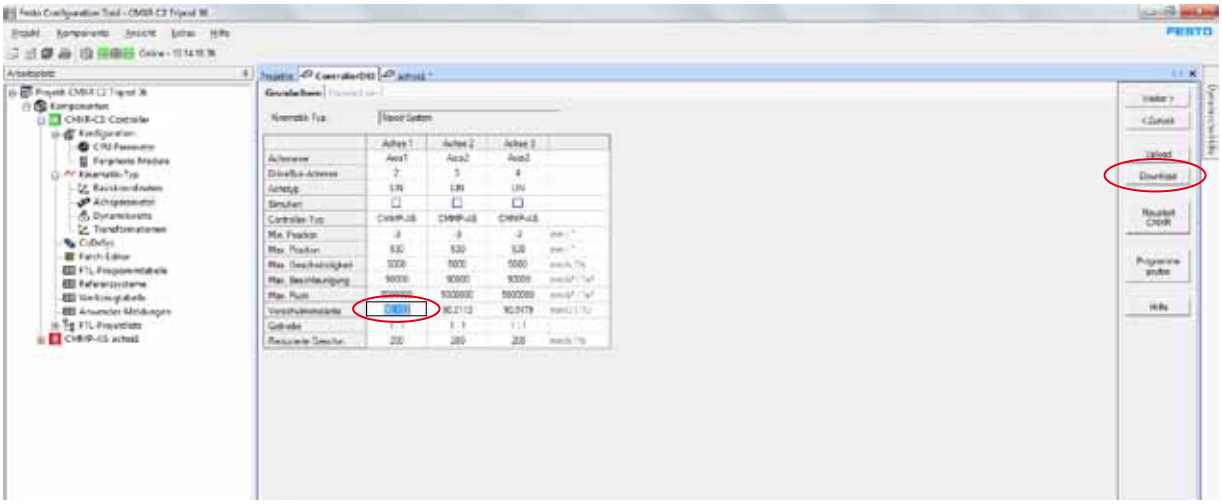
$$Vk_{neu} = \frac{d_3 - d_1}{d_2} \cdot Vk_{alt}$$

d_1	Distance piece = 4 mm
d_2	Slide position [mm] read from CDSA
d_3	Actual gauge length [mm]
Vk_{old}	Feed constant [mm / U] read from FCT

8.2.6 Entering calculated feed constants into the FCT

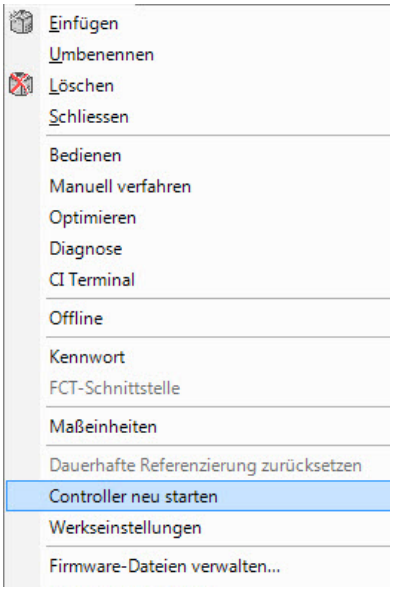
The following steps are used to enter the calculated feed constant into the FCT and transmit it to the controller:

1. In the bar on the left, select the [CMXR-CS: Controller] tab under the [Components] option.
2. Under the option [Kinematics type], select the [Axis parameters] tab.
3. Enter the calculated feed constant into the field circled in the figure.
4. Press the “Download” button to transmit the data to the controller.



The new feed constants must not deviate from 90° by more than ± 0.5°. If they do, the feed constant needs to be set again (see section 8.2 “Setting the feed constant”).

5. The CMXR-C2 then needs to be restarted.



8.3 Calibration

Calibration is required in the following cases:

- If one or more ball studs have been replaced
- If the front unit has been replaced
- If one or more toothed belt axes have been replaced (homing also required)

During calibration, the parallel kinematic system is measured three-dimensionally using a laser tracker. This allows a positioning accuracy of ± 0.1 mm.

Festo always recommends recalibrating calibrated parallel kinematic systems after any of the repairs described above, otherwise a positioning accuracy of ± 0.1 mm can no longer be guaranteed.

The calibration must be carried out by Festo service staff. Please contact the Festo repair service to discuss how to proceed with this.

As part of the parallel kinematic service, Festo also offers customers the option of **commissioning** and **application programming**. The costs for these services shall be borne by the customer. If you are interested in these services, please contact a Festo Service point.

9 Maintenance

Warning

Risk of fatal injury due to electrical shock.

- The parallel kinematic system must be de-energised, depressurised and reliably secured against unauthorised reactivation before the maintenance work begins.
- The parallel kinematic system controller remains energised after the voltage has been shut off (capacitor voltage). As such, you must wait approx. 3 minutes after shutting off the voltage before disconnecting the motor cables. The capacitors will discharge their voltage during this time.

The following section describes the maintenance steps for the individual parallel kinematic system modules. Please note: maintenance intervals **may differ** for the individual modules.

Note

Maintenance work should only be conducted by properly trained personnel in accordance with these instructions.

Festo offers maintenance and servicing every six months. During this process, all the work that is due will be performed by a member of Festo's service staff.

9.1 Checking the mounting screws between the mounting frame and plant frame

The connection between the mounting frame and the parallel kinematic system on the plant frame should be checked at regular intervals.

The mounting screws must have the following tightening torques:

Type of mounting	Tightening torque
Direct mounting using four M8 screws per corner	25 Nm
Direct mounting using one M20 screw per corner	425 Nm
Slot nut mounting	10 Nm ± 20 %

9.2 Maintaining the front unit

Perform the maintenance work on the front unit in accordance with the relevant operating instructions (www.festo.com).

9.3 Maintaining the parallel kinematic system module (rods and ball studs)

Maintenance on the rods and the two ball studs should be performed every 2000 operating hours:

- Check all the balls and ball head for signs of wear.
- Check the springs, pins, screws and washers for wear.
- If notches or severe signs of wear are found, replace the affected components.
- Apply a thin film of grease to the friction surfaces of the ball heads and ball cups (LUB-KC1, silicone-free).

See section 5 “Repair steps for the parallel kinematic system module”.

Silicone-free lubricating grease LUB-KC1 is included in the scope of delivery for the parallel kinematic system.

See the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

9.4 Maintaining the servo motor EMMS-AS-100-S-...

Clean the motor housing regularly and remove any dust that has collected on it. Burnt-in layers of dust can catch fire.

9.5 Maintenance steps for the toothed belt axis DGE-25-...-ZR-RF

This section contains key technical information about how to carry out maintenance work on the toothed belt axis. A detailed description of the steps for care and maintenance can be found in the axis operating instructions (www.festo.com).

Maintenance on the toothed belt axis DGE-25-...-ZR-RF should be performed every 6000 operating hours.

9.5.1 Checking and lubricating the profile track roller guide

Each time maintenance is performed, check whether the profile track roller guide is set so it is free of backlash and tension.

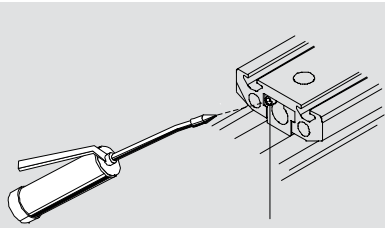
The guide rods of the profile track rollers are lubricated by oil-impregnated felt scrapers during operation. The scrapers must be relubricated every 6000 operating hours. The relubrication interval must be reduced in dusty and dirty environments, as well as for very short working strokes. The maximum capacity of the scrapers is approx. 5 ml.

Recommended oil	Manufacturer/source	Comment
Constant OY 390	Klüber (www.klueber.com) Available in a 200 ml container via Festo; purchase details on request	Oils from other manufacturers with the same specification can also be used

The lubrication nipples pressed onto both sides that are used for re-oiling of the scrapers are miniature, funnel-shaped lubrication nipples based on (but not 100% compliant with) DIN 3405.

Re-oiling must always be performed on both lubrication nipples.

Festo offers a one-hand, high-pressure grease gun with a suitable pointed nozzle for re-oiling these lubrication nipples (see section 11.2 “Special tools”). It is not possible to use a grease or oil press with a pointed nozzle connection (C5) for funnel-type lubrication nipples in accordance with DIN 3405, since the smallest outlet diameter of the tapered nozzle is too large and the resilient pressure ball of the funnel-type lubrication nipple cannot press against the nozzle.



Lubrication nipple

More detailed information on assembly aids and lubricants can be found in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

9.5.2 Toothed belt pretensioning

The toothed belt is set to the specified value in the factory, and is thus maintenance-free for its entire service life.

The pretension of the toothed belt diminishes during storage and operation. This is a normal process and not an indication of wear.

9.6 Maintaining the toothed belt axis EGC-80-...-TB-KF

This section contains key technical information about how to carry out maintenance work on the toothed belt axis. A detailed description of the steps for care and maintenance can be found in the axis operating instructions (www.festo.com).

Maintenance on the toothed belt axis EGC-80-...-TB-KF should be performed every 6000 operating hours.

9.6.1 Cleaning and lubricating the toothed belt axis

Clean the guide rail using a soft cloth and a gentle detergent if necessary.

Grease the surface of the guide rail with silicone-free LUB-KC1 if the layer of grease has been used up.

Silicone-free lubricating grease LUB-KC1 is included in the scope of delivery for the parallel kinematic system.

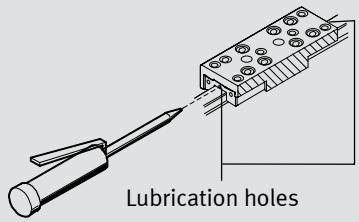
See the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

9.6.2 Lubricating the recirculating ball bearing guide

The slide has lubrication holes on the front sides of both roller carriages. Silicone-free lubricating grease LUB-KC1 must be inserted into both lubrication holes, as the two roller carriages do not share lubricant.

Festo offers a one-hand, high-pressure grease gun with a suitable pointed nozzle for lubricating these lubrication holes (see section 11.2 “Special tools”).

The slide must be moved forwards and backwards on the guide rail during lubrication so that the grease penetrates all the spaces in the roller carriages.



More detailed information on assembly aids and lubricants can be found in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

9.6.3 Toothed belt pretensioning

The toothed belt is set to the specified value in the factory, and is thus maintenance-free for its entire service life.

The pretension of the toothed belt diminishes during storage and operation. This is a normal process and not an indication of wear.

10 Cleaning and greasing

10.1 Cleaning

Warning

Festo recommends LOCTITE 7063 and LOCTITE 7070 for cleaning.

When using other cleaning agents, make sure that they do not corrode any of the plastic components. In case of doubt, check the resistance of the plastic components using the data on the Festo website (www.festo.com).

10.2 Greasing

More detailed information on assembly aids and lubricants can be found in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

10.2.1 Definition of terms

10.2.1.1 Grease reservoir

There is a defined amount of grease enclosed between two edges or in an enclosed ring volume.

10.2.1.2 Thin grease film

A film of grease covers the bearing surface so that the grease colour darkens the surface slightly.

Recommendation:

Apply the grease with a soft brush or similar.

10.2.1.3 Extremely thin grease film

A barely continuous film of grease covers the bearing surface. The grease can give a sheen to the surface; however, the colour of the grease must not darken it.

Recommendation:

Apply the grease using a cloth or similar dipped in the grease. Remove any excess grease.

11 Tools, equipment and accessories

This section provides an overview of the tools and aids required to repair and maintain the parallel kinematic system.

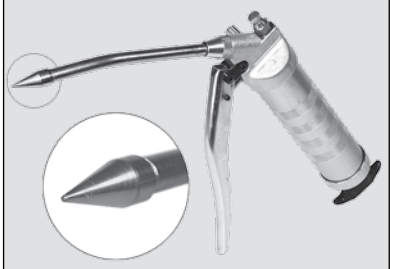
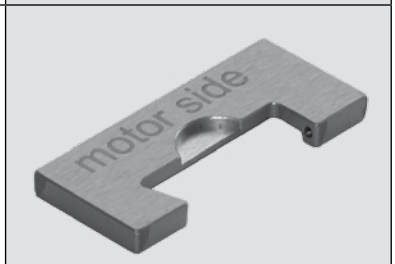
11.1 Standard tools

The following standard tools are required for repair and maintenance of the parallel kinematic system:

- Allen key
- Torque spanner
- Torque spanner with dial gauge and/or drag indicator
- Pliers for retaining rings (interior protection for hole and exterior protection for pins)
- Flat pliers
- Tensile and pressure force meter
- Plastic hammer
- Sturdy general-purpose scissors or metal shears
- Ruler

11.2 Special tools

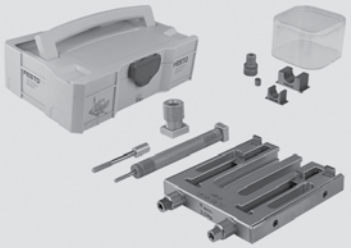
The following special tools are required for repair and maintenance of the toothed belt axes:

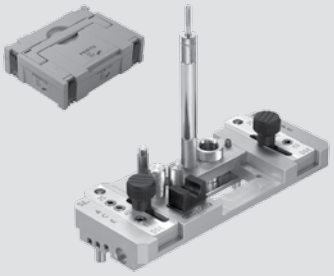
Designation	Additional information	Festo order no.	Illustration
One-hand, high-pressure grease gun	Pinpoint nozzle for miniature, funnel-shaped lubrication nipples and lubricating holes	647958	
Distance piece	The distance piece is required for homing the parallel kinematic system.	1495926	

Further information on the special tools is included in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

11.3 Equipment and meters

The following equipment and meters are required for repair and maintenance of the toothed belt axes:

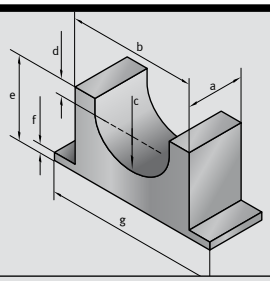
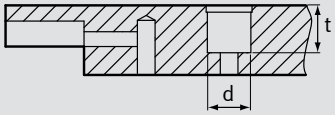
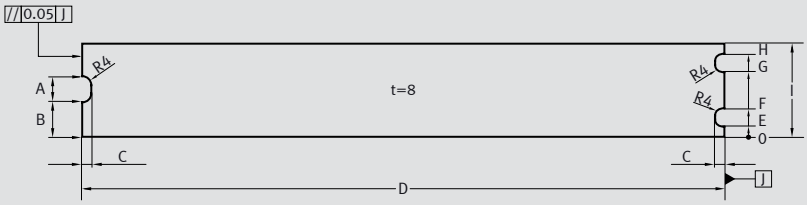
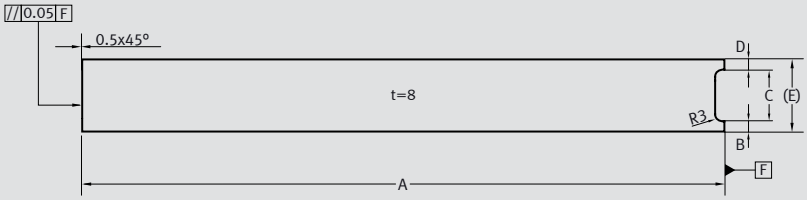
Designation Order no.	Description	Illustration
TB-TE-EQ10 Order no. 8026615	Contents: • Test device for checking the toothed belt pretension in Systainer with foam insert. Suitable for the following toothed belt axes: – DGE-25 / 40 / 63-ZR(-KF) – DGE-25/40/63-ZR-RF – EGC-50 / 70 / 80 / 120 / 185-TB-KF – EGC-HD-125 / 160 / 220-...-TB-...(-GP) – ELGA-TB-G / RF-70 / 80 / 120 – DGEA-18 / 25 / 40-ZR • Acoustic frequency meter type TB-TE-EQ3. • End clamp for DGE-25-ZR-RF • End clamp for DGE-40-ZR-RF • Round magnet (L = 6 mm) for DGE-63 • Plastic box for small parts The exact procedure for checking the toothed belt pretension can be found in the operating instructions **"Test device for toothed belt pretension TB-TE-EQ12"** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ12_en.pdf).	
TB-TE-EQ12 Order no. 8026617	Contents: • Test device for checking the toothed belt pretension in Systainer with foam insert. Suitable for the following toothed belt axes: – DGE-25 / 40 / 63-ZR(-KF) – DGE-25/40/63-ZR-RF – EGC-50 / 70 / 80 / 120 / 185-TB-KF – EGC-HD-125 / 160 / 220-...-TB-...(-GP) – ELGA-TB-G / RF-70 / 80 / 120 – DGEA-18 / 25 / 40-ZR • End clamp for DGE-25-ZR-RF • End clamp for DGE-40-ZR-RF • Round magnet (L = 6 mm) for DGE-63 • Plastic box for small parts The exact procedure for checking the toothed belt pretension can be found in the operating instructions **"Test device for toothed belt pretension TB-TE-EQ12"** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ12_en.pdf).	

Designation Order no.	Description	Illustration
TB-TE-EQ3 Order no. 760459	Acoustic frequency meter for measurements with and without a test device. The test probe on the frequency meter has a special adhesive bond, making it suitable for use with the test device. The O-ring 10x1 for mounting the test probe in the corresponding test device is included in the scope of delivery. **Order alternatives:** Type: Optibelt TT mini S plus Exclusively available from Schäfer Technik GmbH www.schaefer-technik.de	
O-ring 10x1 Order no. 200926	Mounts the acoustic test probe in the test device by means of clamping friction. Included in the scope of delivery of the frequency meter TB-TE-EQ3.	
TB-TE-EQ2 No longer available	Basic device for checking the toothed belt pretension. Suitable for the following toothed belt axes: • DGE-25 / 40 / 63-ZR(-KF) • DGE-25/40/63-ZR-RF • EGC-50 / 70 / 80 / 120 / 185-TB-KF • with mounting kit TB-TE-EQ7 (see below) EGC-HD-125 / 160 / 220-...-TB-...(-GP) • and with mounting kit TB-TE-EQ4 (see below) ELGA-TB-G / RF-70 / 80 / 120. Holds the test probe of the acoustic frequency meter type TB-TE-EQ3 and excites the toothed belt using a plunger. The exact procedure for checking the toothed belt pretension can be found in the operating instructions **“Test device for toothed belt pretension TB-TE-EQ02”** (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/TB-TE-EQ02_en.pdf).	

Further information on the equipment and measuring devices can be found in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

11.4 Devices for in-house assembly

For toothed belt axis DGE-25-...-ZR-RF, an end clamp must be used to check and adjust the toothed belt axis pretension, ensuring that the toothed belt can oscillate freely without hitting the cylinder barrel (see table). The easiest way to check the toothed belt pretension is using the toothed belt pretension test device (see section 11.3 “Equipment and meters”).

Designation	Dimensions	Illustration
End clamp for DGE-25 (In-house assembly of the end clamp is necessary if you are **not** using a test device.)	a = 10 mm b = $15^{-0.1}$ mm c = R 5 mm d = 1.85 mm e = 11 mm f = $0.95^{-0.05}$ mm g = 20 mm	
Socket with milled spanner flat For tightening the hex nuts of the eccentric screws	WAF 10 with 1/4" square drive Max. outer diameter 14.5 mm Spanner flat 10 mm	
Hole dimensions of the slide for manufacturing the socket	d = 14.7 -0.1 mm t = 16 mm	
Distance plates for parallel kinematic system EXPT-45 / 70 The distance plate must be produced by the customer. The exact dimensions can be found in the adjacent schematic diagram.	 A: $14^{+0.2}$ | B: $18^{+0.1}$ | C: $5^{+0.2}$ | D: 350 | E: $5.1^{-0.1}$ | F: $15^{+0.1}$ | G: $35^{-0.1}$ | H: $45^{+0.1}$ | I: 50 All dimensions in millimetres [mm]	
Distance plates for parallel kinematic system EXPT-95 / 120 The distance plate must be produced by the customer. The exact dimensions can be found in the adjacent schematic diagram.	 A: 600 | B: $6^{-0.1}$ | C: $34^{+0.1}$ | D: $5^{-0.1}$ | (E): 45 All dimensions in millimetres [mm]	

Further information on the equipment and measuring devices can be found in the information brochure **“Accessories, equipment and tools”**. This can be found in the online spare parts catalogue on the Festo website (http://spareparts.festo.com/xdki/data/SPC/0/PDF_SAFE/Fitting%20aids.pdf).

11.5 Accessories

The following accessories are required for commissioning the parallel kinematic system EXPT together with the control system CMCA:

- PC (laptop) with Festo Configuration Tool (FCT) installed
- Operator unit CDSA
- USB memory card with parameterisation data (customer project) for the control components
- Distance plate for homing the axes
- Accompanying documentation

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