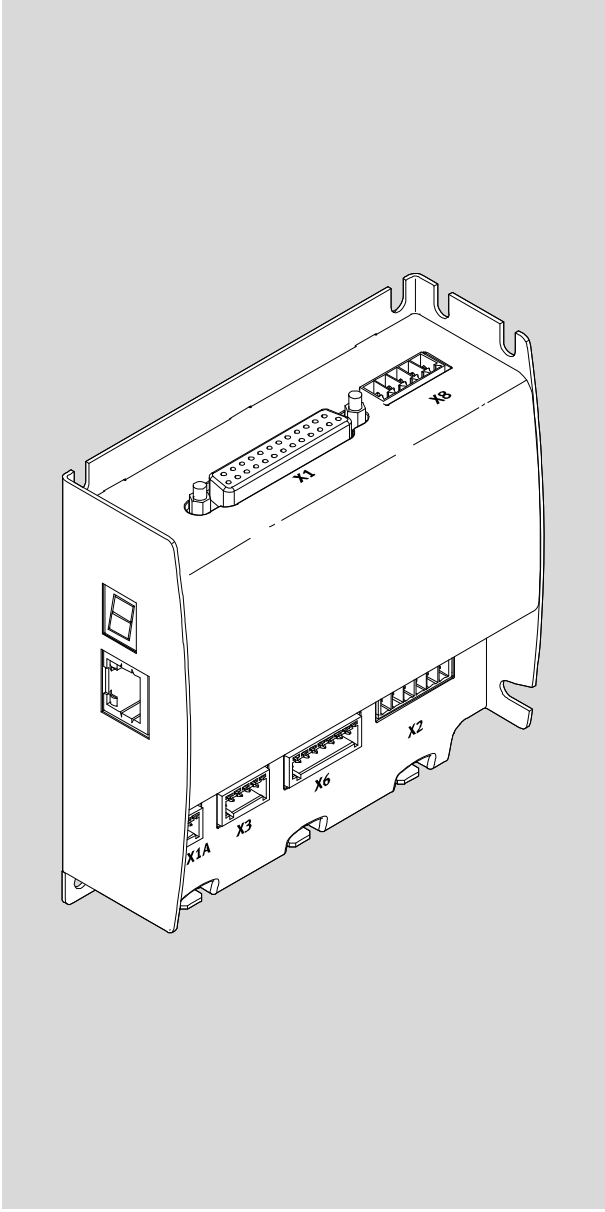
Motor controller

CMMO-ST-...-DION/DIOP



FESTO

Description

Motor controller with
I/O interface

CMMO-ST-C5-1-DIOP
CMMO-ST-C5-1-DION

8071657
2017-05c
[8071659]

Original instructions
GDCP-CMMO-ST-EA-SY-EN

Identification of hazards and instructions on how to prevent them:

Warning
Hazards that can cause death or serious injuries.

Caution
Hazards that can cause minor injuries or serious material damage.

Other symbols:

Note
Material damage or loss of function.

Recommendations, tips, references to other documentation.

Essential or useful accessories.

Information on environmentally sound usage.

Text designations:
- Activities that may be carried out in any order.
1. Activities that should be carried out in the order stated.
– General lists.

Software markings:

‹xxx›	Buttons in the software
[xxx] [xxx]	References to menu and sub-menu structures in the software
FCT [...] [xxx]	FCT PlugIn meny for components in the “Workplace” window
FCT menu [xxx]	FCT-main menu

Table of Contents – CMMO-ST-...-DION/DIOP

Service
Please consult your regional Festo contact if you have any technical problems.

Motor controller documentation

For all available product documentation ➔ www.festo.com/sp

This documentation (GDCP-CMMO-ST-EA-SY-...) describes the functions of the motor controller CMMO-ST-C5-1-DIOP/DION. The full description of the motor controller includes the following documents:

Designation	Table of contents
Short description CMMO-ST-... [1]	Brief equipment and functional description of the motor controller for initial information
Manual GDCP-CMMO-ST-EA-SY-...[2]	Equipment and functional description of the motor controller for all product variants – Mounting – Commissioning via web server/Festo Configuration Tool (FCT) – Communication via I/O interface – Technical data
Help system for the FCT software[2]	Descriptions of the Festo Configuration Tool (FCT) for commissioning and parameterisation of: – Configurable axis/motor combinations – Positioning systems in Festo's Optimised Motion Series (OMS)
Description GDCP-CMMO-ST-EA-S1-...[2]	Use of the STO safety function (“Safe Torque Off”)
Parameter lists[2] OMS_Parameter_xxxx_de_en.pdf	List with default settings of the parameter files for positioning systems in Festo's Optimised Motion Series (OMS)
Special documentation CMMO-ST_SPUL[1]	Requirements for operating the product in the USA and Canada in accordance with certification by Underwriters Laboratories Inc. (UL).

1) The documentation is enclosed in printed format.
2) The documentation can be found on the accompanying CD-ROM.

Tab. 1 Documentation for the motor controller

Target group
This documentation is intended exclusively for technicians trained in control and automation technology, who have experience in installation, commissioning, programming and diagnostics of positioning systems.

Additional information about the product:
- Brief documentation (Quick Start Guide) for initial start-up and diagnostics of positioning systems in Festo's Optimised Motion Series (OMS) with the web server of the CMMO-ST (in scope of delivery)
- Overview of accessories (catalogue) ➔ www.festo.com/catalogue
- Operating instructions for configurable actuators and the positioning systems from Festo (e.g. EPCO) ➔ www.festo.com/sp
- Function elements for CODESYS ➔ www.festo.com/sp
- Certificates, declaration of conformity ➔ www.festo.com/sp

Version status

This documentation refers to the following version of motor controller:
- Firmware: V 1.2.x and above
- FCT plug-in: CMMO-ST V 1.2.x and above

Firmware	What's new?	Which FCT plug-in?
V 1.0.x and above	The motor controller supports – the positioning system for EPCO electric cylinders – Festo actuators with stepper motor EMMS-ST – user-defined actuators	CMMO-ST from V 1.0.x
From V 1.1.x	Advanced parameter settings for positioning systems via web browser	CMMO-ST from V 1.1.x
From V 1.2.x	The motor controller supports additional positioning systems, such as: – Toothed belt axis ELGR	CMMO-ST from V 1.2.1
	– Electric semi-rotary drive ERMO – Electric cylinder EPCO-...-KF	CMMO-ST from V 1.3.0

Tab. 2 Version statuses of firmware and related FCT PlugIns

The following details are displayed in the software with an active online connection:
- Firmware version and MAC-ID ➔ Diagnostics page “Diagnosis” for the integrated web servers
- Hardware version, firmware version ➔ FCT (“Controller” page)
  If at this time there is no online connection, the information from the most recent connection is displayed.

Additional version details e.g. Revision: ➔ Product labelling of the motor controller

Note

Before using a newer firmware version:
- Check whether a newer version of the FCT plug-in or user documentation is available (➔ www.festo.com/sp).

1 Safety and requirements for product use

1.1 Safety

1.1.1 General safety instructions

Warning
Serious injury or damage to components as a result of collisions
- Ensure that nobody can place their hand in the positioning range of the axes or other connected actuators and that there are no objects in the positioning path while the system is connected to energy sources.
- Make sure that nobody is in the operating area of the connected actuators.
- Secure the danger zone through suitable safeguarding measures, e.g. guards and warnings.

Caution
Injuries as a result of automatic movement of the passive actuators as a result of
– voltage failure
– switching off the power supply
– Switching off the output stage
During installation of the actuator in an inclined or vertical position, falling loads!
- Secure loads through external safety measures (e.g. toothed pawls or moved pivot pins). This especially applies to vertical axes without automatic locking mechanics, clamping units or counterbalancing.
- Prevent movement of the passive motor in particular with suspended loads or other external forces, e.g. with a holding brake.

Caution
High temperatures on the housing surface of the motor controller
Touching the surface may cause a person to be startled or to react in an uncontrolled manner, causing subsequent secondary damage.
- Protect the motor controller to prevent accidental touching.
- Inform operating and maintenance staff about any potential hazards.
- Before touching the product, e.g. for mounting or installation: Allow the motor controller to cool down to room temperature.

During start-up of electric actuators, observe the safety instructions and warnings in the documentation of the motor controller and the documentation of the other components used.

- Switch off the supply voltage before mounting and installation work. Secure against accidental reactivation.
- Never remove or insert a plug connector when the motor controller is powered.
- Observe the handling specifications for electrostatically sensitive devices.
- Only switch on the supply voltage when mounting and installation work are completely finished.
- Only enable the controller if the electric actuator has been professionally installed and fully parameterised.
- Do not perform any repairs on the motor controller. In the event of a defect: Replace the complete motor controller.

1.1.2 Use for intended purpose

The motor controller CMMO-ST is intended for controlling the following actuators:

– Positioning systems in the Optimised Motion Series (OMS) with axis/motor units from Festo, e.g. EPCO electric cylinder
– Configurable actuators with the following components
  – Festo 2-phase stepper motor (EMMS-ST)
  – Festo rotary or linear shaft, e.g. EGC, DNCE, DGE or
  – User Defined Axis

The motor controller supports the STO safety function (Safe Torque Off).

Only use the motor controller as follows

– In perfect technical condition
– in its original condition, without unauthorised modifications
– within the limits of the product defined through the technical data
– In an industrial environment
– as an installed device in a control cabinet
  Use outside the control cabinet is possible if all of the plug connectors are connected or sealed with protective caps.

1.2 Requirements for product use

1.2.1 Operating conditions

For correct and safe use of the product in a machine or system:

- Provide the complete product documentation to the following personnel:
  - the design engineer and the installer of the machine or system
  - the personnel responsible for commissioning
- Keep the documentation safe throughout the entire product lifecycle.
- Ensure compliance with all of the specifications in the documentation for the motor controller. Take into consideration the documentation for the other components and modules (e.g. motor, cables, etc.).
- Take into consideration all of the legal regulations that are applicable for the installation site, as well as the following documents:
  - Regulations and standards
  - Regulations of the testing organisations and insurers
  - National specifications

For correct and safe use of the STO function:

- Observe the additional notes in the manual for the GDCP-CMMO-ST-EA-S1-

1.2.2 Transport and storage conditions

- Protect the product during transport and storage from excessive stress factors, such as:
  - mechanical loads
  - impermissible temperatures
  - moisture
  - aggressive atmospheres
- Store and transport the product in its original packaging. The original packaging offers sufficient protection from typical stresses.

1.2.3 Technical prerequisites

For correct and safe use of the product:

- Comply with the connection and ambient conditions of the product (➔ Appendix A), and all connected components specified in the technical data. Compliance with the limit values and load limits permits operation of the product in compliance with the relevant safety regulations.
- Observe the notes and warnings in this documentation.

1.2.4 Qualified specialists

The steps described in this documentation may only be carried out by qualified specialists. The trained personnel must be familiar with:

- electrical control technology
- the applicable regulations for operating safety-engineered systems
- the applicable regulations for accident prevention and industrial safety
- the documentation for the product

1.2.5 Product conformity and certifications

The motor controller with integrated safety function Safe Torque Off (STO) is a safety component. The motor controller is labelled with CE marking.

Guideline for	Standard
2006/42/EC	EN ISO 13849-1:2008
	EN ISO 13849-2:2008
	EN 1037:1995+A1:2008
2004/108/EC	EN 61800-3:2004
	EN 61326-1:2006

Tab. 1.1 Listed directives and standards (declaration of conformity)

Certain configurations of the product have been certified by Underwriters Laboratories Inc. (UL) for the USA and Canada and are labelled with the symbol shown here:

– UL Listing Mark for Canada and the United States

Rules for observing the UL certification can be found in the separate UL special documentation. The technical data stated therein take priority. The technical data in this documentation may show values deviating from this.

Additional information:

– Certificates and the declaration of conformity for this product ➔ www.festo.com/sp
– Other standards and test values ➔ Appendix A.1

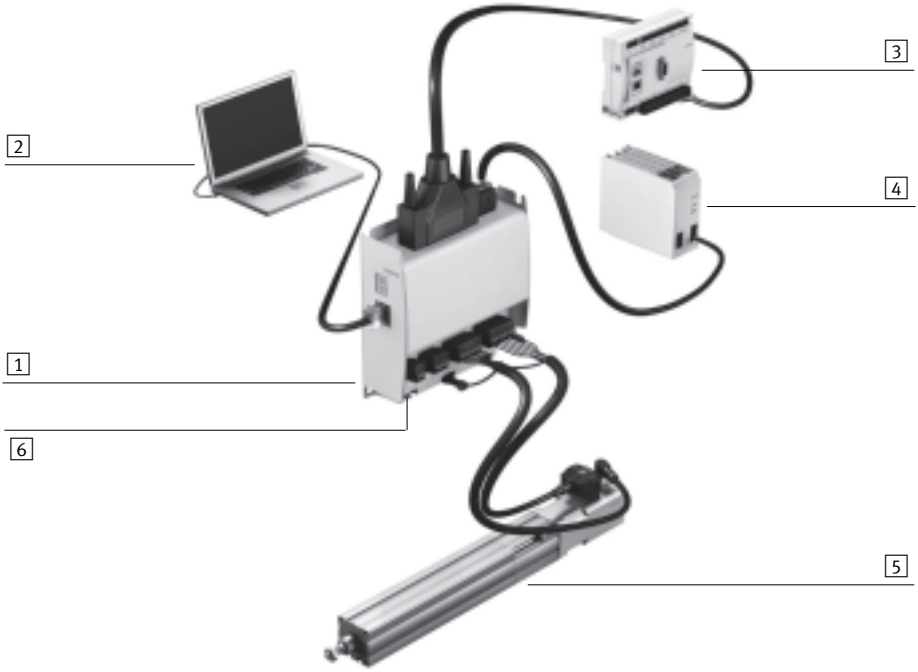
1.2.6 Safety function Safe Torque Off

The safety function enables two-channel switching off of the voltage supply to the motor and therefore Safe Torque Off (STO) via connection [X3].

The STO safety function is described in detail in document GDCP-CMMO-ST-EA-S1-.... The safety function STO should only be used in the manner described in this document.

2 Product description

2.1 System structure



1 Motor controller CMMO-ST
2 PC with Ethernet LAN connection for commissioning and diagnostics with software support by the web server or FCT (Festo Configuration Tool) integrated in CMMO-ST
3 Higher-order controller (SPS/IPC) for control via I/O interface e.g. CECC
4 PELV power supply unit for 24 V supply voltage
5 Actuator (here: electric cylinder EPCO with encoder)
6 Functional earth with earth plate (protective ground ➔ Special documentation CMMO-ST_SPUL)

Fig. 2.1 System structure (example)

2.2 Product overview

2.2.1 Components

1 [X9] Load/logic voltage
2 [X1] I/O interface for control system with SPC/IPC
3 Front view with 7-segment display
4 [X18] Parameterisation interface Ethernet (RJ-45)
5 [X1A] Reference switch
6 [X3] STO
7 [X2] Encoder (RS422)
8 [X6] Motor
9 Functional earth (3x)
10 Mounting surface (H-rail)
11 Mounting surface

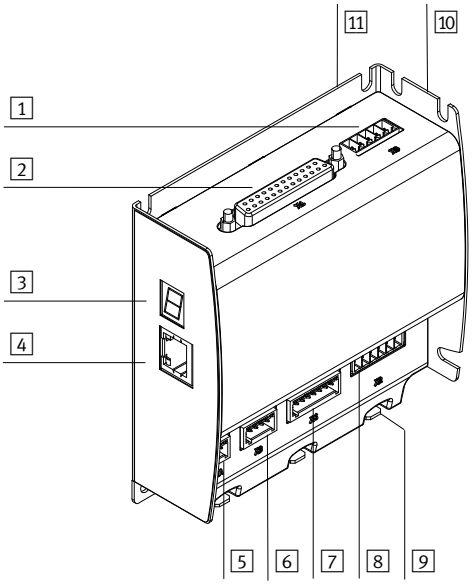
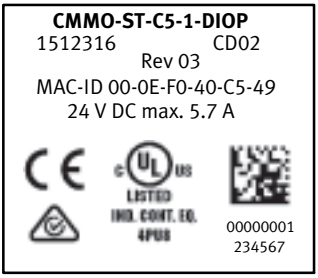


Fig. 2.2 Components of the CMMO

2.2.2 Product identification

Product labelling	Example	Function
	CMMO-ST-C5-1-DIOP	Type code (➔ Tab. 2.2)
	1512316	Part number
	CD02	Serial number (➔ Tab. 2.3)
	Rev 03	Revision (hardware/firmware status on delivery)
	MAC-ID	MAC (Media-Access-Control)
	00-0E-F0-40-C5-49	address
	24 V DC. max. 5.7 A	Connection data
	Data matrix code	Coded serial number (corresponds to the number below the code)

Tab. 2.1 Product labelling of motor controller (example)

The product key of the product can be entered as a search term in the Festo Support Portal to determine the revision of the device (➔ www.festo.com/sp).
The type code on the product labelling indicates the equipment features of the various versions of the motor controller. This documentation describes the following product variants:

Feature	Type code	Specification
Motor controller	CMMO-	motor with controller, series A
Motor technology	ST-	Stepper motor
Nominal current	C5	5.7 A
Nominal operating voltage	1	24 V DC
Activation	DIOP	Digital I/O interface, PNP switching logic
	DION	Digital I/O interface, NPN switching logic

Tab. 2.2 Type codes

Serial number
On the type plate, both characters of the serial number indicate the production period in encrypted form. Example: serial number CD ➔ Year of manufacture C=2012, month of manufacture D=December.

1st character = year of manufacture						
X = 2009	A = 2010	B = 2011	C = 2012	D = 2013	E = 2014	F = 2015
H = 2016	J = 2017	K = 2018	L = 2019	M = 2020	N = 2021	P = 2022
R = 2023	S = 2024	T = 2025	U = 2026	V = 2027	W = 2028	X = 2029

Tab. 2.3 Manufacturing year (20-year cycle)

2nd character = month of manufacture					
1 = January	2 = February	3 = March	4 = April	5 = May	6 = June
7 = July	8 = August	9 = September	O = October	N = November	D = December

Tab. 2.4 Manufacturing month

2.2.3 Scope of delivery and accessories

Quantity	Component
1	Motor controller CMMO-ST-...-DION/DIOP

1	Operator package
	– Brief description
	– CD-ROM with following contents:
	  – Documentation about the product ➔ Tab. 1
	  – Parameter files for supported positioning systems (e.g. EPCO, ELGR)

1	Assortment of plugs NEKM-C-10 with 5 plug connectors for – Reference switch [X1A] – Safety function STO [X3] – Encoder [X2] – Motor [X6] – Power supply [X9]
2	H-rail clip (pre-assembled)

Tab. 2.5 Scope of delivery

Current information on accessories ➔ www.festo.com/catalogue.
You will, for example, need the following cables and components as accessories:

- Control cable for the higher-order controller (I/O interface)
  - Control cable NEBC-S1G25-K-3.2-N-LE25
  - 25-pin Sub-D plug NEFC-S1G25-C2W25-S6
- Connecting the I/O interface via a connection block
  - Connection block NEFC-S1G25-C2W25-S7
  - Cable CMMO-ST/connection block NEBC-S1G25-K-...-.0-N-S1G25
- Motor and encoder cables NEBM-... in accordance with the actuator configuration in various plug connector versions and lengths
- I/O simulation box CDSM-S3-P/N with manual control unit, interconnecting cable, user manual

2.2.4 Product features

Feature	Description

Electronics	– Electronic control unit with
	  – cascade control for current, speed and position
	  – Commutation control[1)]
	  – Pulse width modulation
	  – Encoder connection (RS422 signals) for closed-loop operation
	  – Digital 3-pin input for reference signal
	  – Safety function STO (Safe Torque Off)
	– Integrated brake resistance (brake chopper)

Power supply	Separate load and logic supply[2)] – Load supply 24 V DC – Logic supply 24 V DC – Maximum motor current 5.7 A
Mounting	– H-rail – Mounting plate
Functions	– Process control with up to 31 parameterisable sets of commands. – Position linking for workflow sequences – Acceleration with jerk limitation – Monitoring of different process variables (torque, speed, position, time)
Commissioning	– Parameterisation via Ethernet interface TCP/IP – Software support: FCT, web server
Open-loop control	Via I/O interface Optional control via Ethernet (CVE)
Diagnostics	– Operating mode and error display via 7-segment display – Diagnostic memory via web server and FCT

1) Current regulation in accordance with actual load leads to lower levels of heat generation.

2) No new homing is required, e.g. after emergency stop.

Tab. 2.6 Product features

Write cycles to the permanent data memory

A flash memory is integrated in the motor controller as a non-volatile memory element. With the following procedures, entries are written to the flash memory:

– Download of a parameter file
– Firmware update
– Teaching with automatic storage
– Backing up of parameters via FCT
– Configuration of fault properties / error responses
– Recording of movements with the trace function in FCT

The number of usable sectors declines with flash storage in terms of write/delete operations. The FLASH memory used by the CMMO-ST is designed for 100,000 write cycles.

Note

Damage to the FLASH memory

In positioning mode, the target positions for absolute sets of commands can be taught and saved automatically via the I/O interface.

- Do **not** use the TEACH function in combination with “automatic storage” in continuous operation. This would otherwise rapidly use up the permitted number of write cycles.
- Disable automatic saving after saving via FCT ➔ FCT [...] [Controller] [I/O Configuration]

2.2.5 Supported motor configurations

Step motor and holding brake

The motor controller supports

– Motors without a holding brake
– Motors with an integrated holding brake (electrically actuated spring accumulator brake)

The holding brake is not suitable for braking moving masses or loads.

The holding brake is actuated automatically by the controller enable of the motor controller.

Motor configuration	Function
Without holding brake	The actuator can move freely once the controller has been inhibited.
With holding brake	After inhibiting the controller, the actuator is maintained in position by the holding brake.

Tab. 2.7 Motor configuration: holding brake

Step motor and encoder

If a step motor is operated without an encoder the motor must always be operated **below** its performance limits. If for example the motor is operated by the driving mass to its performance limit during fast acceleration, this can have the following consequences:

– The rotor may no longer be able to follow the rotary field (load torque › motor torque).
– The resultant step losses lead to incorrect position values.

If a step motor is controlled by an encoder, it can be loaded up to its performance limit. The encoder must have the same rotor position and it reports this back to the position controller. This prevents imprecise positioning caused by step losses.

The motor controller supports

– Step motors with encoder in closed-loop operation (optional: in open-loop operation)
– Step motors without encoder in open-loop operation

Motor configuration	Function	
Motor with encoder[1)]	Controlled operation (closed-loop operation)	Only the energy needed to move the load is directed into the motor. The motor works in an energy-optimised way and produces less heat. The motor is position-controlled when stationary. Standstill monitoring is active.
Motor without encoder	Controlled operation (open-loop operation)	The motor is always operated with the set driving current when travelling. When at a standstill, the motor is maintained in its position at the set holding current. The following functions are **not** supported: – Homing/driving to stop – Force Comparator – Force mode

1) For specific applications, the "open-loop operation" function can be set with FCT. This function corresponds to that of a motor without encoder.

Tab. 2.8 Motor configuration: encoder

2.3 Software for configuration and commissioning

2.3.1 FCT (Festo Configuration Tool)

The Festo Configuration Tool (FCT) is the Windows-based software platform for parameterisation, commissioning and diagnosis of actuators with configurable motor-axis combinations and positioning systems (OMS). To prepare for commissioning, parameterisation on the PC can take place without a connection to the controller (“offline”). For commissioning, a connection is required via the parameterisation interface (“online”).

FCT is included in the scope of delivery (CD-ROM) and is installed using an installation program. More recent versions are available as downloads ➔ www.festo.com/sp , CMMO-ST.

The FCT comprises the following modules:

– the framework with general control elements and software functions
– extension modules integrated in the framework (PlugIns) for every implemented type of device

The framework facilitates consistent project and data management of all supported types of device. The plug-ins are managed and started from the framework. The PlugIn of a type of device supports the structured delivery of all necessary steps to commission the actuator.

The software Help system contains detailed manuals relating to the FCT. The FCT online help also has information about possible commissioning scenarios and initial start-up. These contents are also available as PDF files (de/en).

General help (framework):

Information about work on projects and for adding a device to a project

– FCT: menu [Help] [General FCT content] [Festo]
– PDF: (FCT table of contents)\Help\FCT_de.pdf

Help for PlugIn:

Detailed information about configuration, parameterisation and commissioning

– FCT: Menu [Help] [Content of installed PlugIns] [Festo] [PlugIn name]
– PDF: (FCT installation directory)\HardwareFamilies\Festo\(device type)\V...\Help\CMMO-ST_....pdf

With the “Print” button in the Help window, individual topics from the FCT online help can be printed out. To view and print out these PDF files, it is advisable to have the program Adobe Reader.

Software	Functions

FCT Offline/Online	– Configuration and parameterisation of all components in the actuator
	– Parameterisation of actuator components (motor, axis and controller), the interfaces, the dimensional reference system, the homing method etc.
	– Parameterisation of error categories and messages
	– Parameterisation of standard values for sets of commands
	– Input of tables of records for the I/O control profile “Valve”
	  – max. 7 sets of commands
	  – Type of record: positioning mode
	– Input of tables of records for the I/O control profile “Binary”
	  – max. 31 sets of commands
	  – Type of record: positioning mode, power mode, velocity (speed) mode
	  – Record Linking
	– Import/export of FCT parameter files for data backup, data transmission during device replacement and data transmission to the web browser

FCT Online	– Display of communication status, device status, I/O signals – Carrying out homing – Manual movement of the actuator (jog) – Teaching of sets of records with preconfigured standard values – Test of sets of commands or sequences in the record table – Manual precision adjustment of the controller data – Recording of measuring data in real time, e.g. to evaluate the control characteristics – Monitoring of the output stage temperature – Readout/deletion of the diagnostic memory – Firmware download in service cases – Restore factory setting

Tab. 2.9 Festo Configuration Tool (FCT), Plugin CMMO-ST

2.3.2 Web servers

The integrated web server on the motor controller supports the diagnosis and parameterisation of a Festo positioning system via web browser with two device-specific websites:

– “Diagnosis” for identification of the actuator and diagnosis during operation
– “Parameters” for upload/download of parameter files and for simplified commissioning of positioning systems for which a parameter file (OMS) exists.

If the controller is connected to a PC via the parameterisation interface, after input of the IP address on the device, the “Diagnosis” website is displayed automatically in the web browser, e.g. in Internet Explorer (Version 6 or higher).

During start-up with the web server, parameterisation is performed by a parameter file.

Tested parameter files and the documentation for the most important parameter settings for positioning systems (OMS) are included in the scope of delivery on CD-ROM.
More recent versions are available as downloads ➔ www.festo.com/sp:

Website	Functions	Profile
“Diagnosis” (Diagnostics)	– Status information e.g. – Display of device type and firmware version – Display of IP and MAC address – Identification on the network (wave function) – Operating messages (Motion Complete, Referenced, Actual Position, Record Set Number etc.) – Error display – Temperature display – Dimensional units for positioning (changeover) – Display of signal statuses of the I/O interface – Reading and displaying the diagnostic memory	Valve Binary
“Parameters” (Parameter)	– Status information (cf. “Diagnosis”) – Device control, controller enable – Uploading a parameter file, e.g. to save current settings on the PC – Downloading a parameter file, e.g. to restored settings – Password protection	Valve Binary
	– Simplified commissioning of positioning systems (OMS): – Download of tested parameter files from the Festo Internet Server (“Parameter Cloud”) – Carrying out homing – Jogging and teaching – Parameterising and testing of sets of commands	Valve

Tab. 2.10 Web pages of the motor controller

2.3.3 Password protection

Password protection protects the controller from unauthorised or accidental changes to the parameterisation and prevents controlling access to the actuator via FCT or web server.

Password query	
FCT	The password is queried when establishing the online connection between FCT and motor controller. Following input of the correct password, all functions are released until the software is shut down.
Web browser	The query is made when changing from the “Diagnosis” web page to the “Parameters” web page. In the input dialogue “Authentication required”, the “User name” box can remain empty. This is not evaluated. Following input of the correct password, all functions are released until the web browser is shut down.

Tab. 2.11 Password query

The web server does not support an HTTPS connection. The password is transferred insecurely. The web browser notes the entered password even after the tab card has closed on the web server, until the web browser is closed. Before the web browser is closed, the cache (buffer memory) needs to be deleted as a precaution(with Microsoft Internet Explorer menu [Options], command “Delete browser”)

Enabling password protection

In delivery condition, password protection is enabled. To enable, a password is defined in the FCT (➔ Chapter 5.4.6) **or** via the web browser (➔ Chapter 5.3.6). After input of a valid password, the password protection becomes effective simultaneously for FCT **and** for the web browser.

Firmware version< V1.1.2.4:
The password is saved in the parameter file of the controller.
By downloading another parameter file to the controller, the password can be changed or lost.

Firmware version ≥ V1.1.2.4:
The password is saved permanently and is not changed by the download of a parameter file. To establish the compatibility with older firmware versions, the password continues to be saved in the parameter file. To create a compatible parameter file:

- Save the parameter file after enabling the password.

Changing/deleting the password

To change or delete, the active password must be known. Changing involves the input of a new password. Deletion involves the use of a blank input field

Password forgotten?

If the password has been forgotten, it can be reset using Festo Service.

2.4 Parameterisation and control interfaces

Interface		Functions
Ethernet	[X18]	– Parameterisation, commissioning and diagnostics with software support (FCT, web server) – Optional: open-loop control via Ethernet (CVE)
I/O	[X1]	control via digital input (DIN digital inputs) and output (DOUT digital output) options: – PNP switching logic (CMMO-ST...DIOP) or NPN (CMMO-ST...DION) – 2 controller profiles: valve, binary

Tab. 2.12 Parameterisation and control interfaces

2.4.1 Ethernet interface

For commissioning, the motor controller is configured ex-factory as an active DHCP server. The DHCP server of the motor controller facilitates a **direct connection** to a PC configured individually as a DHCP client.

DHCP/IPv4	Addressing	IP configuration

Servers	static	– IP address: 192.168.178.1 (private IP)
		– Subnet mask: 255.255.255.0
		– Gateway: –
		– Port
		  – Web browser: 80
		  – FCT: 7508
		  – CVE: 49700

Tab. 2.13 TCP/IPv4 configuration of the motor controller (factory setting)

Note

The factory setting is generally not suitable for network operation (with what is usually an existing and active DHCP server):

– Two active DHCP servers on a network can lead to network faults.
– The DHPC server on the motor controller is not intended for supplying existing networks with IP addresses.

To integrate in a network, the factory setting of the motor controller must be modified **before** integration in the network ➔ Chapter 5.7.4

Connection	Description
Server - Client	The motor controller is connected as an active DHCP[1)] server via an Ethernet line directly to the PC (point-to-point connection). The Ethernet interface used on the PC must have the following (standard) settings ➔ Windows system control: – Obtain an IP address automatically – Obtain DNS server address automatically The DHCP server on the motor controller assigns the PC (DHCP client) an appropriate IP configuration: – IP addresses from the following range: 192.168.178.110 to 192.168.178.209 – Subnet mask: 255.255.255.0 – Gateway address is not issued

1) Dynamic Host Configuration Protocol

Tab. 2.14 Direct connection via Ethernet (factory setting)

Connection	Description
Client - Client Client - Server	The motor controller is connected to a network as a DHCP[1)] client. There is the option of connecting the motor controller to a fixed IP address, or it may be assigned an IP address.

1) Dynamic Host Configuration Protocol

Tab. 2.15 Integration in a network via Ethernet

2.4.2 Control profiles of the I/O interface (valve, binary)

For activation of the motor controller via the I/O interface, 2 control profiles (valve, binary) are available. During the initial start-up phase the valve profile is active (factory setting).
The change of profile takes place via FCT [...] [Application Data] Operation Modes

A web server start-up requires the valve profile to be set for the I/O interface. A change of profile via web server involves the downloading of a corresponding parameter file to the motor controller. All OMS parameter files from Festo contain “Valve Profile” parameterisation.

Profile	Description
Valve ➔ Chapter 5.5	I/O control for a simple positioning mode, optionally with reduced torque. Based on the pneumatic valve pilot, 7 position records can be selected directly through one input each (7 separate inputs). Upon reaching the target position the output corresponding to the input is set (7 separate outputs).
Binary ➔ Chapter 5.6	I/O control with extended function in all controller operating modes. Via 5 inputs, 31 records can be addressed in binary form (plus record 0 = homing). Achievement of the target parameter is reported via the MOTION COMPLETE output. The binary profile can be changed over by input DIN8 between 2 operating modes: – Mode 0: Normal operation – Mode 1: jogging/teaching during the commissioning process

Tab. 2.16 Control profiles of the I/O interface

2.4.3 Device control (master control)

Device Control is an exclusive access right and it ensures that the actuator is only ever controlled via one connection. Simultaneous control by multiple connections would result in uncontrollable behaviour of the actuator.
There is always an approval signal from the connection that controls the device at that time. After switching on the motor controller, the I/O interface always has control of the device.

Active and passive connections via Ethernet interface

Via the Ethernet interface, a maximum of 3 simultaneous connections are permitted on the motor controller:

– 2 TCP/IP - connections
– 1 HTTP connection

Protocol	Connections		
TCP/IP	FCT	•	
		•	•
	CVE		•
HTTP	Web servers	•	•

Tab. 2.17 Maximum permitted simultaneous connections via Ethernet interface

Where 2 TCP/IP connections are created, the first of those connections is the active one. The 2nd connection is the passive one. A passive connection cannot become an active connection. For that, both connections would first have to be dismantled, then reconstructed in the desired sequence.

Connections	Rights
Active connection	Write rights for parameterisation, control, transfer of master control and read rights
Passive connection	Read rights for diagnostics

Tab. 2.18 Connections and rights via Ethernet interface

An active HTTP connection can always be reconstructed. If the active TCP connection does not have master control, the HTTP connection can assume master control.

Changeover of device control

Every active Ethernet connection can take over device control from the I/O interface. Changeover is possible in approved as well as in non-approved status. Transfer of device control can also take place during execution of an order. For this, an ongoing order is stopped (Quick Stop).
Recommendation: stop current orders before reversing the device control.

Connection	Changeover of device control
FCT	Device control can be assumed by all other connections (device control: enable FCT). When the device control is disabled, master control is restored to the I/O interface.
CVE	Device control can be assumed by all other connections and can assign device control to an existing active connection (object #3).
Web servers	Can take over device control from the I/O interface. When the device control is disabled, master control is restored to the I/O interface.

Tab. 2.19 Changeover of device control

Inhibit switch over

Device control can be adopted by an active connection if that process is not inhibited by CVE parameter “master control inhibit” (object #4).
Return of device control to the I/O interface in the FCT or web browser cannot take place if the block has been enabled.

2.4.4 Time-out characteristics

The motor controller detects if the network connection to the FCT software has been interrupted and it behaves in accordance with the settings parameterised in FCT on the “Error management” page (error number 0x32). The waiting time is typically 1 s, but it can be longer in slow networks, as the waiting time is dynamically adapted to the transmission rate. The time-out characteristics can be parameterised by the network settings in the FCT.

The motor controller does not detect if the connection to a web browser is interrupted. Movements that have been started via the web browser can **no longer** be stopped by interrupting the Ethernet connections using the browser.

2.5 Drive functions

Drive function	Brief description	Profile	➔ Chapter
Homing	Homing operation for defining the reference point	Valve Binary	2.5.2
	Option: automatic homing when starting a set of commands, if the axis is not already referenced.	Valve	2.5.2
Jog / Jogging	Continuous movement of the actuator or movement in individual steps via web server, FCT or I/O interface	Valve[1)] Binary	2.5.3
Teaching	Acceptance of current position of axis as parameter setting via FCT, web server or I/O interface	Valve[1)] Binary	2.5.4
stopping	Terminate an ongoing order (stop)	Valve	2.5.5
	Interrupt an ongoing order (intermediate stop, pause), with the option of deleting the remaining path	Binary	
Actuate the holding brake	Activation of holding brake on motors with integrated holding brake	Valve Binary	2.5.6
Positioning mode	Operating mode for travelling to a specified target position (point-to-point positioning), with the option of reduced torque[3)]	Valve[2)] Binary	2.5.7
Profile Velocity Mode	Operating mode to drive a distance at constant speed, with the option of stroke limitation	Binary	2.5.8
Force mode[3)]	Operating mode to apply a constant force to linear axes or a constant torque to rotary axes (torque operation) with the option of stroke limitation.	Binary	2.5.9

1) This function is only possible via FCT/web server.

2) This function in the valve profile has a reduced functional scope.

3) The function requires close-loop control operation (motor with encoder).

Tab. 2.20 Overview of the drive functions

2.5.1 Measuring reference system

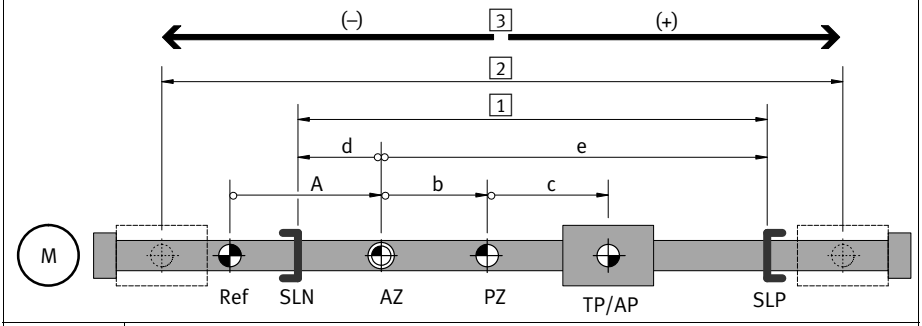
All actuator functions are based upon a uniform dimensional reference system. The algebraic signs of all parameters set up are defined ex-factory as follows, viewing the input end of the motor:

– Positive (+) = direction of movement with clockwise direction of rotation of motor shaft.
– Negative (–) = direction of movement with anti-clockwise direction of rotation of motor shaft.

The direction of movement of load is e.g. dependent on the spindle type of the axis (clockwise/anti-clockwise) and on the gear unit employed. When using angle or toothed belt gear units, the reverse arrangement of direction of rotation may be of benefit ➔ FCT [...] [Application Data]Environment]: Inverse Rotation Polarity..

Recommendation: check direction of movement in job mode and, if required, reverse it:
– increasing actual values = positive direction (+)
– decreasing actual values = negative direction (-)

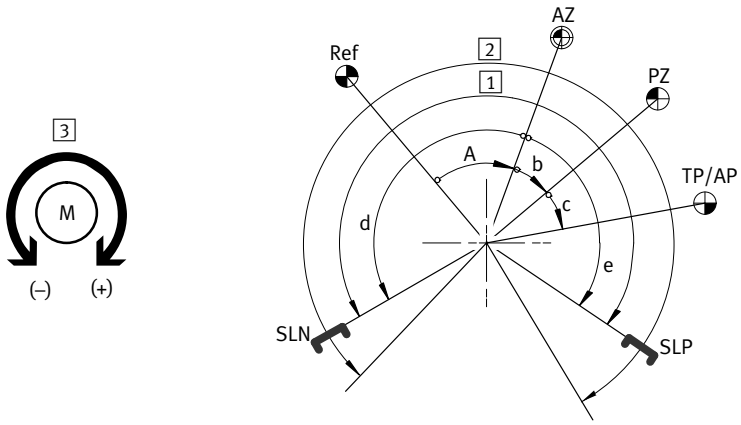
Example: linear drive



Ref	Homing point (reference point)
AZ	Axis zero point
PZ	Project zero point
SLN	Negative software end position (SW limit negative)
SLP	Positive software end position (SW limit positive)
SP	Target position
AP	Actual position
a	Offset axis zero point (AZ)
b	Offset project zero point (PZ)
c	Target/actual position (TP/AP)
d	Software limit negative (SLN)
e	Software limit positive (SLP)
1	Usable range (usage stroke)
2	Operating range (effective stroke)
3	Direction of movement with the factory setting

Tab. 2.21 Dimensional reference system ➔ FCT [...] [Axis] [Measurements]

Example: rotary actuators



Ref	Homing point (reference point)
AZ	Axis zero point
PZ	Project zero point
SLN	Negative software end position (SW limit negative)
SLP	Positive software end position (SW limit positive)
SP	Target position
AP	Actual position
a	Offset axis zero point (AZ)
b	Offset project zero point (PZ)
c	Target/actual position (TP/AP)
d	Option: software limit negative (SLN)[1)]
e	Option: software limit positive (SLP)[1)]
1	Usable range
2	Working area
3	Direction of rotation with factory setting, viewing front surface of motor shaft

1) On rotary shafts with “unlimited” configuration, no end position can be parameterised.

Tab. 2.22 Dimensional reference system ➔ FCT [...] [Axis] [Measurements]

Calculation rules for the dimension reference system

Point of reference	Calculation rule			
Axis zero point	AZ	= REF + a		
Project zero point	PZ	= AZ + b	= REF + a + b	
Negative software end position	SLN	= AZ + d	= REF + a + d	
Positive software end position	SLP	= AZ + e	= REF + a + e	
Target position/actual position	TP/AP	= PZ + c	= AZ + b + c	= REF + a + b + c

Tab. 2.23 Calculation rules for the dimension reference system

Other notes on the parameterisation of the dimensional reference system ➔ FCT [...] [Axis] [Measurements]

Software end position SLN/SLP

The delimitation of a useful area within the work space involves the parameterisation of software limits. The position is indicated relative to the axis zero point AZ.

Note

movement to fixed stops is not permitted during operation.

- Delimit work space using software limits.
- Define software limits far enough away from the mechanical stops.

The controller checks if the target position of the set of commands is located between the software limits SNL and SLP. If a target position lies outside this range, the positioning record is not executed and the reaction parameterised in the FCT-error management is triggered ➔ FCT [...] [Controller] [Error Management].

Before the software limit is reached, the actuator is braked to a stop in accordance with the error response so that the position of the software limit is not exceeded. After stopping, the positioning direction is blocked.

If the controller is not released or is not referenced, no monitoring of software limits takes place. If the actuator is moved manually behind a software limit, after release of the controller, only travel in the opposite direction to the exceeded software limit is possible. If the time of the next positioning movement is behind the software limit, the “software limit” error message is displayed. If the target is in the permitted range, it is possible to move out of the software limit position without an error.

2.5.2 Homing

When homing, the reference point of the dimensional reference system is determined. The reference point is the absolute reference point for the axis zero point. Orders cannot be started if homing has been completed successfully (exception: jogging).

Note
The reference point is saved temporarily in the motor controller. When there is an open circuit in the logic power supply, the homing point is lost.

Homing must be carried out in the following cases:
– during initial commissioning of an actuator
– after every time the logic power supply is switched on
– after a change in homing method
– after changing between closed-loop control and open-loop control mode
– after a reversal in the direction of rotation

Recommendation for repeating the homing operation:
– after system faults during which the homing point can be lost
– after a step loss during open-loop operation

Start the homing run

Device control	Start function	Profile
FCT	FCT online tab “Homing”	Valve, binary
Web servers	“Parameters” website	Valve
I/O interface	DIN8 (REF)	Valve
	DIN1...DIN5 (RECORD 0) + DIN6 (START)	Binary

Tab. 2.24 Start homing

Automatic start for homing

Start option	Description	Profile
– active	Automatic homing is performed automatically if the axis is not already referenced when starting a set of commands. After homing is completed, the active set of commands is executed. If the set of commands is inactive during the homing process, the homing process is terminated.	Valve
– Inactive	Reference travel (homing) is not carried out automatically (factory setting):	

Tab. 2.25 Automatic start ➔ FCT [...] [Axis] [Homing] Settings

Process of homing

The homing procedure is dependent on the following settings:
- Reference travel parameters ➔ Tab. 2.28
- Reference travel method ➔ Tab. 2.29
- Reference travel option ➔ Tab. 2.26

The selection of the homing method and parameterisation is made via FCT [...] [Axis] [Reference travel] Method. When starting up the web server, settings are transferred from the actuator parameter file.

The homing method defines which target is being sought by the reference travel. The homing drive profile is set by the reference travel parameters in such a way that the homing point can be located. As an option, the actuator can, after finding the reference point, move automatically to the parameterised axis zero point.

Reference travel option: travel to the axis zero point	
– Active[1)]	After reaching the homing point, the actuator automatically moves on to the axis zero point (actual position = 0 – offset PZ)
– Inactive	When the homing point is reached, reference travel (homing) is completed. (actual position = 0 – offset AZ – offset PZ)

1) Default setting ➔ FCT [...] [Axis] [Homing] Settings. In the homing method “reference travel to stop”, the option cannot be disabled.

Tab. 2.26 Travel to the axis zero point

Motion Complete is disabled during reference travel (MC=0). Homing is completed once the homing point or, optionally, the axis zero point is reached (MC=1).

Status display

Device control	**Status display**
FCT	FCT online tab: Homing
Web servers	Web pages “Diagnosis”, “Parameters”
I/O interface	Referenced: DOUT9 Reference travel enabled/reference travel valid: configurable for DOUT6 ... 7

Tab. 2.27 Status display for homing

Homing parameters

Target and direction of reference travel are specified by the homing method. Depending on the homing method, other parameter settings may be required prior to reference travel:

Parameters	Description	Method
Homing		
Search speed (Search Velocity)	Velocity for searching travel to the defined target.	– Homing Switch – Stop
Creep speed (Crawling Velocity)	Speed for crawling speed to the homing point	– Homing Switch
Acceleration (Acceleration)	Acceleration/deceleration for all phases of reference travel	– Position Actual Value – Homing Switch – Stop
Travel to the axis zero point		
travel speed (Drive Velocity)	Positioning speed for the option “Drive to axis zero point”	– Position Actual Value – Homing Switch – Stop
Axis zero point (Axis Zero Point)	The distance of the axis zero point from the reference point in positive or negative direction (offset)	
Stop recognition (closed-loop operation)		
Force/torque limit (Force Limit/Torque Limit)	Percentage figure for force (related to maximum current) at which a stop is detected.	– Stop
Damping time (Message Delay)	Time period during which the force must be greater than the force limit in order for a stop to be identified.	
Time-out (open-loop operation)		
Time-out	If a switch has not been found after a certain period of time, the homing run is aborted with an error message (0x22).	– Reference switch without index

Tab. 2.28 Homing parameters ➔ FCT [...] [Axis] [Homing] Method

Recommendation for parameterisation:

- Select low search/crawl speed to enable the target points to be identified as accurately as possible.
- Set deceleration high enough to prevent the target points from being overrun during the search run.

Methods of homing

The homing method defines which target determines the homing point.

Objective	CiA 402[1]		Brief description
Position Actual Value	DDh	-35	The current position becomes the homing point.
Index – Positive direction – Negative direction	 22h 21h	 34 33	The next index of the encoder is searched for during the homing process. When successful, the position of the index becomes the homing point.
Stop[2] – Positive direction – Negative direction	 EEh EFh	 -18 -17	The mechanical stop is sought during homing. If the stop is detected in accordance with the parameterisation (force limit, damping time), the position becomes the homing point.
Homing Switch[3] – Positive direction – Negative direction	 17h 1Bh	 23 27	The reference switch is sought during the homing process. When successful, the position of the switch becomes the homing point.
Homing Switch with Index[3][2] – Positive direction – Negative direction	 07h 0Bh	 7 11	The reference switch is sought during the homing process. When successful, the actuator moves in the opposite direction to homing as far as the next index point for the sensor. The position reached becomes the homing point.

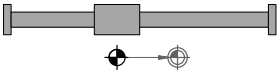
1) The homing methods are based on the CANopen device profile CiA 402 (electric actuators).

2) Prerequisite: motor with encoder (open-loop operation).

3) Prerequisite: reference switch (NO, NC) is parameterised ➔ FCT [...] [Axis] Axis Options

Tab. 2.29 Homing methods ➔ FCT [Axis] [Homing] Method

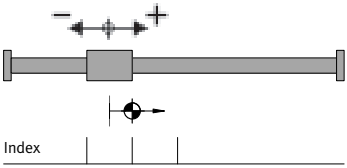
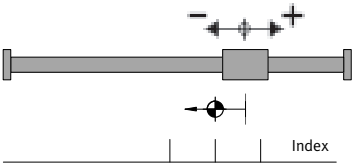
Homing to current position

Homing to current position	Example: linear drive
The current position is taken as the homing point. A movement only takes place if the “Position to axis zero point” option is enabled.[1]	

1) Homing option “Position to axis zero point” ➔ Tab. 2.26

Tab. 2.30 Homing method – current position

Homing to index

Homing to index	
1. Search for the index of the encoder with search speed in the parameterised direction. The position of the next index is taken as the homing point. 2. Optional: travel to the axis zero point.	
Direction: positive (method 22_h; 34)	Direction: negative (method 21_h; 33)
	

Tab. 2.31 Homing method – homing to index

Homing to the stop

A homing run to a fixed stop is only possible in open-loop operation (motor with encoder). The stop is detected by a motor shutdown in combination with a sharp rise in the motor current. After that, the stop position must be quit by positioning to the axis zero point.

Note

If the motor controller is continuously in close-loop operation against a flexible stop, the temperature rises sharply and the controller shuts itself down. For prevention purposes:

- Set parameters for stop detection (force limit, damping time)
- Option of enabling “Position from homing point to axis zero point”.
- Set axis zero point in such a way that the axis in operation, even if with a following error, does not move to stop/limit position damping (e.g. ≥ 3mm).
- Pay attention to algebraic sign on the offset (direction: away from stop).

Note

- Homing to a stop: protect delicate stops by reducing the search velocity.

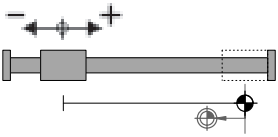
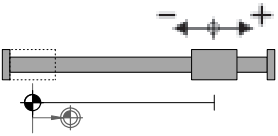
Note

Material damage due to moved dimensional reference system

The controller wrongly detects a stop if the actuator stops while homing, e.g.:

– In the event of greatly reduced dynamic values (low maximum motor current) combined with high travelling resistance (e.g. due to frictional grip)
– At excessively low values for (lower) force limit and damping time

- Adjust values so that the stop is reached.

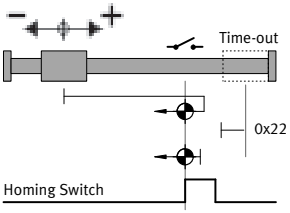
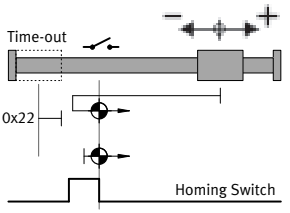
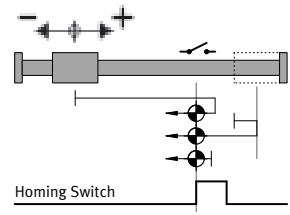
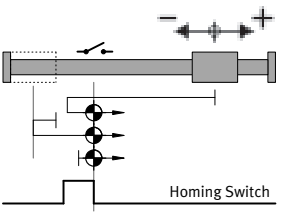
Homing to the stop	
Controlled operation	
1. Search of stop with search speed in the parameterised direction: – Stop missing (rotary axis): actuator continues infinitely. – Stop not recognised: controller in closed-loop operation against the stop, shuts down if temperature rises above its defined limit. 2. Stop detected: position is adopted as the homing point. 3. Travel to the axis zero point[1)]	
Direction: positive	Direction: negative
	

1) Homing option “Position to axis zero point” must be enabled. ➔ Tab. 2.26

Tab. 2.32 Homing method – homing to stop

Homing to reference switch (without index)

Requirement is for parameterisation of reference switch (NO, NC) ➔ FCT [...] [Axis] Axis Options. Homing without index evaluation is possible in open-loop as well as closed-loop operation. In open-loop operation, no stop can be detected. The actuator therefore must always be positioned before the start of a homing run so that it can find the switch in the parameterised direction.

Homing to reference switch[1)]	
Controlled operation	
1. Search for the reference switch with search speed in the parameterised direction. – Switch not found: termination after the parameterised time (Time-out)[2)] with error message 0x22 2. Reference switch found: position at crawling speed in opposite direction until the reference switch is disabled. This position is taken as the homing point.[3)]	
Direction: positive	Direction: negative
	
Controlled operation	
1. Search for the reference switch with search speed in the parameterised direction. – Switch not found: position to stop, search in opposite direction. – Switch not found in opposite direction: termination with error message 0x22. 2. Reference switch found: position at crawling speed in opposite direction until the reference switch is disabled. This position is taken as the homing point.[3)]	
Direction: positive	Direction: negative
	

1) If the reference switch is enabled when a homing run starts, step 2 is executed immediately

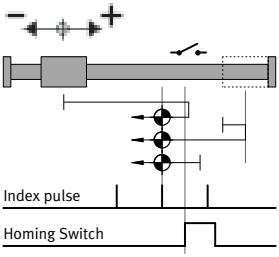
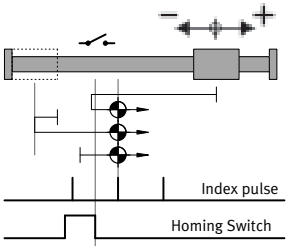
2) FCT [...] [Axis] [Homing] Settings: Timeout

3) Homing option "Position to axis zero point" ➔ Tab. 2.26

Tab. 2.33 Homing method – reference switch without index

Homing to reference switch (with index)

Requirement is for parameterisation of reference switch (NO, NC) ➔FCT [...] [Axis] Axis Options. Homing with index evaluation is only possible in closed-loop operation.

Homing to reference switch[1)]	
Controlled operation	
1. Search for the reference switch with search speed in the parameterised direction. – Switch not found: position to stop, search in opposite direction – Switch not found in opposite direction: termination (error message 0x22) 2. Reference switch found: – position at crawling speed in opposite direction until the reference switch is disabled 3. Continue until first index impulse from sensor – Index impulse not found: termination after a motor revolution (fault message 0x23) 4. Index impulse found: position is accepted as the homing point.[2)]	
Direction: positive	Direction: negative
	

1) If the reference switch is enabled when a homing run starts, step 2 is executed immediately

2) Homing option "Position to axis zero point"➔ Tab. 2.26

Tab. 2.34 Homing method – reference switch with index

The angle position of the encoder (index impulse) must be far enough from the reference switch. If the distance between the switching flank on the reference switch and the index impulse is small, temperature factors or mechanical clearance can move the reference point when the homing run is repeated by one index impulse, i.e. one motor revolution.

On positioning systems (OMS) with a reference switch, during assembly the angle position of the encoder is determined. Then the mechanism is installed at Festo in such a way that the index impulse is far enough away from the reference switch.

- Do **not** align factory-preinstalled reference switch mechanically.
- Do not alter the attachment position of the motor.

Aligning the reference switch:

- Check distance between switching flank and index impulse in the FCT ➔ FCT online tab Homing.
- Align reference switch until the switching flank is centred between two index pulses.

1 Position of the switching flank
2 Index pulse
3 Distance to the index pulse

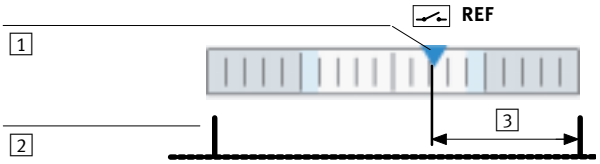


Fig. 2.3 Alignment of the reference switch during index evaluation

2.5.3 Jogging

When jogging the actuator moves continuously with the profile that can be parameterised by FCT in a negative or a positive direction.

Permits control of the actuator by jogging

– Approaching the teach positions during commissioning
– The positioning of the actuator after a unit malfunction
– Manual positioning as a normal operating mode (manually operated feed)

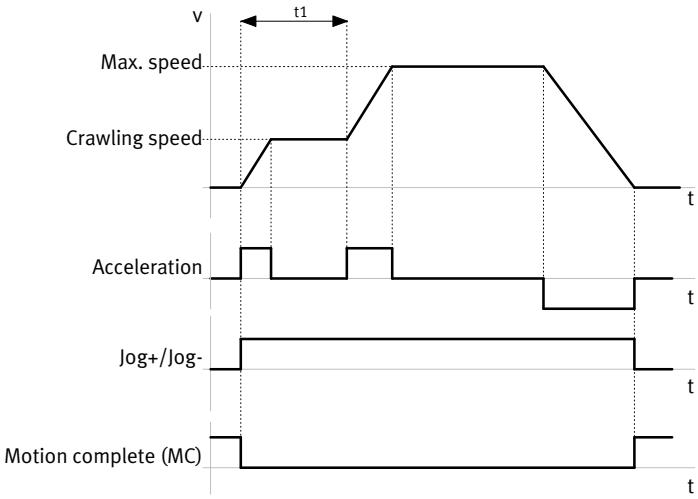
The actuator must be stationary when starting the jog mode. Homing is not required for jogging. The positioning range differs depending on the status of the referencing operation:

– Status = not referenced: positioning range between the stops
  The software limits are not monitored.
– Status = referenced: positioning range between the software end positions
  The actuator stops automatically when it reaches a software end position. Normally, the software end position is not passed because the deceleration path is taken into account.

If the parameterisation is OK, the actuator starts by moving slowly when jogged, then it moves faster (➔ Tab. 2.35):

– As the jog signal flank rises, the actuator moves at crawl speed in a positive (Jog+) or a negative direction (Jog-). That enables the actuator to be positioned more precisely.
– If the job signal continues after the end of the crawl period, the actuator continues at max (jog) speed. Bigger strokes can be completed more rapidly.
– As the flank of the jog signal declines, the actuator with the parameterised delay is brought to a standstill.

If both signals (Jog+/Jog-) are present at the same time, Jog- is preferred.



t1: Slow-moving time

Fig. 2.4 Parameter for influencing the track characteristics — example

Parameters	Description
Crawling speed (Crawling Velocity)	Setpoint value for the speed when starting a jog movement
Slow-moving time (Slow Moving Time)	Setpoint value for the slow-moving time
Max. speed (Maximum Velocity)	Maximum velocity at the end of slow-moving time
Acceleration (Acceleration)	Setpoint value for acceleration phases and the retardation phase
Max. permitted following error (Maximum Following Error)	Value for the permissible following error for jog movement
Damping time (Message Delay)	A fault is generated if the following error is present for longer than the time parameterised here.

Tab. 2.35 Parameter for influencing the track characteristics

Manual positioning in individual steps
With FCT the actuator can also be positioned in single steps. Homing is required for positioning in single steps. Increment and speed can be parameterised in FCT.
For more information: ➔ FCT PlugIn help, position manually

2.5.4 Teaching

Teaching can be used to adopt the current position of the actuator for the following parameter settings:

Parameter	Teaching by ...
Target position of the record currently selected[1)]	I/O interface, FCT, web server
Axis zero point	FCT
Position comparator limits	FCT
Project zero point	FCT
Software end positions	FCT

1) Record type “Positioning to absolute position”

Tab. 2.36 Teaching in positions

The drive must not stand still for teaching. However, even at low speeds, inaccuracies of several millimetres are possible, due to the usual cycle times of the motor controller and the higher-order controller. The speed must be set during teaching in such a way that the position is detected accurately enough.

The Teach process always runs in the following steps:

1. The parameter ➔ Tab. 2.36 is selected and/or addressed.
2. The actuator is moved into the desired position (e.g through jogging ➔ Section 2.5.3).
3. A teach command is triggered to adopt the current position.

Teaching with FCT or web server

The taught position is displayed after successful teaching in the software. Parameterisation in the controller becomes effective through download. Additional information:

– Teaching with web server ➔ Chapter 5.3.5
– Teaching with FCT ➔ PlugIn aid for FCT

Teaching via I/O interface (binary profile)

The number of teachable target positions is limited to 7 sets of commands. The Teach process is performed with a handshake process using signals TEACH/ ACK. The taught position is displayed in the controller immediately after successful teaching. The position is saved permanently using the “Automatic saving” option. If this option is not set, permanent saving via FCT or web server is possible. Other information ➔ Chapter 5.6.7

2.5.5 Stopping

Function	Description	Profile
Halt (STOP)	Aborting the current set of commands – The actuator is braked down to a stop using the retardation set of commands[1)] After braking to a standstill: – Open-loop operation: the drive is held at the position reached by the holding current setting. – Closed-loop operation: the actuator remains stationary and position-controlled at the position reached. Standstill monitoring is activated. – Motion complete is set.	Valve Binary
Pause (PAUSE)	Interruption to the current set of commands – The actuator is braked down to a stop using the retardation set of commands. After braking to a standstill: – Open-loop operation: the drive is held at the position reached by the holding current setting. – Closed-loop operation: the actuator remains stationary and position-controlled at the position reached. Standstill monitoring is activated. – Motion complete is **not** set. Continued – The order can be continued using the corresponding signal to the control interface. Delete remaining path: – The remaining path can be deleted using the corresponding signal to the control interface. – Motion complete is set.	Binary

1) Parameterisation of record retardation under FCT [...] [Axis] [Record Table]

Tab. 2.37 Stopping actuator

Quick Stop by removal of controller enable

Through removal of controller enable, the current actuator function can be terminated. After braking to a stop with the parameterised Quick-Stop retardation function, the closed-loop controller is blocked. The actuator is not controlled after this.

2.5.6 Actuating the holding brake

The integrated holding brake on the motor holds the actuator in its current position after lifting of the controller inhibit. The holding brake is not suitable for braking the motor or the moved masses.

Note

Controlling motors with an integrated holding brake.

When the output stage is switched off during a movement or whenever the power supply is interrupted, there is no deceleration of the actuator via a braking ramp. The holding brake is closed immediately.

- Check whether the integrated holding brake can stop the actuators.
- Note the mechanical inertia of the holding brake.
- Take into consideration the higher wear of the holding brake in comparison to automatic brake control in normal operation.

Automatic activation for a holding brake

The motor controller automatically controls the holding brake via the controller enable function:

– The holding brake is opened as soon as the closed-loop controller has been released.
– The holding brake is closed before the controller is blocked.

Controller enable:	Open-loop control via output X6.5 (BR+/BR-)
CONTROL ENABLE 0➔1	Open holding brake
CONTROL ENABLE 1➔0	Close holding brake

Tab. 2.38 Automatic brake control

The mechanical inertia of the holding brake means that it takes a certain length of time to open and close it. The behaviour of the motor controller during control enable is adapted to the mechanical inertia of the holding brake by the following parameters:

Parameters	Description
Switch-on delay	No orders are processed until the switch-on delay has elapsed. That keeps the actuator at a standstill (setpoint speed=0). The engagement delay must be set in such a way that the holding brake finishes up completely open. After the engagement delay has elapsed, the motor controller is ready for operation (READY) and orders are accepted.
Switch-off delay	The actuator is maintained in its current position by the closed-loop controller until the end of the switch-off delay in its current position, which enables the holding brake to reach its full holding torque level. After that, the controller is disabled. The switch-on delay must be set in such a way that the holding brake finishes up completely closed.

Tab. 2.39 Parameterisation of the holding brake ➔ FCT [...] [Motor], Brake control

Opening the holding brake

Caution

Violation through movement of the actuator while opening the holding brake. During installation of the actuator in an inclined or vertical position: falling loads!

- Prevent unauthorised access.
- Inform operating and maintenance staff about any potential hazards.
- Secure loads before disabling the holding brake.

When the closed-loop controller is blocked, the holding brake can be opened

– Via I/O interface [X1.9] DIN BRAKE CONTROL = 1
– With FCT (“Project output” window, device control: disable “Brake”)

After opening the holding brake, the actuator can be moved manually.

2.5.7 Positioning mode

Positioning mode makes it possible to position to a specified target position (point-to-point positioning), with the option of reduced torque.

Variants	Description
Absolute	Position, referenced to the axis zero point
Relative to the setpoint position	Distance referenced to the last setpoint position
Relative to the actual position	Distance referenced to the current position (actual position)

Tab. 2.40 Order variants in positioning mode

For certain applications (e.g. axis of rotation) an endless mode can be parameterised to enable the actuator (for example) always only to move in the positive direction. The software limit stops must be disabled for this.

Course of path

The controller computes a new path course from the parameterisation of the command to activate the motor. The calculated path track remains unchanged until the end of the order. While carrying out an order, the deviation between setpoint position based on path characteristics and the actual position should be calculated and monitored (➔ Chapter 2.7.1, following error).

Parameters	Description
Position	Target specification (variants ➔ Tab. 2.40)
Velocity	Maximum value for velocity (speed)
Acceleration	Maximum value for acceleration
Retardation[1)] (deceleration)	Maximum value for deceleration
Jerk acceleration (jerk in acceleration)	Acceleration change at start and end of the acceleration phase. Lower values result in gentler movement. The value “0” means that no reverse limiting is enabled.
Jerk in deceleration[1)] (jerk in deceleration)	Change in acceleration at the start and end of the deceleration phase. Lower values cause gentler braking action. The value “0” means that no reverse limiting is enabled.
Final speed[2)]	Final speed of the order (standard = 0)

1) Separately adjustable in FCT if the asymmetric ramp generator has been enabled. Otherwise identical to acceleration.

2) Parameterisation for record linking (binary profile)

Tab. 2.41 Parameter for influencing the track characteristics

Target recognition

The characteristics when the target position are reached depends on the final speed. When carrying out single orders (without record linking) the final speed = 0.

With record linking a final speed › 0 can be parameterised in positioning mode for the order. The current record ends at the target position with the defined final velocity. The actuator can thus start a subsequent record with this velocity without coming to a standstill ➔ Tab. 2.54

Target recognition	Behaviour after target recognition:
The actual position is in the target window for the parameterised damping time.	The “Motion Complete” signal is set. Open-loop operation: the actuator remains at the target position and is maintained in position with the predefined holding current. Closed-loop operation: the actuator remains stationary and position-controlled at the target position.

Tab. 2.42 Target recognition in positioning mode

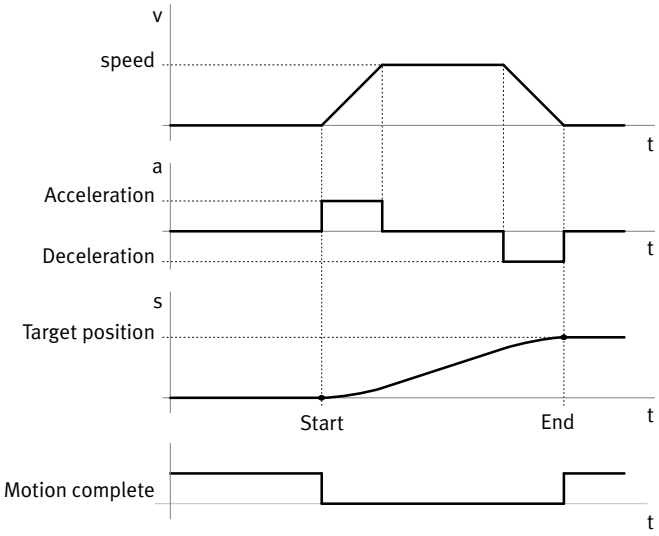


Fig. 2.5 Positioning order – example: start speed and setpoint final speed 0 mm/s, without reverse limiting

2.5.8 Velocity mode

The velocity mode enables a distance to be travelled at a constant rotational speed, with the option of stroke limitation. Stroke is defined as the absolute difference between the actual position and the position at the start of the order. Stroke limitation determines the maximum permitted distance for the order, relative to the starting position.

Variants	Description
Without stroke limitation	Travel over an unlimited distance, e.g. for rotary actuators
With stroke limitation	Covers a limited distance relative to the start position

Tab. 2.43 Order variants in velocity mode

Course of path

Before carrying out the order, the controller computes a new path course from the parameterisation of the command to activate the motor. The calculated path track remains unchanged until the end of the order. While carrying out an order, the deviation between setpoint speed (based on path characteristics) and the actual speed should be calculated and monitored. (➔ Chapter 2.7.1, following error).

Parameters	Description
Velocity	Target specification for the speed
Acceleration	Maximum value for acceleration
Retardation (deceleration)[1)]	Maximum value for retardation (deceleration)
Jerk acceleration (jerk in acceleration)	Acceleration change at start and end of the acceleration phase. Lower values result in gentler movement. The value “0” means that no reverse limiting is enabled.
Jerk Deceleration (jerk in deceleration)[1)]	Change in acceleration at the start and end of the deceleration phase. Lower values cause gentler braking action. The value “0” means that no reverse limiting is enabled.

1) Separately adjustable in FCT if the asymmetric ramp generator has been enabled. Otherwise identical to acceleration.

Tab. 2.44 Parameter for influencing the track characteristics

Target recognition

The characteristics when the target position are reached (target recognition) depends on the stroke limitation.

Target recognition	Behaviour after target recognition:
... without stroke limitation	
Speed is reached, i.e. the actual speed is inside the target speed window for the duration of the damping time.	The “Motion Complete” signal is set. The actuator continues to move at target speed. Monitoring of the speed deviation remains active. Force remains at the maximum value specified in the speed record.
... With stroke limitation	
– Stroke limitation is reached first	The “Stroke limitation” signal is set. The actuator is braked down to a stop using the parameterised Quick-Stop deceleration function. Although the target speed has not yet been reached, the Motion Complete signal was set (➔ Fig. 2.6 and Fig. 2.7) Open-loop operation: the actuator remains at the target position and is maintained in position with the predefined holding current. Closed-loop operation: the actuator remains position-controlled.
– Speed is reached first, i.e. the actual speed is inside the target speed window for the duration of the damping time.	The “Motion Complete” signal is set. The actuator continues to move at target speed in closed-loop operation. Monitoring of the speed deviation remains active; force remains limited to the maximum stated in the order; stroke limitation remains enabled.

Tab. 2.45 Target recognition in velocity mode

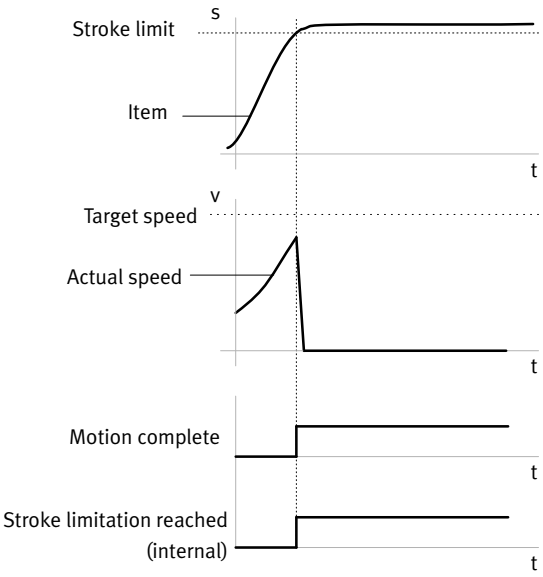


Fig. 2.6 Stroke limitation reached before target speed - example

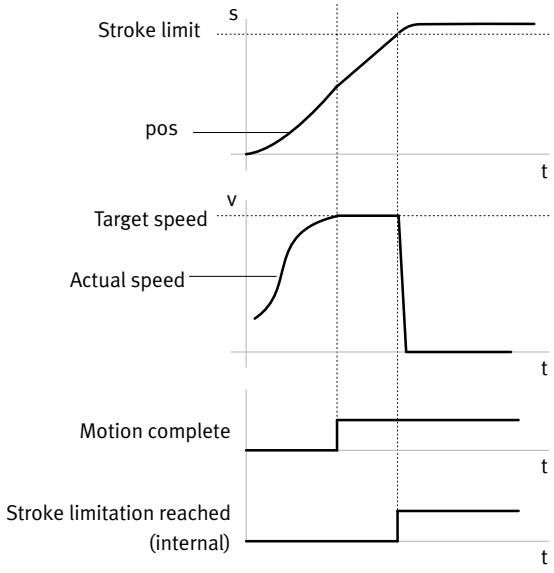


Fig. 2.7 Stroke limitation reached after target speed - example

2.5.9 Force mode

Force mode makes it possible to apply constant power, with the option of stroke limitation. The function requires close-loop control operation (motor with encoder). Stroke is defined as the absolute difference between the actual position and the position at the start of the order. Stroke limitation determines the maximum permitted stroke, relative to the starting position.

Variants	Description
Without stroke limitation	Travel over an unlimited distance
With stroke limitation	Covers a limited distance relative to the start position

Tab. 2.46 Order variants in power mode

Force is controlled by closed-loop control of motor current. Depending on the mechanism of the actuator, a torque level or a linear force can be determined from the level of current measured. The target specification is based on a percentage basis on the nominal motor current. The actual force at the axis must be checked during commissioning using external measurement devices, and parameterisation should be adapted as required.

Parameters	Description
Force (Force)	Target specification for force (% related to nominal motor current)
Speed (Velocity)	Setpoint value for speed (velocity)

Tab. 2.47 Parameters in force mode

Target recognition

The characteristics when the target position are reached (target recognition) depends on the stroke limitation.

Target recognition	Behaviour after target recognition:
... without stroke limitation	
Force is reached i.e. the actual motor current is located in the time window the defined damping time.	The “Motion Complete” signal is set. As long as no other actuator function is executed, the actuator will continue to be controlled by the setpoint force. The speed is limited to the maximum value specified in the order.
... With stroke limitation	
– Stroke limitation is reached	The “Stroke limitation” signal is set. The actuator is braked down to a stop using the parameterised Quick-Stop deceleration function. The actuator remains position-controlled at the stroke limit. Stationary monitoring is enabled and the “Motion Complete” signal is set.
– Force is reached i.e. the actual motor current is located in the time window the defined damping time.	The “Motion Complete” signal is set. As long as no other actuator function is executed, the actuator will continue to be controlled by the target force. The speed remains limited to the maximum value specified in the order. Stroke limitation remains active.

Tab. 2.48 Target recognition in force mode

2.6 Operational principle for record selection

2.6.1 Command records

Orders will be saved in CMMO-ST as parameterised sets of commands. Parameterisation of records is performed via web server (valve profile) or FCT (valve/binary profile).
Every set contains the required parameters for order processing in accordance with the stipulated type of record. To address an order, the controlling PLC only needs to transfer the record number to the output data (record selection).

Parameters	Description	Valve profile	Binary profile
Record number	Number for addressing and executing parameterised records	7 sets	31 sets
Record type	Positioning mode – Absolute positioning (PA) – Relative positioning to the last target position (PRN) – Relative positioning to the actual position (PRA)	PA, PRN, PRA	PA, PRN, PRA
	Profile Velocity Mode – With stroke limitation (VSL) – Without stroke limitation (V)	–	VSL,V
	Force mode – With stroke limitation (FSL) – Without stroke limitation (F)	–	FSL, F

Tab. 2.49 Record parameter (record number, record type)

Record selection via I/O interface

When activating via the I/O interface, the execution of a record differs depending on the open-loop control profile

– Valve profile: the record is executed directly when the record number is addressed.
– Binary profile: the record is executed after addressing the record number with the next START signal.

Record selection via Ethernet interface

Via the Ethernet interface, records can also be started from a PC program. For this, in-depth knowledge of programming TCP/IP applications is required (➔ Appendix B.1, Control via Ethernet [CVE])

Record selection with FCT

Single records can be started from the record table for test purposes. Also, records can be compiled in any order and executed as a sequence (test cycle).

Other record parameters

Parameters	Description
Controller parameters (basic data)	
Objective (Target) Velocity Acceleration/delay	Parameterisation depends on the operating mode – Positioning mode ➔ Section 2.5.7 – Velocity mode ➔ Section 2.5.8 – Force mode ➔ Section 2.5.9
Additional load (Extra Load)	Payload transported in addition to the basic load
Torque feed forward (Torque Feed Forward)	– for greater dynamics with large masses – increases the motor current during acceleration and deceleration by the pre-defined percentage value. The nominal current is not exceeded. – Value must be determined experimentally.
Sequence control	
Start Condition (Start Condition)	A start condition can be defined for every record (e.g. with FCT). The start condition status how the record should respond to a start signal if the current order is not yet completed (➔ Tab. 2.51, record switching)
Condition Start Delay MC visible Final velocity (Final Velocity) Following Set	Several records in the record table can be linked with one another. These are executed directly after one another using a start signal if the applicable conditions for onward switching are satisfied (➔ Tab. 2.52, record linking)
Comparators	
Force comparator (Force Comparator) Position comparator (Position Comparator) Velocity Comparator Time Comparator Time Comparator	Specification of a tolerance window with trigger levels and applicable damping times (➔ Section 2.7.2)
Limitations	
Force compensation (Force Limit/ Torque Limit)	Maximum permitted force or permitte torque when executing the order in positioning or velocity mode
Stroke limit (Stroke limit)	Maximum permitted distance for execution of the order
Max. Following Error (Max. Following Error)	Control deviation in positioning or velocity mode at which the message “following error” is issued

Tab. 2.50 Record parameter

2.6.2 Record switching

Record switching enables flexible switching between sets of commands. For each record saved it is possible to define how the actuator should behave if this record is started while, at the same time, a different record is being executed.

Start Condition[1)]	Description	Profile
Ignore (Ignore)	While the order is being executed, the start signal is ignored. The current order is completed. The order can only be restarted with another start signal once Motion Complete is enabled (standard).	Binary
Waiting (Delay)	The current order is completed. The subsequent order addressed by the last start signal is executed once the current order has been completed (after Motion Complete).	Binary
Interrupt (Interrupt)	The current task is interrupted immediately and the newly addressed task is executed directly.	Valve Binary

1) With binary professional, can be parameterised using ➔ FCT [...] [Controller] [Record Table] Basic Data

Tab. 2.51 Parameter “Start condition” for record switching

Example: “ignore” start condition

The start signal (here for record B) is ignored. The current order (here record A) is completed.

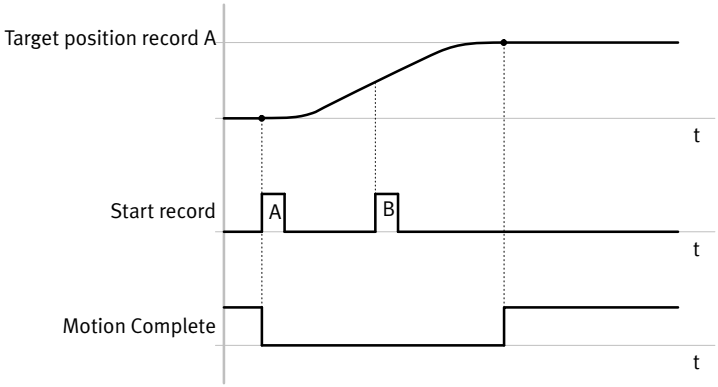


Fig. 2.8 “Ignore” start condition

Example: start condition “Waiting”

Initially, the start signals (here for records B and C) are ignored. The current order (here record A) is completed. Then the last order (here record C) is executed without another start signal.

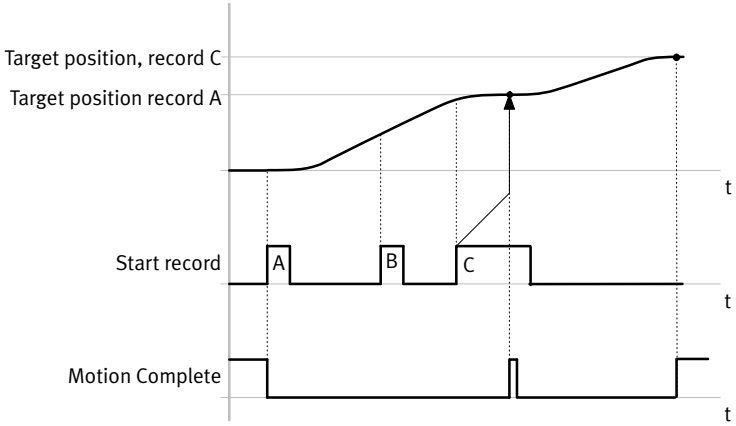


Fig. 2.9 Start condition “Waiting”

Example: start condition “Interrupt”

The current task (here record A) is interrupted immediately and the newly addressed task (here record B) is executed directly.

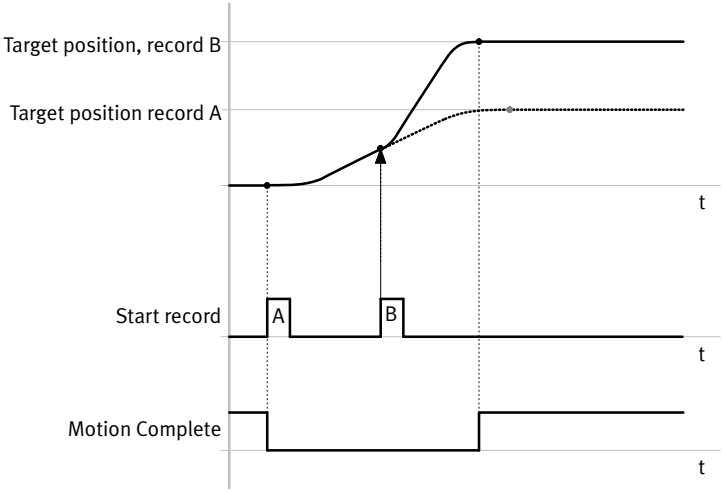


Fig. 2.10 Start condition “Interrupt”

2.6.3 Record linking

With record linking in binary profile, sets of commands are executed in a specified sequence. In every record, the number of the next record to be executed is parameterised. As soon as the step enabling condition is satisfied, the specified subsequent record is started. A record sequence is executed with the start of a record in the sequence without any further start command, up to the last record in the sequence. Record linking can be used to implement complex movement sequences, e.g.:

– Running a speed profile
– Positioning and clamping in a motion sequence
– Executing a force profile for pressing procedures.

The linking sequence can be influenced by the following parameters:

Parameters	Description
Condition (Condition)	Indicates when the subsequent record should be started (step enabling) ➔ Tab. 2.53
Start Delay	Waiting time that expires before the record is started from a record chaining.
MC visible (MC visible)	Indicates whether the “Motion Complete” signal should occur between the individual records of a record sequence.
Final Velocity	Final speed at which the record should be completed at the target position. The final velocity must be less than or equal to the parameterised maximum speed of the order.
Following Set (Following Set)	Number of the record that should be started automatically when the condition is reached

Tab. 2.52 Parameters for influencing the track characteristics

A comparator, by way of example, can be used as a condition. The following conditions are possible:

Condition	The following record is started if ...
Motion Complete	... the signal “Motion Complete” is enabled
Position comparator active	... the current position is in the position window
Speed comparator active	... the speed is within the defined velocity window
Force comparator active	... the force is within the force/torque window
Time comparator active	... the length of time for which order processing is in the time window

Tab. 2.53 Step enabling conditions

Target recognition

The characteristics when the target position (target recognition) are reached depends on the final speed.

Target recognition	Behaviour after target recognition:
End speed = 0	
The actual position is in the target window for the parameterised damping time.	– Open-loop operation: the actuator remains at the target position and is maintained in position with the predefined holding current until the subsequent record starts. – Closed-loop operation: the actuator stops at the target position in response to position control until the next record starts
End velocity ≠ 0 (with record sequencing)	
The actual position matches the target position, or has exceeded it.	– Open-loop operation: the actuator continues in open-loop control mode at the final velocity of the positioning order (without monitoring of the deviation). The force continues to be limited to the maximum value defined in the order. A subsequent order can start without the actuator being at a standstill. – Closed-loop operation: the actuator continues in a speed-controller manner at the final velocity of the positioning order (without monitoring of the deviation). The force continues to be limited to the maximum value defined in the order. A subsequent order can start without the actuator being at a standstill.

Tab. 2.54 Target recognition (message “Motion Complete”) in positioning mode

Example: record linking with final velocity ≠ 0 (positioning mode)

The following diagram shows the effect of the parameter “Final velocity” on record sequencing. Final and setpoint velocity for record A share the same value. Record B is started without start delay when record A reaches setpoint position.

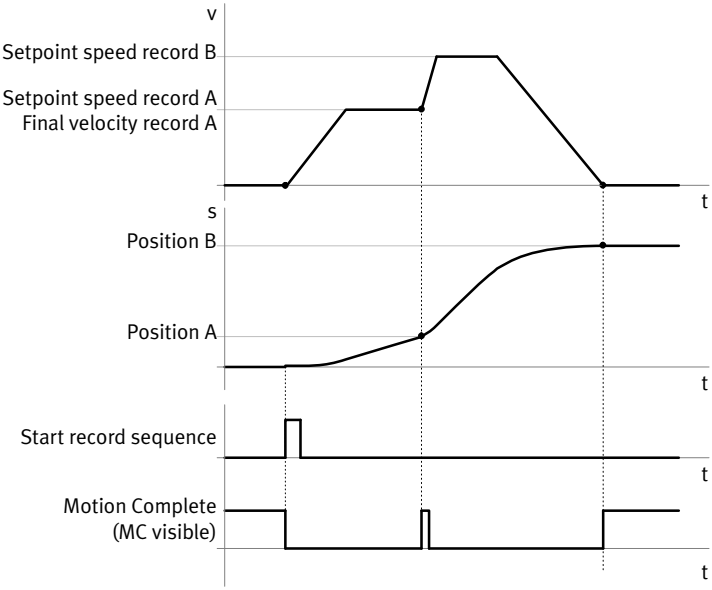


Fig. 2.11 Subsequent record with final velocity v ≠ 0

2.7 Monitoring of the actuator behaviour

The actuator characteristics can be monitored and controlled by messages and comparators. Furthermore, the motor controller has internal protection functions, e.g. to protect internal components from damage in the event of operator error.

2.7.1 Dispatches

Messages become enabled if the target value is within a tolerance window for a defined period of time. Messages can be output by means of configurable, digital outputs.

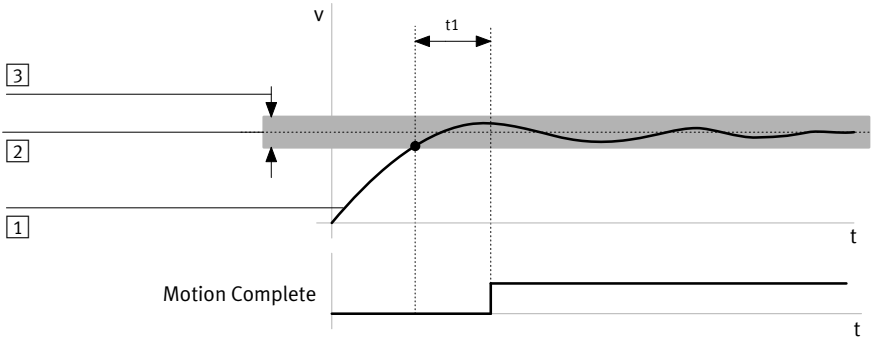
Message	Brief description	Profile
Motion Complete (target recognition)	... signals the end of an order that was started by record selection.	Valve Binary
Monitoring of following errors ($2F_h$)	... monitors the closed-loop control characteristics while an order is in positioning and velocity mode (➔ Fig. 2.13)	Binary
Standstill monitoring (37_h)[1)]	... in closed-loop operation, monitors the characteristics after Motion Complete, Stop or Pause (➔ Fig. 2.14)	Binary

1) The error management functionality of FCT makes it possible to parameterise the response to this message (➔ FCT error management).

Tab. 2.55 Dispatches

“Motion Complete” message

“Motion Complete” signals the end of an order. A window is defined for each order type (position, velocity or force mode). As soon as the actual value of the target parameter is in the time window for the duration of the parameterised damping time, the Motion Complete message (order ended) is triggered.



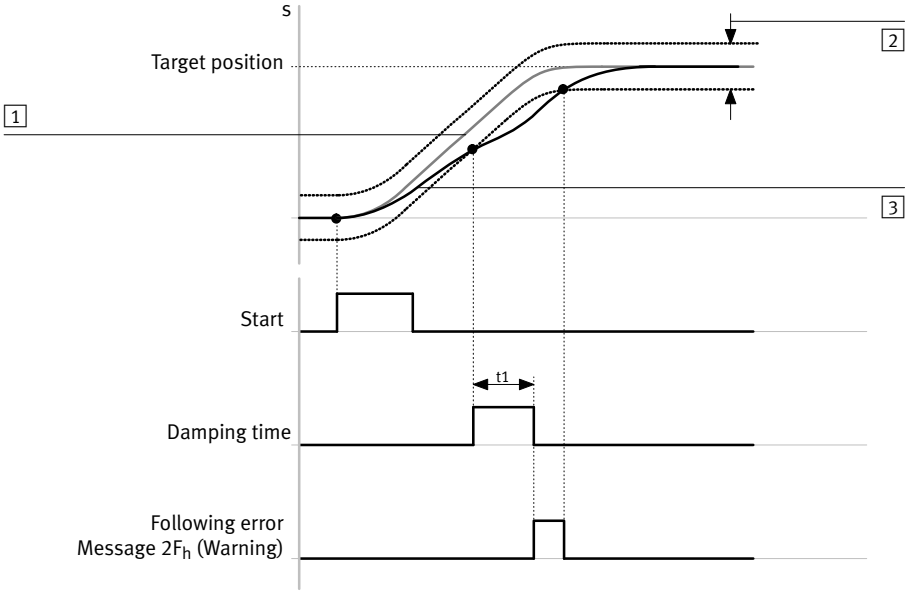
t1: Damping time, Motion Complete

1 Actual speed
2 Setpoint speed
3 Time window, Motion Complete

Fig. 2.12 Motion Complete – example of velocity mode

“Following error” message

With positioning and velocity modes, any exceeding of the max. permitted following error can be monitored, e.g. in the event of impaired ease of movement or overloading of the actuator.
From the parameters of an order, before it is executed, a theoretical set of characteristics is calculated (➔ Fig. 2.13, 1). While carrying out an order, the variance between the calculated setpoint and the current actual value is monitored. The permitted difference (max. permitted following error) is defined by means of parameterisation. The message is enabled if the difference between the setpoint and actual value of the current variable (displacement, velocity), the time parameterised here lies outside the permitted difference.



t1: Damping time for following error

1 Nominal positioning characteristics
2 Max. Following Error
3 Actual positioning characteristics

Fig. 2.13 Timing diagram: message “Following error” - example, positioning control, warning

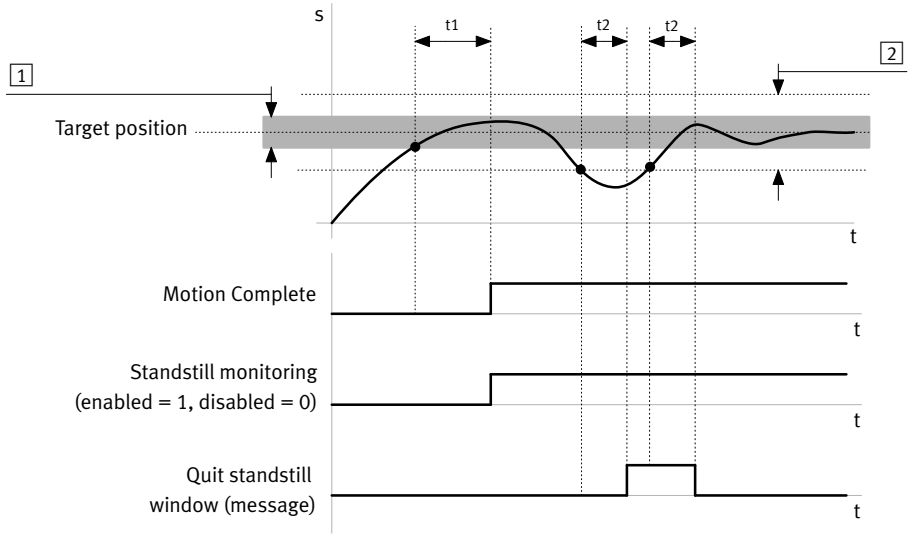
The error management functionality of FCT makes it possible to parameterise the response to this message ($2F_h$) (➔ FCT error management). If the following error was configured as a warning, the message is deleted automatically once the actual value once again lies inside the following error window.

“Standstill monitoring” message

The standstill monitoring function checks in positioning mode if the actuator is within the standstill window of the target position for the duration of the damping time (➔ Fig. 2.14).

After reaching the target position (“Motion Complete”) the standstill monitoring function is enabled. If the actuator is moved during active standstill monitoring, e.g. by external forces for the duration of the standstill window, the following response occurs:

– The motor controller issues the diagnostic message “Actual position lies outside the standstill window”.
  (enabled = 1: Axis has left the standstill window; disabled = 0: Axis in standstill window).
– The position controller attempts to return the actuator to the standstill window.



t1: Damping time, Motion Complete
t2: Damping time, standstill monitoring
1 Positioning Window
2 Standstill window

Fig. 2.14 Standstill monitoring - example

The standstill monitoring cannot be switched on or off. It is disabled when the standstill window is set to the value “0”.

The error management functionality of FCT makes it possible to parameterise the response to this message ($37F_h$) (➔ FCT error management).

2.7.2 Comparators

Comparators are used to check if a value lies within a defined range of values (window). The comparator is used

– to control sequences of records (➔ Chapter 2.7.2, record sequencing)
– for the message on a digital output (➔ Chapter 5.6.1)

The window is defined by a lower and an upper limit value. If the monitored value is within this window, the related comparator message is enabled. If a time can be indicated for the comparator, the monitored value must be within this window for the stipulated length of time. The message is inactive outside this window.

No plausibility check takes place: if the lower limit value is greater than the upper limit value, the comparator message is never enabled
Limits are stated for negative value ranges preceded by an algebraic symbol. That algebraic symbol indicates the direction. Example “Position comparator”:
-50 mm (= minimum) ≤ actual position ≤ -40 mm (= maximum).

Parameters[1)]	Description
Minimum (Min.)	Lower limit of the window
Maximum (Max.)	Upper limit of the window
Time[2)]	Minimum dwell time within the window

1) Parameterisation takes place via FCT [...] [Controller] [Record Table] Record Messages
2) Time parameter for the comparators position, velocity, force

Tab. 2.56 Parameter for the comparator

Comparator	Parameter	Description	Profile
Time	– Min. – Max.	The message is enabled if the elapsed time since the start of the order lies within the window.	Binary
Item	– ±Min. – ±Max. – Time	The limit values must lie within the permissible range between the software end positions. Even the relative position limits are always specified in absolute values (reference to the zero point). The message is enabled if the actual value for the parameterised time lies within the window.	Binary Valve
speed	– ±Min. – ±Max. – Time	The message is enabled if the actual value for the parameterised time lies within the window.	Binary
Force[1)]	– ±Min. – ±Max. – Time	The limits are stated between -100 % and + 100 %, referenced to the nominal current of the motor. The message is enabled if the actual value for the parameterised time lies within the window.	Binary

1) Only present in closed-loop operation.

Tab. 2.57 Comparators

2.7.3 Protective functions

The motor controller has an array of sensors that monitor the function of the control section, power section and the motor.

A few protective functions cause the control section to shut down the output stage (power section). The power section cannot be switched back on until the error has been eliminated and then acknowledged (➔ Chapter 6.3)

Monitoring	Fault number[1)]	Description
Software limit	11_h, 12_h, 29_h, $2A_h$	Exceeding of the software end positions (➔ Chapter 2.5.1)
I^2t (motor current)	$2D_h$, $0E_h$	If the maximum value of the current²-time-integral of the closed-loop controller is exceeded, a message is issued. Current is limited to the nominal current to protect the motor from overheating.
Logic voltage	17_h, 18_h	Undervoltages and overvoltages
Intermediate circuit voltage	$1A_h$, $1B_h$	
Output stage temperature	15_h, 16_h, 33_h	The output stage temperature is measured with a temperature sensor. The output stage temperature and CPU temperature are monitored cyclically. If the temperature drops below or rises above a limit value, an error message is triggered

1) The response to the malfunction can be parameterised ➔ FCT [...] [Controller] [Error Management].

Tab. 2.58 Protective functions

3 Mounting

Caution
Unexpected and unintended movement of the drive during mounting, installation and maintenance work
- Before starting work: Switch off power supplies.
- Secure the power supplies against accidental reactivation.

Note
Damage to the product from incorrect handling
- Never remove or insert interconnecting cables when the motor controller is powered.
- Observe the handling specifications for electrostatically sensitive devices.

3.1 Installation dimensions

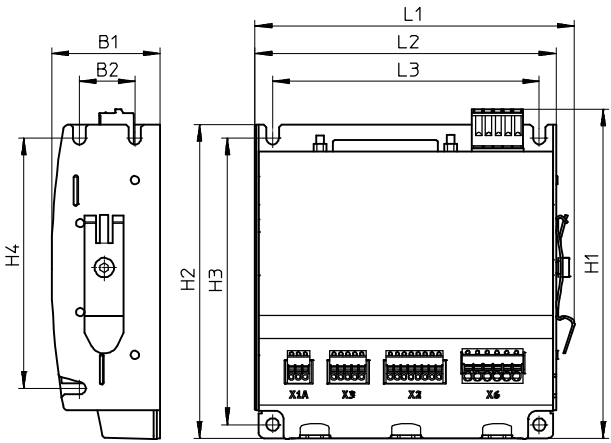


Fig. 3.1 Installation dimensions

Dimension	B1	B2	H1	H2	H3	H4	L1	L2	L3
[mm]	39	20	118.7	113	103.1	90	115	108.8	96

Tab. 3.1 Installation dimensions

3.2 Mounting on an H-rail

1. Mount an H-rail (mounting rail in accordance with IEC/EN 60715: TH 35–7.5 or TH 35–15).
2. If not pre-installed: Screw the H-rail clip to the side of the control ➔ Fig. 3.2 [1]
   - Use original screw.
   - When using another screw: Please observe screw-in depth (max. 5 mm).
3. Attach motor controller from above to hook on bracket.
4. Press motor controller against the H-rail until the bracket engages.
5. When installing several controllers, maintain the specified minimum distance.

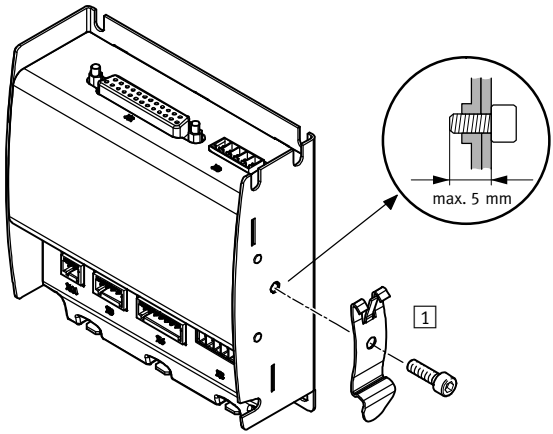
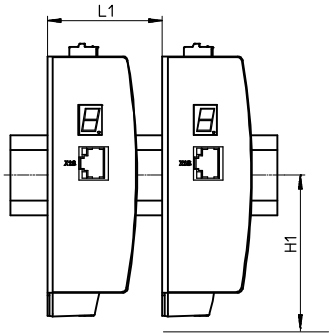


Fig. 3.2 H-rail installation



Dimension	L1	H1
[mm]	41	61.35

Tab. 3.2 Minimum distance of motor controller during H-rail installation

3.3 Mounting on a mounting plate

If an H-rail clip is mounted:

- , you can remove it.

Upright installation

For upright installation, 3 recesses are provided on the mounting surface ➔ Fig. 3.3 2.

- Bolt device into place using 3 x M4 screws.
- If necessary, use washers / spring washers.

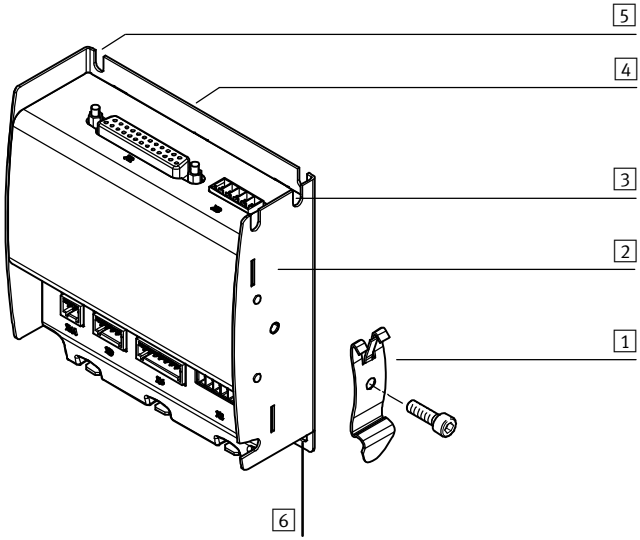
When replacing the controller

- Unfasten 3 x M4 screws a few turns.
- Swivel out the controller.

Horizontal assembly

For horizontal installation, there are 2 recesses and 2 bores on the mounting surface ➔ Fig. 3.3 4

- Bolt device into place using 4 x M4 screws.
- If necessary, use washers / spring washers.



1 Remove the H-rail clip
2 Mounting surface
3 Recesses (3x)
4 Mounting surface
5 Recesses (2x)
6 Bores (2x)

Fig. 3.3 Mounting on an even surface

4 Electrical installation

Caution
Unexpected and unintended movement of the drive during mounting, installation and maintenance work
- Before starting work: Switch off power supplies. Cancelling the enable signal on the controller is not sufficient.
- Secure the power supplies against accidental reactivation.

4.1 EMC-compliant wiring

Note
Interference caused by electromagnetic factors
To ensure electromagnetic compatibility in accordance with the EMC directives:
- Connect the metal sub-base of the CMMO-ST to the earth potential with low impedance (short cable with large cross section). ➔ Chapter 4.2

Recommendation for the routing of cables:
– Do not run signal cables parallel to power cables.
– Minimum distance of signal cables to power cables is 25 m.
– Avoided crossing power cables or running them at a 90° angle.
– Note permitted cable lengths (max. length 30 m)
– On shielded lines with unshielded connector housings. Make the length of the unshielded cores at the end of the cable as short as possible.

4.2 Functional earth FE

The lower base plate of the motor controller acts as a functional earth (➔ Fig. 4.1, 8). The connection is designed as a flat connector. The base plate is galvanically isolated from the power supply.
Connection to earth potential
– Shortest possible earth conductor
– braided cable, alternatively: cable with min. cross section of 2.5 ... 4 mm²
Depending on the installation situation, a different cable may be required.

Functional earth connection		Size		Counterplug
FE	Flat pin	mm	6.3 x 0.8	Flat connector sleeve

Tab. 4.1 Functional earth connection

4.3 Connections and cables

Caution
Unexpected and unintended movement of the actuator as a result of incorrectly assembled cables
- Only use the plug connectors provided and preferably the cables listed in the specified accessories (➔ Chapter 2.2.3).
- Observe the tightening torques in the documentation of the cables and plugs used.
- Lay all flexible cables so that they are free of kinks and mechanical stress; if necessary in a drag chain. Observe the instructions for the axis and the additional components.

ESD protection
At unassigned plug connectors, there is the danger that damage may occur to the device or to other system parts as a result of ESD (electrostatic discharge).
- Observe the handling specifications for electrostatically sensitive devices.
- Seal unassigned plug connectors with protective caps.
- Earth system parts prior to installation.
- Use appropriate ESD equipment (e.g. shoes, earthing straps, etc.).

Note
When mounting the controller outside the control cabinet:
- Observe the IP protection class of the controller and the connectors/cables.
- Seal unassigned plug connectors with protective caps.

1 [X9] Power supply
2 [X1] I/O (SPC/IPC)
3 [X18] Ethernet
4 [X1A] Reference switch
5 [X3] STO
6 [X2] Encoder
7 [X6] Motor
8 FE function earth (3x)

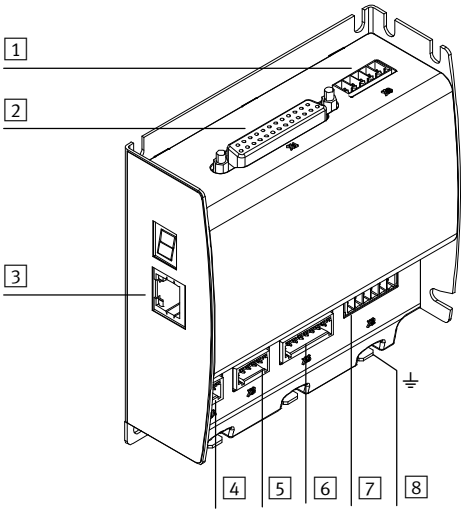


Fig. 4.1 Ports

The following connections are designed as terminal strips (connectors). The connectors are included in the scope of delivery (connector assortment NEKM-C-10).

Connection		Grid [mm]	Wire cross-section [mm²]	Stripping the cable [mm]	Plug version
[X1A]	3-pin	2.5	0.081 … 0.518	7 … 8	CAGE-AWG20-28
[X2]	8-pin	2.5	0.081 … 0.518	7 … 8	CAGE-AWG20-28
[X3]	5-pin	2.5	0.081 … 0.518	7 … 8	CAGE-AWG20-28
[X6]	6-pin	3.5	0.081 … 1.31	8 … 9	CAGE-AWG16-28
[X9]	5-pin	3.5	0.081 … 1.31	8 … 9	CAGE-AWG16-28

Tab. 4.2 Overview of connectors (accessories)

Connection		Cable length [m]	Cable version
[X1]	I/O	≤ 30	unshielded[1)]
[X1A]	Homing Switch	≤ 30	unshielded[1)]
[X2]	Encoder	≤ 10	Screened[1)]
[X3]	STO	≤ 30	Screened[2)]
[X6]	motor	≤ 10	Screened[1)]
[X9]	Power supply	≤ 30	unshielded[2)]
[X18]	Ethernet	≤ 30	Screened[3)]

1) This cable is available as an accessory ➔ www.festo.com/catalogue.

2) The cable must be packaged by the customer.

3) Standard network cable. Applicable for the fieldbus length are the specifications for Ethernet networks according to ANSI/TIA/EIA-568-B.1.

Tab. 4.3 Cable version

4.3.1 [X1] I/O interface

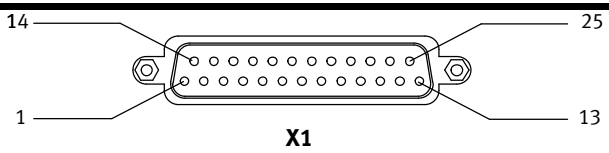
Communication with the higher-order controller (PLC/IPC) occurs via the I/O interface.

The switching logic of the inputs and outputs is dependent on the interface variant of the controller:

– Type CMMO-...-DIOP = positive logic PNP (➔ Fig. 4.2)
– Type CMMO-...-DION = negative logic NPN (➔ Fig. 4.3)

The routing of inputs/outputs depends on the control unit profile employed (binary, valve). Description of the control unit profiles ➔ Chapter 5.5 and Chapter 5.6

Connection



X1

Pin	1	2	...	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Digital inputs (DIN)				Digital outputs (DOUT)											–	LOGIC Out	GND
	01	02	...	11	01	02	03	04	05	06	07	08	09	10	11	–	+24 V	0 V

Tab. 4.4 Connection [X1]

Note

Damage to the device in the event of an overload / short circuit

The auxiliary supply to Pin 24 (+24 V Out) is not overload-proof ($I_{max.}$ = 100 mA)

- Only use auxiliary power supply for switching the digital inputs.

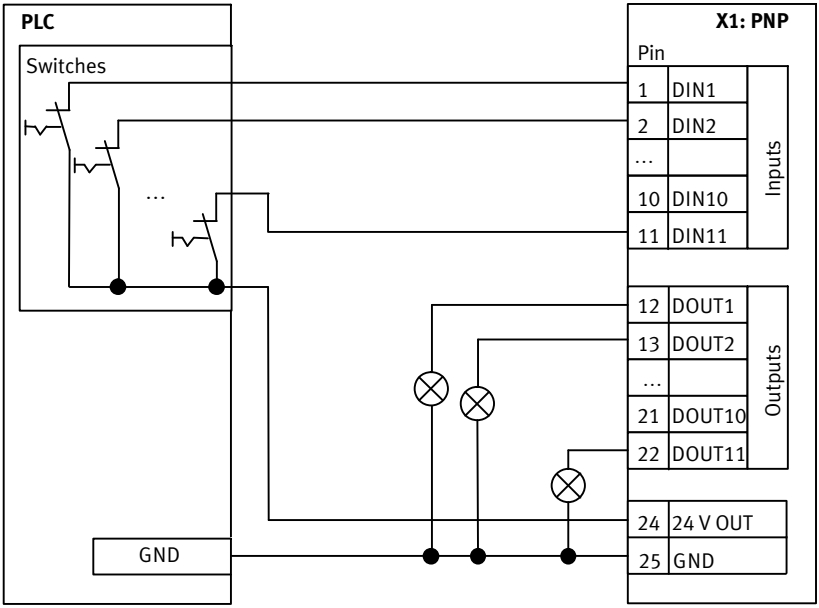


Fig. 4.2 Connection of interface variant PNP (CMMO-...DIOP)

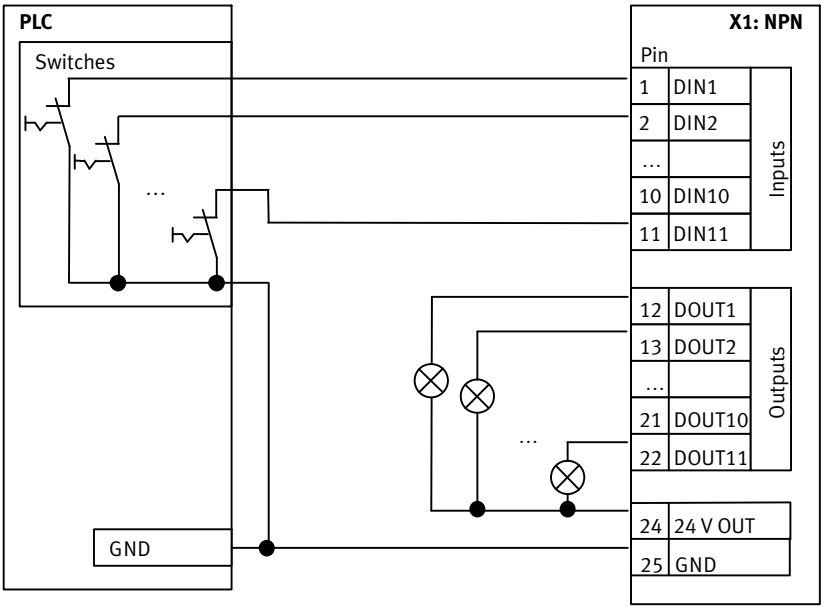
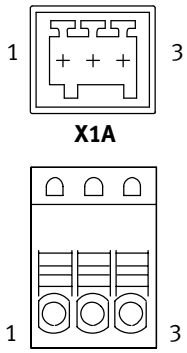


Fig. 4.3 Connection of interface variant NPN (CMMO-...DION)

4.3.2 [X1A] Reference switch

The types listed in the Festo catalogue for the respective actuator are suitable for use as reference switches (➔ www.festo.com/catalogue).

Connection	Pin	Function	
	1	+24 V LOGIC OUT	Voltage output for supplying the reference switch. No overload protection.
	2	SIGNAL REF	CMMO-...-DIOP: – Input for PNP switch – switches to +24 V – NO/NC version[1)] CMMO-...-DION: – Input for NPN switch – switches to ground – NO/NC version[1)]
	3	0 V GND	Reference potential (ground)

1) NO/NC = Normally Opened/Normally Closed

Tab. 4.5 Connection X1A reference switch

Note

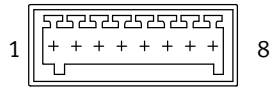
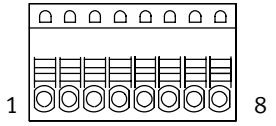
Damage to the device in the event of an overload

Pin 1 (+24 V Out) is not overload-proof (max. 100 mA).

- Only use to supply power to the reference switch.

4.3.3 [X2] Encoder

An incremental encoder with AB signals in accordance with RS422 can be connected at connection [X2]. The ready-to-use cables from Festo (➔ www.festo.com/catalogue) offer sufficiently large cable cross sections as well as screening of the motor/encoder cable with earth contact on both sides for connected components.

Connection	Pin	Function	
 **X2** 	1	A [1]	Incremental encoder signal A+
	2	A/ [1]	Incremental encoder signal A–
	3	B [1]	Incremental encoder signal B+
	4	B/ [1]	Incremental encoder signal B–
	5	N [1]	Incremental sensor signal zero impulse
	6	N/ [1]	Incremental sensor signal zero impulse
	7	+5 V	Supply of the sensor – +5 V ± 10 % – Max. 100 mA – No overload protection
	8	GND	Reference potential 0 V

1) At each pin: 5 V and Ri = approx. 120 Ω

Tab. 4.6 Encoder connection [X2]

Note

Damage to the device in the event of an overload

Pin 7 (+5 V Out) is not overload-proof (max. 100 mA).

- Only use to supply power to the incremental sensor.

4.3.4 [X3] STO

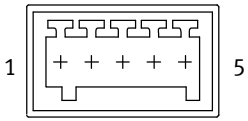
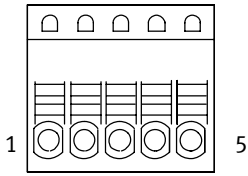
To establish ready status during start-up via FCT or web server and for control via I/O, control inputs STO1/STO2 on [X3] must be enabled.

Circuitry without use of the STO safety function

If you do not need the integrated safety function STO in your application, to operate the motor controller you must bridge Pins 1, 2 and 3 at the X3 interface. This deactivates the integrated safety function! With this circuitry, safety in the application must be ensured through other appropriate measures.

Circuitry with use of the STO safety function

The STO safety function (“Safe Torque Off”) is described in detail in the documentation GDCP-CMMO-ST-EA-S1. The STO function should only be used in the manner described in this document.

Connection	Pin	Function	
 **X3** 	1	+24 V DC[1)] LOGIC OUT	Logic voltage output – Supply via [X9] – Max. 100 mA – No overload protection
	2	STO 1	Control ports for STO function
	3	STO 2	
	4	DIAG 1	Feedback contact – Potential-free – Low impedance if the STO function has been requested and activated via two channels.
	5	DIAG 2	

1) Reference potential (0 V) is pin 4 on connection [X9] power supply

Tab. 4.7 Connection STO [X3]

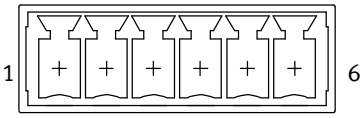
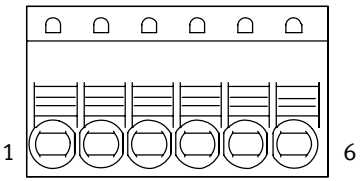
Note

Damage to the device in the event of an overload

Pin 1 (+24 V Out) is not overload-proof (max. 100 mA). The logic supply can be optionally used to supply external, active sensors.

4.3.5 [X6] Motor

The ready-to-use cables from Festo (➔ www.festo.com/catalogue) offer sufficiently large cable cross sections as well as screening of the motor/encoder cable with earth contact on both sides for connected components.

Connection	Pin	Function	
 **X6**	1	String A	Connection of the two motor strings
	2	String A/	
	3	String B	
	4	String B/	
	5	BR+	Connection of the holding brake – +24 V – Max. 1.4 A – 33 W – Short-circuit-proof and overload-proof BR– = GND, BR+ is switched (24 V load)
	6	BR–	

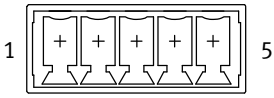
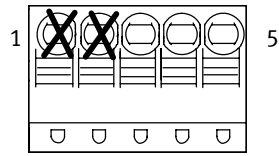
Tab. 4.8 Motor connection [X6]

4.3.6 [X9] Power supply

Warning
Electric shock from voltage sources without safeguarding
- For the electrical power supply, use only PELV circuits in accordance with IEC 60204-1 (Protective Extra-Low Voltage, PELV)
- Also observe the general requirements for PELV circuits IEC 60204-1.
- Use only voltage sources which guarantee reliable electrical isolation of the operating and load voltage in accordance with IEC 60204-1.

Caution
Risk of burning through heating of device in the event of a connection fault.
- Pay attention to the correct pin numbers corresponding to the plug location [X9] on the device.
- Do **not** connect up Pin 1 and Pin 2.

Note
Damage to the device caused by overvoltage
The inputs for the power supply do not have any protection against overvoltage.
- Comply with permitted voltage tolerance.

Connection	Pin	Function
 **X9** 	1	Do not connect!
	2	Do not connect!
	3	Power supply to the control electronics is +24 V DC (logic voltage)
	4	Reference potential of 0 V for – Load voltage – Logic voltage – STO – I/O interface
	5	+24 V DC supply of the power output stage and the motor (load voltage)

Tab. 4.9 Connection [X9] without plug connector and with plug connector fitted (assortment of plugs NEKM-C-10)

4.3.7 [X18] Ethernet interface

Note

Unauthorised access to the device can cause damage or malfunctions. When connecting the device to a network:

- Protect the network from unauthorised access.

Measures for protecting the network include:

– Firewall
– intrusion prevention system (IPS)
– Network segmentation
– Virtual LAN (VLAN)
– Virtual Private Network (VPN)
– Security at a physical access level (Port Security).

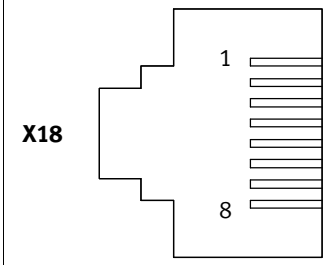
Additional information ➔ Guidelines and standards for security in information technology, e.g. IEC 62443, ISO/IEC 27001.

Note

Faulty installation and high transmission rates may cause data transmission errors as a result of signal reflections and attenuations

Transmission errors can be caused by:

– faulty screened connection
– branches
– transmission over distances which are too long
– Unsuitable cables (cable specification ➔ Chapter A.2.5)

Connection	Pin	Function	
	1	TD+	Transmitted data +
	2	TD–	Transmitted data –
	3	RD+	Received data +
	4	–	–
	5	–	–
	6	RD–	Received data +
	7	–	–
	8	–	–

Tab. 4.10 Connection [X18] (connector RJ45)

The motor controller supports the function “crossover detection” (Auto-MDI/MDI-X). To connect the motor controller to the network or to a PC, this means you can choose between patch cables or crossover cables. The circuitry for network connections [X18] is adapted automatically.

5 Commissioning

5.1 Notes on commissioning

Caution
Faults during configuration or parameterisation can lead to unexpected behaviour from the motor controller if the regulator is approved.
- Do not operate motor controller with unknown settings.
- Only enable the regulator if the motor controller has been configured and parameterised by technically qualified staff.

To establish ready status during start-up via FCT or web server and for control via I/O, control inputs STO1/STO2 must be enabled.

Circuitry without use of the STO safety function

If you do **not** need the integrated safety function STO in your application, to operate the motor controller you must bridge Pins 1, 2 and 3 at the X3 interface. This deactivates the integrated safety function! With this circuitry, safety in the application must be ensured through other appropriate measures.

Circuitry with use of the STO safety function

The STO safety function (“Safe Torque Off”) is described in detail in the document GDCP-CMMO-ST-EA-S1. The STO function should only be used in the manner described in this document.

Safety instructions
- For use of safety function STO: check the STO function (➔ Documentation GDCP-CMMO-ST-EA-S1).
- Make sure that movement of the actuator does not endanger anyone.
- Conduct test runs with reduced force and speed.

Before switching on the power supply of the motor controller
1. Check mounting of the axle attachment.
2. Check the installation of the motor controller (➔ Chapter 4).
3. Connect all FU protective conductors, even for brief measuring and test purposes.
4. Establish an Ethernet connection with the PC (➔ Chapter 5.2).

After the 1st time the power supply is switched on:
- Initial start-up with web server (➔ Chapter 5.3) -or-
- Perform first start-up with FCT (➔ Chapter 5.4)

Each time after switching on the (logic) power supply
- Executing a reference run

5.2 Establish an Ethernet connection

Note

On delivery, the integrated DHCP server (Dynamic Host Configuration Protocol) of the motor controller is active. The DHCP server enables **direct connection** between the motor controller and a PC configured individually as a DHCP client.
The factory setting “DHCP Server Active” is generally not suitable for network operation. In an existing network, there is typically a DHCP server already available. Two active DHCP servers on a network can lead to network faults.

- For initial start-up, connect the motor controller directly to the PC via the Ethernet interface .
- Do **not** connect the motor controller to the network as a DHCP server if another DHCP server is already enabled on the network.
- To integrated in a network, first change the IP configuration of the motor controller with FCT (➔ Chapter 5.7.4).

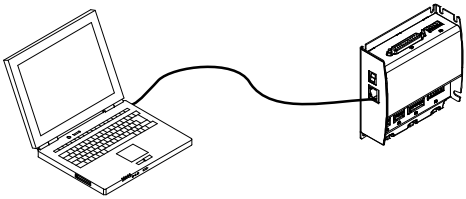


Fig. 5.1 Initial start-up via direct connection (point-to-point connection)

Ethernet direct connection	
Prerequisites	– The PC is configured as a DHCP client (usually the default setting for PCs). – The motor controller is configured as a DHCP server (factory setting).
Connection to be established	1. Connect the Ethernet interface of the motor controller directly to the Ethernet interface of the PC (point-to-point connection). 2. Switch on power supply to the motor controller. The DHCP server on the motor controller assigns an IP address to the PC. That means that a network connection has been established.
Connection to be tested with the web server	• Call up the website of the web server in the web browser (➔ Chapter 5.3.1)
Connection Test with FCT	1. Install and start FCT (➔ Chapter 5.4.1) 2. Configure the FCT interface. 3. With FCT menu [Component] [Online] [Login] establish an online connection.

Tab. 5.1 Connection of motor controller as active DHCP server (factory setting).

Note

With communication problems

- Check activation of the following TCP/IPv4 settings on the Ethernet interface used on the PC (➔ Windows System Settings):
  - Assign IP address automatically.
  - Obtain DNS server address automatically.

  For setting up the network configuration Windows administrator rights are required.
- Establish the current address of the motor controller with FCT (➔ FCT menu [Component] [FCT Interface] ‹Scan...›).

5.3 Commissioning via web server

Caution
Violation by accidental movements of the actuator when the connection to the web browser is interrupted.
An interruption in the Ethernet connection cannot be stopped in advance by movements that have been started via the web browser. The motor controller cannot detect that the connection to the web browser has been interrupted.
- Ensure that accidental ongoing movements cannot pose a hazard to other people.

During start-up with the web server, parameterisation is performed by a parameter file. Parameter files tested by Festo (*fpf) with standard settings for the positioning systems (OMS) can be found on the Internet and on the CD-ROM provided. If there is no Internet connection the download can be made directly from the CD-ROM. The most important settings are documented in the related parameter lists. Other parameters can, if necessary, be displayed with FCT (e.g. maximum values for speed, acceleration, force). Alternatively, the settings can be modified using FCT and saved in the parameter file.

Prerequisites for commissioning:
– The application requires a simple positioning actuator with max. 7 sets of commands (valve profile).
– The appropriate parameter file *.fpf for each actuator is available.
– The web page“parameters” is displayed in the web browser (web server call ➔ Chapter 5.3.1)

A web server start-up requires the valve profile to be set for the I/O interface (factory setting). A change of profile via web server involves the downloading of a corresponding parameter file to the motor controller. All OMS parameter files from Festo contain“Valve Profile” parameterisation.

Signals required from the STO interface
Input signals STO1 and STO2 on [X3]

First commissioning
After the web server call, the following steps must be performed:
1. Configure and parameterise the actuator using a parameter file ➔ Chapter 5.3.3
2. Perform homing ➔ Chapter 5.3.4
3. Create and test sets of commands ➔ Chapter 5.3.5
4. Conclude commissioning ➔ Chapter 5.3.6

5.3.1 Web server call

Requirements:

– The Ethernet connection between motor controller and PC is established (➔ Chapter 5.2).
– Web browser is enabled on the PC (Internet Explorer ›6; Firefox ›3; JavaScript).
– The power supply to the motor controller is switched on.

Calling the web server:

Fig. 5.2 Call the web server

1. Open the web browser.
2. Enter the IP address of the motor controller in the address row of the browser:
   - Factory setting: 192.168.178.1.
   - if required: establish the current IP address (➔ FCT menu [Component] [FCT Interface], ‹Scan...›).

   Then the online connection is established.

After the web browser call, the“Diagnosis” web page is displayed with information about the actuator connected. The button on the right side of the page effects the change to the“Parameter” web page.
Once password protection for the motor controller has been enabled, the password needs to be entered to change pages; the“Username” box in the query dialogue on the browser can remain empty because it is not evaluated. ➔ Chapter 2.3.3, password protection.

Website	Sections[1)]	Description
Diagnosis	Status[2)]	Status information about the device and identification of the motor controller (wave function); adjustment to the dimensional system (unit: mm/inch/inc)
	E/A-Interface[2)]	Signal statuses of the digital inputs/outputs
	Diagnostic Memory	Readout of the diagnostic memory
Parameters	Parameter Up/Download	Uploading and downloading a parameter file
	Status[2)]	Status information about a device
	Control	Acceptance of device control and controller enable
	Password	Password protection
	Homing [3)]	Carrying out homing
	Record Table[3)]	Parameterising and testing of sets of commands (valve profile)

1) By scrolling, the individual components of the website can be moved into the visible section of the window
2) Active signals are marked with a blue dot. Inactive signals are marked with a grey dot.
3) The section is only available for positioning systems (OMS)

Tab. 5.2 Website“Diagnosis” and“Parameters”

5.3.2 Access via web browser to the motor controller

Acceptance of device control

With the“Device Control” check box, the read/write access to the motor controller is enabled via web browser. If the actuator is running a set of commands at the time it is enabled, the actuator is stopped. The drive is uncontrolled. After enabling Device Control, the release signal of the I/O interface (DIN CONTROL ENABLE) stops being evaluated

Fig. 5.3 “Parameters” website - Device Control

To accept Device Control, select“Control” on the“Parameters” page

- enable“Device Control”.

Enabling via web browser

Caution

Faults during configuration or parameterisation can lead to unexpected behaviour from the motor controller if the controller is approved.

- Only enable the controller if the motor controller has been configured and parameterised by downloading the relevant parameter file.
- Do not operate the positioning system with unknown settings. The documentation of *.pdf parameter files is available on CD-ROM (/Parameter-Sets/) and on the Internet ➔ www.festo.com/sp

Fig. 5.4 “Parameters” website - request Control Enable

Using check box“Control Enable”, the controller and power output stage can be enabled. The motor controller can be controlled via the web browser.

To accept via web browser, on the“Parameters” page,“Control” section,

- Enable“Device Control”.
- Enable“Control Enable”.

5.3.3 Configuring and parameterising the actuator

Note

To accept a parameter file from the Festo server, enter the complete OMS ID on the“Parameters” website in accordance with the product labelling. Incomplete entry of the code may result in malfunctions, uncontrolled behaviour and damage.

- Only select the parameter file via OMS-ID for positioning systems (OMS) in delivery status.
- After a modification to the OMS system, e.g. a change in the attachment position of a motor, perform start-up with FCT.

Adopting the Festo parameter file from the Internet

If an Internet connection is available (via 2nd Ethernet interface or WLAN/WiFi), the required parameter file from the Festo Parameter Cloud is saved to the PC:

1. Calling“Parameters” website in the web browser
2. Enter the complete OMS-ID under“Parameter upload/download”.
   With OMS systems without OMS-ID: enter the complete type code
3. Search for file (Parameter upload/download: ‹Search›)
4. Save file (Parameter upload/download: ‹Save›)

Alternatively, you can search for the file in the Festo Support Portal and save it to the PC before the download ➔ www.festo.com/sp, CMMO-ST

Downloading the parameter file (*.fpf)

In a download, the selected parameter file is written to the permanent memory of the motor controller:

1. Enable“Parameters” page, section“Control”,“Device Control”.
2. Select file saved in file system ‹Browse›.
3. Download file to the controller ‹Download parameter set to CMMO›.
   The parameter file is then saved automatically and in permanent form to the motor controller.

Wait for at least 3 seconds between 2 parameter file downloads.

5.3.4 Executing a homing run

During initial start-up of an actuator, also execute a homing run to determine the homing point. The reference point is saved temporarily in the motor controller. When there is an open circuit in the logic power supply, the homing point is lost and the homing run must be repeated.
The required settings for the dimensional reference system and the homing run are taken from the parameter file of the actuator (➔ Parameter list).

When required, automatic execution with FCT can be enabled (➔ Tab. 2.25)
In delivery condition, automatic running of the homing function is disabled.
Further information about homing:
- Dimensional reference system ➔ Chapter 2.5.1
- Homing ➔ Chapter 2.5.2

Requirements:
- The actuator is completely configured and parameterised by a parameter file
- With homing on a reference switch: the inputs for the reference switch are enabled.

Carrying out homing
1. Approval by web server:
   - Enable“Parameters”, section“Control”,“Device Control”.
   - Enable“Parameters”, section“Control”,“Control Enable”.
2. During initial start-up: check functionality of the actuator.
   - Move actuator manually with ‹Jog neg.› or ‹Jog pos.› in both directions.
   - Check direction of rotation/direction of travel of the electromechanical actuator.
     Optional: enable reversal of direction of rotation with FCT.
   - Check signal characteristics of the digital I/O (e.g. reference switch).
3. Click ‹Start Homing› button.
   Following successful completion of homing, the actuator is referenced to the dimensional reference system.
4. During first commissioning: Check end positions
   - Move actuator in both directions with ‹Jog neg.› or ‹Jog pos.›.
   - Check displayed positions of the axis.
   - Move to the limits of the positioning range and check the software end positions.

5.3.5 Creating and testing sets of commands

Default values for sets of commands (speed, acceleration, limitations etc.) are predefined for Festo components and can if required be altered in the FCT ➔ FCT [...] [Controller] [Default Values]. The default values are adopted automatically for each record when an absolute position is being taught.

Requirements

The actuator is referenced in the dimensional reference system (➔ Chapter 5.3.4)

Enter other sets of commands

1. Approval by web server:
   - Enable“Parameters”, section“Control”,“Device Control”.
   - Enable“Parameters”, section“Control”,“Control Enable”.
2. Section“Control”,“Positioning type”: select type of record (drop-down selection)
3. Enter value for position or, optionally, with record type“Positioning to absolute position”:
   Teaching position:
   - First move the actuator to the desired position with ‹Jog neg.› or ‹Jog pos.›.
   - Then click ‹Teach Pos› for the set of commands.
     The position is displayed in the set of commands.
4. Enter or adapt the record parameters, e.g. travel speed (“Velocity”), acceleration (“Acceleration”) and force limitation (“Torque”) in the input fields.
   For testing: select 10 % of the maximum values for“Velocity” and“Acceleration”.
5. Enter other sets of commands.

Testing and saving sets of commands

1. Sets of commands temporarily transferred to the motor controller with ‹Download› (below ‹Teach Pos›).
2. Conduct a test run of sets of commands with ‹Move to Pos.›. This run can be interrupted with ‹Stop›.
3. Adjust parameters as required.
4. Reset approval by web server:
   - “Parameters” page,“Control” section: disable“Control Enable”.
5. With ‹Store› (below the table of sets of commands) the sets of commands can be saved permanently to the motor controller.

5.3.6 Completing commissioning

Recommendation: check temperature characteristics

- Check the long-term characteristics of the output stage temperature with FCT.
  In the FCT, the temperature characteristics are displayed for a period of 30 minutes (FCT online tab“Monitoring”).

Recommendation: disable“Automatic saving” option

- Under FCT [...] [Controller] [I/O Configuration] disable the automatic saving of taught positions in the Flash memory

Creating a backup file

The creation of a backup file (Restore file) makes it possible:

– to parameterise a few motor controller quickly when replacing a device
– to commission several actuators quickly with the same parameterisation
– to restore the parameterisation of the motor controller in the event of data loss

When creating a backup file, the complete parameter file is loaded from the motor controller and is saved on the PC. If no valid parameter file is present in the controller, the default parameter file is loaded and saved.

1. Adopt device control on the web browser (reset controller enable)
2. With ‹Store› (below the table of sets of commands) the sets of commands can be saved permanently to the motor controller.
3. Interrogate parameter file from the permanent memory of the controller with ‹Upload parameter set to CMMO›
4. Save parameter file *. fpf to data carrier via the displayed Windows dialogue.

Transferring a backup file

To transfer a backup file from the PC to the motor controller:

- Write the parameter file to the permanent memory of the controller with ‹Download parameter set to CMMO›.
- After the download: reboot the motor controller (Power on/off).

Enabling password protection

Password protection protects the motor controller from unauthorised modifications and prevents controlling access to the actuator via FCT or web server:

1. Adopt device control on the web browser (reset controller enable)
2. Enter a password (website“Parameters”: Password):
   – Maximum length of password: 16 characters
   – Permitted characters: a-Z, A-Z, 0-9 !"#$%&'()*+,-./:;‹=›?@[\]^_{|}~
   The password is case-sensitive.
3. Save the password with ‹Apply›.
   The password is permanently stored in the motor controller.

To create a compatible parameter file for firmware < V1.1.2.4 all current parameters are also saved in the parameter file of the controller with ‹Apply›. For further information about password protection ➔ Chapter 2.3.3

5.4 Commissioning with FCT (Festo Configuration Tool)

Notes on commissioning

The following information provides an initial guide to working with the FCT. The entire commissioning process must be carried out in accordance with the detailed instructions in the FCT Help system:

➔ Help for FCT: working with the FCT

➔ Help for the PlugIn workflow: tasks with the PlugIn CMMO-ST

Prerequisites for commissioning:

The following information must be presented for the drive configuration and for application purposes:

– Type designation or OMS-ID for Festo drive components (optional: type code, parts number)
– Properties of the motor and axis
– Type of reference switch and referencing method
– Required controller profile (valve or binary profile ➔ Chapter 2.4.2)

Signals required from the STO interface

Input signals STO1 and STO2 on [X3]

First commissioning

For initial start-up, the following steps can be performed:

1. Configure and parameterise ➔ Chapter 5.4.2
2. Perform homing ➔ Chapter 5.4.4
3. Create and test command records ➔ Chapter 5.4.5
4. Conclude commissioning ➔ Chapter 5.4.6

5.4.1 Installing FCT

Installation of software with the appropriate PlugIn is performed by an installation program. The appropriate version of PlugIn for delivery condition of the motor controller (firmware) is included in the CD-ROM provided. Administrator rights are required for installation.

1. Close all other programs before starting installation
2. Insert the “Festo Configuration Tool” CD in the CD-ROM drive.
   - With Auto-Run: installation starts automatically.
   - Without Auto-Run: start setup.exe on the CD-ROM.
3. Follow the instructions in setup.exe (FCT assistant).

5.4.2 Configuring and parameterising the actuator

Start and creating a project

1. Double-click the FCT icon on the desktop or select the following Windows menu path:
   [Start] [‹Program path›] [Festo Software] [Festo Configuration Tool].
2. Create FCT project via the FCT menu [Project] [New]:
   - Indicate the project properties.
   - Predefine the display of technical values in the FCT (dimensional unit, decimal places).
   - Insert component in the project (component selection [Festo] [CMMO-ST]
   - Create new actuator configuration (Configuration Assistant)

If the actuator comprises Festo components, component-specific parameters and limit values are predefined when creating the actuator configuration. If the actuator contains components from other manufacturers, you must determine these parameters and limit values for your actuator and set them up in the FCT, e.g. to ensure that the permitted loading of actuator components is not exceeded. You must define application-related parameters and limit values on the basis of the application.

PlugIn workflow

Configuration and parameterisation of the actuator is supported by a workflow, which can also be used to prepare for commissioning without a connection to a controller (“offline”):

1. Start workflow in “Workstation” window with FCT [...] [Configuration].
   Check details and call up the Configuration Assistant if necessary
   – Use ‹Change› to select other drive components
   – To create a new actuator configuration via ‹Delete›
2. Continue workflow to end with ‹Next›.
3. Save project via FCT menu [Project] [Save]

To download the parameter file to the motor controller and to continue the start-up process, an online connection is required via the Ethernet interface ➔ Chapter 5.4.3. Wait at least 3 seconds between 2 downloads.

5.4.3 Access via FCT to the motor controller

Configure interface

1. Configure FCT interface via FCT menu [Component] [FCT Interface].
2. Create Ethernet connection between motor controller and PC (➔ Chapter 5.2).

Establish an online connection

A system check takes place before a connection is established. The online connection is required to transmit data with FCT and to enable the motor controller.

To create the online connection:

- Select FCT menu [Component] [Online] [Login] or button ‹Offline/Online›.

Requirement in the FCT	Functions
Online connection	– Status displays – Diagnostics
Online connection + device control	– Download, upload and comparison of parameters – Permanent saving of parameters in the controller.
Online connection + device control + enable	– Moving/stopping the actuator in jog mode – Executing homing – Teaching of positions – Executing command records – Creating and executing record sequences – Optimising of controller parameters

Tab. 5.3 The most important online functions in the FCT

Acceptance of device control

The “FCT” checkbox is used to activate read/write access via FCT to the motor controller. If the actuator executes a command record during this enable sequence, the actuator is stopped. The actuator is uncontrolled. After enabling Device Control, the release signal of the I/O interface (DIN CONTROL ENABLE) stops being evaluated.

The current parameterisation of the motor controllers is compared against the FCT project and the data can be synchronised.

1. Create an online connection with the FCT menu [Component] [Online] [Login].
2. In the FCT online tab, enable “FCT” at Device Control.
3. Synchronise data (upload, download, comparison)

Enabling via FCT

Caution

Faults during configuration or parameterisation can lead to unexpected behaviour from the motor controller if the controller is approved.

- Do not operate motor controller with unknown settings.
- Only enable the controller if the motor controller has been configured and parameterised by technically qualified staff.

Using check box “Enable” , the controller and power output stage can be enabled. This keeps the actuator in its current position. The motor controller can be controlled via FCT.

1. Create an online connection with the FCT menu [Component] [Online] [Login].
2. In the FCT online tab, enable “FCT” at Device Control.
   - Enable “FCT” .
   - “Enable” enable.

5.4.4 Executing a homing run

During initial start-up of an actuator, also execute a homing run to determine the homing point. The reference point is saved temporarily in the motor controller. When there is an open circuit in the logic power supply, the homing point is lost and the homing run must be repeated. The required settings for the dimensional reference system and the homing run are made on the parameter page of the FCT [...] [Axis] [Homing].

To perform the homing run:

- Select low search/creep speed to enable the target points to be identified as accurately as possible.
- Set deceleration high enough to prevent the target points from being overrun during the search run.

For control with valve profile, the automatic homing run function can be enabled with FCT. (➔ Tab. 2.25). In delivery condition, automatic running of the homing function is disabled.
Further information about homing:
- Dimensional reference system ➔ Chapter 2.5.1
- Homing ➔ Chapter 2.5.2

Requirements:

- The actuator is completely configured.
- The dimensional reference system is parameterised ➔ FCT [...] [Axis] [Measurements].
- Homing has been parameterised ➔ FCT [...] [Axis] [Homing].
- When homing on reference switch:
  - The inputs for the reference switch are enabled.
  - The type of switch used is configured correctly in the FCT
- All parameter settings were transferred with FCT ‹Download› to the controller.

Carry out homing run and test run:

1. Enabling via FCT
2. During initial start-up: check functionality of the actuator
   - Move actuator manually in both directions (➔ FCT online tab “Manual Move”).
   - Check direction of rotation/direction of travel of the electromechanical actuator.
     Optional: enable reversal of direction of rotation (➔ FCT [...] [Application Data] [Environment]).
   - Check signal characteristics of the digital I/O (e.g. reference switch).
3. Start homing run (➔ FCT online tab “Homing”).
   Following successful completion of homing, the actuator is referenced to the dimensional reference system.
4. For initial start-up: perform a test run (➔ FCT online tab “Manual Move”).
   - Move actuator in both directions with ‹Single Step.› or ‹Jog›.
   - Check displayed positions of the axis.
   - Move to the limits of the positioning range and check the software end positions.

5.4.5 Creating and testing command records

Default values for command records (speed, acceleration, limitations etc.) are predefined for Festo components and can if required be altered in the FCT ➔ FCT [...] [Controller] [Default Values]. The default values are adopted automatically for each record when a record type is selected.

Requirements
The actuator is referenced in the dimensional reference system (➔ Chapter 5.4.4)

Creating command records:
1. FCT [...] [Controller] [Record Table] Basic Data:: Select record type (drop-down selection).
2. Enter target value,
   optional with record type PA: teach position ➔ Online tab “Manual Move”
3. Enter or adapt values for other record parameters:
   – FCT [...] [Controller] [Record Table] basic data
   – FCT [...] [Controller] [Record Table] limitations
   For testing: select low values for travel speeds and acceleration.
4. Enter other sets of commands.

Testing command records
1. Enabling via FCT
2. With ‹Download›, command records are temporarily transferred to the motor controller.
3. Conduct a test run of records using the Start button for the record number.
   - Optional: create and execute test cycle with several records
     (➔ FCT online tab “Manual Move” or “Optimise“)
4. If necessary:
   - Adapt record parameters.
   - Optimise controller settings (➔ FCT online tab “Optimise”)
     Modified controller parameters become effective immediately and on a temporary basis in the controller.
   - Optimised controller settings for saving with ‹Accept›, transferred to the project.

Note
Damage to device caused by incorrect controller setting
- Only change controller default settings if absolutely necessary.
- Check settings carefully.

5.4.6 Completing commissioning

Recommendation: check temperature characteristics

- Check the long-term characteristics of the output stage temperature with FCT.
  In the FCT, the temperature characteristics are displayed for a period of 30 minutes (FCT online tab “Monitoring”).

Recommendation: disable “Automatic saving” option

- Under FCT [...] [Controller] [I/O Configuration] disable the automatic saving of taught positions in the Flash memory

Save parameterisation in the motor controller

1. Adopt device control in the FCT (reset controller enable)
2. With ‹Store›, back up the current parameterisation in the motor controller.

Creating a backup file

The creation of a backup file (Restore file) makes it possible:

– to parameterise a few motor controller quickly when replacing a device
– to commission several actuators quickly with the same parameterisation
– to restore the parameterisation of the motor controller

When creating a backup file, the complete parameter file is loaded from the motor controller and is saved on the PC. If no valid parameter file is present in the controller, the default parameter file is loaded and saved.

1. Adopt device control in the FCT (reset controller enable)
2. With ‹Store›, back up the current parameterisation in the motor controller.
3. In the FCT menu [Component] [Online] Restore file..., ‹Back up device data›, save the file onto a data carrier via the displayed Windows dialogue.

Transferring a backup file

To transfer a backup file from the PC to the motor controller:

- Select [Component] [Online] Backup Recovery ... “Recover” from the FCT menu.
- After a restore: reboot the motor controller using the FCT menu [Component] [Online] “Restart Controller” (or Power on/off)

Further information, e.g. about how to restore the parameterisation of the motor controller ➔ Can be found in the FCT PlugIn Help

Activating a password

Password protection protects the controller from unauthorised modifications and prevents controlling access to the actuator via FCT or web server:

1. Adopt device control in the FCT (reset controller enable)
2. Enter the password for the FCT menu [Component] [Online] [Password]):
   – Maximum length of password: 16 characters
   – Permitted characters: a-Z, A-Z, 0-9 !"#$%&” ()*+,-./:;‹=›?@[\]^_{|}~
   The password is case-sensitive.
3. Save the password with ‹Accept›.

After that, the password is permanently stored in the motor controller.

To create a compatible parameter file for firmware < V1.1.2.4:

- Save parameter file in the controller via FCT ‹Store›.

For further information about password protection ➔ Chapter 2.3.3

5.5 Control via I/O control unit profile (valve)

The valve profile is based on the methodology of pneumatic valve pilots. The user only needs low-level programming knowledge of the kind needed to control a pneumatic actuator. The device function is simple to check.
By means of 7 digital inputs (DIN1...7), a maximum of 7 command records can be addressed directly. Achievement of the objective of this command record is reported by the corresponding output (DOUT1...7). DIN8/DOUT9 are reserved for execution of the homing function.

Supported functions:
- Positioning mode, optionally with reduced torque
- Automatic homing
- Record changeover (start condition: “Interrupt”)
- Power limitation of command record to maximum permitted force
- Comparator: position
- Message: Motion Complete

Non-supported functions:
- Jogging and teaching the position via I/O
- Operating modes for speed/force operation
- Record Linking
- Drag error monitoring, stationary monitoring
- Asymmetric acceleration and deceleration ramp

5.5.1 Digital inputs/outputs

Designation		Pin
DIN		
1...7	RECORD 1...7 (START/STOP)	X1.1...7
8	Ref	X1.8
9	BRAKE CONTROL	X1.9
10	CONTROL ENABLE	X1.10
11	RESET	X1.11
DOUT		
1...7	RECORD 1 ... 7 (REACHED)	X1.12...18
8	IN ZONE	X1.19
9	REFERENCED	X1.20
10	Ready	X1.21
11	TORQUE LIMIT REACHED	X1.22

Tab. 5.4 Valve profile: digital inputs/outputs

The inputs are scanned at intervals (scanning rate tmax = 1 ms). That enables the controller to respond to an input signal after a delay.

Logical status of inputs/outputs

Note the difference between the electrical level (High, Low) and the logical status (1, 0) of an input or output, dependent on the version of the motor controller (PNP/NPN). The timing diagrams shown in the following chapters illustrate the logical status. Logical status “1” is the active status.

Logical State	electrical level	
	with positive logic (CMMO-ST- PNP)	with negative logic (CMMO-ST- NPN)
1	High-level (24 V)	Low-level (0 V)
0	Low-level (0 V)	High-level (24 V)

Tab. 5.5 Logical status

Signal	Description
DIN1...7	RECORD 1...7 (START/STOP)
0➔1	Addressing and start of order with DINx: RECORD x. The order is executed while the input is active. When the target position is reached, DOUT x: POSITION x is set.
1➔0	During execution of the order: the actuator is brought to a complete stop by the parameterised braking ramp (deceleration record).
DIN8	Ref
0➔1	Start of a homing run. If an input RECORD 1...7 is active at the same time, an error is reported.
1➔0	If the input becomes inactive during execution, the homing run is terminated. After establishing the homing point, the output DOUT9: REFERENCED is enabled. After that, the input can be disabled.
DIN9	BRAKE CONTROL
1	Opens the holding brake via X6.5 (BR+) whenever the regulator is blocked. Makes manual offset of the axis possible. The holding brake remains opened while the 1-signal is present (regardless of DIN10: CONTROL ENABLE).
0	Automatic brake control via DIN10: CONTROL ENABLE (normal operation)
DIN10	CONTROL ENABLE
0➔1	Requirement for controller enable and automatic opening of the brake on motor with holding brake
1➔0	Controlled braking to a stop with the parameterised deceleration function (Quick Stop). On motor with holding brake: apply the brake. Disabling the controller
DIN11	RESET
0➔1	Reset an acknowledgeable error

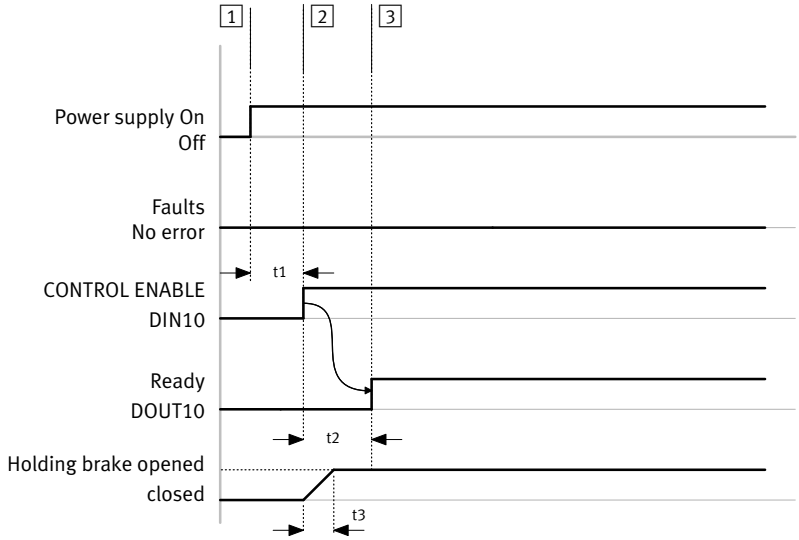
Tab. 5.6 Valve profile: function of digital inputs

Signal	Description
DOUT1…7	RECORD 1…7 (REACHED)
=1	The output will be enabled whenever the target position of the respective position record is reached (Motion complete). The output remains active whenever the input is reset. The output is inactive whenever a different input is enabled.
DOUT8	IN ZONE
=1	The actuator is located within the parameterised position comparator of the active order to DIN1…7. Whenever the corresponding input 1…7 is disabled, the output remains enabled. If, however, the actuator is pushed out of position and then returns, the output remains disabled. If another input RECORD 1….7 is enabled, then the current position is compared to its position zone and output 8 is reset, depending on the result.
DOUT9	REFERENCED
=1	After a successful homing run this output is set and remains set for as long as the drive is referenced.
DOUT10	Ready
=1	The drive is ready for operation. All requirements for starting a command record are fulfilled: – Load voltage / logic voltage is present – Input signals [X3] STO1/STO2 = 1 – CONTROL ENABLE = 1 – No error
DOUT11	TORQUE LIMIT REACHED
=1	The parameterised torque/force limit has been reached.

Tab. 5.7 Valve profile: function of digital outputs

5.5.2 Establish ready status (READY)

The power supply must be switched on for at least 1 s (t1) before inputs can be enabled. Ready status can be established if the input signals [X3] STO1/STO2 are = 1 and if no errors are present.
Errors present must be remedied and, if necessary, acknowledged (➔Chapter 5.5.3).



Switch-on time t1 ≥ 1s
Delay times:
t2: depending on the parameterised switch-on delay
t3: depending on the mechanical inertia of the holding brake

1 Switch on the power supply
2 Request controller enable
3 Ready for operation

Fig. 5.5 Valve profile: establish ready status

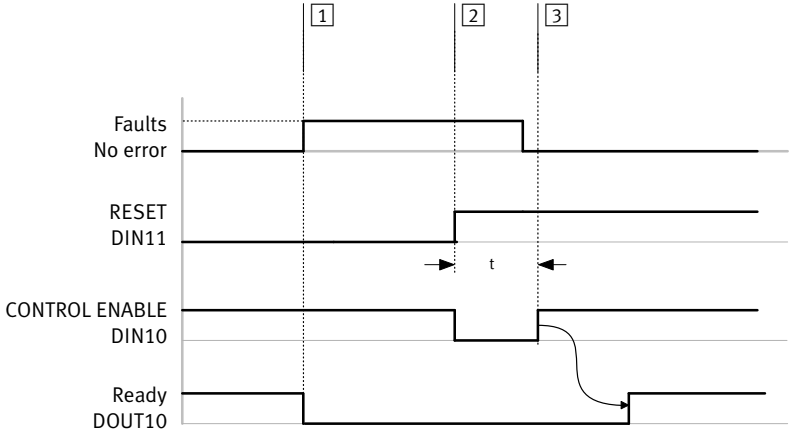
The response time (t2) between requesting controller enable and ready status lengthens:
- On motor with encoder by the time required to search for the commutation angle after the first time the power supply is switched on
- On a motor with holding brake in accordance with the parameterised switch-on delay.

5.5.3 Acknowledge error (RESET)

Whenever an error occurs, the motor controller goes into error status (READY=0). **Acknowledgeable** errors (➔ Chapter 6.3.2) can be reset by pressing RESET. If the error cannot be acknowledged, the controller must be restarted.

In a few cases, acknowledgement is possible immediately, e.g. with a drag error. In other cases, the troubleshooting must be remedied first (e.g. temperature error, load voltage error).

Shortly after acknowledging the error (RESET 0➔1) the error is reset. To enable the controller, a rising flank (CONTROL ENABLE 0➔1) is required. After that, the motor controller is once again ready for operation (READY=1).



Time delay t≥ 2 ms

1 Error event

2 Acknowledge error

3 Request controller enable

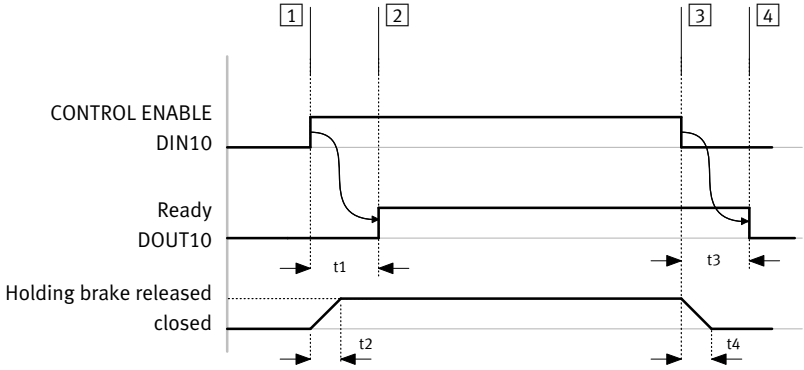
Fig. 5.6 Valve profile: acknowledge error

5.5.4 Controller enable (CONTROL ENABLE)

The controller enable is requested by CONTROL ENABLE. On motors with a holding brake, the holding brake is opened automatically when controller enable is requested, and is closed when controller enable is revoked.

– CONTROL ENABLE 0➔1
  If no error is present, the controller is enabled and READY = 1. The motor controller is ready to operate and orders can be executed. When stationary and with the controller enabled, the actuator is maintained in its position:
  – in its controlled operation by the parameterised holding current
  – in controlled operation by standstill monitoring
– CONTROL ENABLE 1➔0
  The actuator is braked down to a stop using the parameterised Quick-Stop deceleration function. READY=0 is used to signal that ready status has been disabled. In this status, no further orders will be accepted. On motors without a holding brake, the axis can be offset manually.

On motors with a holding brake, the holding brake can be opened by 1-signal on the BRAKE CONTROL input. Further information about the holding brake ➔ Chapter 2.5.6.



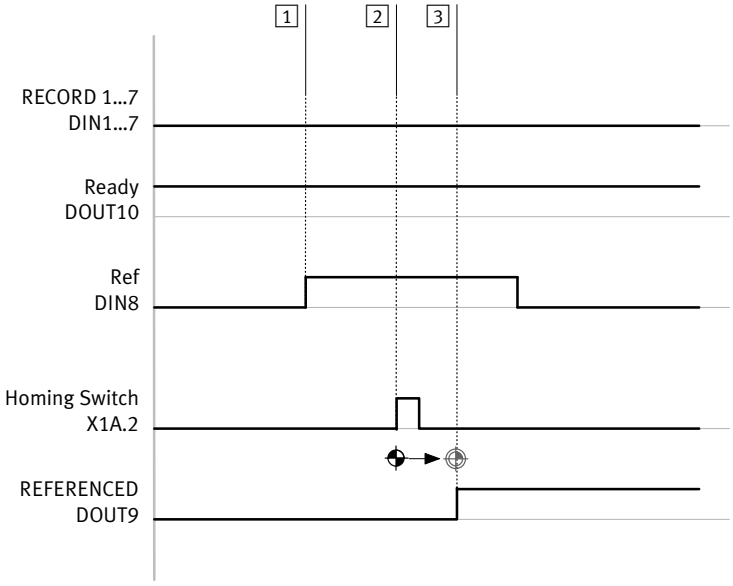
Delay times:
t1: depending on the parameterised switch-on delay
t2: depending on the mechanical inertia of the holding brake
t3: depending on the parameterised switch-off delay
t4: depending on the mechanical inertia of the holding brake

1 Request controller enable
2 Controller has been enabled
3 Revoke controller enable
4 Confirmation that controller is blocked

Fig. 5.7 Valve profile: release/inhibit controller

5.5.5 Carrying out homing (REF)

Homing is started by input REF 0➔1. If an input RECORD 1...7 is active at the same time, an error is reported. The REF input must remain enabled during the homing operation. As soon as homing has been concluded, the output REFERENCED =1 (Motion complete).
If after the homing operation movement ensues to the datum point on the axis, the REFERENCED output is not set until that axis datum point is reached.
Only after that can the REF input be disabled. The REFERENCED output remains enabled while the actuator is being homed.



1 Start homing
2 Homing point found
3 Axis zero point reached

Fig. 5.8 Valve profile: homing to reference switch

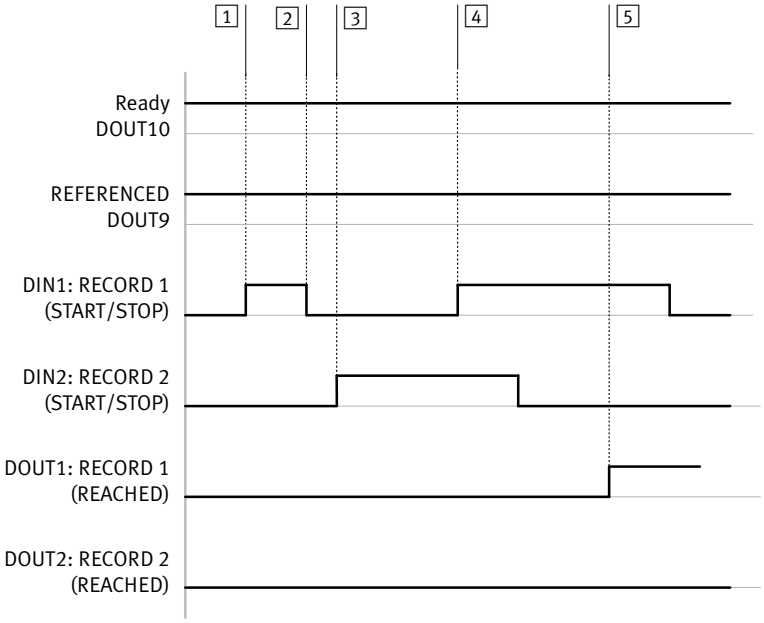
The input for reference switch signal to X1A.2 signals that the homing position has been reached. The type of switch used (NC/NO) is selected using FCT [...] [Axis] Axis Options. Detailed information about the homing process and about how the homing point is determined ➔ Chapter 2.5.2

5.5.6 Execute command records (RECORD)

To initiate a command record, in addition to ready status, the following conditions must be satisfied: the actuator is referenced (DOUT REFERENCED = 1)
The inputs for starting the command records (RECORD 1 to 7, REF) are flank-controlled. After the flank change 0➔1 the signal must remain in place until the action triggered by it has been completed. If the signal is reset, the actuator is braked down to a stop using the parameterised braking ramp (deceleration record). If the actuator comes up against a physical stop, it uses the parameterised nominal torque to press against the stop until the input is disabled.

Start/Stop sequence with record switching

- Start record: by enabling an input RECORDx the command record is addressed and the order is started. The input RECORDx must remain enabled until the specified target has been reached.
- Stop record: during execution of the order, if input RECORD x is disabled, the actuator is slowed down to a complete stop by the parameterised record delay. The order is discontinued. The output RECORDx is not enabled.
- Record changeover: execution of the record is interrupted during selection of the following record and the following record is executed immediately without a stop. The output is not set. Note about programming: first, enable input of following record, then disable input of interrupted record.
- Target reached (Motion complete):
  the actuator is in the position window for the parameterised rest time. The corresponding output RECORDx REACHED is set. The output remains set while the actuator remains at the target positon (even if the input is reset).



1 Start record 1
2 Stop record 1
3 Start record 2
4 Record changeover from record 2 to record 1
Start condition record 1: interrupt
5 Target for record 1 reached

Fig. 5.9 Valve profile: e.g. record selection with record switching

5.6 Control via I/O control unit profile (binary)

The binary profile addresses a total of 32 sets of commands via the binary coding of digital inputs DIN1 ... DIN5. Record 0 is reserved for reference travel (homing), while records 1 .... 31 can be parameterised.
Achievement of the objective of the active command record is reported by the MOTION COMPLETE output. The binary profile can be changed over by input DIN8 between normal operating mode (mode 0) and teaching mode (mode 1).

Binary coding of the record number
Binary addressing of the command record depends on the selected mode for the binary profile
➔ Tab. 5.11

DIN	5	4	3	2	1		DIN	3	2	1
Bit	2^4	2^3	2^2	2^1	2^0		Bit	2^2	2^1	2^0
Record	Coding mode 0						Record	Coding mode 1		
0[1)]	0	0	0	0	0		—	—		
1	0	0	0	0	1		1	0	0	1
2	0	0	0	1	0		2	0	1	0
3	0	0	0	1	1		3	0	1	1
4	0	0	1	0	0		4	1	0	0
5	0	0	1	0	1		5	1	0	1
6	0	0	1	1	0		6	1	1	0
7	0	0	1	1	1		7	1	1	1
...	...	...	...	...	...		—	—		
31	1	1	1	1	1		—	—		

1) Homing

Tab. 5.8 Binary coding of the record number via digital inputs

Supported functions:
- Open-loop control mode, positioning mode, velocity (speed) mode
- Closed-loop control mode: positioning mode, force mode and velocity (speed) mode
- Jogging with 2-stage speed profile and drag error monitoring (Mode 1)
- Teaching the position via I/O (mode 1)
- Drag error mode, target achievement (Motion Complete), stationary monitoring
- Comparators: position, speed, force, time
- Asymmetric acceleration and deceleration ramp
- Changing over the set of commands during movement without an intermediate stop.
- Record Linking
- Optional: stopping the current actuator function or time delay

Unsupported function:
- Automatic homing

5.6.1 Digital inputs/outputs

Designation		Designation	Pin
DIN	MODE 0 (record selection)	MODE 1 (jogging/teaching)	
1	RECORD Bit 0	RECORD Bit 0	X1.1
2	RECORD Bit 1	RECORD Bit 1	X1.2
3	RECORD Bit 2	RECORD Bit 2	X1.3
4	RECORD Bit 3	JOG+	X1.4
5	RECORD Bit 4	JOG–	X1.5
6	Start	TEACH	X1.6
7	TIME DELAY#	STOP#	X1.7
8	MODE		X1.8
9	BRAKE CONTROL		X1.9
10	ENABLE		X1.10
11	RESET		X1.11
DOUT	MODE 0 (record selection)	MODE 1 (jogging/teaching)	
1	Motion complete		X1.12
2	START ACK#	TEACH ACK#	X1.13
3	PAUSED/STOPPED#	STOPPED#	X1.14
4	MOVING		X1.15
5	ERROR#		X1.16
6...7	parameterisable ➔ FCT [...] [Controller] [I/O Configuration] Digital Outputs		X1.17...18
8	IN ZONE		X1.19
9	REFERENCED		X1.20
10	Ready		X1.21
11	TORQUE LIMIT REACHED		X1.22

Tab. 5.9 Binary profile: overview of digital inputs/outputs

The inputs are scanned at intervals (scanning rate tmax = 1 ms). That enables the controller to respond to an input signal after a delay.

Logical status of inputs/outputs

Note the difference between the electrical level (High, Low) and the logical status (1, 0) of an input or output, dependent on the version of the motor controller. The timing diagrams shown in the following chapters illustrate the logical status.

Logical	electrical level	
State	Positive logic (CMMO-ST PNP)	Negative logic (CMMO-ST NPN)
1	High-level (24 V)	Low-level (0 V)
0	Low-level (0 V)	High-level (24 V)

Tab. 5.10 Logical status

In standard cases, logical status “1” is the active status. Inputs/outputs for which the logical status differs, i.e. is “0”, are labelled in Tab. 5.9 with the # symbol.

Function of inputs and outputs

DIN	Mode 0: Record selection		Mode 1: Jogging and teaching		Pin
1	RECORD Bit 0...4	Binary addressing of the set of commands for record selection ➔ Tab. 5.8. Record 0 is reserved for reference travel (homing). Records 1 .... 31 can be parameterised.	RECORD Bit 0...2	Binary addressing of the set of commands ➔ Tab. 5.8 Records 1 .... 7 can be parameterised.	X1.1
2					X1.2
3					X1.3
4			JOG+	1: Jog positive	X1.4
5			JOG–	1: Jog negative	X1.5
6	Start	0➔1: Starts the addressed set of commands	TEACH	0➔1: Transfer current position to addressed set of commands	X1.6
7	PAUSE	0: Actuator stops (intermediate stop). 1: With START the addressed record can be continued. Optional: delete remaining path (DIN11)	Stop	0: Actuator stops 1: JOG+/JOG- can be performed.	X1.7
8	MODE	Switch over mode. 0➔1: mode 1 1➔0: mode 0			X1.8
9	BRAKE CONTROL	1: Opens the holding brake via X6.5 (BR+) whenever the closed-loop control is closed. Makes manual offset of the axis possible. The holding brake remains opened while the 1-signal is present (regardless of CONTROL ENABLE). 0: Automatic brake control via CONTROL ENABLE (normal operation)			X1.9
10	Control ENABLE	0➔1 Requirement for controller enable and automatic opening of the brake on motor with holding brake 1➔0 Controlled braking to a stop with the parameterised deceleration function (Quick Stop). On motor with holding brake: apply the brake. Disabling the closed-loop controller.			X1.10
11	RESET	0➔1: In the event of a malfunction: reset an acknowledgeable error - or - delete remaining path after PAUSE			X1.11

Tab. 5.11 Binary profile: function of the digital inputs

DOUT	Mode 0: Normal operation		Mode 1: Jogging and teaching		Pin
1	Motion complete	Target position, target force or target speed reached.	Motion complete	Target position reached.	X1.12
2	START ACK	Confirmation of the start of a record	TEACH ACK	confirmation of successful teaching	X1.13
3	PAUSED/ STOPPED	The actuator has been stopped	STOPPED	The actuator has been stopped.	X1.14
4	MOVING	The drive moves.			X1.15
5	ERROR	An error has occurred.			X1.16
6	parameterisable ➔ FCT [...] [Controller] [I/O Configuration] Digital Outputs				X1.17
7					X1.18
8	IN ZONE	The drive is located within the configured position zone of the current position record, i.e. within the position comparators.			X1.19
9	REFER-ENCED	The drive is referenced.			X1.20
10	Ready	The drive is ready for operation.			X1.21
11	TORQUE LIMIT REACHED	Force compensation reached. Only for positioning and speed mode.			X1.22

Tab. 5.12 Binary profile function of the digital outputs

Force limitation (TORQUE LIMIT REACHED) in closed-loop control mode

By parameterisation of force limitation in the FCT, a load limit can be displayed on the digital output DOUT X1.11 at which the motor is no longer able to follow the position sequence (following error). An additional following errors message is not then issued.

The freely configurable digital outputs can depict one of the following signals:

Function		DOUT2 supplies ...
–	– “High” output	... always 1-signal
	– “Low” output	... always 0-signal
Motion (Motion)	– Motion Complete (Actual Value)	... 1-signal, if the actual value of the current record is in the time window.
	– Motion Complete (Setpoint)	... 1-signal whenever the setpoint value of the current record is in the time window.
	– Axis In Motion	... 1-signal whenever the axis moves.
	– Constant-speed reached	... 1-signal whenever the target velocity is reached.
	– Force limit reached	... 1-signal whenever the force limit specified in the record has been reached.
	– Stationary monitoring (0x37)	... 1-signal whenever the “Standstill monitoring” message is active.[1)]
Homing (Homing)	– Homing active	... 1-signal whenever homing is being carried out.
	– Reference position valid	... 1-signal whenever the homing position is valid.
Comparators (Comparators)	– Position Comparator[2)]	... 1-signal whenever the corresponding comparator is active.[1)]
	– Velocity Comparator	
	– Force Comparator	
	– Time Comparator	
Faults/ warnings (errors/ warnings)	– Common error	... 0-signal whenever at least one error is reported.
	– Following error (0x2F)	...1-signal whenever the corresponding message is active.[1)]
	– I^2t error (0x0E)	
	– I^2t warning (0x2D)	
	– Overvoltage load (0x1A)	
	– Undervoltage load (0x1B)	

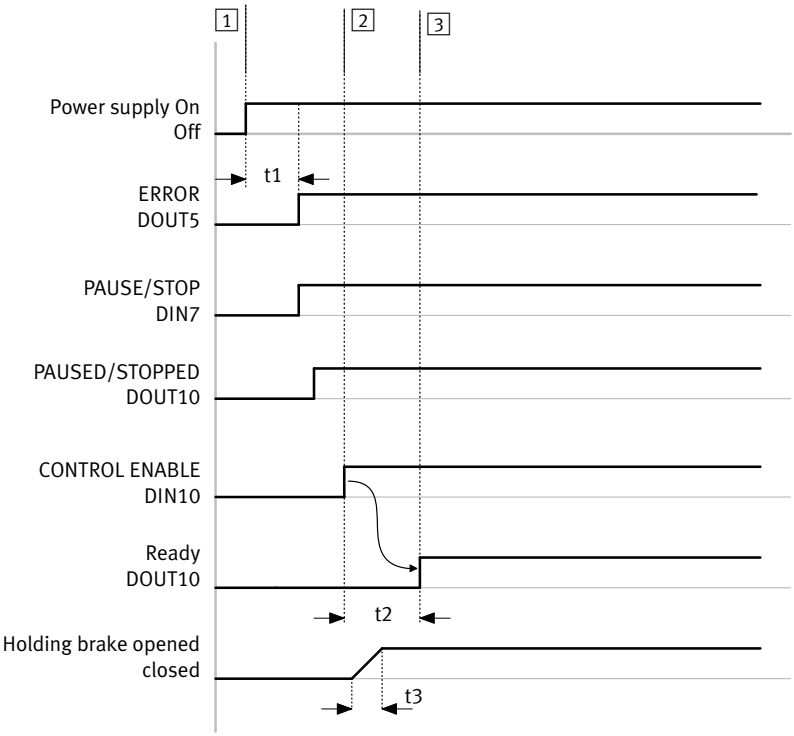
1) Information for monitoring the actuator behaviour ➔ Chapter 2.7.

2) Identical to DOUT8 IN ZONE

Tab. 5.13 Functions of the freely configurable digital output

5.6.2 Establish ready status (READY)

The power supply must be switched on for at least 1 s (t1) before inputs can be enabled. Ready status can be established if the input signals [X3] STO1/STO2 are = 1 and if no errors are present.
Errors present must be remedied and, if necessary, acknowledged (➔ Chapter 5.6.4).



Switch-on time t1 ≥ 1s

Delay times:

t2: depending on the parameterised switch-on delay

t3: depending on the mechanical inertia of the holding brake

1 Switch on the power supply
2 Request controller enable
3 Ready for operation

Fig. 5.10 Binary profile: establish ready status

The response time (t2) between requesting controller enable and ready status lengthens:
- On motor with encoder by the time required to search for the commutation angle after the first time the power supply is switched on.
- On a motor with holding brake in accordance with the parameterised switch-on delay.

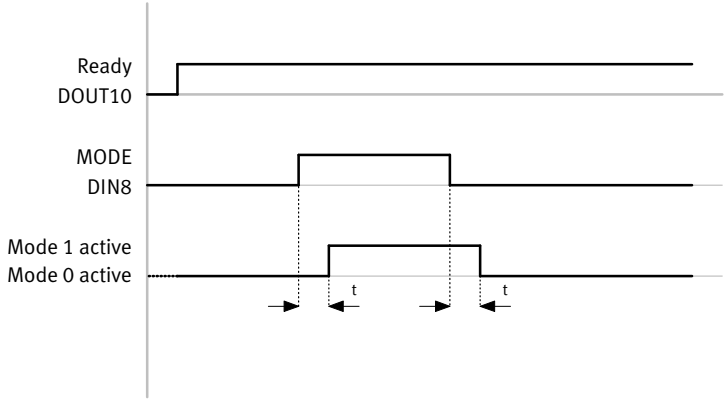
5.6.3 Change between record selection and jog/teach (MODE)

The I/O interface is changed over via DIN MODE.
This requires the motor controller to be ready for operation (READY = 1). If the changeover coincides with an order being executed, the current order is braked to a stop by Quick Stop.

Pin	Inlet	DIN8	Description
[X1.8]	MODE	0	Mode 0: Record selection
		1	Mode 1: Jog/teach

Tab. 5.14 Mode for the I/O interface

To avoid malfunctions during mode changeover, the time delay of t . 5 ms must be observed. Then enable the inputs.



Time delay t ≥ 5 ms

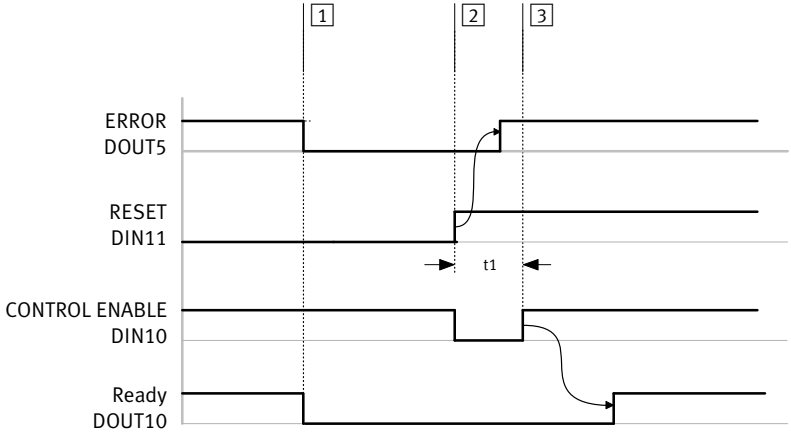
Fig. 5.11 Binary profile: change between record selection and jog/teach

5.6.4 Acknowledge error (RESET)

Whenever an error occurs, the motor controller goes into error status (ERROR=1, READY=0). **Acknowledgeable** errors (➔ Chapter 6.3.2) can be reset by pressing RESET. If the error cannot be acknowledged, the controller must be restarted.

In a few cases, acknowledgement is possible immediately, e.g. with a drag error. In other cases, the troubleshooting must be remedied first (e.g. temperature error, load voltage error).

Shortly after acknowledging the error (RESET 0➔1) the error is reset. To enable the controller, a rising flank (CONTROL ENABLE 0➔1) is required. After that, the motor controller is once again ready for operation (READY=1).



Time delay t1 ≥ 2 ms

1 Error event
2 Acknowledge error
3 Request controller enable

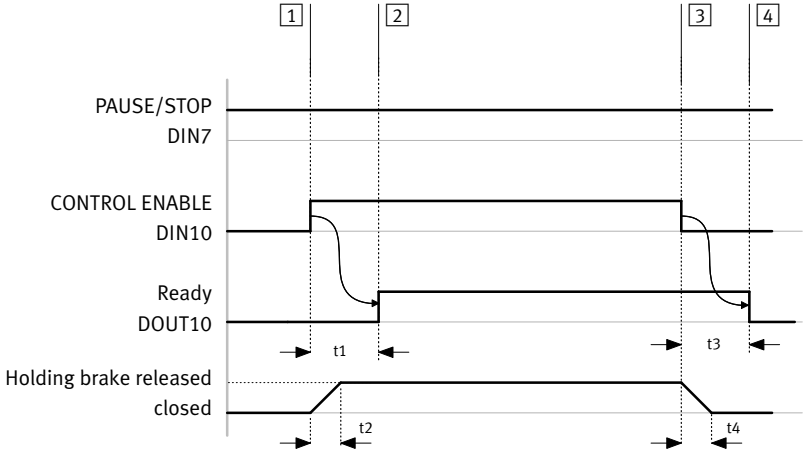
Fig. 5.12 Binary profile: acknowledge error

5.6.5 Controller enable (CONTROL ENABLE)

Input DIN 10 controls closed-loop control enable and the power output stage.
The first time ENABLE is set after the power supply is switched on, the controller conducts a commutation angle search (duration: up to 2 seconds).
On devices with a holding brake, activation of the holding brake is linked via X6.5 (BR+) to closed-loop control enable:

– CONTROL ENABLE 0➔1
  The controller is switched on. On devices with a holding brake, the holding brake is opened automatically during the switch-on delay. If no error is present, READY=1. In status ENABLE=1 the actuator is held in position while stationary.
– CONTROL ENABLE 1➔0
  The ongoing order is stopped (Quick Stop). On devices with a holding brake, the holding brake is closed automatically during the switch-off delay. After that, the closed-loop controller is switched off and READY=0 disables ready status.
  In ENABLE=0 status, no orders are accepted. On motors without a holding brake, the axis can be offset manually.

On motors with a holding brake, the holding brake can be opened by 1-signal on the BRAKE CONTROL input. Further information about the holding brake ➔ Chapter 2.5.6.



Delay times:
t1: depending on the parameterised switch-on delay
t2: depending on the mechanical inertia of the holding brake
t3: depending on the parameterised switch-off delay
t4: depending on the mechanical inertia of the holding brake

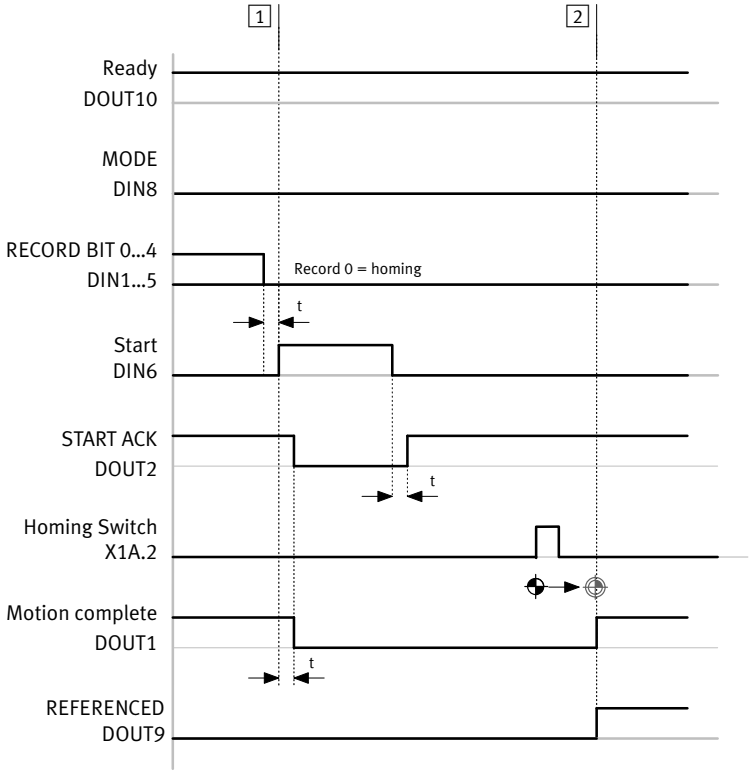
1 Request controller enable
2 Controller has been enabled
3 Revoke controller enable
4 Confirmation that controller is blocked

Fig. 5.13 Binary profile: release/inhibit controller

5.6.6 Carrying out homing (REF)

To perform homing, RECORD set of commands 0 must be addressed at the inputs. Homing is started by input START 0➔1.

Following successful completion of the homing run the REFERENCED output is set. REFERENCED remains enabled while the actuator is being homed.



Time delay t ≥ 2 ms

1 Start homing

2 Drive is referenced

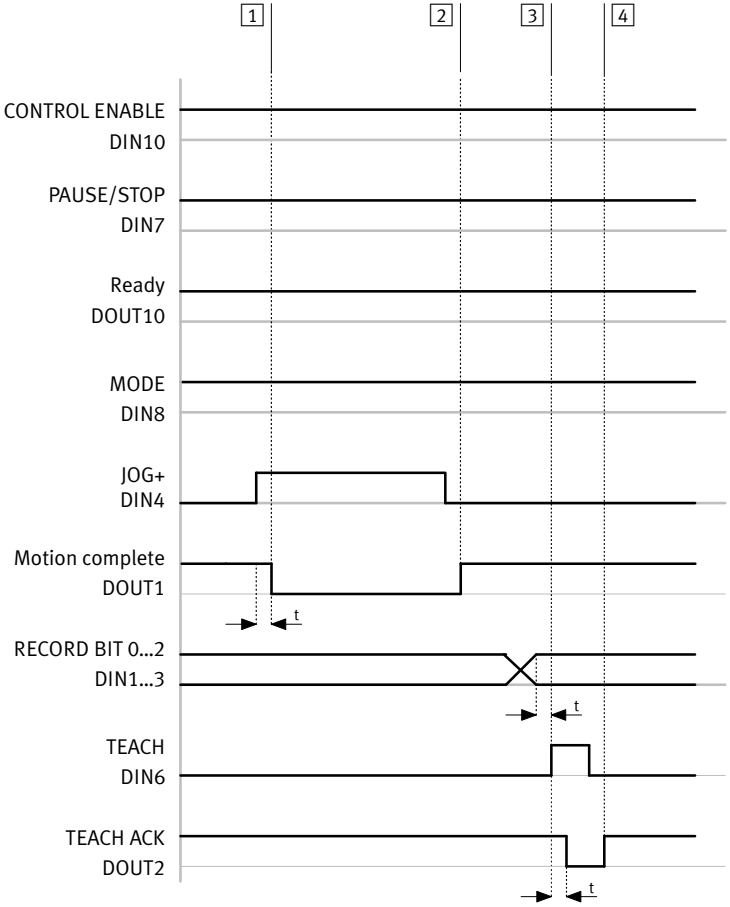
Fig. 5.14 Binary profile (mode 0): homing to reference switch

The input for reference switch signal to X1A.2 signals that the homing position has been reached. The type of switch used (NC/NO) is selected using FCT [...] [Axis] Axis Options. Detailed information about the homing process and about how the homing point is determined ➔ Chapter 2.5.2

5.6.7 Teaching (TEACH)

In positioning mode, the target positions for 7 absolute sets of commands can be taught via the I/O interface.

The TEACH signals are flank-triggered. If the TEACH signal was set and if the process cannot be executed, the TEACH signal needs to be reset. A new process cannot be started until after that.



Time delay t ≥ 2 ms

1 Jog JOG+ started
2 Jog JOG+ was stopped
3 Establish teach readiness
4 Current position was applied

Fig. 5.15 Binary profile (mode 1): teaching

The Teach process is performed with a handshake process using signals TEACH/TEACH ACK:
– The set of commands is addressed by the PLC via DIN1…3 (RECORD1…7).
– Via JOG+ or JOG- the actuator can be positioned. If both signals are active at the same time, JOG- is preferred.
– A rising flank at DIN6 (TEACH) signals that a teach process should be performed.
– The motor controller signals via a declining flank to DOUT2 (TEACH ACK) that the Teach process can be performed.
– A declining flank at DIN6 (TEACH) signals that the actual position should be adopted as a parameter. The motor controller saves the position automatically in the addressed record.
– The motor controller signals via a rising flank to DOUT2 (TEACH ACK) that the position was accepted successfully.

Automatic saving:
Automatic saving of the taught position can either be temporary or permanent:
– Option set (factory specification): the taught position is saved permanently.
– Option not set: the taught position is effective temporarily and is then lost when the logic power supply is switched off. Permanent storage via FCT or web server remains possible.

Note
Damage to the FLASH memory
The FLASH memory is designed for 100,000 write cycles.
- Only use the TEACH function in combination with automatic storage for commissioning and **not** in continuous operation. This would otherwise rapidly use up the permitted number of write cycles.
- Disable automatic saving after saving via FCT ➔ FCT […] [Controller] [I/O Configuration].

5.6.8 Execute command records (RECORD)

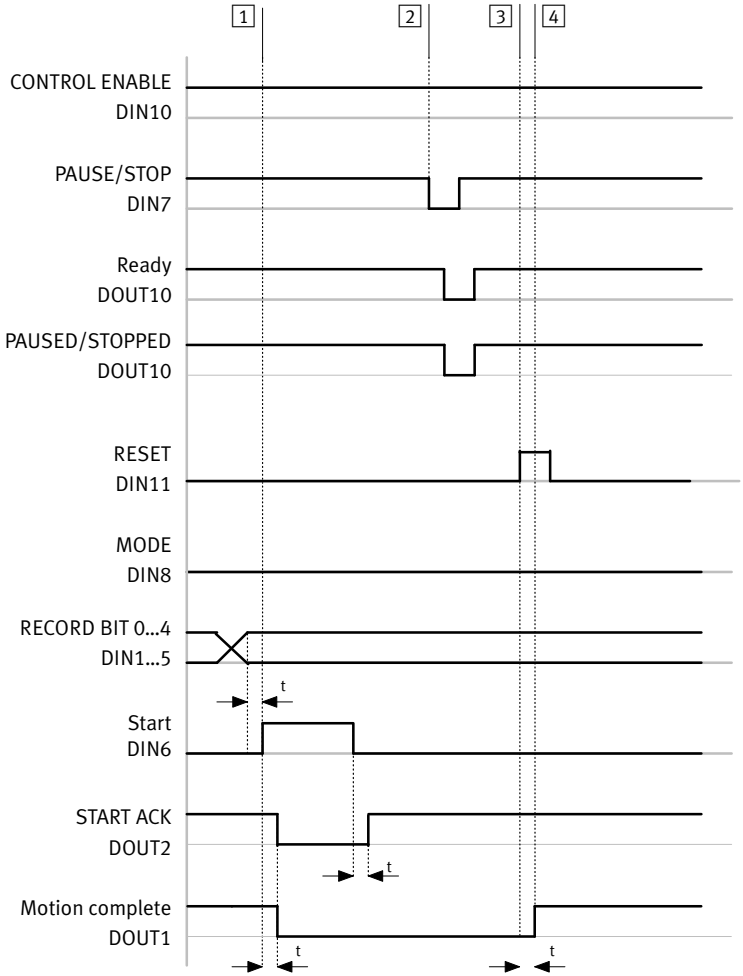
To initiate a command record, in addition to ready status, the following conditions must be satisfied: the actuator is referenced:

- The actuator is referenced (DOUT REFERENCED = 1)
- Input MODE = 0

Clear start/stop sequence with residual travel, record switching

- Select record:
  The desired record number is addressed via the inputs RECORD BIT 0 ... 4.
- Start record:
  Once the actuator is ready for operation, the order is started by enabling the START input. The start signal is acknowledged by the START ACK signal.
- Stop record:
  Stop record: during execution of the order, if input PAUSE/STOP is disabled, the actuator is slowed down to a complete stop by the parameterised record delay. The order is interrupted (pause). The output MOTION COMPLETE is not enabled. In this condition, the set of commands can be continued with START or the remaining path can be deleted.
- Delete remaining path:
  The remaining path can be deleted using the corresponding signal to the control interface. The output MOTION COMPLETE is enabled.
- Target reached / remaining path deleted (Motion complete):
  the actuator is in the position window for the parameterised rest time. The corresponding output MOTION COMPLETE is set.
- Record changeover (start condition for following record: “Interrupt”)
  The execution of the record is interrupted during selection of the following record and the following record is executed immediately without a stop.

Record selection: delete start/stop with remaining path

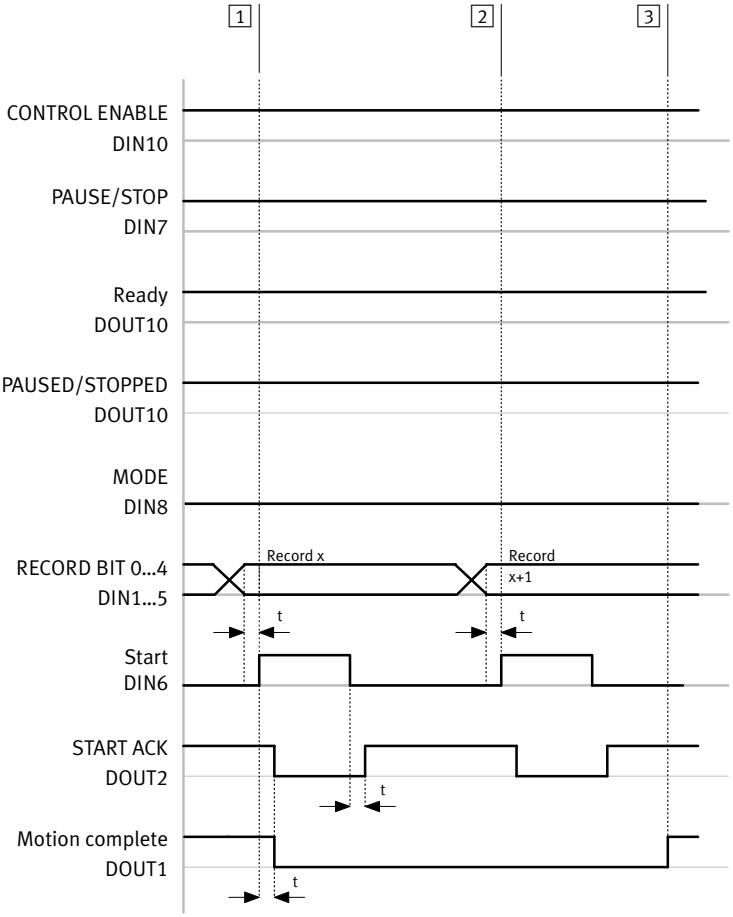


Time delay t ≥ 2 ms

1 Start record
2 Stop record (PAUSE)
3 Delete remaining path
4 Signal for order complete (target reached)

Fig. 5.16 Binary profile (Mode 0): e.g. record selection, delete start/stop with remaining path

Record selection with record switching



Time delay t ≥ 2 ms

1 Record x start

2 Record changeover from record x to record x+1
Start condition record x+1: interrupt

3 Target reached (record X+1)

Fig. 5.17 Binary operation (mode 0): record switching with start condition = interrupt

5.7 Instructions on operation

5.7.1 Recording of trace data with FCT (Trace)

FCT makes it possible to record drive data over a defined period in real time, e.g. speeds and contouring errors during a movement.
Additional information on this ➔ FCT Help .

5.7.2 Restore factory setting

FCT makes it possible to restore the factory setting of the device. This involves deleting all parameters and the factory presettings being restored.
Firmware updates already carried out are **not** however reversed. The firmware delivered ex-factory can however be reloaded in a device with FCT (➔ FCT menu [Component] [Firmware Download]).

5.7.3 Loading firmware

FCT makes it possible to update the device firmware. If needed, an older version of the firmware can also be loaded into the motor controller.

Festo provides firmware versions on the Internet via the Support Portal (➔ www.festo.com/sp):

- Enter the part number or order code of the product in accordance with the product labelling
- Check to see that an appropriate version of the firmware is available
- Check to find out if an updated plug-in is available for the firmware

When loading the firmware with the FCT, first only transmit identification data to the motor controller. The motor controller checks if the firmware is compatible with the device

– Firmware is not compatible: The loading process is terminated and a corresponding error message is displayed.
– Firmware is compatible: The firmware is transmitted to the device.
  If the existing parameterisation is compatible with the firmware, it is retained. If the firmware was transmitted incorrectly, the device restarts automatically and loads the new firmware.

Note
Incorrectly or improperly executed firmware downloads can render the device unusable.
Recommendation:

- Back up parameter file before the firmware download using the web server or with FCT (backup file).
- After download of the firmware for the new motor controller, download its backup file from the web server or with FCT to the motor controller (download).

5.7.4 Integration in a network

Note

Unauthorised access to the device can cause damage or malfunctions. When connecting the device to a network:

- Protect your network from unauthorised access.

Measures for protecting the network include:

- Firewall
- intrusion prevention system (IPS)
- Network segmentation
- Virtual LAN (VLAN)
- Virtual Private Network (VPN)
- Security at a physical access level (Port Security).

For further information, please refer to the guidelines and standards for security in information technology, e.g. IEC 62443, ISO/IEC 27001.

Prior to integration in a network, the IP addressing of the device must be changed with FCT. The IP configuration on the device can be changed without the current IP configuration of the device matching that of the PC.

DHCP/IPv4	Addressing	Description
Client	Automatic	The device obtains its IP configuration from a DHCP server in your network. This method is necessary for network operation if another DHCP server already exists on the network.
	static	The IP configuration of the device can be permanently assigned manually. However, the device can only be addressed if the assigned IP configuration matches the IP configuration of the PC. Permanently set IP configurations do not become effective until after a reboot (Power OFF, ON).

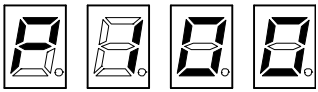
Tab. 5.15 TCP/IPv4 setting for integration in a network

6 Diagnostics

6.1 7-segment display

6.1.1 Display of diagnostic messages

The 7-segment display on the CMMO-ST provides information about the current operating mode, errors and warnings. 4 characters are always displayed in succession, followed by a space. The numbers of diagnostic messages for the error or warning categories are coded in **hexadecimal** format (➔ Chapter 6.3.2).



Advertisement	Operating mode/event	Priority	
B L E	Bootloader error	1	Error during the firmware update. • Switch the device off and back on again (reset) If the error occurs repeatedly, please contact your local Festo Service.
Exxx[1)]	Faults	2	Error messages interrupt messages with a lower priority and must be acknowledged.
Axxx[1)]	Warning	3	Warnings have a lower priority than errors and are not displayed if they occur when an error is already displayed. Otherwise they are displayed twice in succession. Warnings do not have to be confirmed (acknowledged).
HHHH	STO – Safe torque off	4	The STO function has been requested.
P000	Homing	5	Normal operation
P070	Jog positive		
P071	Inch negative		
P1xx[2)]	Positioning mode		
P2xx[2)]	High-power mode		
P3xx[2)]	High-speed mode		

1) xxx = Fault number, hexadecimal

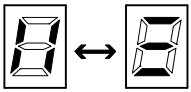
2) xx = Record number, decimal

Tab. 6.1 Messages on the 7-segment display

Messages with a higher priority interrupt messages with a lower priority. As malfunctions can occur and be acknowledged faster than they can be displayed on the 7-segment display, it may be the case that not all messages are displayed. Read the diagnostic memory ( ) in order to have all messages displayed (➔ Chapter 6.2).

6.1.2 Display during a firmware update

During a firmware update the display alternates between vertical and horizontal segments.



6.1.3 Waving function

The wave function enables a motor controller to be identified within a network that has multiple motor controllers. The point flashes in the display of the selected motor controller; the motor controller “nods”.

Enable waving function with web server:

- “Diagnosis” website: click option box “Identify this CMMO: on”.

Enable waving function with FCT:

- FCT menu [Component] [FCT Interface] open the window “FCT Interface”
- With ‹Search› start the “Festo Field Device Tool” (Netscan) program. All reachable motor controllers are displayed in accordance with the filter setting.
- In the Context menu [Identification] of the searched for motor controller, select “On”.

6.2 Diagnostic memory

The motor controller has a non-volatile diagnostic memory for the recording of diagnostic messages. The diagnosis memory is designed as a ring memory with a capacity of 200 diagnostic messages. The relevant diagnostic messages are written consecutively to the diagnosis memory. Whenever the diagnostic memory is full, the oldest diagnostic message will be overwritten when a new diagnostic message arrives. The diagnostic message that gets logged can be defined by the FCT error management function ➔ FCT [...] [Controller] [Error Management].

Access to the diagnostic memory

– Interrogate, display, delete or export diagnostic memory ➔ FCT online tab “Diagnosis”
– Interrogate and display diagnostic memory ➔ “Diagnosis” memory: “Diagnostic Memory”

The most recent diagnostic message is displayed in the top row.

Deleting the diagnostic memory

The diagnostic memory can also be cleared using FCT. When deleting, a “Start-up event” (message 3Dh) is generated and is logged in the diagnostic memory. The counter is not reset.

Information	Description
Counter (Counter)	Counter number of diagnostic message. The most recent message (top) has the highest number.
Type (Type)	Classification of the diagnostic message (➔ Tab. 6.3)
number (No.)	Hexadecimal number of the message (0x = hex prefix).
Message (Message)	Brief description of the diagnostic message
Timestamp (Timestamp)	Time of the fault in the format "HH.MM.SS:nnn (HH = hours, MM = minutes, SS = seconds, nnn = milliseconds). The time base is the respective switch-on time of the motor controller.
Additional info (Additional Info)	Additional information for Festo Service in respect of complex malfunctions

Tab. 6.2 Displays in the diagnostic memory

6.3 Diagnostic messages

6.3.1 Error management

The parameterisable diagnostic messages from the motor controller can be classified with FCT as errors, warnings or as information. All diagnostic messages can be parameterised in a way that enables them to be stored in the diagnostic memory.

Classification	Description
Faults (Error)	Errors always generate an error response and these must be acknowledged. Certain errors cannot be acknowledged until their cause has been remedied
Warning (Warning)	Warnings have no influence on the behaviour of the actuator and do not need to be acknowledged. The cause of a warning should be eliminated to prevent the warning from resulting in an error.
information, (Information)	Information can have an influence on the behaviour of the actuator and do not need to be acknowledged.

Tab. 6.3 Classifications of diagnostic messages ➔ FCT [...] [Controller] [Error Management]

Error responses can be assigned to some of the errors that influence the stop characteristics and subsequent disconnection of the output stage:

Error response	Description
Free run-out (Free-weeling)	The output stage is switched off. The drive gradually comes to a standstill.
Quick stop deceleration (QS deceleration)	The movement is stopped immediately with the parameterised quick-stop deceleration function. There is the option of shutting down the output stage.
Satz-Verzögerung (Deceleration record)	The movement is stopped immediately with the current record for parameterised deceleration. There is the option of shutting down the output stage.
End record (Finish record)	The current set is performed until the target is met (Motion Complete). There is the option of shutting down the output stage.

Tab. 6.4 Error response

Caution

Injuries as a result of automatic movement of the passive actuators as a result of error responses that shut down the output stage

During installation of the actuator in an inclined or vertical position, falling loads!

- Secure loads through external safety measures (e.g. toothed pawls or moved pivot pins). This especially applies to vertical axes without automatic locking mechanics, clamping units or counterbalancing.
- Prevent movement of the passive motor in particular with suspended loads or other external forces, e.g. with a holding brake.

Note

Wear on holding brakes with error response “A” (free outlet)

When the output stage is switched off during a movement there is no deceleration of the actuator via a braking ramp. The holding brake is closed immediately.

- Check whether the integrated holding brake can stop the actuators.
- Note the mechanical inertia of the holding brake.
- Take into consideration the higher wear of the holding brake in comparison to automatic brake control in normal operation.

6.3.2 Tables

The tables for the diagnostic messages contain the following information:-

Term	Function
no.	Number of the diagnostic message in hexadecimal notation.
Classifiable as ...	**F**/W/I = Fault/Warning/Information (➔ Tab. 6.3) Indicates which classification is possible for a diagnostic message. The factory setting is printed in bold (here F). If a classification is not possible, this is indicated by dashes. Example: “F/–/–” means that the diagnostic message can only be classified as a fault.
Diagnostic memory	Indicates whether an entry is made in the diagnostic memory or if this can be parameterised in FCT.
Acknowledgement option	Contains information about the scope for acknowledgement. Acknowledgement can be performed by FCT, web server or I/O interface DIN11 (RESET) **Software reset:** If the fault cannot be acknowledged, a restart must be performed: – Restart FCT with the command [Component] [Online] [Restart controller] – or switch device on and off
Error response	For every diagnostic message, provides the parameterisable error responses as Code letters (A to G) (➔ Tab. 6.6). Code letters for the ex-factory response settings are printed in bold.

Tab. 6.5 Explanations about the diagnostic messages

Code letters for the parameterisable error responses	
A	Free outlet – no braking ramp, turn off output stage
B	Quick-Stop deceleration - quick-stop braking ramp, turn off output stage
C	Set deceleration - turn off braking ramp of current position records, turn off output stage
D	Ending a record - execute the record to the end until Motion complete, turn off output stage
E	Quick-Stop deceleration – quick-stop braking ramp, do **not** turn off output stage
F	Record deceleration - do not turn off braking ramp on current position records, **do not** turn off output stage
G	Ending a record - continue to execute the record until Motion Complete, do **not** turn off output stage

Tab. 6.6 Error responses (code letters)

Diagnostic messages and fault clearance		
01h	**Software error**	Definable as: **F**/-/- Diagnostic memory: always
An internal firmware error has been detected. • Contact Festo Service. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		
02h	**Default parameter file invalid**	Definable as: **F**/-/- Diagnostic memory: always
An error has been detected when examining the default parameter file. The file is damaged. • Reload the default parameter file into the device via a firmware update. If the error is still present, it means the memory may be faulty and the device needs to be replaced. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		
05h	**Zero angle determination**	Definable as: **F**/-/- Diagnostic memory: always
The rotor position could not be clearly identified. The commutation point is invalid. • Is there a motor with encoder and, if yes, is the encoder cable connected? The drive is blocked: Ensure freedom of movement. • Excessively high load: Reduce load. • The axis is not fastened stiffly enough: Stiffen the axis mounting. • The effective load is not fastened stiffly enough on the axis: Stiffen the connection. • Effective load can vibrate: Form a stiffer load; modify the natural frequency of the load. • If several drives are fitted in a system that can vibrate: Carry out commutation point search one after the other. • Controller parameters have been set incorrectly: Determine the controller parameters and set the correct value. To do this, you may have to perform a commutation point search without a load (remove the load, correctly set the tool mass and applied load), start the axis, connect the load (correctly set the tool mass and applied load), determine the new controller parameters (see FCT help on controller parameterisation), reparameterise the drive and then restart the commutation point search with new controller parameters. • This error can also occur if the set motor current is too low to move the shaft and any possible load. Correct the settings for the motor current, if necessary. – Resettable: Error can be reset immediately. Definable error reaction(s): A		

Diagnostic messages and fault clearance

06h	**Encoder**	Definable as: **F**/-/- Diagnostic memory: always
An error has occurred during evaluation of the encoder. The current position values may be incorrect. • Check encoder cable and connection for short-circuits, breaks or incorrect pin assignment. • Conduct a software reset with a commutation angle search and homing procedure. • If the error is still present, the hardware (encoder) may be defective. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		
09h	**Offset determination for current measurement**	Definable as: **F**/-/- Diagnostic memory: always
An error has occurred during initialisation of the current measurement. • Perform a software reset. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		
0Ah	**General error**	Definable as: **F**/-/- Diagnostic memory: always
An internal error has occurred. • Restart device. If the error occurs frequently, contact Festo Service. – Resettable: Error can be reset immediately. Definable error response(s): B		
0Bh	**Parameter file invalid**	Definable as: **F**/-/- Diagnostic memory: always
No valid parameter set stored. After creation of the parameter file, a firmware update is performed, if necessary: As much data as possible is automatically loaded from the parameter file. Parameters that are not initialised by the parameter file are loaded from the default parameter file. • Enter a valid parameter set in the device. If the error is still present, the hardware may be defective. – Resettable: Error can be reset immediately. Definable error reaction(s): A		
0Ch	**Firmware update execution error**	Definable as: **F**/-/- Diagnostic memory: optional
The firmware update has not been properly executed or completed. • Check Ethernet connection between device and PC. Restart device and perform the firmware update again. Check whether valid firmware has been selected for the device. The previous firmware version remains active until the firmware update has been successfully completed. If this error is still present, the hardware may be defective. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		

Diagnostic messages and fault clearance		
0Dh	**Over-current**	Definable as: **F**/-/- Diagnostic memory: always
Short circuit in the motor, lines or brake chopper. Output stage defective. Incorrect parameterisation of the current regulator. • Check parameterisation of the current regulator. An incorrectly parameterised current regulator can generate currents up to the short-circuit limit; as a rule this is clearly noticeable through high frequency whistling. Inspection with the trace function in FCT (active current actual value). • Error message immediately after connecting to the load supply: Short circuit in the output stage. The device must be replaced immediately. • Error message only occurs when setting the output stage enable: Disconnect the motor plug directly at the controller; if the error still occurs, the controller must be replaced. If the error only occurs when the motor cable is connected, check the motor and cable for short circuits, e.g. with a multimeter. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		
0Eh	**I²t malfunction motor**	Definable as: **F**/-/- Diagnostic memory: always
The I²t limit for the motor is reached. The motor or the drive system may be insufficient for the required task. • Check the layout of the drive system. • Check the mechanical system for sluggishness. • Reduce load/dynamic response, longer time delays. – Resettable: Error can only be reset after the cause of the error has been eliminated. Definable error response(s): B, **C**		
11h	**Software limit positive**	Definable as: **F**/-/- Diagnostic memory: optional
The position setpoint has reached or exceeded the respective software end position. • Check target data. • Check positioning area. • This error can be reset immediately. Afterwards start a corresponding positioning record or move the drive by using the jogging function. Movements in a positive direction are blocked. – Resettable: Error can be reset immediately. Definable error response(s): A, **B**, C, E, F		

Diagnostic messages and fault clearance

12h	**Software limit negative**	Definable as: **F**/-/- Diagnostic memory: optional
The position setpoint has reached or exceeded the respective software end position. • Check target data. • Check positioning area. • This error can be reset immediately. Afterwards start a corresponding positioning record or move the drive by using the jogging function. Movements in a negative direction are blocked. – Resettable: Error can be reset immediately. Definable error response(s): A, **B**, C, E, F		
13h	**Positive direction locked**	Definable as: **F**/-/- Diagnostic memory: optional
A limit switch error or a software limit position error has occurred and subsequent positioning in the blocked direction has been initiated. • Check target data. • Check positioning area. • This error can be reset immediately. Afterwards start a corresponding positioning record or move the drive by using the jogging function. Movements in a positive direction are blocked. – Resettable: Error can be reset immediately. Definable error response(s): A, **B**, C, E, F		
14h	**Negative direction locked**	Definable as: **F**/-/- Diagnostic memory: optional
A limit switch error or a software limit position error has occurred and subsequent positioning in the blocked direction has been initiated. • Check target data. • Check positioning area. • This error can be reset immediately. Afterwards start a corresponding positioning record or move the drive by using the jogging function. Movements in a negative direction are blocked. – Resettable: Error can be reset immediately. Definable error response(s): A, **B**, C, E, F		

Diagnostic messages and fault clearance

15h	**Output stage temperature exceeded**	Definable as: **F**/-/- Diagnostic memory: optional
The permissible limit value for the output stage temperature has been exceeded. The output stage is possibly overloaded. • This error can only be acknowledged if the temperature is within the permissible range. • Check cylinder sizing. • Check the mechanical system for sluggishness. • Reduce the ambient temperature, improve heat dissipation. Check motor and cabling for short circuits. – Acknowledgeability: Error can only be acknowledged after eliminating the cause. Definable error response(s): A, B, **C**, D		
16h	**Output stage temperature too low**	Definable as: **F**/-/- Diagnostic memory: optional
The ambient temperature is below the permissible range. • Increase the ambient temperature. This error can only be acknowledged if the temperature is within the permissible range. – Resettable: Error can only be reset after the cause of the error has been eliminated. Definable error response(s): A, B, **C**, D		
17h	**Logic voltage exceeded**	Definable as: **F**/-/- Diagnostic memory: optional
The logic power supply monitor has detected an overvoltage. This is either due to an internal defect or an excessive supply voltage. • Check external supply voltage directly on the device. • If the error is still present after a reset has been conducted, it means there is an internal defect and the device has to be replaced. – Resettable: Error can only be reset after the cause of the error has been eliminated. Definable error response(s): A, **B**		
18h	**Logic voltage too low**	Definable as: **F**/-/- Diagnostic memory: optional
The logic power supply monitor has detected an undervoltage. There is either an internal defect or an overload/short circuit caused by connected peripherals. • Separate device from the entire peripheral equipment and check whether the error is still present after reset. If it is, it means there is an internal defect and the device has to be replaced. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		

Diagnostic messages and fault clearance

19h	**Real time error LM-CPU**	Definable as: **F**/-/- Diagnostic memory: optional

The LM-CPU requires more computation time than is available to it.
- Check whether multiple connections have been established to the device. If yes, terminate the unneeded connections. Further remedial measures: Do without trace drawings, reduce bus load

– Resettable: Error can be reset immediately.
  Definable error response(s): A, **B**

1Ah	**Intermediate circuit voltage exceeded**	Definable as: **F**/-/- Diagnostic memory: always

Load voltage not within the permissible range.
Braking resistor is overloaded; too much braking energy, which cannot be dissipated quickly enough.
Braking resistor is defective.
- Check the load voltage; measure voltage directly at the controller input.
- Check cylinder sizing: braking resistor overloaded?
- In the event of a defective internal braking resistor: Replace the controller.

– Acknowledgeability: Error can only be acknowledged after eliminating the cause.
  Definable error response(s): A, **B**

1Bh	**Intermediate circuit voltage too low**	Definable as: **F**/W/- Diagnostic memory: optional

The load voltage is too low.
- Voltage drops under load: power supply unit too weak, supply line too long, cross section too small?
- If you intentionally want to operate the device with a lower voltage, parameterise this malfunction as a warning or information.
- Measure load voltage (directly at the controller input).

– For parameterisation as an error: The error can only be acknowledged after the cause is eliminated.
  Definable error reaction(s): **A**

– For parameterisation as a warning: The warning disappears if the load voltage is back within the permissible range.

22h	**Homing**	Definable as: **F**/-/- Diagnostic memory: optional

Homing run to switch unsuccessful. A corresponding switch has not been found.
- Check to make sure the correct homing method is set.
- Check to see if the homing switch is connected and if it has been parameterised correctly (normally closed contact/normally open contact?). Check the functionality of the switch and check the cable for wire breaks.
- If the error is still present, it means there is an internal defect and the device has to be replaced.

– Resettable: Error can be reset immediately.
  Definable error response(s): **B**, C, E, F

Diagnostic messages and fault clearance

23h	**No index pulse found**	Definable as: **F**/-/- Diagnostic memory: optional
Error during homing: no zero pulse found. Encoder defective or incorrect parameterisation of the encoder resolution. • Check the output signals of the encoder, in particular the index signal. • Check the parameterisation of the encoder resolution. – Resettable: Cannot be reset; software reset is necessary. Definable error response(s): **B**, C, E, F		
24h	**Drive function is not supported in open-loop operation**	Definable as: **F**/W/- Diagnostic memory: optional
Function is not supported in this mode. The request has been ignored. • Change the operating mode or select a different drive function. – If parameterisation as an error: Error can be acknowledged immediately. Definable error response(s): **E**, F – For parameterisation as a warning: The warning disappears if a switch is made to a valid drive function.		
25h	**Path calculation**	Definable as: **F**/-/- Diagnostic memory: optional
The positioning target cannot be reached through the positioning options or the edge conditions. During record sequencing: The end speed of the last record was higher than the target speed of the following record. • Check the parameterisation of the affected records. • Also check the actual values of the previous positioning process at the switching point, if necessary, by using the trace function. The error may be caused by the actual velocity or the actual acceleration being too high at the switching point. – Resettable: Error can be reset immediately. Definable error reaction(s): A		
27h	**Save parameters**	Definable as: **F**/-/- Diagnostic memory: optional
Error during writing of the internal permanent memory. • Execute the last operation again. • Check the following: Is an error present that can be reset first? When downloading a parameter file, check if the version of the parameter file fits the firmware. If the error occurs again, please contact Festo Service. – Resettable: Error can be reset immediately. Definable error response(s): **F**, G		

Diagnostic messages and fault clearance

28h	**Homing required**	Definable as: **F**/W/- Diagnostic memory: optional
A valid reference travel has not yet been conducted. The drive is no longer referenced (e.g. as a result of a logic power failure or because the homing method or axis zero point has been changed). • Perform homing or repeat the last homing if it was not completed successfully. – If defined as an error: Error can be reset immediately. Definable error reaction(s): **B**, C, D, E, F, G – For parameterisation as a warning: The warning disappears if the homing run has been completed successfully.		
29h	**Target position behind negative software limit**	Definable as: **F**/-/- Diagnostic memory: optional
The start of a positioning task was suppressed because the target lies behind the negative software limit position. • Check target data. • Check positioning area. • Check position set type (absolute/relative?). – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, E, F		
2Ah	**Target position behind positive software limit**	Definable as: **F**/-/- Diagnostic memory: optional
The start of a positioning task was suppressed because the target lies behind the positive software limit position. • Check target data. • Check positioning area. • Check position set type (absolute/relative?). – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, E, F		
2Bh	**Firmware update, invalid firmware**	Definable as: **F**/W/- Diagnostic memory: optional
The firmware update process could not be performed. The firmware version is incompatible with the hardware used. • Determine the version of the hardware. You can ascertain the compatible firmware designs and download the appropriate firmware from the Festo website. – If defined as an error: Error can be reset immediately. Definable error reaction(s): **A** – For parameterisation as a warning: The warning disappears if a new FW download process is started.		

Diagnostic messages and fault clearance

2Dh	**I²t warning motor**	Definable as: -/**W**/I Diagnostic memory: optional
The I²t warning limit for the motor is reached. • Parameterise message as a warning or suppress completely as information. – For parameterisation as a warning: The warning disappears if the I²t integral is below 80 %.		
2Eh	**Index pulse too close on proximity sensor**	Definable as: **F**/-/- Diagnostic memory: optional
The switching point of the proximity sensor is too close to the index pulse. This can in some cases mean that no reproducible reference position can be determined. • Move reference switches on the axis. You can display the distance between the switch and index pulse in the FCT. – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, E, F		
2Fh	**Following error**	Definable as: **F**/W/I Diagnostic memory: optional
The following error has become too great. This error can occur during positioning and speed modes. • Enlarge error window. • Acceleration, speed, jerk or load too great? Mechanics stiff? • Motor overloaded (current limitation from I²t monitoring active?) – If defined as an error: The error can only be reset after the cause is eliminated. Definable error response(s): B, C, **E**, F – For parameterisation as a warning: The warning disappears if the following error is back within the permissible range.		
31h	**CVE connection** (control via Ethernet)	Definable as: **F**/-/- Diagnostic memory: optional
A connection error has occurred during “Control via Ethernet” (CVE). • Check the connection: plug disconnected, cable lengths observed, shielded cable used, screening connected? – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, D, E, F, G		
32h	**FCT connection with master control**	Definable as: **F**/-/- Diagnostic memory: optional
Connection to the FCT has been interrupted. • Check the connection and perform a reset, if necessary. – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, D, E, F, G		

Diagnostic messages and fault clearance

33h	**Output stage temperature warning**	Definable as: -/**W**/I Diagnostic memory: optional
Temperature of output stage increased. • Check cylinder sizing. • Check motor and cabling for short circuits. • Check the mechanical system for sluggishness. • Reduce the ambient temperature; take output derating into account; improve heat dissipation. – For parameterisation as a warning: The warning disappears if the temperature is back below the danger threshold.		
34h	**Safe Torque Off (STO)**	Definable as: F/**W**/I Diagnostic memory: optional
The “Safe Torque Off” safety function has been requested. • Observe the separate documentation for the STO function. – If defined as an error: The error can only be reset after the cause is eliminated. Definable error reaction(s): 0 – For parameterisation as a warning: The warning disappears if the STO is no longer requested.		
37h	**Standstill monitoring**	Definable as: -/**W**/I Diagnostic memory: optional
The actual position is outside the downtime window. Parameterisation of the window may be too narrow. • Check parameterisation of the downtime window. – If defined as a warning: The warning is no longer active when the actual position is within the standstill window again or a new record has been started.		
38h	**Parameter file access**	Definable as: **F**/-/- Diagnostic memory: optional
During a parameter file procedure all other reading and writing routines for the parameter file are blocked. • Wait until the process is complete. The time between 2 parameter file downloads should not be less than 3 s. – Acknowledgement option: Error can only be acknowledged after eliminating the cause. Definable error response(s): **F**, G		
39h	**Trace warning**	Definable as: -/**W**/- Diagnostic memory: optional
An error has occurred during trace recording. • Start a new trace recording. – For parameterisation as a warning: The warning disappears if a new trace has been started.		

Diagnostic messages and fault clearance

3Ah	**Homing timeout**	Definable as: **F**/-/- Diagnostic memory: optional
Error during homing process in controlled operation. The switch has not been found within a certain time. • Check the switch configuration and the electric connection of the switch(es). – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, E, F		
3Bh	**Homing method invalid**	Definable as: **F**/-/- Diagnostic memory: optional
Homing error. A homing method block has been set, for example, in open-loop operation. • Select permitted reference travel method. – Resettable: Error can be reset immediately. Definable error response(s): **E**, F		
3Ch	**Two edges in one pulse**	Definable as: **F**/-/- Diagnostic memory: optional
Two input signals have been set in the valve type in one input read cycle. • Program the PLC so that two records (or a record and homing run) are not started in the same pulse. In the event of manual control, only operate one switch after the other. – Resettable: Error can be reset immediately. Definable error response(s): **B**, C, E, F		
3Dh	**Start-up event**	Definable as: -/-/ Diagnostic memory: always
The device has been switched on or was switched on for longer than 48 days. This event also occurs when deleting the diagnostic memory. The start-up event does not occur if the preceding entry in the diagnostic memory has already been a start-up event. • This event is used only for better documentation of the diagnostic messages that occurred.		
3Eh	**Diagnostic memory**	Definable as: **F**/-/- Diagnostic memory: always
An error has occurred when writing or reading from the diagnostic memory. • Reset error. If the error is still present, it means a memory module is probably defective or an incorrect entry has been stored. • Clear diagnostic memory. If the error is still present, the device needs to be replaced. – Resettable: Error can be reset immediately. Definable error response(s): **F**, G		

Diagnostic messages and fault clearance		
3Fh	**Record invalid**	Definable as: **F**/-/- Diagnostic memory: optional
The started record is invalid. The record data is implausible or the record type is invalid. • Check parameters of the record. – Resettable: Error can be reset immediately. Definable error response(s): B, C, D, **E**, F, G		
40h	**Last teaching not successful**	Definable as: -/**W**/I Diagnostic memory: optional
Teaching of the current positioning record is not possible. • The current positioning record must be of the type 'position record'. – If defined as a warning: The warning is no longer active when the following TEACH attempt is successful or a switch takes place from the Teach mode (mode 1) to normal operation (mode 0).		
41h	**System reset**	Definable as: **F**/-/- Diagnostic memory: always
An internal firmware error has been detected. • Contact Festo Service. – Resettable: Error can be reset immediately. Definable error reaction(s): A		
43h	**FCT connection without master control**	Definable as: -/**W**/I Diagnostic memory: optional
There is no longer a connection to the FCT, e.g. the cable was disconnected. • Check the connection and perform a reset, if necessary. – For parameterisation as a warning: The warning disappears if the connection to the FCT is re-established.		
44h	**Parameter file not compatible with firmware**	Definable as: -/**W**/I Diagnostic memory: always
The parameter file that was just written to the device is not suitable for the firmware of that device. As much data as possible is automatically taken over from the parameter file. Parameters that are not initialised through the parameter file are imported from the default parameter file. If new firmware software is required, all parameters might not be written. • Load a valid parameter file into the device. – If defined as a warning: The warning disappears when a new parameter file is successfully written.		
4Dh	**Bootloader memory error**	Definable as: **F**/-/- Diagnostic memory: always
In the boot procedure, a defective memory cell was detected. • Perform a firmware update. If the error is still present, the memory might be faulty. Then the device must be replaced. – Resettable: Cannot be reset; software reset is necessary. Definable error reaction(s): A		

Diagnostic messages and fault clearance		
4Eh	**Overload 24 V Outputs**	Definable as: **F**/-/- Diagnostic memory: always
A short circuit or overload has occurred to an external 24 V supply voltage of the device. • Check wiring of the STO interface, reference switches and digital inputs and outputs. – Acknowledgement option: Error can only be acknowledged after the cause is eliminated. Definable error response(s): A, **B**		
4Fh	**System information**	Definable as: -/-/- Diagnostic memory: always
A device-specific system event has occurred. • This event is used for extended diagnostics.		

6.4 Problems with the Ethernet connection

In the event of problems with the Ethernet connection, the IP configuration of your motor controller and the IP configuration of your PC are presumably not matched to one another.

Determine the IP configuration of the motor controller and change it

FCT enables the following:

– Search for the motor controller on the network
– Determine the IP configuration and change it

1. Under the FCT menu [Component] [FCT Interface] open the “FCT Interface” window. With ‹Scan...› start the “Festo Field Device Tool” (Netzscan) program. All reachable motor controllers are displayed in accordance with the filter setting.
2. In the context menu for the device found, select the command [Network]. Then the “Network settings for the device” dialog is displayed. With this dialogue, the IP configuration can be determined and changed (possible settings ➔ Tab. 5.15).

Determine the IP configuration of the PC and change it - with Windows (e.g. Windows 7)

1. Select the command [Start] [System control] [Network and Internet] [Network and Approval Center] [Local Area Connection].
2. In the “Status” dialog of [Local Area Connection], select the command “Properties”.
3. Highlight in the following dialog window [Internet protocol Version 4].
4. Select the command “Properties”. After that, in the “Properties of Internet protocol version 4” the IP configuration of the corresponding Ethernet interface of the PC is displayed.
5. Set an IP configuration suitable for the motor controller (➔following example(s)).

Example: Matching IP configurations to suit one another

The ex-factory IP configuration is particularly well suited to a direct connection. Ex factory, the DHCP server of the motor controller is active (➔ Tab. 5.15). In this case, the motor controller has a firmly parameterized IP configuration (IP address 192.168.178.1; subnet mask: 255.255.255.0).
To match the PC to the factory setting, select the PC setting [source the IP address automatically] or set an appropriate fixed IP configuration (e.g. IP address 192.168.178.109; subnet mask: 255.255.255.0; Standardgateway: – (keine Adresse)).

Check the network settings on the PC - with Windows (e.g. Windows 7)

1. Select the command [Start] [(All)Programs] [Accessories] [Input Request].
2. Enter the command **`ipconfig`** or **`ipconfig /all`**.
3. Check whether the devices are accessible in the same subnet. Contact your network administrator, if necessary.

The command **Ping** can be used to determine if the motor controller can be reached on the network.

1. Select the command [Start] [(All)Programs] [Accessories] [Input Request].
2. Enter the following command line: `ping 192.168.178.1` (IP address of the motor controllers ex-factory)

6.5 Other problems and remedies

Problem	Cause	Remedy
Motor controller is not working	Motor controller is connected incorrectly	Check all cables and connections for short circuits, open circuits or incorrect pin allocation.
	defective cable	Observe the instructions in the assembly instructions for the cables and plugs used.
	Burned-through internal fuse (internal short circuit)	Replace the motor controller.
Motor controller fails to achieve the specified performance data	Incorrect control signals from the higher-order controller	Check control program.
	Controller incorrectly set	Check controller parameters. Observe the information in the online help section of the FCT plug-in to ensure correct settings of the controller parameters.
	Error in the power supply.	Comply with voltage tolerances in accordance with “Technical Data” chapter.

Tab. 6.7 Other problems and remedies

7 Maintenance, care, repair and replacement

Caution
Uncontrolled drive motion may cause personal injury and material damage.
Before carrying out mounting, installation and maintenance work:
- Switch off power supplies.
- Secure the power supplies against accidental reactivation.

Warning
Danger of burns from hot housing surfaces.
Contact with housing can cause burn injuries. This can scare people and cause them to act in an unpredictable manner. This can lead to other forms of secondary damage.
- Protect the motor controller to prevent accidental touching.
- Inform operating and maintenance staff about any potential hazards.
- Before touching the product, e.g. for mounting or installation: Allow the motor controller to cool down to room temperature.

7.1 Maintenance and care

If used as intended, the product is maintenance-free.
Regarding care
- Clean the outside of the product with a soft cloth.

7.2 Repair

Repair or maintenance of the product is not permissible.
If necessary, replace the complete product.

7.3 Replacement

Note

Loss of parameterisation

The motor controller parameters are reset to factory settings after replacement.

- Back up parameter file before replacement of motor controller with web server or with FCT (backup file).
- After installation of the new motor controller, download backup file to motor controller from the web server or with FCT (download).

Disassemble in reverse order of installation (➔ Chapter 3).

Before dismantling:

1. Ensure that there is no voltage.
2. Secure the system against being switched back on.
3. Loosen all electrical system lines.

7.4 Disposal

Observe the local regulations for environmentally appropriate disposal of electronic modules. The product is RoHS-compliant.

A Technical appendix

The technical data and safety ID values for the safety function and for connection of STO [X3] can be found in the STO documentation to CMMO-ST.
The technical data for the motor/encoder can be found in the operating instructions of the motor or the axis/motor combination from Festo ➔ www.festo.com/sp

The specified performance data relate to a max. 10 metre length of length of cable for connection of the motor/encoder. With longer cables: please contact Festo Service.

A.1 Technical data

A.1.1 General technical data

Type of mounting		H-rail
		Mounting plate (horizontal or vertical)
Operating and fault signal		7-segment display
Operating modes		
	Open-loop operation	Operating mode for motor without encoder Optionally adjustable, also for motor with encoder
	Closed-loop operation	Operating mode for motor with encoder
Parameterisation interface		Ethernet interface TCP/IP
Parameterisation		with Festo Configuration Tool (FCT)
		via web server
Control interface[1)]		Digital I/O
	Control profile I/O	Valve profile: DIN1 ... DIN11, DOUT1 ... DOUT11
		Binary profile: DIN1 ... DIN11, DOUT1 ... DOUT11
	Switch logic I/O	CMMO-ST- DIOP: PNP
		CMMO-ST- DION: NPN
Protective functions		I^2t monitoring Temperature monitoring (measurement of the power output stage) Current monitoring Overvoltage and undervoltage monitoring Following error monitoring Software end-position detection
Note on materials		RoHS compliant
Dimensions (H*W*D)		➔ Fig. 3.1
Weight	[kg]	0.29

1) Optional: Control Via Ethernet (CVE)

A.1.2 Operating and Environmental Conditions

Operating and Environmental Conditions		
Ambient temperature	[°C]	0 ... +50
Storage temperature	[°C]	–25 ... +75
Cooling		Passive
Temperature warning from output stage		
Output stage temperature exceeded	[°C]	> +85 Warning 0x33
Output stage temperature too low	[°C]	< -15 Warning 0x33
Switch-off temperature for output stage		
Output stage temperature exceeded	[°C]	> +95 error 0x15
Output stage temperature too low	[°C]	< -25 error 0x16
Degree of protection		IP40 (with full pin allocation)
Air humidity (at 25°C)	[%]	0 ... 90, non-condensing
Degree of contamination		2 (per EN 50178)
Permissible setup altitude (above sea level)	[m]	< 2000
Vibration and shock resistance (in accordance with IEC 60068) – Vibration (part 2-6) – Shock (part 2 - 27) – Continuous shock (part 2 - 27)		Severity level (SL)[1] for wall or H-rail mounting – Wall: SG2; H-rail: SG1 – Wall: SG2; H-rail: SG1 – Wall and H-rail: SG1

1) Explanation of the severity level ➔ Table “Explanation on vibration and shock – severity level”

Explanation on vibration and shock – severity level SL:

Vibration load					
Frequency range [Hz]		Acceleration [m/s²]		Deflection [mm]	
Severity level 1	SL2	SL1	SL2	SL1	SL2
2 ... 8	2 ... 8	–	–	±3.5	±3.5
8 ... 27	8 ... 27	10	10	–	–
27 ... 58	27 ... 60	–	–	±0.15	±0.35
58 ... 160	60 ... 160	20	50	–	–
160 ... 200	160 ... 200	10	10	–	–

Shock load					
Acceleration [m/s²]		Duration [ms]		Shocks per direction	
SL1	SL2	SL1	SL2	SL1	SL2
±150	±300	11	11	5	5

Continuous shock load		
Acceleration [m/s²]	Duration [ms]	Shocks per direction
±150	6	1000

A.1.3 Product conformity and certifications	
CE marking (declaration of conformity ➔ www.festo.com)	according to EU Machinery Directive 2006/42/EC
	according to EU EMC Directive 2014/30/EU[1)]
Approvals	UL Listing Mark for Canada and the United States
	RCM (Regulatory Compliance Mark)

1) The component is intended for industrial use. Outside of industrial environments, e.g. in commercial and mixed-residential areas, actions to suppress interference may have to be taken.

Requirements for observing the certified **UL** conditions if the product is operated in the USA or Canada can be found in the separate UL documentation.

A.2 Connection data

A.2.1 General connection data

Nominal voltage	[V DC]	24 ± 15 %
Nominal output current	[A]	5.7
Total current consumption	[A]	up to 9.4 (configuration-dependent)
Protection against electric shock		PELV circuit (Protected Extra-Low Voltage)
Protection class to EN60529		IP40 (plug connector inserted or fitted with protective cap)
Mains filter		Integrated

A.2.2 [X1] I/O interface

Signal level		Base on EN 61131-2:2008-04, type 1
Max. cable length	[m]	< 30
Digital inputs		
Nominal voltage (related to 0 V)	[V DC]	24
Maximum permitted input voltage	[V DC]	29
Nominal current per input	[mA]	2 (typical)
Scanning rate	[ms]	1
Reaction time to input	[ms]	2 (typical)
Galvanic isolation		no
Digital outputs		
Maximum current per output	[mA]	100
Overload protection		No overload protection (not short-circuit proof) Only use for switching the digital inputs.

A.2.3 [X1] Logic auxiliary power supply +24 V OUT [X1.24] GND [X1.25]

Nominal voltage – Supply via [X9] – not additionally filter or stabilized	[V DC]	24
Maximum current	[mA]	100
Overload protection		No overload protection Only use for switching the digital inputs

A.2.4 [X9] power supply

Load voltage (pin 5)			
	Nominal voltage	[V DC]	24 ± 15 %
	Nominal current	[A]	5.7
	Peak current	[A]	9.4
Intermediate circuit voltage			
	Max. intermediate circuit voltage	[V DC]	28
	Overvoltage (error 0 x 17)	[V DC]	›31.0
	Undervoltage (error 0x18)	[V DC]	‹19.0[1)]
Logic supply (pin 3)			
	Nominal voltage	[V DC]	24 ± 15 %
	Nominal current[2)]	[A]	0.3
	Overvoltage (error 0x1A)	[V DC]	›31.0
	Undervoltage (error 0x1B)	[V DC]	‹19.0

1) The value can be parameterised with FCT

2) Figure without power supply to the digital outputs ➔ Chapter A.2.2

A.2.5 [X18] Ethernet interface

Bus interface	IEEE802.3 (10BaseTx)
Transmission rate	100 MBit/s
Connection of plug connector	RJ45, 8-pin
Supported protocols	TCP/IP, UDP
Cable type	Industrial Ethernet cable, screened
Transmission class	Category Cat 5
Connection length	Maximum 30 metres to next star point

B Control via Ethernet (CVE)

B.1 Basic principles

The CMMO-ST can be controlled via the Ethernet interface of a PC program by using the function “Control via Ethernet” (CVE). This enables status data to be written from CMMO-ST and control data to be written to CMMO-ST.
To use the CVE function the CMMO-ST is pre-parameterised with FCT. CVE cannot be used to make any changes to the parameterisation. CVE can be used to start records and a homing run. The intermediate stop (pause) as well as jogging and teaching are not supported.

Communication with the CMMO-ST is achieved via the CVE protocol. This must be implemented in the PC application. Knowledge of programming TCP/IP applications is required for this purpose.

Caution
Not using the CVE interface as intended can result in personal injury and material damage
– The CVE interface is **not real-time capable**.
Controlling the CMMO-ST via Ethernet requires, among other things, a risk assessment by the user, ambient conditions that are free of interference and reliability of data transmission, e.g. via the control programme of the higher-order controller.
- Only use the CVE function in applications in which the lack of real-time capability cannot pose risks.
- In order to ensure machine safety the STO function must be used.

B.1.1 Communication principle

The basis for the CVE protocol is TCP data transmission (Transmission Control Protocol). The controller acts as the server in this setup, while the PC application acts as the client, i.e. the PC application always sends a request to the controller, which sends back a response (client-server principle).
The TCP connection is typically established once and remains in effect for as long as communication is required with the CMMO-ST. If the drive is in motion when the connection is ended, a Quick Stop function is triggered.
The TCP port used can be set via FCT. The default port number is 49700.

B.1.2 CVE protocol

Access to CMMO-ST data is effected via CVE objects. A CVE object always has a unique index that enables identification of the object.
A number of CVE objects are listed in section B.3. Only the objects listed there may be used.

Caution
Personal injury and damage to property
Accidentally writing over undocumented objects can result in unpredictable behaviour of the drive.
- Only use the objects listed in appendix B.3.

Each object has one of the data types listed in Tab. B.1. The byte order is little endian.

Read object
In order to read a CVE object, a request must be sent to the CMMO-ST in accordance with Tab. B.2. This sends back a response Tab. B.3.

Write object:
In order to write a CVE object, a request must be sent to the CMMO-ST corresponding to Tab. B.4. This sends back a response Tab. B.5.

As both directions concern an endless TCP data stream, the individual messages must be filtered out. Strict compliance with the message length is required for this.

Data types

Value	Type	Bytes	Description	Range of values
0x00	–	–	Unknown data type	–
0x01	–	–	–	–
0x02	UINT32	4	32 bit unsigned integer	0 ... 4294967295
0x03	UINT16	2	16 bit unsigned integer	0 ... 65535
0x04	UINT08	1	8 bit unsigned integer	0 ... 255
0x05	–	–	–	–
0x06	SINT32	4	32 bit signed integer	– 2147483648 ... 2147483647
0x07	SINT16	2	16 bit signed integer	– 32768 ... 32767
0x08	SINT08	1	8 bit signed integer	– 128 ... 127

Tab. B.1 Data types

Request “Read CVE object”

Byte	Function	Data type	Description
0x00	Service ID	UINT08	0x10 = Read CVE object from controller
0x01 0x02 0x03 0x04	Message ID	UINT32	Message ID freely assignable by the application. It is always sent back unchanged in the response. This enables a clear assignment of the request and response. The message ID can be used but is not mandatory.
0x05 0x06 0x07 0x08	Data length	UINT32	Always 4 for this request.
0x09	Acknowledge	UINT08	In the request, this field always remains empty (initialise with 0).
0x0A 0x0B 0x0C 0x0D	Reserved	UINT32	Placeholder (initialise with 0).
0x0E 0x0F	Object index	UINT16	Index of the CVE object to be read.
0x10	Object subindex	UINT08	Always 0.
0x11	Reserved	UINT08	Placeholder (initialise with 0).

Tab. B.2 Request “Read CVE object”

Response “Read CVE object”

Byte	Function	Data type	Description
0x00	Service ID	UINT08	0x10 = Read CVE object from controller
0x01 0x02 0x03 0x04	Message ID	UINT32	Message ID included in the request.
0x05 0x06 0x07 0x08	Data length	UINT32	The data length is dependent on the data type of the read CVE object. The following applies: Data length = 4 bytes + data type length Example for UINT32: Data length = 4 bytes + 4 bytes = 8 bytes
0x09	Acknowledge	UINT08	0 if everything is ok. All other values □□mean that the object could not be read. A list of possible causes of the error: ➔ Tab. B.6.
0x0A 0x0B 0x0C 0x0D	Reserved	UINT32	Placeholder
0x0E 0x0F	Object index	UINT16	Index of the read CVE object.
0x10	Object subindex	UINT08	Always 0.
0x11	Data type	UINT08	Data type of the CVE object.
0x12	Data byte 1	corresponding to data type of the CVE object	Object value
...	Data byte K		

Tab. B.3 Response “Read CVE object”

Request “Write CVE object”

Byte	Function	Data type	Description
0x00	Service ID	UINT08	0x11 = write CVE object to the CMMO
0x01 0x02 0x03 0x04	Message ID	UINT32	Message ID freely assignable by the application. It is always sent back unchanged in the response. This enables a clear assignment of the request and response. The message ID can be used but is not mandatory.
0x05 0x06 0x07 0x08	Data length	UINT32	The data length depends on the data type of the CVE object to be written. The following applies: Data length = 4 bytes + data type length Example for SINT08: Data length = 4 bytes + 1 byte = 5 bytes
0x09	Acknowledge	UINT08	In the request, this field always remains empty (initialise with 0).
0x0A 0x0B 0x0C 0x0D	Reserved	UINT32	Placeholder (initialise with 0).
0x0E 0x0F	Object index	UINT16	Index of the CVE object to be written.
0x10	Object subindex	UINT08	Always 0.
0x11	Data type	UINT08	Data type of the CVE object to be written.
0x12	Data byte 1	corresponding to data type of the CVE object	Object value
...	Data byte K		

Tab. B.4 Request “Write CVE object”

Response “Write CVE object”

Byte	Function	Data type	Description
0x00	Service ID	UINT08	0x11 = write CVE object to the CMMO
0x01 0x02 0x03 0x04	Message ID	UINT32	Message ID included in the request.
0x05 0x06 0x07 0x08	Data length	UINT32	Always 4 for this response.
0x09	Acknowledge	UINT08	0 if everything is ok. All other values □□mean that the object could not be written. A list of possible causes of the error: ➔ Tab. B.6.
0x0A 0x0B 0x0C 0x0D	Reserved	UINT32	Placeholder
0x0E 0x0F	Object index	UINT16	Index of the written CVE object.
0x10	Object subindex	UINT08	Always 0.
0x11	Data type	UINT08	Data type of the written CVE object. If an attempt has been made to write an object with an invalid data type, the correct data type is returned.

Tab. B.5 Response “Write CVE object”

Confirmation (acknowledge)

Ack	Description	Remedy
0x00	Everything ok.	–
0x01	Service is not supported.	Check the service ID of the request.
0x03	User data length of the request is invalid.	Check the structure of the request.
0xA0	Range of values □□of another CVE object violated.	Writing the CVE object would cause the range of values of another CVE object to be violated. (The other object uses this CVE object as a minimum or maximum).
0xA2	Invalid object index.	Correct the object index.
0xA4	The CVE object cannot be read.	–
0xA5	The CVE object cannot be written.	–
0xA6	The CVE object cannot be written while the drive is in an "Operation enabled" status.	Quit the "Operation enabled" status.
0xA7	The CVE object must not be written without master control.	Assign master control to the CVE interface. Use CVE object #3 for this purpose.
0xA9	The CVE object cannot be written, as the value is lower than the minimum value.	Correct the value.
0xAA	The CVE object cannot be written, as the value is greater than the maximum value.	Correct the value.
0xAB	The CVE object cannot be written, as the value is not within the valid value set.	Correct the value.
0xAC	The CVE object cannot be written, as the specified data type is incorrect.	Correct the data type.
0xAD	The CVE object cannot be written, as it is password-protected.	Cancel the password protection ➔ Chapter 2.3.3

Tab. B.6 Confirmation (acknowledge)

B.1.3 Controlling the drive

The CMMO-ST has a finite state machine that executes the operating modes of the drive in accordance with the user's specifications. Fig. B.1 shows the possible states. These are described in detail in Tab. B.7. Tab. B.8 shows the possible transitions between the states.

The finite state machine is based on the CANopen standard CiA402.

Control word

The control word, as a bit field, is used to switch back and forth between the statuses (CVE object #2, ➔ Tab. B.9).

Status word

The status word, as a bit field, provides feedback about the current status (CVE object #1, ➔ Tab. B.10).

A drive function can only be started in the “Operation enabled” status.
The desired drive function must be selected via CVE object #120. Before starting a homing run the value 6 must be written into this CVE object; before starting a position record the value 1 must be written into this CVE object. The current or last executed drive function can be read via CVE object #121.

Finite state machine

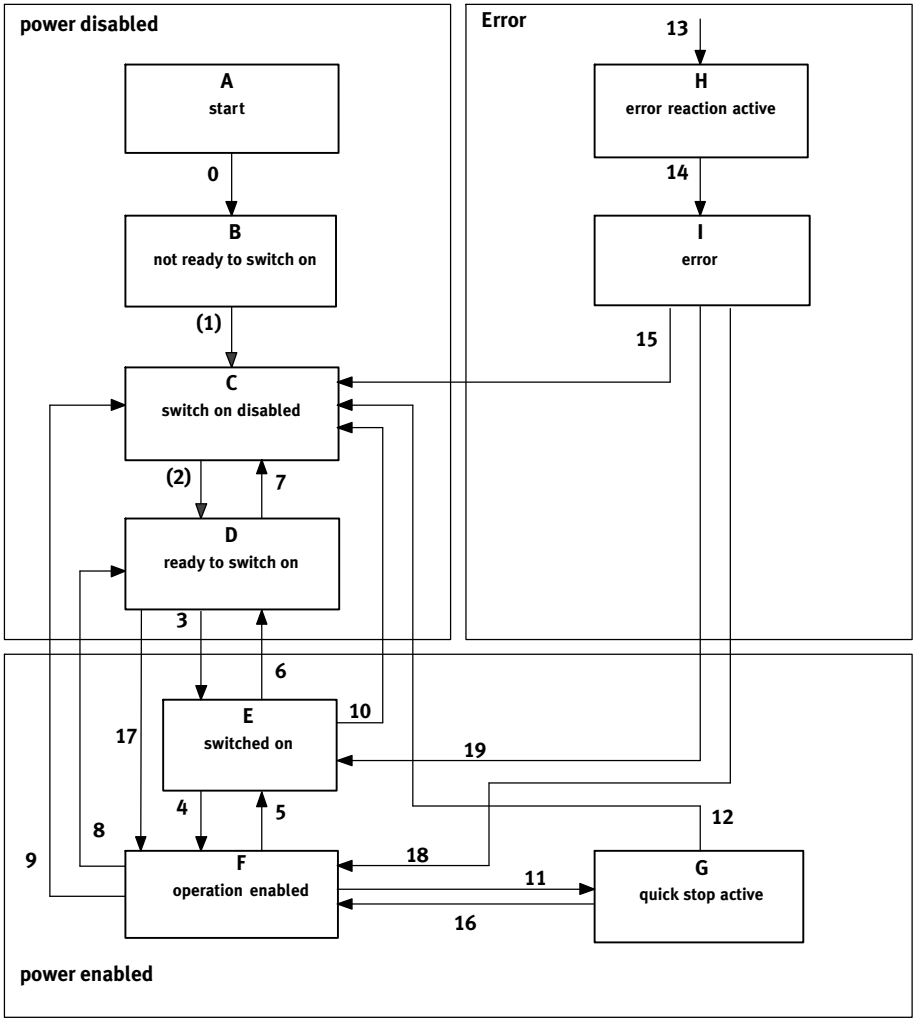


Fig. B.1 Finite state machine of the CMMO-ST

Description of states

Status		Description	Brake
A	Start	This state is assumed at power-on, on reset or when a reset command is entered (e.g. via the fieldbus). After executing the startup code the machine automatically reverts to status B.	Closed
B	Not ready to switch on	In this status CMMO-ST self tests are carried out. The output stage remains switched off.	Closed
C	Switch on disabled	The output stage remains switched off. From this status, changes of state are only possible via the control word or if a serious error has occurred.	Closed
D	Ready to switch on	The output stage is switched on. When switching to the “Switched On” status a commutation angle search is executed (if required).	open
E	Switched on	The output stage is active.	open
F	Operation enabled	The drive waits for positioning tasks and executes them. Normal operating status after successful initialisation.	open
G	Quick Stop active	The Quick Stop function has been activated. The drive brakes with the parameterised Quick Stop deceleration and then stops. The output stage remains switched on, acceptance of positioning tasks is refused.	open
H	Error reaction active	This status can be assumed from any situation if an error response has been triggered. This is then executed. The output stage remains switched on.	open
I	Error	Error status. No more positioning movements are executed. The output stage is either active or inactive depending on the parameterisation of the error.	Open if the output stage is active

Tab. B.7 Description of states

Description of transitions

Condition for status transition		Description
0	Start ➔ Not ready to switch on	This status transition always takes place unconditionally after a (re)start.
1	Not ready to switch on ➔ Switch on disabled	The self test of the logic supply has been completed successfully. Automatic change of state to Switch on disabled.
2	Switch on disabled ➔ Ready to switch on	CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 0
3	Ready to switch on ➔ Switched on	CW.**FR** (Error Reset) = 0 CW.**EO** (Enable Operation) = 0 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1
4	Switched on ➔ Operation enabled	CW.**FR** (Error Reset) = 0 CW.**EO** (Enable Operation) = 1 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1
5	Operation enabled ➔ Switched on	CW.**FR** (Error Reset) = 0 CW.**EO** (Enable Operation) = 0 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1
6	Switched on ➔ Ready to switch on	CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW. **SO** (Switch on) = 0
7	Ready to switch on ➔ Switch on disabled	CW.**FR** (Error Reset) = 0 CW.**EV** (Enable Voltage) = 0 or: CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 0 CW.**EV** (Enable Voltage) = 1
8	Operation enabled ➔ Ready to switch on	CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 0
9	Operation enabled ➔ Switch on disabled	CW.**FR** (Error Reset) = 0 CW.**EV** (Enable Voltage) = 0

Condition for status transition		Description
10	Switched on ➔ Switch on disabled	CW.**FR** (Error Reset) = 0 CW.**EV** (Enable Voltage) = 0 or: CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 0 CW.**EV** (Enable Voltage) = 1
11	Operation enabled ➔ Quick Stop active	CW.**FR** (Error Reset) = 0 CW.**QS** (Quick Stop) = 0 CW.**EV** (Enable Voltage) = 1
12	Quick Stop active ➔ Switch on disabled	CW.**FR** (Error Reset) = 0 CW.**EV** (Enable Voltage) = 0
13	From anywhere to: Error reaction active	Release of an error response by the error management system. The status transition is independent of the control signals currently being sent.
14	Error reaction active ➔ Error	Execution of the error response is complete. Automatic change of state to Error.
15	Error ➔ Switch on disabled	The cause of the error must be eliminated (e.g. overheating, temperature reduced to permissible level). Positive edge for **FR** (Error Reset). CW.**PSOn** (output stage on after Error Reset) = 0 At least one of the following bits is **not** set to 1: CW.**EO** (Enable Operation) CW.**QS** (Quick Stop) CW.**EV** (Enable Voltage) CW.**SO** (Switch on)
16	Quick Stop active ➔ Operation enabled	CW.**FR** (Error Reset) = 0 CW.**EO** (Enable Operation) = 1 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1
17	Ready to switch on ➔ Operation enabled	CW.**FR** (Error Reset) = 0 CW.**EO** (Enable Operation) = 1 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1

Condition for status transition		Description
18	Error ➔ Operation enabled	The cause of the fault must be eliminated (e.g. over-temperature reduced to permissible value). Positive edge for CW.**FR** (Error Reset) CW.**PSOn** (output stage on after Error Reset) = 1 CW.**EO** (Enable Operation) = 1 CW.**QS** (Quick Stop) = 1 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1
19	Error ➔ Switched on	The cause of the fault must be eliminated (e.g. over-temperature reduced to permissible value). Positive edge for **FR** (Error Reset) CW.**PSOn** (output stage on after Error Reset) = 1 CW.**EO** (Enable Operation) = 0 CW.**EV** (Enable Voltage) = 1 CW.**SO** (Switch on) = 1

Tab. B.8 Description of transitions

Control word (CVE object #2)

bit	abbrevi-ation	Description
0	CW.SO	Switch On
1	CW.EV	Enable voltage
2	CW.QS	Quick stop
3	CW.EO	Enable operation
4	CW.ST	Start
5	Must always be 0.	
6	CW.PSOn	Power stage on after reset (Output stage on after error reset)
7	CW.FR	Error reset
8	CW.STP	Stop
9 ... 31	Must always be 0.	

Tab. B.9 Control word

Status word (CVE object #1)

bit	abbrevi-ation	Description		
0	SW.RTSO	Ready to switch on The output stage can be switched on via CW.SO.	Bits 0 ... 3, 5 and 6 display the status of the device (x ... irrelevant for this status)	
1	SW.SO	Switched on. The output stage is switched on.	Value (binary)	status
2	SW.OE	Operation enabled. The drive is ready for operation.	xxxx xxxx x0xx 0000	Not ready to switch on
3	SW.F	Error. At least one error is active.	xxxx xxxx x1xx 0000	Switch on disabled
5	SW.QS	/Quick Stop. If this bit is inactive, a quick stop is executed.	xxxx xxxx x01x 0001	Ready to switch on
6	SW.SOD	Switch on disabled. The output stage cannot be switched on.	xxxx xxxx x01x 0011	Switched on
			xxxx xxxx x01x 0111	Operation enabled
			xxxx xxxx x00x 0111	Quick Stop active
			xxxx xxxx x0xx 1111	Fault reaction active
			xxxx xxxx x0xx 1000	Fault
7	SW.W	Warning. At least one warning is active.		
8	SW.MOV	Move. The drive moves.		
10	SW.TR	Target reached/Motion complete. The target of a positioning motion has been reached (e.g. target position of a position record reached).		
12	SW.SACK	Setpoint Acknowledge. A start has been accepted. This bit is active when CW.ST = 1, provided that the drive function can be executed. It is inactive again when CW.ST = 0 or when SW.TR = 1.		
15	SW.AR	Referenced. The drive is referenced.		
30	SW.DPB	Direction positive blocked. The drive cannot be moved in a positive direction.		
31	SW.DNB	Direction negative blocked. The drive cannot be moved in a negative direction.		

Tab. B.10 Status word

Example: activation of “Operation enabled”

Assumption: the drive has been switched on. An error is not present; the output stage is enabled via the STO input (i.e. CVE object #358 exhibits value 255). Nothing is connected to the I/O interface of the CMMO-ST. The “Switch on disabled” status is active; the status word exhibits the value 0x00800440.

1. Activate the higher-order controller for the CVE connection by writing the value 2 into CVE object #3.
2. Activate the “Ready to switch on” status by writing the control word 0x00000006. When this status has been reached, the status word exhibits the value 0x00000421.
3. Activate the “Switched on” status by writing the control word 0x00000007. When this status has been reached, the status word exhibits the value 0x00040423.
4. Activate the “Operation enabled” status by writing the control word 0x0000000F. When this status has been reached, the status word exhibits the value 0x00060427.

Example: starting homing

Assumption: the “Operation enabled” status is active. Homing has been parameterised correctly via FCT.

1. Select the “homing” drive function by writing the value 6 into CVE object #120.
2. Start the homing run by writing the control word 0x0000001F. At the end of the homing run the status word exhibits the value 0x00068427.
3. Reset the start signal by writing the control word 0x0000000F.

Example: start of a record

Assumption: the “Operation enabled” status is active. The drive is referenced (i.e. SW.AR = 1).

1. Select the “position record” drive function by writing the value 1 into CVE object #120.
2. Select the desired record by writing the record number into CVE object #31.
3. Start the record by writing the control word 0x0000001F. While the positioning record is being executed the status word exhibits the value 0x00048127. When the record has ended the status word exhibits the value 0x00068427.
4. Reset the start signal by writing the control word 0x0000000F.

B.2 Explanation of increments

Encoder increments
The CMMO operates in the field of drive control (e.g. in a path generator) with encoder increments (EINC).

Interface increments
In contrast, so-called interface increments (SINC) are used at all user interfaces and in the field of internal data management. This enables rounding errors to be avoided when reading and writing values.

Conversion factors
The relationship between interface increments (SINC) and encoder increments (EINC) is established via the following conversion factors:
– Transmission ratio of the gear unit
– Feed constant

Size of a SINC
Interface increments are at first dimensionless, i.e, they have no defined unit or size. The unit, i.e. the size of an SINC, is specified in objects #218 “Unit of measurement” and #217 “Power of ten”:

During parameterisation in FCT you can use commonly used units for length specifications, such as millimetres or inches. You do not need any interface increments here.

Parameterise the drive completely in FCT and then read objects #218 “Unit of measurement” and #217 “Power of ten”.

Example:
#218 = 1, i.e. Metre
#217 = –6, i.e. 10^{-6}
➔ 1 mm = 1000 SINC

B.3 List of CVE objects

#	Name	Group
1	Status word	Finite state machine
2	Control word	Finite state machine
3	Higher-order control	System
4	Block higher-order control	System
31	Record number preselection	Record
57	Actual speed	System
58	Actual current	System
59	Actual force	System
60	Setpoint position	System
61	Target speed	System
62	Nominal current	System
63	Setpoint force	System
70	Actual acceleration	System
72	Nominal acceleration	System
96	Position deviation (contouring error)	System
97	Deviation speed	System
98	Current deviation	System
99	Force deviation	System
120	Nominal operating mode	Finite state machine
121	Actual operating mode	Finite state machine
141	Current record number	Record
191	Error with top priority	Error handler
194	Error with top priority acknowledgement option	Error handler
213	Warning with top priority	Error handler
217	Power of ten conversion factor	Drive functions
218	Unit of measurement conversion factor	Drive functions
295	Current target position	Drive functions
358	Hardware enable	System

Explanation of read and write access

Code	Meaning
R	The object is readable.
W1	The object is writeable if the controller is in the “Control disabled” status (➔ Description of the finite state machine).
W2	The object is writeable if the controller is in the "Control enabled" status (➔ Description of the finite state machine).
W3	The object can also be written by an interface that does not currently have master control.
Admin	The object is protected by the administrator password.

Tab. B.11 Access rights

Detailed descriptions of objects

#1	Status word		
Finite state machine		UINT32	R/-/-/-/-
➔ separate description in section B.1.3 Values: 0 ... 4294967295 Default: 0			

#2	Control word		
Finite state machine		UINT32	R/W1/W2/-/-
➔ separate description in section B.1.3 Values: 0 ... 4294967295 Default: 0			

#3	Higher-order control		
System		UINT08	R/W1/W2/W3/-
The master control specifies which interface may control the drive: 0x00 ➔ I/O 0x01 ➔ FCT (Festo Configuration Tool) 0x02 ➔ CVE (Control via Ethernet) 0x03 ➔ Web server The master control may be changed by an interface that does not have this only if it is not blocked via object #4 Block master control. Values: 0 ... 255			

#4	Block higher-order control		
System		UINT08	R/W1/W2/-/-
0x00 ➔ The master control is not blocked. The master control can be changed by all interfaces. 0x01 ➔ The master control is blocked. Before the master control can be changed again, this block has to be removed again. Only the interface that has the master control at the time can do this. Values: 0 ... 1 Default: 0			

#31	Record number preselection		
Record		UINT08	R/W1/W2/-/-
Number of the preselected positioning record. At the controller interface, a new positioning record can already be preselected while an old one is still active. Note: The active positioning record is in object #141 Record 1 ... xx ➔ normal records Values: 1 ... 31			

#57	Actual speed		
System		SINT32	R/-/-/-/-
Current actual velocity Unit: SINC/s Values: –2147483648 ... 2147483647 Default: 0			

#58	Actual current		
System		SINT32	R/-/-/-/-
Current motor current Unit: mA Values: –2147483648 ... 2147483647 Default: 1			

#59	Actual force		
System		SINT16	R/-/-/-/-
Current actual force in one-tenth of one percent of the maximum motor current (calculated from the measured current) Unit: ‰ Values: –32768 ... 32767 Default: 0			

#60	Setpoint position		
System		SINT32	R/-/-/-/-
Current Target Pos. Unit: SINC Values: –2147483648 ... 2147483647 Default: 0			

#61	Target speed		
System		SINT32	R/-/-/-/-
Current nominal speed Unit: SINC/s Values: –2147483648 ... 2147483647 Default: 0			

#62	Nominal current		
System		SINT32	R/-/-/-/-
Current nominal current Unit: mA Values: –2147483648 ... 2147483647 Default: 0			

#63	Setpoint force		
System		SINT16	R/-/-/-/-
Current nominal force in one-tenth of one percent of the maximum motor current (calculated from the nominal current) Unit: ‰ Values: –32768 ... 32767			

#70	Actual acceleration		
System		SINT32	R/-/-/-/-
Current, calculated actual acceleration Unit: SINC/s² Values: –2147483648 ... 2147483647 Default: 0			

#72	Nominal acceleration		
System		SINT32	R/-/-/-/-
Current nominal acceleration Unit: SINC/s² Values: –2147483648 ... 2147483647 Default: 0			

#96	Position deviation		
System		SINT32	R/-/-/-/-
Current following error = actual position - setpoint position Unit: SINC Values: –2147483648 ... 2147483647			

#97	Deviation speed		
System		SINT32	R/-/-/-/-
Current deviation of the speed controller (comparable to following error with position) = actual speed - setpoint speed Unit: SINC/s Values: –2147483648 ... 2147483647			

#98	Current deviation		
System		SINT32	R/-/-/-/-
Current deviation of the current controller (comparable to following error with position) = actual current - target current Unit: mA Values: –2147483648 ... 2147483647			

#99	Force deviation		
System		SINT16	R/-/-/-/-
Current deviation of the current controller converted into force (comparable to following error with position) = actual force - target force Unit: per mill of maximum motor current Unit: ‰ Values: –32768 ... 32767			

#120	Nominal operating mode		
Finite state machine		SINT08	R/W1/W2/-/-
Permissible values are: 0: No operating mode selected 1: Positioning mode 3: Speed mode 4: Force mode/torque mode 6: Homing mode –3: Jog positive –4: Jog negative Values: 0, 1, 3, 4, 6, –3, –4 Default: 0			

#121	Actual operating mode		
Finite state machine		SINT08	R/-/-/-/-
Operating mode that is currently being executed. Values: ➔ object #120 Values: –128 ... 127 Default: 0			

#141	Current record number		
Record		UINT08	R/-/-/-/-
Number of the record that is currently being executed or that was executed last. Refer to object #31. Values: 0 ... 255 Default: 0			

#191	Error with top priority		
Error handler		UINT16	R/-/-/-/-
Specifies the malfunction number of the error that currently has top priority. 0xFFFF means that no error is present. Values: 0 ... 65535 Default: 65535			

#194	Error with top priority acknowledgement option		
Error handler		UINT08	R/-/-/-/-
Specifies whether the currently top priority error is erasable. 0x00 – The error cannot be acknowledged. 0x01 – The malfunction is still active; the error can be deleted only after the malfunction is eliminated. 0x02 – The error can be eliminated immediately. 0xFF – There is not error. Values: 0 ... 255			

#213	Warning with top priority		
Error handler		UINT16	R/-/-/-/-
Specifies the malfunction error of the warning that currently has the highest priority. 0xFFFF means that no warning is present. Values: 0 ... 65535 Default: 65535			

#217	Power of ten conversion factor		
Drive functions		SINT08	R/W1/-/-/-
➔ Example in section B.2 Unit: 10^X Values: < 0 Default: 0			

#218	Unit of measurement conversion factor		
Drive functions		UINT08	R/W1/-/-/-
➔ Example in section B.2 0: Undefined 1: Metre 2: Inch 3: Revolutions 4: Degree Values: 0 ... 4 Default: 0			

#295	Current target position		
Drive functions		SINT32	R/-/-/-/-
Target position of the currently executed drive function. The target position is calculated according to the definition as follows: – Position record: absolute target position – Reference travel with movement to zero: target position = 0 – Reference travel without movement to zero: target position = (–1) * axis zero point – Jog positive: positive software end position, if this is activated, otherwise $2^{31}-1$ – Jog negative: negative software end position, if this is activated, otherwise -2^{31} – Speed & force record: Absolute position specified through the stroke limit (braking begins at the stroke limit). If the stroke limit is deactivated, target position is calculated from the software limit positions. For record linking, the target position of the current positioning record is always relevant. Unit: SINC Values: –2147483648 ... 2147483647 Default: 0			

#358	Unit of measurement conversion factor		
System		UINT08	R/-/-/-/-
Bit field for the Enable status (e.g. STO) Bit 0: STO Bits 1 ... 7: reserved Only if all bits are 1 can the finite state machine be switched to the status “Operation enabled” through the control word. Unit: Bit field Values: 0 ... 255 Default: 254			

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