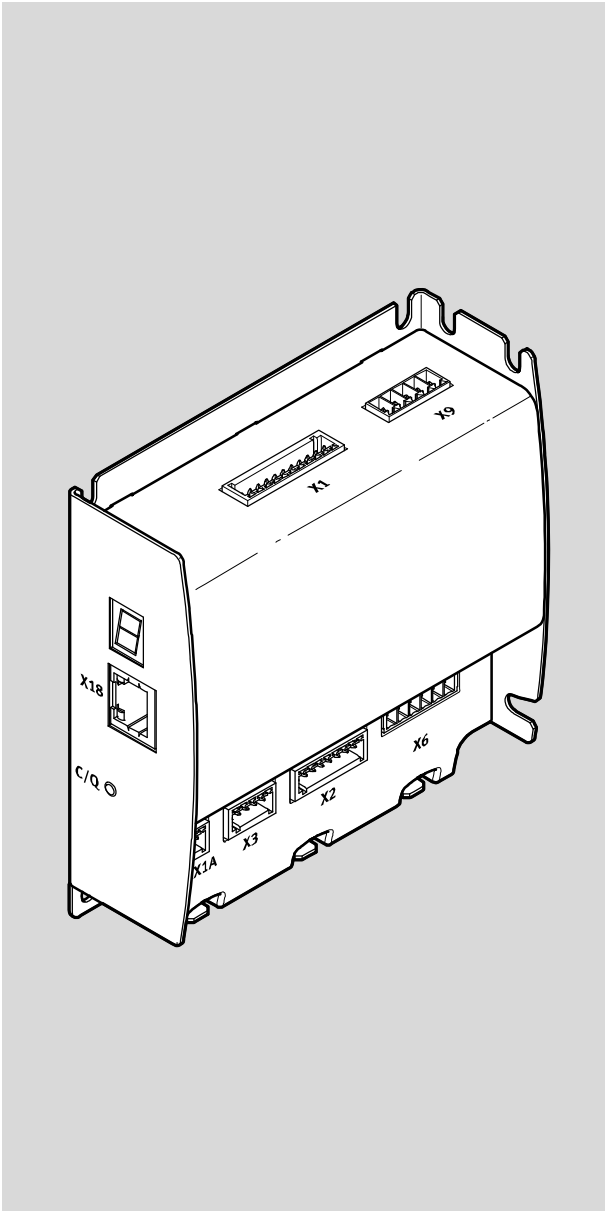
Motor controller

CMMO-ST-C5-1-LKP



FESTO

Description

Motor controller with interface for
– IO-Link
– I-Port
– Modbus TCP

Device and functional description

8071685
2017-05b
[8071687]

Original instructions
GDCP-CMMO-ST-LK-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 identification:

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

Table of Contents – CMMO-ST-C5-1-LKP

Motor controller documentation

This documentation (GDCP-CMMO-ST-LK-SY-...) describes the functions of the motor controller CMMO-ST-C5-1-LKP.

The full description of the motor controller includes the following documents:

Designation	Content
Condensed documentation CMMO-ST-LK... [1)]	Brief equipment and functional description of the motor controller for initial information
Manual GDCP-CMMO-ST-LK-SY-...	Equipment and functional description of the motor controller: – Mounting – Commissioning via web server/Festo Configuration Tool (FCT) – Technical data
Manual GDCP-CMMO-ST-LK-C-HP-...	Description of the control and parameterisation of the motor controller with the device profile FHPP (Festo Handling and Positioning Profile) via: – IO-Link – I-Port – Modbus TCP
Manual GDCP-CMMO-ST-LK-S1-...	Description of the safety function STO (“Safe Torque Off”)
Help system for the FCT software	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)
Special documentation CMMO-ST_UL[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.

Tab. 1 Documentation for the motor controller

Additional information about the product:

- CMMO-ST-Quickguide-...:brief description of the initial commissioning and diagnostics of positioning systems in Festo’s Optimised Motion Series (OMS) with the web server of the CMMO-ST
- Overview of accessories (catalogue) ➔ www.festo.com/catalogue
- Operating instructions for configurable drives and the positioning systems from Festo (e.g. EPCO) ➔ www.festo.com/sp
- Parameter lists: Default settings of the commissioning parameters for positioning systems in Festo’s Optimised Motion Series (OMS) ➔ www.festo.com/sp
- Function elements (CODESYS, ...) ➔ www.festo.com/sp
- Certificates, declaration of conformity ➔ www.festo.com/sp

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.

Version status

This documentation refers to the following version of motor controller:

– Firmware: V 1.4.x and higher
– FCT plug-in: CMMO-ST V 1.4.x and later

Firmware	What is new?	Which FCT plug-in?
From V 1.4.x[1)]	The motor controller CMMO-ST-C5-1-LKP supports the control interfaces IO-Link, I-Port, Modbus	CMMO-ST from V 1.4.0[1)]

1) Earlier versions support the motor controller CMMO-ST-C5-1-DION/DIOP

Tab. 2 Version statuses of the firmware and related FCT plug-ins

The following details are displayed in the software with an active online connection:

– Firmware version and MAC-ID ➔ “Information” tab of the integrated web server
– 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).

Service

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

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
Falling loads if the drive is installed in an inclined or vertical position!
- Secure loads through external safety measures (e.g. toothed latches or moveable bolts). 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.

Warning
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 commissioning 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)
  – Rotating or linear axis from Festo e.g. EGC, DNCE, DGE or
  – User-defined axis

The motor controller supports the safety function ”safe torque off (STO, 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 description for the GDCP-CMMO-ST-LK-S1-

1.2.2 Transport and storage conditions

- Protect the product during transport and storage from excessive stress factors, such as:
  - mechanical loads
  - excessive 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 personnel

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 occupational 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	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

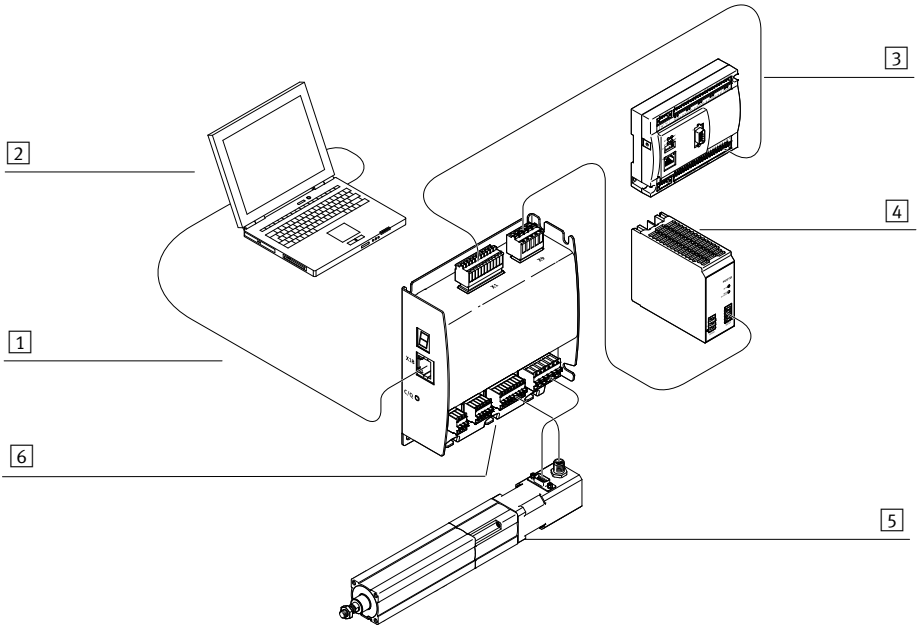
1.2.6 Safety function Safe Torque Off

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-LK-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 through the web server integrated in the CMMO-ST or FCT (Festo Configuration Tool)
3 Higher-order controller (PLC/IPC) e.g. CECC
4 PELV power supply unit for 24 V supply voltage
5 Drive (here: electric cylinder EPCO with encoder)
6 Functional earthing via base plate (protective earth ➔ Special documentation CMMO-ST_UL)

Fig. 2.1 System structure (example)

2.2 Product overview

2.2.1 Components

1 [X9] Load/logic voltage
2 [X1] Interface for control with PLC/IPC
– IO-Link/I-Port
– optional: digital inputs/outputs
3 7-segment display
4 [X18] Ethernet (RJ-45)
– Parameterisation interface TCP/IP
– Control interface Modbus TCP
5 Link/activity LED C/Q
6 [X1A] Reference switch
7 [X3] STO (Safe Torque Off)
8 [X2] Encoder (RS422)
9 [X6] Motor
10 FE functional earth (3x)
11 Mounting surface (H-rail)
12 Mounting surface

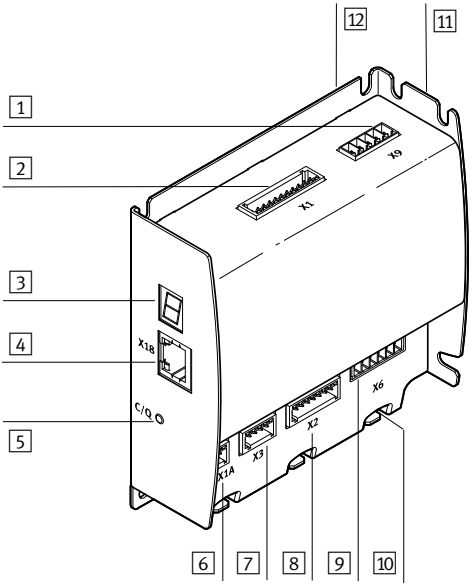
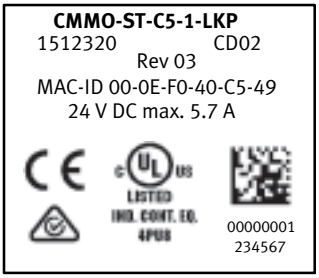


Fig. 2.2 Components of the motor controller

2.2.2 Product identification

Product labelling	Example	Significance
	CMMO-ST-C5-1-LKP 1512320 CD02 Rev 03 MAC-ID 00-0E-F0-40-C5-49 24 V DC max. 5.7 A	Type code (➔ Tab. 2.2) Part number Production number (➔ Tab. 2.3) + production plant Revision (hardware/firmware status on delivery) MAC (Media-Access-Control) address 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 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:

Characteristic	Type code		Specification
Motor controller	CMMO		–
Motor technology	ST		Stepper motor
Nominal current	C5		5.7 A
Nominal input voltage	1		24 V DC
Bus protocol/activation	LK	P	IO-Link interface (LK), combined with I/O interface, switching logic PNP (P)

Tab. 2.2 Type code

Production number

On the type plate, the first two characters of the production number encode the production period. Example: production number CD ➔ Production year C=2012, production month 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 Production year (20-year cycle)

2nd character = production month					
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 Production month

2.2.3 Scope of delivery and accessories

Quantity	Component
1	Motor controller CMMO-ST-C5-1-LKP
1	Documentation for the product: – Brief documentation for the CMMO-ST + quick guide for positioning systems (OMS) – CD-ROM with additional documentation – Special documentation corresponding to the certifications of the product
1	Assortment of plugs NEKM-C-14 with 6 plug connectors for – Control interface [X1] – Reference switch [X1A] – Safety function STO [X3] – Encoder [X2] – Motor [X6] – Power supply [X9]
1	H-rail bracket (pre-assembled)

Tab. 2.5 Scope of delivery

Current information on accessories ➔ www.festo.com/catalogue.
Motor and encoder cables NEBM-... are available as accessories in various plug connector designs and lengths corresponding to the drive configuration

2.2.4 Product characteristics

Characteristic	Description

Electronics	– Electronic control unit with
	  – Cascade regulation for current, rotational speed and position
	  – Encoder connection (RS422 signals) for closed-loop operation
	  – Digital input for reference signal
	  – Safety function STO (Safe Torque Off)
	– Integrated braking resistor with brake chopper

Power supply	Split load and logic voltage [1)] – Load voltage 24 V DC – Logic voltage 24 V DC – Maximum motor current 5.7 A
Mounting	– H-rail – Mounting plate
Functions	– Process control with up to 64 parameterisable command records. – Record linking for workflow sequences – Acceleration with jerk limitation – Monitoring of various process variables (e.g. speed, position, time)
Commissioning	– Parameterisation via Ethernet interface TCP/IP – Software support: FCT, web server

Control	– Interfaces
	  – IO-Link/I-Port
	  – Modbus TCP
	– Process control with Festo Handling and Positioning Profile (FHPP)
	– Additional control functions via digital I/O interface
	  (1 input/3 outputs)

Diagnostics	– Operating mode and error display via 7-segment display – Diagnostic memory via web server and FCT

1) No new reference travel necessary, e.g. after emergency off.

Tab. 2.6 Product characteristics

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
– Backing up of parameters via FCT
– Configuration of fault characteristics/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 storage is designed for 100,000 writing cycles.

2.2.5 Supported motor configurations

Stepper motor and holding brake

The motor controller supports

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

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

Control of the holding brake is automatic through controller enable of the motor controller

➔ Chapter 2.5.6

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

Tab. 2.7 Motor configuration: holding brake

Stepper motor and encoder

If a stepper motor is operated without encoder, the motor must always be operated **below** its power limits. If, for example, the driven load brings the motor 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 stepper motor is controlled by an encoder, it can be loaded up to its performance limit. The encoder measures the exact rotor position and reports this back to the position controller. This prevents imprecise positioning caused by step losses.

The motor controller supports

– Stepper motors with encoder in closed-loop operation (optional: in open-loop operation)
– Stepper 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 fed into the motor. The motor works in an energy-optimised way and produces less heat. The motor at rest is position-controlled. Standstill monitoring is active.
Motor without encoder	Open-loop operation (open-loop operation)	The motor is always operated with the set driving current when travelling. When at a standstill, the drive is maintained in its position with the set holding current. The following functions are **not** supported: – Homing to stop – Homing to reference switch with index – 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 diagnostics of drives with configurable motor-axis combinations and of positioning systems (OMS). FCT is available as download ➔ www.festo.com/sp, CMMO-ST.
In commissioning with FCT, configuration and parameterisation take place through a page-oriented workflow. Compared to commissioning with a web server, FCT enables the following:
– Configuration of the entire Festo modular system of axes and motors
– Configuration of user-specific axes/ mechanicals
– Use of the maximum function range of the motor controller
– Extended status displays, diagnostics options and test functions

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”).
The FCT comprises the following modules:
– the framework with general control elements and software functions
– extension modules integrated into the framework (plug-ins) for every implemented type of device
The framework facilitates consistent project and data management of all supported types of equipment. The plug-ins are managed and started from the framework. The plug-in of a type of equipment supports the structured performance of all necessary steps to commission the drive.

The software Help system contains detailed instructions for the FCT. The FCT online Help also has information about possible commissioning scenarios and initial commissioning. 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 installation directory)\Help\FCT_de.pdf

Help for the plug-in:

Detailed information about configuration, parameterisation and commissioning
– FCT: Menu [Help] [Content of installed plug-ins] [Festo] [Plug-in name]
– PDF: (FCT installation directory)\HardwareFamilies\Festo\(type of equipment)\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 of the drive
	– Parameterisation of the drive components (motor, axis and controller), interfaces, dimension reference system, reference travel method, etc.
	– Parameterisation of error categories and messages
	– Parameterisation of standard values for command records
	– Input of record tables for record selection
	  – Max. 64 command records
	  – Type of record: positioning mode, power mode, speed mode
	– Parameterisation of the FHPP parameters for direct application
	– 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 drive (jog) – Teaching positions – Test of command records or sequences in the record table – Manual precision adjustment of the controller data – Recording of measuring data in real time, e.g. to evaluate non-conformity of the control behaviour – Monitoring of the output stage temperature – Read-out/deletion of the diagnostic memory – Firmware download in service cases – Restore factory setting

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

2.3.2 Web server

The integrated web server of the motor controller supports
– diagnostics of the CMMO-ST motor controller via web browser
– simplified parameterisation and commissioning of the positioning systems of the Optimised Motion Series (OMS)
– transmission of FCT parameter files, e.g. when replicating serial machines.

Positioning systems in the Optimised Motion Series include selected axis-motor combinations from Festo, e.g. with the EPCO electric cylinder. OMS enables:
– ordering of the complete system, including motor controller, through an ID code
– simplified commissioning via OMS-ID with pre-parameterised parameter files

Information on the systems that can be ordered ➔ www.festo.com/sp.

If the controller is connected to a PC through the parameterisation interface, after the IP address of the device is entered, the website of the motor controller is automatically displayed in the web browser, e.g. Internet Explorer (➔ Chapter 5.3.1).

Tab	Functions

Information	– Status information e.g.
	  – Display of device type and firmware version
	  – Display of IP and MAC address
	  – Identification on the network (wave function)
	  – Current position
	  – Error display
	  – Temperature display
	  – Dimensional units for positioning (changeover)

Status	Functions: – Device control, controller enable – Start homing – Stop job – Acknowledge error Displays: – Display of operating messages (e.g. Motion Complete, Homing valid) – Display of the signal statuses of the I/O interface and reference switch input
Control interface	Parameterisation of the current controller interface: IO-Link, I-Port or Modbus
FHPP profile	Selection of device profile (FHPP or FHPP + FPC channel)
Network	Parameterisation of the network IP address
Parameter	Upload/download of a parameter file
Direct mode	Parameterisation of the FHPP parameters for direct application
Test mode	Test of direct applications in the positioning, speed or force mode
Password	Specification of a password for protection from unauthorised access
Diagnostics	Reading and deleting the messages of the diagnostic memory
Support	Hyperlinks to the Festo Support Portal, e.g. for download of the firmware, parameter files and technical documentation

Tab. 2.10 Website of the motor controller

2.3.3 Password protection

Password protection protects the controller from unauthorised or unintended modifications of the parameterisation. Controlling access to the drive via FCT or web browser is possible only after entry of the correct password.

Password query	
FCT	The password is queried when the online connection between FCT and motor controller is established. After the correct password is entered, all functions are enabled until the software is closed.
Web browser	The query takes place when the website of the web server is called up. In the input dialogue “Authentication required”, the “User name” field can remain empty. This is not evaluated. After the correct password is entered, all functions are enabled until the web browser is closed.

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 buffer (cache) should be cleared (in Microsoft Internet Explorer menu [Extras], command “Delete browser history”)

Activating password protection

In the delivery status, password protection is inactive. To activate it, a password is determined in the FCT (➔ Chapter 5.4.6) **or** through the web browser (➔ Chapter 5.3.6). After a valid password is entered, password protection is effective for FCT **and** web browser simultaneously.

Changing/deleting the password

To change or delete it, the active password must be known. Changing involves the input of a new password. Deletion is done through an empty input field.

Password forgotten?

If the password is no longer known, it can be reset by Festo Service.

2.4 Parameterisation and control interfaces

2.4.1 Control options

The motor controller can be controlled via the parameterisation interface [X18] for commissioning with FCT or a web server. In operation, control takes place through the control interface [X1] or [X18] with the device profile ➔ chapter 2.4.2

Connection	Process control
FCT	Commissioning: – Homing run – Manual process (individual step, jogging) – Record selection (manual, test cycle)
Web server	Commissioning: – Homing run – Direct application (test)
FHPP	In operation: – Homing run – Jogging – Record selection – Direct application

Tab. 2.12 Overview of control options

Interface	Functions
[X1] IO-Link/I-Port	– Control interface for control in operation via IO-Link or I-Port – Point-to-point connection at field-level – Master-device communication – I/O technology corresponding to IEC 61131-9
	– Additional digital inputs/output for optional use – Input DIN ENABLE – Output DOUT READY – 2 configurable outputs
[X18] Ethernet	– Parameterisation interface for parameterising, commissioning and diagnostics with software support (FCT, web server).
	– Control interface for control via Modbus TCP conforming to IEC 61158

Tab. 2.13 Parameterisation and control interfaces

2.4.2 Festo Handling and Positioning Profile (FHPP)

Process control and data transmission through the control interfaces takes place with the device profile “Festo Handling and Positioning Profile (FHPP)”
All functions are directly accessible through the FHPP object directory. Functional components are available for programming the process control, e.g. for Siemens, Rockwell, Codesys.

Device profile	Description
FHPP (standard)	FHPP supports the operating modes “record selection” and “direct mode”. Communication takes place via 8-byte control and status data. (Cyclical I/O data)
FHPP (standard) + FPC1)	Through an additional 8-byte parameter channel, the controller has write and read access to nearly all parameters of the motor controller.

1) Festo Parameter Channel

Tab. 2.14 Parameterisable variants of the device profile

Operating mode	Description
Record selection	A specific number of positioning records can be saved in the motor controller. A record contains all the parameters which are specified for a positioning job. The record number is transferred to the cyclical I/O data as the setpoint or actual value.
Direct mode	The task is transferred directly in the I/O telegram. The most important setpoint values (position, speed, force/torque) are transferred here. Supplementary parameters are defined through FCT/web server or transmitted through the parameter channel FPC (e.g. acceleration).

Tab. 2.15 Overview of FHPP operating modes

Additional information on the FHPP ➔ Description GDCP-CMMO-ST-LK-C-HP-...

2.4.3 Control via IO-Link/I-Port

IO-Link and I-Port permit connection to gateways for all fieldbuses and and RTE-networks. IO-Link is a standardised I/O technology (IEC 61131-9) for exchanging serial data with sensors and actuators bi-directionally via a 3-wire connection. The motor controller is an **IO-Link device** in accordance with the IO-Link Interface Specification Version 1.1 [IOL].

Functions:

– Exchange of cyclical process data (FHPP process data)
– Telegram Parameter Manager – acyclic parameter exchange
– Event Dispatcher – reporting of controller errors and warnings
– Parameterisable FHPP channel configuration (FPC on/off)
– Activation/deactivation of the IO-Link interface
– Transmission rate 230.4 kBaud (COM3)

Parameters	Description
Device profile	FHPP standard/FHPP standard + FPC

Tab. 2.16 IO-Link/I-Port parameter

I-port interface

I-Port supports the simple connection of Festo components to each other and the interface with subsystems from Festo. The availability of gateway solutions permits connection to the global network technologies.

Through predefined device classes, a device description file (IODD) for the higher-order network configuration is not required in the case of I-Port connections.

Additional information for control via IO-Link/I-Port ➔ Description GDCP-CMMO-ST-LK-C-HP-...

2.4.4 Control via Modbus TCP

Modbus TCP is an industrial communication protocol and can be used as an Ethernet-based fieldbus for decentralised I/O systems. Modbus communication requires building a TCP connection between a Modbus client (PC, controller) and the Modbus server (CMMO-ST). The client creates a connection with the server. The server waits for an incoming connection from the client. As soon as a connection is created, the server answers the requests of the client until the client closes the connection.
The following operations (Modbus transactions) are supported:

Modbus transactions	Function code
Read Holding Registers	0x03
Read Exception Status	0x07
Write Multiple Registers	(0x10
Read/Write Multiple Registers	0x17
Read Device Identification	0x2B

Tab. 2.17 Modbus transactions

Parameter	Value
Device profile	FHPP/FHPP + FPC
TCP-Port:	502 (Default)
Time-out	The TCP/IP-protocol registers failures typically after a few seconds. Through specification of a time in the FCT, an adapted time-out monitoring can be activated for communication on the bus. Value = 0: no special time-out monitoring Value ≠ 0: Time-out monitoring is activated with the specified time (in milliseconds).

Tab. 2.18 Modbus TCP parameters

Additional information for control via Modbus ➔ Description GDCP-CMMO-ST-LK-C-HP-...

2.4.5 Function of the digital inputs/outputs

The circuitry of the digital I/O modules is not absolutely required for operation of the motor controller. The following functions can optionally be used:

DIN/DOUT			Pin
DOUT	DOUT2	Configurable status signals	X1.3
	DOUT1	➔ FCT [...] [Controller] [I/O Configuration] Digital Outputs	X1.4
	Ready	Indicates ready status	X1.5
DIN	ENABLE	The input is only evaluated if the enable logic “DIN + control” is parameterised (➔ Tab. 2.20).	X1.6

Tab. 2.19 Function of the digital inputs/outputs

Controller enable

Controller enable takes place over the connection that has master control (➔ Chap. 2.4.8).
Depending on the parameterisation of the enable logic, activation in addition to the controller enable must take place over the digital input ENABLE.

Enable logic[1)]	Request of controller enable
Controller	Request of controller enable takes place over the interface that has master control (➔ Chap. 2.4.8). DIN ENABLE is not evaluated. If the enable signal is present, the controller is enabled and the drive held in its position.
DIN + controller	Request of controller enable takes place over the interface that has master control and over DIN ENABLE: – With FCT or web browser, first DIN ENABLE must be set so that the enable can take place in the software. – For FHPP, both signals are on an equal footing. The signal last set requests controller enable. If both signals are present, the controller is enabled and the drive held in its position.

1) Parameterisation of the enable logic takes place under FCT [Controller]

Tab. 2.20 Enable logic

Removal of the controller enable stops the ongoing job (quick stop). If the search speed v=0, the ready status is reset (DOUT READY = 0) and the controller blocked. For motors without a holding brake, the drive is then freely movable.

Motor with holding brake

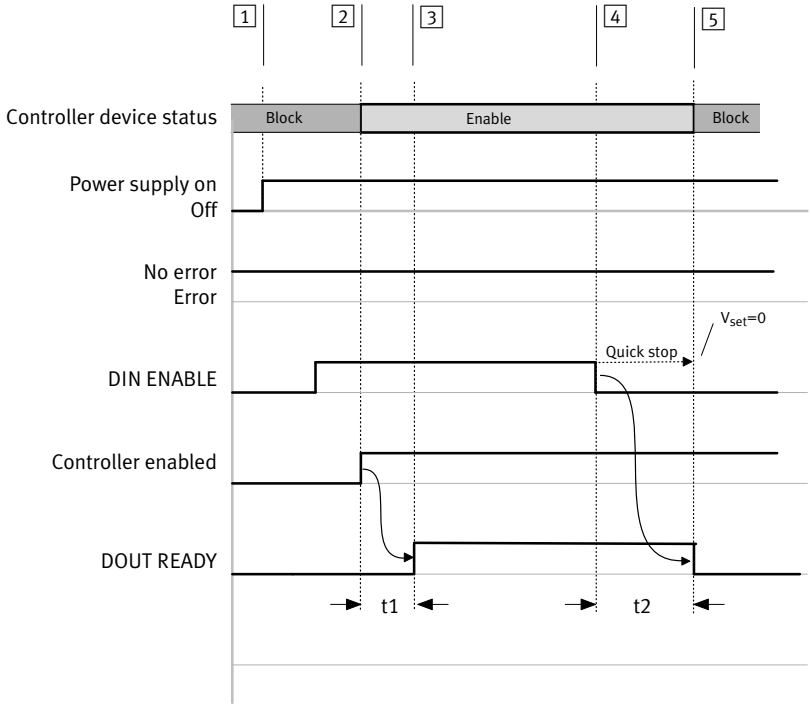
The automatic control of the holding brake is coupled to the controller enable:
– With controller enable, the brake is opened.
– With removal of controller enable, the brake is closed.
Further information about control of the holding brake ➔ chapter 2.5.6.

Achieving ready status

The ready status is achieved if the following requirements are met

– Input signals STO1 and STO2 (24 V) at [X3.2/3]
– Input signal ENABLE at [X1.6] with enable logic “DIN + control interface”
– Controller enabled via the connection that has master control (FHPP, FCT or web server)
– No error

If all requirements are met, the READY output is set.



Delay times:

t1: Reaction time

t2: Reaction time + duration of quick stop

1 Switch on the power supply
2 Request controller enable
3 Ready for operation
4 Revoke controller enable
5 Controller blocked

Fig. 2.3 Achieve ready status (enable logic: controller + DIN)

The delay time (t1) between request of controller enable and achievement of the ready status increases for motors with encoder by the time of searching for the commutation angle after the power supply is first switched on.

Configurable digital outputs (DOUT1, DOUT2)

The freely configurable digital outputs DOUT1/DOUT2 can depict one of the following signals. Configuration takes place with FCT [...] [Controller] [I/O Configuration] Digital Outputs.

Function		DOUT supplies ...
–	– "High" output	... always logic 1
	– "Low" output	... always logic 0
Movement (Motion)	– Motion Complete (actual value)	... logic 1, if the actual value of the target variable of the job is within the target window.
	– Motion Complete (setpoint value)	... logic 1, if the setpoint value of the target variable of the job is within the target window.
	– Axis In Motion	... logic 1 whenever the axis moves.
	– Constant-speed reached	... logic 1 if the target speed or maximum speed of the job is reached.
	– Force/torque limit reached	... logic 1, if the force limit specified in the job is reached.
	– Standstill monitoring	... logic 1, if the "Standstill monitoring" message is active.[1)]
Reference travel (Homing)	– Homing active	... logic 1, if homing is being carried out.
	– Reference position valid	... logic 1, if the homing position is valid.
Comparators (Comparators)	– Position comparator	... logic 1, if the corresponding comparator is active.[1)]
	– Speed comparator	
	– Force comparator	
	– Time comparator	
Errors/ warnings (Errors/ warnings)	– Common error	... logic 0, if at least one error is reported.
	– Following error	...logic 1, if the corresponding message is active.[1)]
	– I^2t error	
	– I^2t warning	
	– Load overvoltage	
	– Load undervoltage	

1) Information for monitoring the drive behaviour ➔ Chapter 2.8.

Tab. 2.21 Functions of the freely configurable digital output

2.4.6 Configuration of the Ethernet interface

The Ethernet interface [X18] is used in parallel as both a control and parameterisation interface. The following TCP communication connections are built up for that purpose:
- Communication with FCT
- Communication with web browser
- Process coupling via Modbus TCP with the device profile FHPP

The TCP/IP stack handles all incoming packages with the same priority. At the application level, processing the data of the control interface has priority over the other Ethernet-based services.

For commissioning, the motor controller is configured from the factory as an active DHCP server (DHCP = Dynamic Host Configuration Protocol). The DHCP server of the motor controller permits a **direct connection** with an individual PC configured as a DHCP client (point-to-point connection).

TCP/IPv4 configuration	
IP configuration	– DHCP server
IP address	– 192.168.178.1 (private IP)
Subnetwork mask	– Subnet mask: 255.255.255.0
Gateway	– Not assigned
Port	– Webserver: 80 – FCT: 7508 – Modbus: 502

Tab. 2.22 TCP/IPv4 configuration of the motor controller (factory setting)

The Ethernet interface used on the PC must have the following (standard) settings ➔ Windows System Control Center:
- Obtain an IP address automatically
- Obtain DNS server address automatically

The DHCP server of 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 assigned.

Note

The factory setting of the Ethernet interface is generally not suitable for network operation (with an active DHCP server that is usually already present):
- 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 connect to a network, the factory setting of the motor controller must be changed **before** integration into the network ➔ Chapter 2.4.7

2.4.7 Integration into 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, refer to the guidelines and standards for security in information technology, e.g. IEC 62443, ISO/IEC 27001.

Before integration into a network, the IP address of the device must be revised with FCT or a web server. The IP configuration on the device can be revised without the current IP configuration of the device matching that of the PC.

DHCP/IPv4	Address	Description
Client	Obtain an IP address automatically	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.
----	Use static IP address	The IP configuration of the device can be assigned manually (“fixed” address). 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. 2.23 TCP/IPv4 setting of the motor controller for integration into a network

2.4.8 Device control (master control)

Device control is an exclusive access right and ensures that the drive always has a controlling access (master control) over only one connection. Simultaneous control by multiple connections would result in uncontrollable behaviour of the drive. Only the connection that currently has master control can enable the drive and start or stop it.

Device control	Master control	Rights
Active	Yes	– Read rights for diagnostics – Write rights for parameterisation – Control of the drive
Inactive	No	Read rights for diagnostics

Tab. 2.24 Access rights

In addition to the connection over the control interface, 1 TCP connection can be used for FCT. Access to the HTTP server for provision of the website is likewise also possible. A maximum of 3 connections are permitted simultaneously, of which only one can have master control:

Connection via ...		Quantity
Control interface	FHPP	1
Parameterisation interface	FCT	1
	Web server	1

Tab. 2.25 Simultaneously permissible connections

Switching of device control

After the controller is switched on or restarted, the parameterised control interface has master control. Switching of the device control is possible both in the enabled and in the not-enabled status of the motor controller. The device control can also be taken over during execution of a job. For this, an ongoing order is stopped (Quick Stop). Recommendation:

- Stop ongoing jobs before switching over the device control.

Connection	Switching of device control
FCT	Can take over device control from all other connections. If FCT has master control, it cannot be taken over by any others (➔ FHPP, status bit SCON.LOCK). When device control is deactivated, the active control interface (FHPP) receives back master control.
Web server	Can take over device control from the active control interface (FHPP) (but not from FCT). When device control is deactivated, the active control interface (FHPP) receives back master control.

Tab. 2.26 Switching of device control

Blocking switch over

The device control can be taken over from FCT or web server only of the takeover is not prevented via FHPP. If the control bit CCON.LOCK is set, master control is not taken over.
➔ Device profile FHPP: description GDCP-CMMO-ST-LK-C-HP-...

2.5 Drive functions

Drive function	Brief description	➔ Chapter
Homing	Perform homing to define the reference point	2.5.2
Jogging	Continuous movement of the drive	2.5.3
Teach[1)]	Take over the current position of the axis as a parameter setting	2.5.4
Stop	Interrupt an ongoing job (quick stop)	2.5.5
	Interruption of an ongoing job (intermediate stop), optionally with deletion of the remaining path (halt)	
Actuate holding brake	Activate the holding brake on motors with integrated holding brake	2.5.6
Positioning mode	Operating mode for travelling to a specified target position (point-to-point positioning), optionally with reduced torque[2)]	2.5.7
Speed mode	Operating mode for execution of a job with constant rotational speed, optionally with stroke limitation	2.5.8
Force mode[2)]	Operating mode to apply a constant force for linear axes or a constant torque for rotary axes (torque operation), optionally with stroke limitation.	2.5.9

1) The function is not available via web server.

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

Tab. 2.27 Overview of the drive functions

2.5.1 Measuring reference system

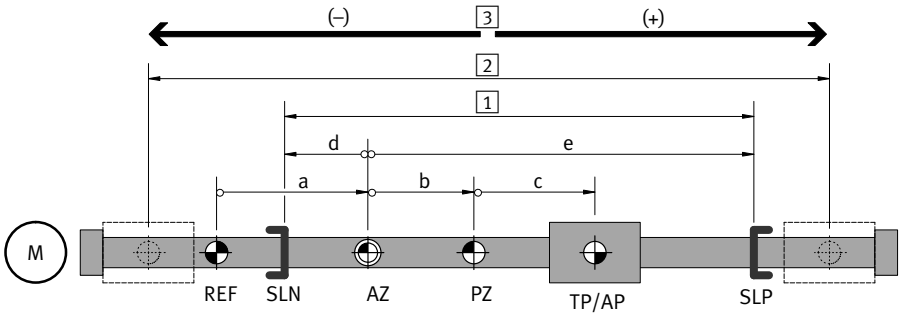
All drive functions are based upon a uniform dimensional reference system. The algebraic signs of all parameters set up are defined ex-factory as follows, viewing the input end of the motor:

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

The direction of movement of load is, for example, dependent on the spindle type of the axis (clockwise/anti-clockwise) and on the gear unit employed. If angular or toothed belt gear units are used, the opposite assignment of the direction of rotation can be advantageous ➔ 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 (-)

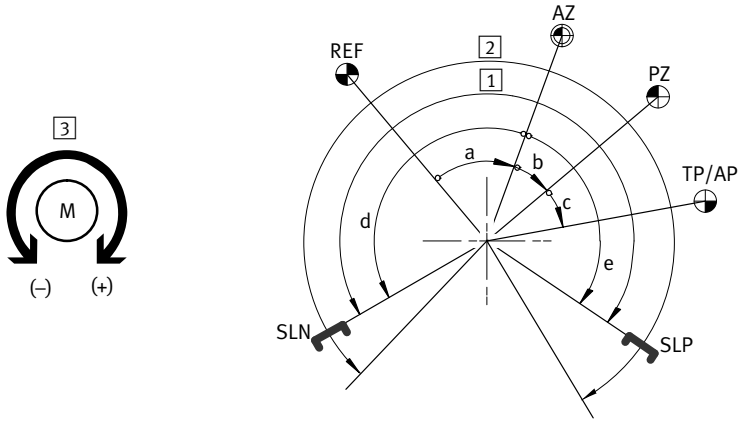
Example: linear drive



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/current position (actual position)
a	Offset axis zero point (AZ)
b	Offset project zero point (PZ)
c	Target/actual position (TP/AP)
d	Negative software end position (SLN)
e	Positive software end position (SLP)
1	Usable range (working stroke)
2	Operating range (working stroke)
3	Direction of movement with the factory setting

Tab. 2.28 Dimensional reference system ➔ FCT [...] [Axis] [Measurements]

Example: rotary drives



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)
TP	Target position
AP	Actual position/current position
a	Offset axis zero point (AZ)
b	Offset project zero point (PZ)
c	Target/actual position (TP/AP)
d	Optional: negative software end position (SLN)[1)]
e	Optional: positive software end position (SLP)[1)]
1	Usable range
2	Operating area
3	Direction of rotation with factory setting, looking at the front surface of the motor shaft

1) For rotating axes with the configuration “unlimited”, no end position can be parameterised.

Tab. 2.29 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. 2.30 Calculation rules for the dimension reference system

Software end position SLN/SLP

Delineation of an area of use within the operating area takes place through parameterisation of software end positions. The position is specified relative to the axis zero point AZ.

Note

Movement to fixed stops is not permitted during operation.

- Limit operating area through software end positions.
- Establish software end positions sufficiently far away from the mechanical stops.

The controller checks whether the target position of the command record lies between the software end positions SLN/SLP.

If a target position lies outside this area, the position record is not executed and the parameterised error response (error 11h, 12h) is triggered ➔ FCT [...] [Controller] [Error Management].

Before the software end position is reached, the drive is braked according to the error response, so that, if possible, the software end position is not passed. 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 drive 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 target of the next positioning motion is beyond the software end position, the error 29h or 2Ah is reported. If the target lies within the permitted area, travel outside the software end position is possible without error.

2.5.2 Homing

In 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 first commissioning of a drive
– after every time the logic power supply is switched on
– after a change in homing method
– after switching 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

Process of homing

The homing procedure is dependent on the following settings:
– Reference travel parameters ➔ Tab. 2.32
– Reference travel method ➔ Tab. 2.33
– Reference travel option ➔ Tab. 2.31

Selection of the homing method and parameterisation takes place in the FHPP or via FCT [...] [Axis] [Homing] Method. In commissioning via web server, settings are transferred from the parameter file of the drive.

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 drive 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 the reference point is reached, the drive continues to travel automatically 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. In the homing method “reference travel to stop”, the option cannot be disabled.

Tab. 2.31 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).

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:

Parameter	Description	Method
Homing		
Search speed (Search Velocity)	Speed for searching travel to the defined target	– Reference switch – Stop
Creep speed (Crawling Velocity)	Speed for crawling to the homing point	– Reference switch
Acceleration (Acceleration)	Acceleration/deceleration for all phases of reference travel	– Current position – Reference switch – Stop
Travel to the axis zero point		
Travel speed (Drive Velocity)	Positioning speed for the option “Drive to axis zero point”	– Current position – Reference 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 specification of the force (related to the maximum current) at which a stop is detected	– Stop
Damping time (Message Delay)	Time period in which the force must lie above the force limit so that a stop is considered detected	
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. 2.32 Homing parameters ➔ FCT [...] [Axis] [Homing] Method

Recommendation for parameterisation:

- Select low search/creep speed so that the target points can be identified accurately.
- 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.

Target	CiA 402[1)]		Brief description
Current position	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.
Reference 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.
Reference 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 drive continues against the homing direction up to the next index pulse of the encoder. The position reached becomes the homing point.

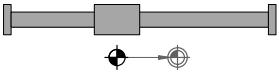
1) The homing methods are oriented on the CANopen device profile CiA 402 (electric drives).

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

3) Requirement: Reference switch (normally open, normally closed) is parameterised ➔ FCT [...] [Axis] Axis Options

Tab. 2.33 Homing methods ➔ FCT [Axis] [Homing] Method

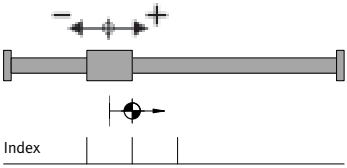
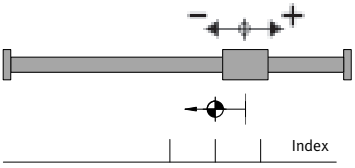
Homing to current position

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

1) Homing option “Travel to axis zero point” ➔ Tab. 2.31

Tab. 2.34 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. 2.35 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, travel must leave the stop position: The option is activated at the factory (default) and cannot be deactivated.

Note

If the motor controller continuously controls against a flexible stop, the temperature rises sharply and the controller shuts itself down. To prevent this:

- Set parameters for stop detection (force limit, damping time)
- 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. ≥ 3 mm).
- Pay attention to algebraic sign on the offset (direction: away from stop).

Note

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

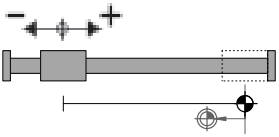
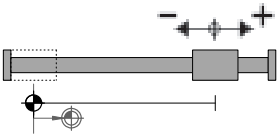
Note

Material damage due to moved dimensional reference system

The controller wrongly detects a stop if the drive 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.

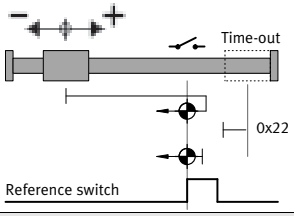
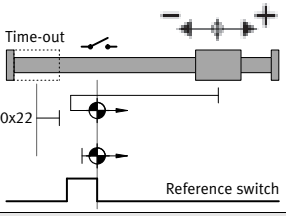
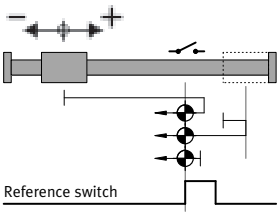
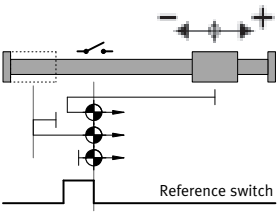
Homing to the stop	
Closed-loop operation	
1. Search for the stop with search speed in the parameterised direction: – Stop missing (rotary axis): drive continues infinitely. – Stop not recognised: controller regulates against the stop, shuts down if temperature rises above its defined limit. 2. Stop 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 active. ➔ Tab. 2.31

Tab. 2.36 Homing method – homing to stop

Homing to reference switch (without index)

Requirement is for parameterisation of the 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 drive 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 (Timeout)[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
	
Closed-loop operation	
1. Search for the reference switch with search speed in the parameterised direction – Switch not found: travel to stop, search in opposite direction – Switch in opposite direction not found: 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

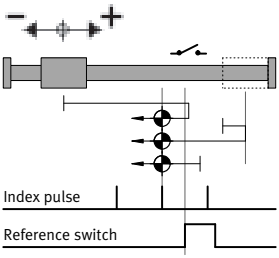
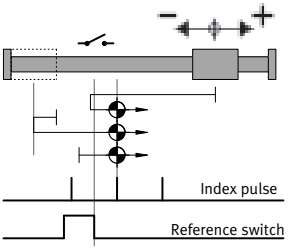
2) FCT [...] [Axis] [Homing] Settings: Timeout

3) Homing option "Position to axis zero point" ➔ Tab. 2.31

Tab. 2.37 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)]	
Closed-loop operation	
1. Search for the reference switch with search speed in the parameterised direction. – Switch not found: travel to stop, search in opposite direction – Switch in opposite direction not found: termination (error message 0x22) 2. Reference switch found: – travel at crawling speed in opposite direction until the reference switch is disabled 3. Continue until first index pulse from sensor – Index pulse not found: termination after one motor revolution (error message 0x23) 4. Index pulse 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. 2.31

Tab. 2.38 Homing method – reference switch with index

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

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

- Do **not** mechanically align reference switches pre-assembled at the factory.
- Do not alter the attachment position of the motor.

Aligning the reference switch:

- Check distance between switching flank and index pulse 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

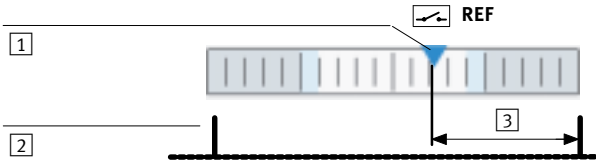


Fig. 2.4 Alignment of the reference switch during index evaluation

2.5.3 Jogging

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

Permits control of the drive by jogging:

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

The drive 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:

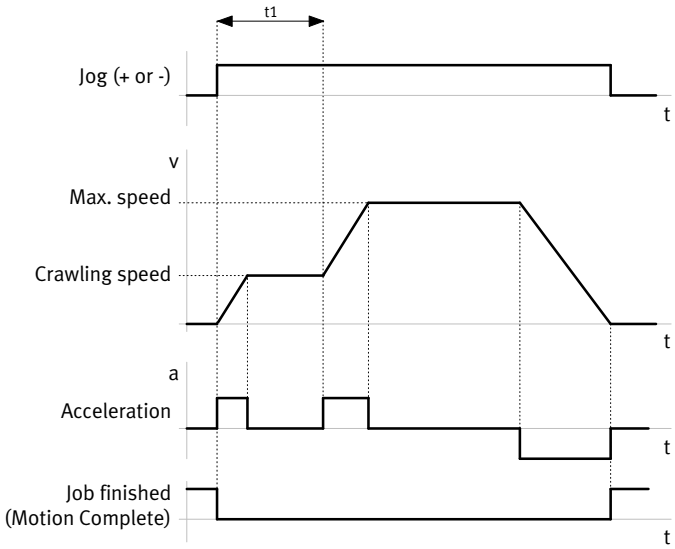
– Status = not referenced: positioning range between the stops
  The software end positions are not monitored.
– Status = referenced: positioning range between the software end positions
  When a software end position is reached, the drive stops automatically. The software end position is normally not passed, since the required deceleration path is taken into account.

Parameter	Description
Crawling speed (Crawling Velocity)	Setpoint value for the speed when starting a jog movement
Crawling duration (Slow Moving Time)	Setpoint value for the duration of crawling
Max. speed (Maximum Velocity)	Maximum speed after end of crawling
Acceleration (Acceleration)	Setpoint value for acceleration phases and the deceleration phase
Max. permitted following error (Maximum Following Error)	Value for the permissible following error for jog movement
Damping time (Message Delay)	Minimum time period that the following error must be present until a malfunction is displayed.

Tab. 2.39 Parameter for influencing the path characteristics

If the parameterisation is OK, the drive starts by moving slowly when jogged, then it moves faster (➔ Tab. 2.39):
– As the jog signal flank rises, the drive moves at crawl speed in a positive (Jog+) or a negative direction (Jog-). That enables the drive to be positioned more precisely.
– If the job signal continues after the end of the crawl period, the drive continues at max (jog) speed. Bigger strokes can be completed more rapidly.
– As the flank of the jog signal falls, the drive with the parameterised delay is brought to a standstill.

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



t1 : Crawling duration

Fig. 2.5 Jogging – example

Manual positioning in individual steps

With FCT, the drive can also be positioned in individual steps (single step). Homing is required for positioning in individual steps. Increment and speed can be parameterised in the FCT.

For more information: ➔ FCT PlugIn help, position manually

2.5.4 Teaching

Teaching can be used to adopt the current position of the drive for the following parameter settings:
- Target position of the currently selected record (record type “Positioning to absolute position”)
- Axis zero point
- Position comparator limits
- Project zero point
- Software end positions

The drive must not stand still for teaching. Of course, imprecision of several millimetres is possible even at low speeds, due to the normal cycle times of the motor controller, data transmission 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 is selected or addressed.
2. The drive is moved to the desired position (e.g. through jogging) ➔ Chap. 2.5.3).
3. A teach command is triggered to adopt the current position.

Teaching with FCT

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

For more information: Teaching with FCT ➔ Plug-in help for the FCT

2.5.5 Stopping

<table>
<tr><th>Function</th><th colspan="2">Description</th></tr>
<tr><td>Fast stop
(Quick Stop)</td><td colspan="2">Interruption of the current job: Quick-Stop is triggered in the following cases:
– when the stroke limit is reached
– upon withdrawal of controller enable during a job
– for errors with the parameterised error response “Quick Stop deceleration” (with or without switching off the output stage)
– through the signal CCON.STOP of the controller
The drive is braked with the Quick Stop deceleration until standstill. Motion complete is set.
– If controller enable is rescinded or the output stage is switched off, the drive stands unregulated.
– Open-loop operation: After braking, the drive remains at the reached position with the set holding current.
– Closed-loop operation: After braking, the drive remains positioned correctly at the reached position. Standstill monitoring is activated.</td></tr>
<tr><td rowspan="3">Halt</td><td colspan="2">Interruption of the current job: A halt is triggered due to:
– the stop functions in the FCT or web server
– through the signal CPOS.HALT of the controller.
The drive is braked with the deceleration of the active job until standstill.
– Open-loop operation: After braking, the drive remains at the reached position with the set holding current
– Closed-loop operation: After braking, the drive remains positioned correctly at the reached position. Standstill monitoring is activated.</td></tr>
<tr><td>Positioning mode</td><td>Speed and force mode</td></tr>
<tr><td>Motion complete is not set. The job is considered not ended and can be continued (intermediate stop).
– Continue job: The job can be continued through the corresponding signal of the control interface.
– Delete remaining path: The remaining path can be deleted through the corresponding signal of the control interface.
Motion Complete is set.</td><td>Motion complete is set. The job is considered completed.</td></tr>
</table>

Tab. 2.40 Stopping drive

2.5.6 Actuating the holding brake

The integrated holding brake on the motor holds the drive 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 drive via a braking ramp. The holding brake is closed immediately.

- Check whether the integrated holding brake can stop the drives.
- 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 of the holding brake

The motor controller controls the holding brake automatically through controller enable and the connection X6 (➔ Chap. 4.3.5):

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

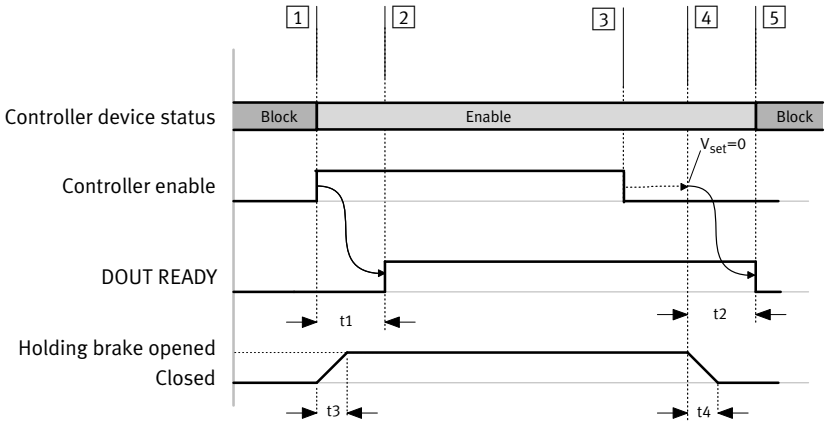
The mechanical inertia of the holding brake means that it takes a certain length of time to open and close it. The behaviour of the motor controller during controller enable is adapted to the mechanical inertia of the holding brake by the following parameters:

Parameter	Description
Switch-on delay	No orders are processed until the switch-on delay has elapsed. As a result, the drive remains at rest (setpoint speed=0). The switch-on delay must be set in such a way that the holding brake finishes up completely open.
Switch-off delay	The drive 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-off delay must be set in such a way that the holding brake finishes up completely closed.

Tab. 2.41 Parameterisation of the holding brake ➔ FCT [...] [Motor], Brake control

Controller enable	Control of the holding brake
0➔1	Open holding brake: After controller enable is requested, the controller is enabled and the drive held in its position. The holding brake is then automatically opened. After the switch-on delay has expired, the motor controller is ready for operation (READY=1)
1➔0	Close holding brake: Removal of the controller enable stops the ongoing job (quick stop). If setpoint speed v = 0, the holding brake is automatically closed. After expiration of the switch-off delay, the controller is blocked and the ready status deactivated (DOUT READY = 0). The drive is maintained in its position by the holding brake and cannot be moved.

Tab. 2.42 Control of the holding brake



Delay times:

t1: Duration dependent on switch-on delay (t1 ≥ t3)

t2: Duration dependent on switch-off delay (t2 ≥ t4)

t3: Duration dependent on the mechanical inertia of the holding brake

t4: Duration dependent on the mechanical inertia of the holding brake

1 Request of controller enable (corresponding to the enable logic ➔ Tab. 2.20)
2 Ready for operation
3 Withdrawal of controller enable (⟶ Quick stop)
4 Brake closes.
5 Controller blocked.

Fig. 2.6 Control of the holding brake

Opening the holding brake

If the controller is blocked, the holding brake can be opened via FHPP or FCT ➔ FCT: tab “Operate”, Device Control: ‹Brake›. After the holding brake is opened, the drive can be moved manually.

Caution

Injury due to movement of the drive during opening of the holding brake. During installation of the drive 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.

2.5.7 Positioning mode

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

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

Tab. 2.43 Order variants in positioning mode

For certain applications (e.g. axis of rotation), an endless operation can be parameterised, so the drive always travels in the positive direction, for example. The software limit stops must be deactivated for this.

Course of path

The controller computes a new path course from the parameterisation of the order to activate the motor. The calculated path course remains unchanged until the end of the order. During execution of the order, the deviation between the setpoint position corresponding to the path course and the actual position is calculated and monitored (➔ Chapter 2.8.2, following error).

Parameter	Description
Position	Target specification (variants ➔ Tab. 2.43)
Speed (Velocity)	Maximum value for speed
Acceleration	Maximum value for acceleration
Deceleration[1)]	Maximum value for deceleration
Jerk in acceleration (Jerk for acceleration)	Acceleration change at start and end of the acceleration phase. Lower values result in gentler movement. The value “0” means that no smoothing is active.
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 smoothing is active.
Final speed[2)]	Final speed of the order (standard = 0)

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

2) Parameterisation with record chaining

Tab. 2.44 Parameter for influencing the path characteristics

Target recognition

The behaviour 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 drive can thus start a subsequent record with this velocity without coming to a standstill
➔ Tab. 2.58

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 drive remains at the target position and is maintained in position with the predefined holding current. Closed-loop operation: The drive remains positioned correctly at the target position.

Tab. 2.45 Target recognition in positioning mode

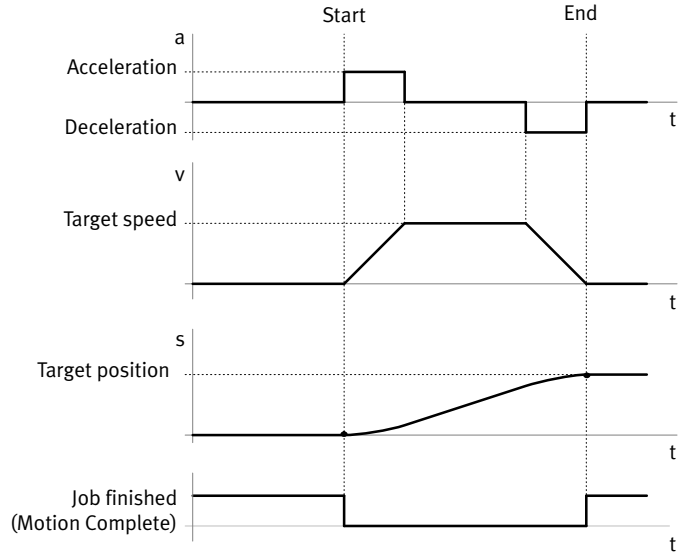


Fig. 2.7 Positioning task – example: starting speed and final speed 0 mm/s, without smoothing

2.5.8 Speed mode

The velocity mode enables a distance to be travelled at a constant rotational speed, optionally with 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 of an unlimited distance, e.g. for rotating drives
With stroke limitation	Travels a limited distance relative to the start position

Tab. 2.46 Order variants in speed mode

Course of path

Before carrying out the order, the controller computes a new path course to activate the motor. The calculated path course remains unchanged until the end of the order. During execution of the order, the deviation between the setpoint rotational speed (corresponding to the path course) and the actual rotational speed is processed and monitored. (➔ Chapter 2.8.2, following error).

Parameter	Description
Speed (Velocity)	Target specification for the speed
Acceleration	Maximum value for acceleration
Deceleration[1)]	Maximum value for deceleration
Jerk in acceleration (Jerk for acceleration)	Acceleration change at start and end of the acceleration phase. Lower values result in gentler movement. The value “0” means that no smoothing is active.
Jerk in deceleration (Jerk for 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 smoothing is active.

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

Tab. 2.47 Parameter for influencing the path characteristics

Target recognition

The behaviour when the target position is reached (target recognition) depends on the stroke limitation.

Target recognition	Behaviour after target recognition
... without stroke limitation	
Speed is reached, that is, the actual speed is within the target window for the duration of the damping time.	The “Motion Complete” signal is set. The drive continues to move at target speed. Monitoring of the speed deviation remains active. Force remains at the maximum value specified in the speed record. The signal “Motion Complete” remains set even if the target window is left again.

Tab. 2.48 Target recognition in speed mode (without stroke limitation)

Target recognition	Behaviour after target recognition
… with stroke limitation	
– Stroke limitation is reached first (example ➔ Fig. 2.8)	The “Stroke limitation” signal is set. The drive is braked down to a stop using the parameterised Quick-Stop deceleration function. Although the target speed has not been reached yet, the signal “Motion Complete” is set. Open-loop operation: The drive remains at the target position and is maintained in position with the predefined holding current. Closed-loop operation: The drive stops in a position-controlled way.
– Speed is reached first, that is, the actual speed is within the target window for the duration of the damping time. (Example ➔ Fig. 2.9)	The “Motion Complete” signal is set. The drive continues to move at target speed in a controlled manner. Monitoring of the speed deviation remains active; force remains limited to the maximum stated in the order; stroke limitation remains enabled.

Tab. 2.49 Target recognition in speed mode (with stroke limitation)

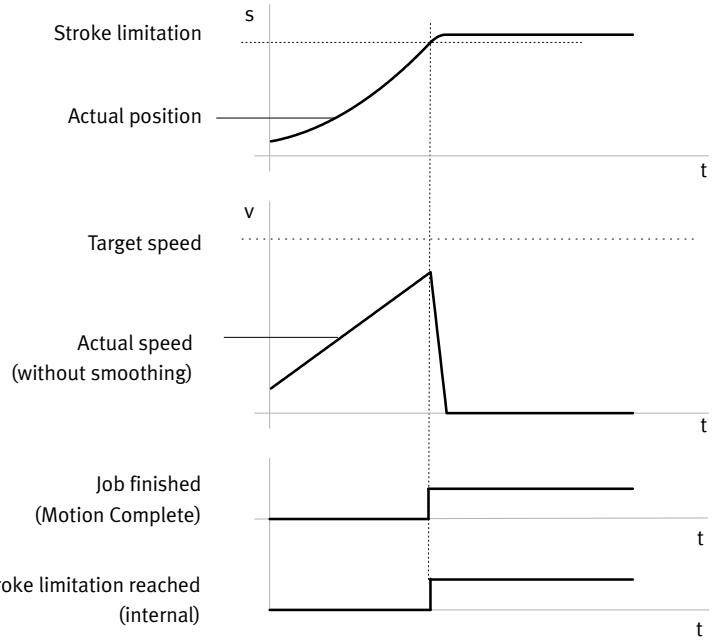


Fig. 2.8 Speed mode with stroke limitation (stroke limitation reached first)

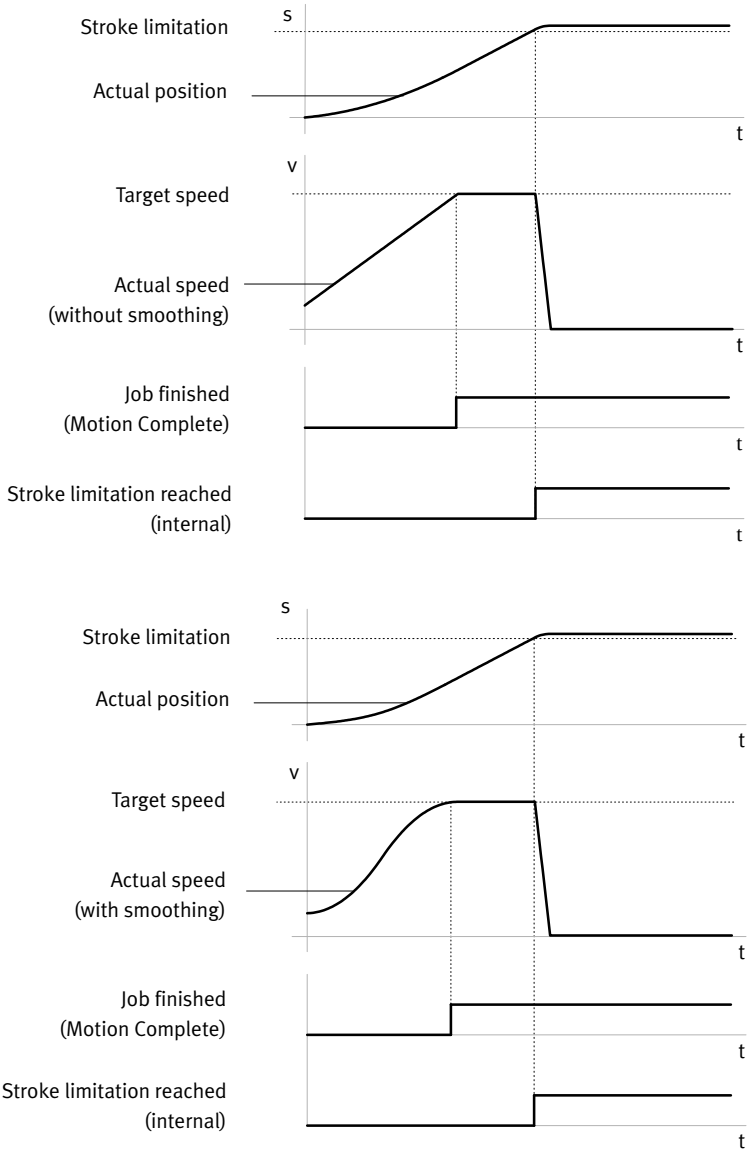


Fig. 2.9 Speed mode with stroke limitation (target speed reached first)

2.5.9 Force mode

Force mode makes it possible to apply constant power, optionally with stroke limitation. The function requires closed-loop 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	Travels a limited distance relative to the start position

Tab. 2.50 Order variants in power mode

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

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

Tab. 2.51 Parameters in force mode

Target recognition

The behaviour when the target position is 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 target window for the defined damping time.	The “Motion Complete” signal is set. As long as no other drive function is executed, the drive will continue to be controlled by the target force. The speed is limited to the maximum value specified in the order. The signal “Motion Complete” remains set even if the target window is left again.
... with stroke limitation	
– Stroke limitation is reached	The “Stroke limitation” signal is set. The drive is braked down to a stop using the parameterised Quick-Stop deceleration function. The drive stops in a position-controlled way. Stationary monitoring is enabled and the “Motion Complete” signal is set.
– Force is reached i.e. the actual motor current is located in the target window for the defined damping time.	The “Motion Complete” signal is set. As long as no other drive function is executed, the drive will continue to be controlled by the target force. The signal “Motion Complete” remains set even if the target window is left again. The speed is limited to the maximum value specified in the order. Stroke limitation remains active.

Tab. 2.52 Target recognition in force mode

2.6 Operational principle of direct application

Orders are transferred with FHPP through I/O messages (I/O messaging). Only the target variables corresponding to the operating mode (positioning mode, speed mode, force mode) are transferred. Supplemental parameters (e.g. acceleration) are determined through parameterisation with FCT or web server. An advantage compared to record selection is that the orders can be dynamically adapted (e.g. to different workpiece sizes) without parameterising a record list again. The orders are managed completely in the controller and sent directly to the motor controller. Additional information
➔ FHPP device profile: description GDCP-CMMO-ST-LK-CHP-...

Test with web server: Direct applications can be executed via web browser in order to test the parameterisation. Parameterisation of the supplementary parameters takes place in the “Direct Mode” tab. After download of the parameters, the target variable of the direct application can be specified in the “Test Mode” tab and then the order started.

2.7 Operational principle for record selection

2.7.1 Command records

Orders are stored in the CMMO-ST as parameterised command records (maximum 64). Parameterisation of the records takes place via FCT.
Every record 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).

Test with FCT: Records from the record table can be started individually for testing. Also, records can be compiled in any order and executed as a sequence (test cycle).

Parameter	Description
Record number	Number for addressing and executing parameterised records
Record type	Positioning mode – Absolute positioning (PA) – Positioning relative to the last target position (PRN) – Positioning relative to the actual position (PRA)
	Speed mode – With stroke limitation (VSL) – Without stroke limitation (V)
	Force mode – With stroke limitation (FSL) – Without stroke limitation (F)

Tab. 2.53 Record parameter (record number, record type)

Other record parameters

Parameter	Description
Basic data	
Objective (target)	Parameterisation dependent on the operating mode – Positioning mode ➔ Chap. 2.5.7 – Speed mode ➔ Chap. 2.5.8 – Force mode ➔ Chap. 2.5.9
Speed (Velocity)	
Acceleration/deceleration (Acceleration/deceleration)	
Additional load (Extra load)	Payload transported in addition to the basic load
Torque pilot control (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.
Record switching/record chaining	
Start condition (Start condition)	A start condition can be established for each record. The start condition specifies what the reaction should be to a start signal for the record if the current order has not been ended yet (➔ Tab. 2.55, record switching)
Condition (Condition) Start deceleration (Start delay) MC visible (MC visible) Final speed (Final velocity) Following record (Following record)	Several records in the record table can be linked with one another. These are executed with a start signal directly one after the other if the respective conditions for continuation are met ➔ Chap. 2.7.3
Comparators	
Force comparator (Force comparator)	Specification of a tolerance window with trigger levels and related damping times (➔ Chap. 2.8.4)
Position comparator (Position comparator)	
Speed comparator (Velocity comparator)	
Time Comparator (Time comparator)	
Limitations	
Force compensation (Force limit/torque limit)	Maximum permitted force or torque when executing the order in positioning or speed mode
Stroke limitation (Stroke limit)	Maximum permitted distance for execution of the order
Max. following error (Max. following error)	Control deviation in positioning or speed mode, in which the message “following error” is issued

Tab. 2.54 Record parameter

2.7.2 Record switching

Record switching enables flexible switching between command records. For every saved record, it can be determined how the drive should behave when the record is started while another order is being executed simultaneously.

Start Condition[1)]	Description
Ignore (Ignore)	During execution of another order, the start signal for the record is ignored. The current order is completed. The record can only be started with a new start signal after Motion Complete is active (standard).
Wait (Delay)	The current order is completed. The record is not executed until the ongoing order has been ended (after Motion Complete).
Interrupt (Interrupt)	The ongoing order is interrupted immediately and the record is executed directly.

1) ➔ FCT […] [Controller] [Record Table] Basic Data

Tab. 2.55 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.

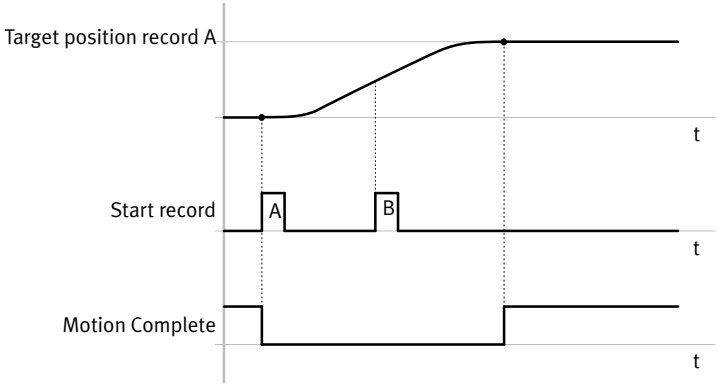


Fig. 2.10 Start condition record B = “Ignore”

Example: start condition “Wait”

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.

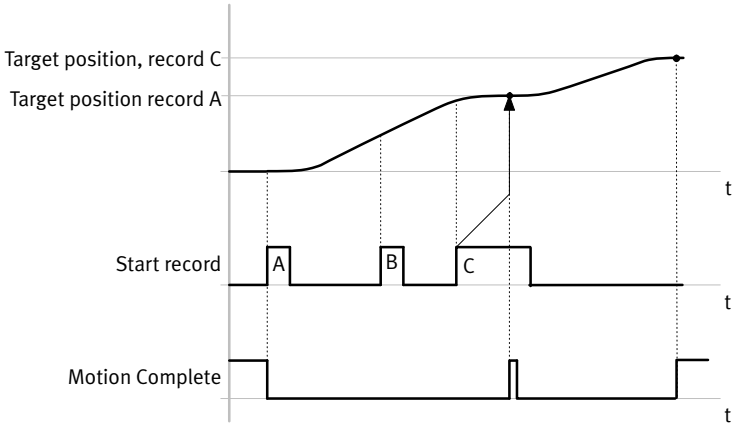


Fig. 2.11 Start condition record B and record C = “Wait”

Example: start condition “Interrupt”

The ongoing order (here record A) is interrupted and the newly addressed order (here record B) is executed immediately.

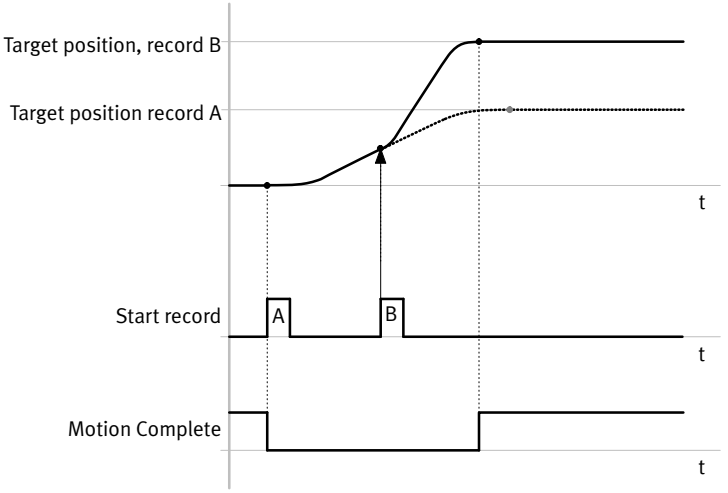


Fig. 2.12 Start condition record B = “Interrupt”

2.7.3 Record linking

With record linking, command records 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.:

– Travelling 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:

Parameter	Description
Condition (Condition)	Step enabling condition that specifies when the following record should be started ➔ Tab. 2.57
Start delay (Start delay)	Waiting time before the start of the record when the record is linked as the following record
MC visible (MC visible)	Output of the signal “Motion Complete” between the individual records of a record linking
Final speed (Final velocity)	Final speed with which the record should be ended at the target position. The final speed must be less than or equal to the parameterised maximum speed of the order.
Following record (Following record)	Number of the record that should be started automatically when the condition is reached

Tab. 2.56 Parameters for influencing the movement course

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

Condition (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 speed 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. 2.57 Step enabling conditions

Target recognition

The behaviour when the target position (target recognition) is 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 drive remains at the target position and is maintained in position with the predefined holding current until the following record starts. – Closed-loop operation: The drive stops position-controlled at the target position until the following record starts.
End speed ≠ 0 (with record sequencing)	
The actual position corresponds to the target position or has passed it.	– Open-loop operation: The drive continues controlled with the final speed of the positioning order (without monitoring of the deviation). The force continues to be limited to the maximum value defined in the order. A following record can start without the drive being at a standstill. – Closed-loop operation: The drive continues in a speed-controller manner with the final speed of the positioning order (without monitoring of the deviation). The force continues to be limited to the maximum value defined in the order. A following record can start without the drive being at a standstill.

Tab. 2.58 Target recognition (message “Motion Complete”) in positioning mode

Example: Record linking with final speed ≠ 0 (positioning mode)

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

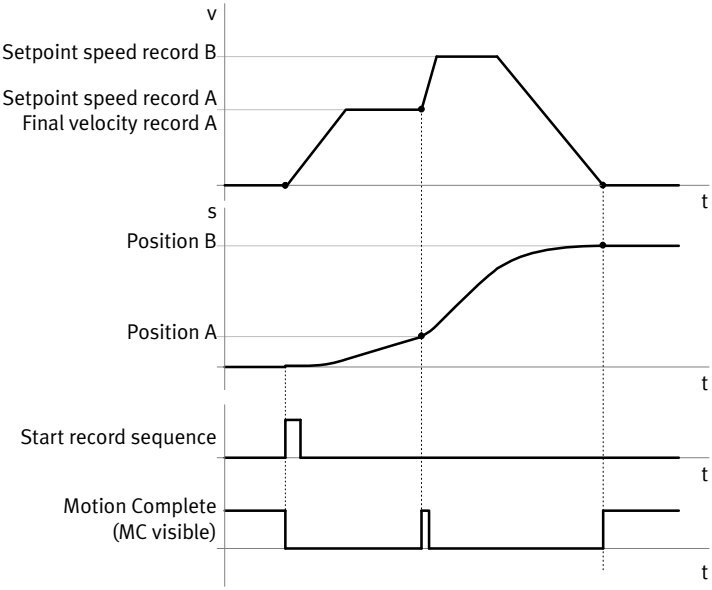


Fig. 2.13 Following record with final velocity v ≠ 0

2.8 Monitoring of the drive behaviour

To monitor and control the drive behaviour and for protection of the motor controller, e.g. in case of overload, the following functions are available:

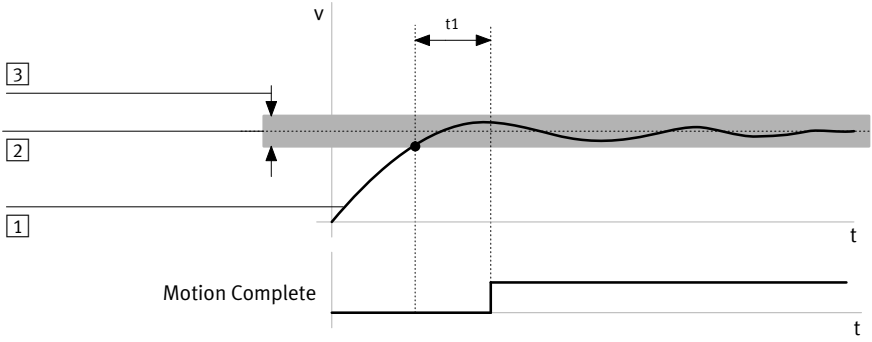
Functions	Brief description
Target recognition (Motion Complete)	... signals the end of an order.
Following error monitoring	... monitors deviations during an order in positioning and speed mode.
Standstill monitoring	... monitors in closed-loop operation behaviour after Motion Complete or Stop.
Comparators	... check whether, for example, the actual value of the order lies within an established range of values (window).
Protective functions	... monitor limit values with integrated sensors for protection of control section, power section and motor.

Tab. 2.59 Monitoring of the drive behaviour

Messages for the monitoring functions take place:
– via (configurable) digital outputs ➔ Tab. 2.21
– via diagnostic messages, in part with parameterisable error responses ➔ Chap. 6.3.2

2.8.1 Target recognition (Motion Complete)

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



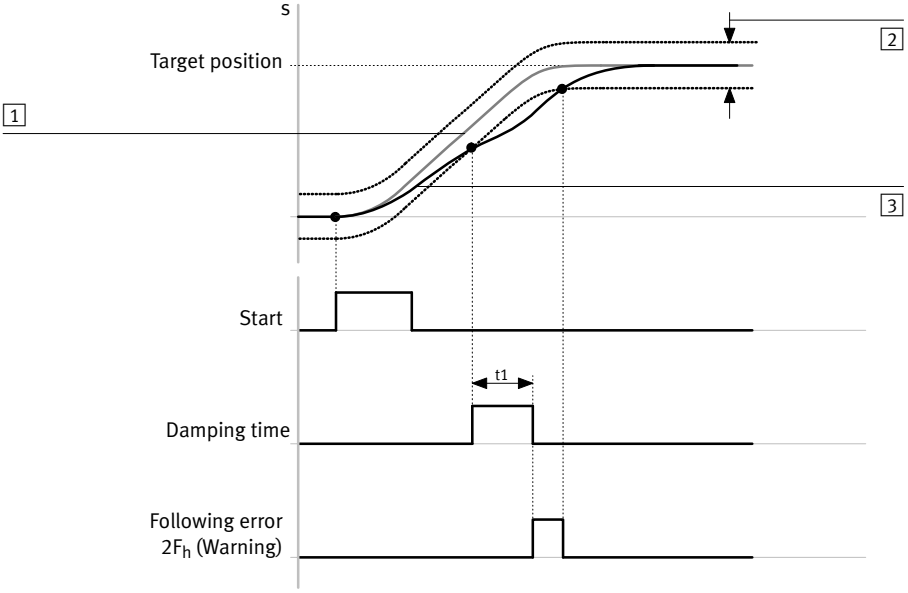
t1: Damping time, Motion Complete

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

Fig. 2.14 Motion Complete – example of velocity mode

2.8.2 Following error monitoring

In position and speed mode, exceeding the maximum permissible following error can be monitored, e.g. in the case of sluggishness or overload of the drive.
A theoretical progression is calculated from the parameters of a job before it is executed (➔ Fig. 2.15, 1). While carrying out an order, the variance between the calculated setpoint and the current actual value is monitored.
The permitted difference (= maximum permissible following error) is parameterised. The message "Following error" is activated after the damping time has expired if the difference between the setpoint and actual value of the current controlled variable (path, speed) lies outside the parameterised difference. The reaction to the diagnostic message can be parameterised with the FCT error management.
If the diagnostic message is parameterised as a warning, the message is automatically deleted as soon as the actual value lies again within the following error window (refer to Fig. 2.15).



t1: Damping time standstill monitoring

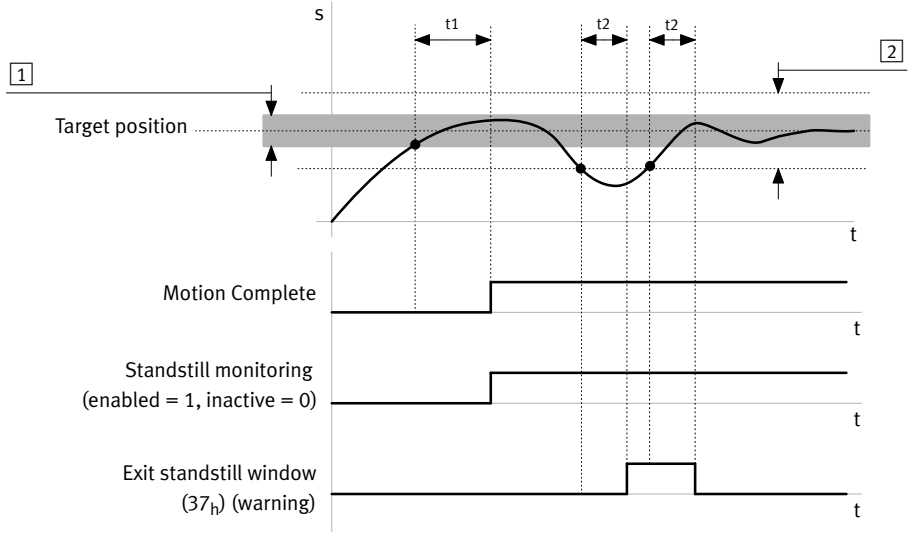
1 Set positioning path
2 Max. following error
3 Actual positioning path

Fig. 2.15 Timing diagram: message "Following error" – position control example, message parameterised as a warning

2.8.3 Standstill monitoring

The standstill monitoring checks in positioning mode if the drive is within the standstill window of the target position for the duration of the damping time (➔ Fig. 2.16):
Standstill monitoring is automatically activated after the target position is reached (“Motion Complete”). Standstill monitoring can be suppressed, if required, by setting the standstill window to the value “0”.
During standstill monitoring, if the actual position of the drive leaves the standstill window for the duration of the standstill monitoring time, e.g. due to external forces, the motor controller reacts as follows:

– The “standstill monitoring” diagnostic message is triggered.
  The reaction to the diagnostic message can be parameterised with the FCT error management. If the diagnostic message is parameterised as a warning, the message is automatically deleted as soon as the actual position is within the standstill window again (refer to Fig. 2.16) or a new job is started.
– The position controller attempts to return the drive to the standstill window.



t1: Damping time, Motion Complete

t2: Damping time, standstill monitoring

1 Target window

2 Standstill window

Fig. 2.16 Standstill monitoring - example

2.8.4 Comparators

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

– for control of record linking (➔ Chapter 2.8.4)
– for messages to a configurable digital output (➔ Tab. 2.21)

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 active. 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.

For the comparators position, speed, force, the limit values are specified as directional variables. Negative ranges of values are entered with an algebraic sign. Example “Position comparator”:
-50 mm (= minimum) ≤ actual position ≤ -40 mm (= maximum).
A plausibility check takes place: If the lower limit value is larger than the upper limit value, the comparator message is never active.

Parameter[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, speed, force

Tab. 2.60 Parameter for the comparator

Comparator	Parameter	Description
Time	– Min. – Max.	The message is active if the elapsed time since the start of the order lies within the window.
Position	– Min. – Max. – Time	The limits must lie within the permissible range between the software end positions. Limits are always specified in absolute values (related to the zero point), even for relative position records. The message is active if the actual value for the parameterised time is within the window.
Speed	– Min. – Max. – Time	The message is active if the actual value for the parameterised time lies within the window.
Force[1)]	– Min. – Max. – Time	The limits are specified as percentages (related to the motor nominal current). The message is active if the actual value for the parameterised time lies within the window.

1) Only present in closed-loop operation.

Tab. 2.61 Comparators

2.8.5 Protective functions

Some 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 6.2).

Monitoring	Fault number[1)]	Description
Software end position	11_h, 12_h, 29_h, $2A_h$	Software end positions exceeded (➔ 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. 2.62 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. Removal of controller enable is not sufficient.
- 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

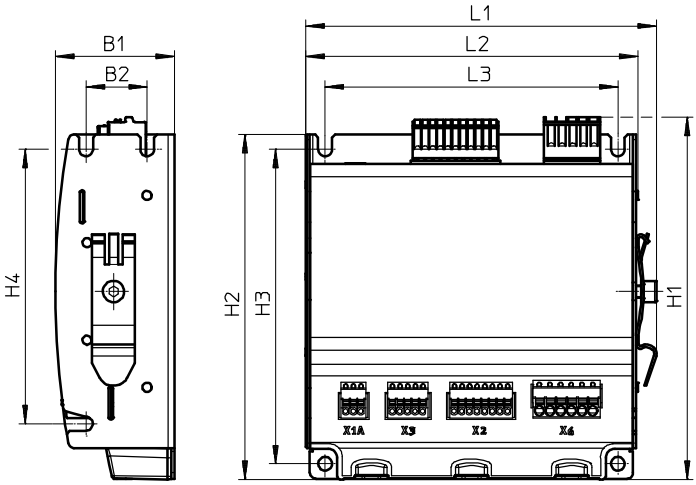


Fig. 3.1 Installation dimensions

Dimension	B1	B2	H1	H2	H3	H4	L1	L2	L3
[mm]	39	20	118.7	112.9	103.1	90	115	108	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 premounted: screw H-rail bracket to the side of the controller ➔ 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 mounting several controllers, maintain the specified minimum distance.

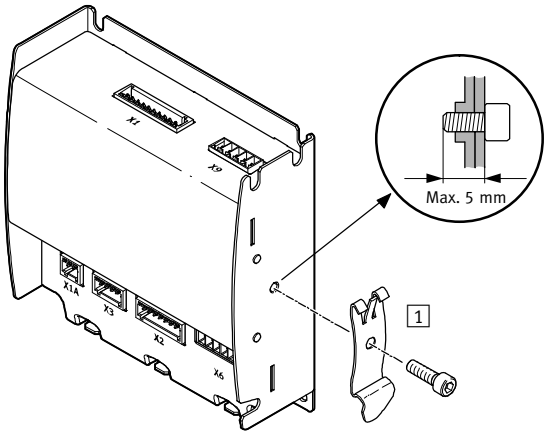
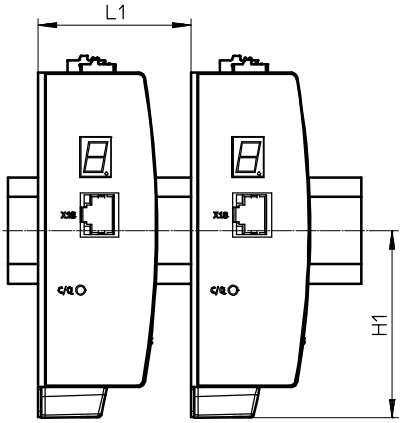


Fig. 3.2 H-rail mounting



Dimension	L1	H1
[mm]	41	61.35

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

3.3 Mounting on a mounting plate

If an H-rail bracket is mounted:

- Remove H-rail bracket.

Upright mounting

There are 3 recesses for upright mounting on the mounting surface ➔ Fig. 3.3 [2].

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

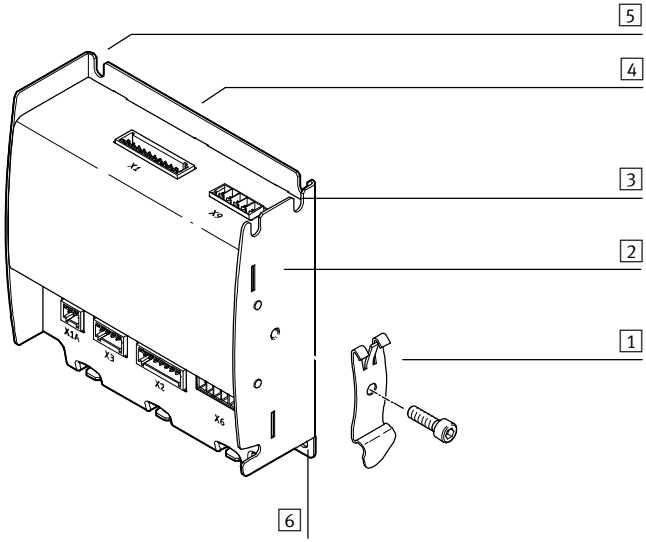
When replacing the controller

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

Horizontal mounting

There are 2 recesses and 2 drill holes on the mounting surface for horizontal mounting ➔ Fig. 3.3 [4]

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



[1] Remove the H-rail bracket
[2] Mounting surface
[3] Recesses (3x)
[4] Mounting surface
[5] Recesses (2x)
[6] Drill holes (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. Removal of controller enable 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.
– Maintain distance between signal lines and power lines of at least 25 cm.
– Avoid crossing power cables or running them at a 90° angle.
– Observe permitted cable lengths (max. length 30 m).
– On shielded lines with unshielded connector housings: Make the length of the unshielded wires at the end of the cable as short as possible.

4.2 Functional earth FE

The lower base plate of the motor controller serves as 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		Dimension		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 movements of the drive as a result of incorrectly pre-assembled cables

- Only use the plug connectors provided and preferably the cables listed in the specified accessories (➔ Chapter 2.2.3).
- Make sure tightening torques correspond to 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 an energy 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] Load/logic voltage
2 [X1] PLC/IPC control interface
– IO-Link/I-Port
– optional: digital inputs/outputs
3 [X18] Ethernet (RJ-45)
– Parameterisation interface TCP/IP
– Control interface Modbus TCP
4 [X1A] Reference switch
5 [X3] STO (Safe Torque Off)
6 [X2] Encoder (RS422)
7 [X6] Motor
8 FE functional earth (3x)

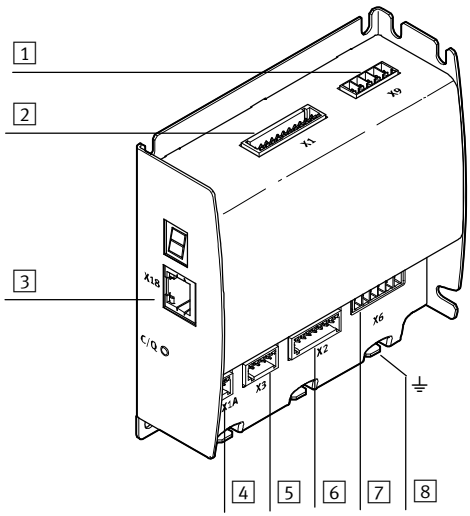


Fig. 4.1 Connections

The following connections are designed as terminal strips (connectors). The connectors are included in the scope of delivery (connector assortment NEKM-C-14).

Connection		Grid [mm]	Wire cross-section [mm²]	Stripping the cable [mm]	Plug version
[X1]	11-pin	2.5	0.081 … 0.518	7 … 8	CAGE-AWG20-28
[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]	IO-Link/I-Port/digital I/O	≤ 20	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 TCP/IP	≤ 30	Screened[3)]
	Modbus TCP	≤ 30	

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

2) The cable must be assembled 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] IO-Link/I-Port interface and digital inputs/outputs

The IO-Link/I-Port interface is used for exchange of serial data from decentralised function modules (devices) at field level. The point-to-point communication takes place over a 3-wire connection without additional demands on the cable material. The IO-Link connection is designed to be compatible with a Master Port Class A.

The circuitry of the digital I/O modules is not absolutely required for operation of the motor controller.

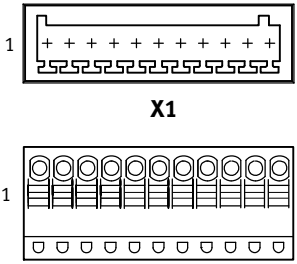
Note

Device damage in case of overload/short circuit

The auxiliary supply pin 1 (+24 V Out) is not overload-resistant ($I_{max.}$ = 100 mA)

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

Note
Galvanic isolation
The IO-Link/ I-Port interface is not galvanically isolated. Under certain circumstances, the CMMO-ST can bypass the galvanic isolation of an IO-Link Master.

Connection	Pin	Function	
	Digital I/O modules (DIN/DOUT)		
	1	+24 V (OUT)	Output +24 V[1] e.g. provision of a potential-free relay contact for the ENABLE input
	2	0 V (GND)	Reference potential for output signals
	3	DOUT2	Output 2, parameterisable
	4	DOUT1	Output 1, parameterisable
	5	READY	Output “ready for operation”
	6	ENABLE	Input “controller enable”[2]
	7	–	No function, not connected internally[3]
	8	–	
	IO-Link/I-Port		
	9	L–	0 volt (GND)
	10	C/Q	IO-Link/I-Port signal
	11	L+	24 volt of the IO-Link/I-Port IC (not connected to the logic supply at X9)

1) The pin is not overload-proof (maximum 100 mA).
2) The required signals for controller enable can be parameterised ➔ Chapter 2.4.5
3) Pin 7 and 8 can be used for the 4th and 5th conductor of the I-Port/IO-Link cable.

Tab. 4.4 Connection [X1] IO-Link/I-Port and digital inputs/outputs

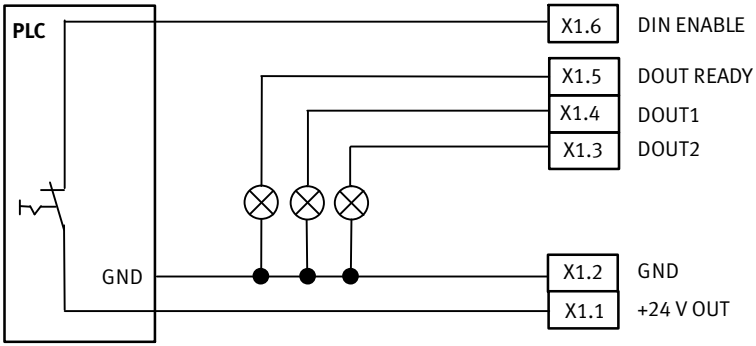
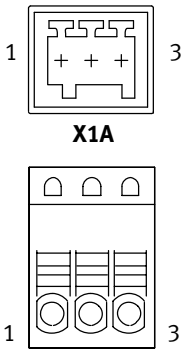


Fig. 4.2 Circuitry of the digital I/O interface (PNP)

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	– Input for PNP switch – Switches to +24 V – NO/NC version[1)]
	3	0 V GND	Reference potential (ground)

1) NO/NC = normally opened/normally closed

Tab. 4.5 Reference switch connection [X1A]

Note

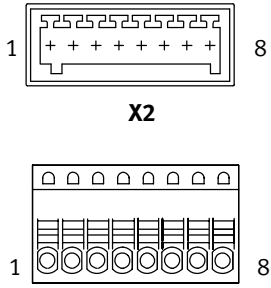
Device damage in case of overload

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 pre-assembled cables of the connected components 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.

Connection	Pin	Function	
	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 encoder signal zero pulse+
	6	N/[1]	Incremental encoder signal zero pulse-
	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

Device damage in case of overload

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

- Only use to supply power to the incremental encoder.

4.3.4 [X3] STO

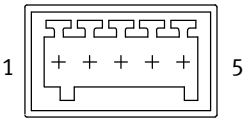
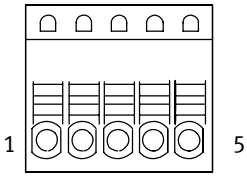
To establish ready status during commissioning via FCT or web server and for control via I/O, circuitry of the control inputs STO1/STO2 at [X3] is required.

Circuitry without use of the STO safety function

If you do **not** need the integrated safety function STO in your application, you must bridge Pin 1, 2 and 3 at the X3 interface to operate the motor controller. 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-LK-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	Acknowledgment 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]

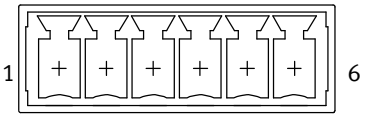
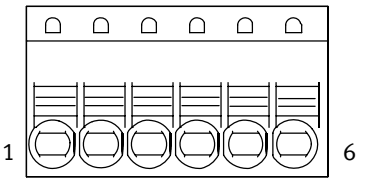
Note

Device damage in case of 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 pre-assembled 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
	6	BR–	– Short-circuit-proof and overload-proof BR– = GND, BR+ is switched (24 V load)

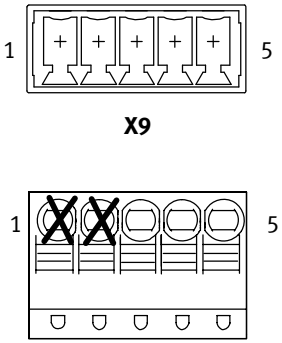
Tab. 4.8 Motor connection [X6]

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
Danger of burns due to heating of the device in the event of a connection error.
- Pay attention to the correct pin numbers corresponding to the plug location [X9] on the device.
- Do **not** connect 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
	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	Supply of the power output stage and the motor with +24 V DC (load voltage)

Tab. 4.9 Connection [X9] without plug connector and with plug connector attached (assortment of plugs NEKM-C-14)

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).

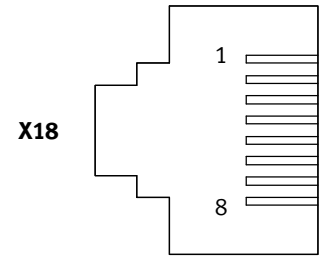
Additional information ➔ Guidelines and standards for security in information technology, e.g. IEC 62443, ISO/IEC 27001.

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 ➔ Tab. 4.3)

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, you can choose between using patch cables or crossover cables. The circuitry for network connections [X18] is adapted automatically.

5 Commissioning

5.1 Notes on commissioning

Caution
Errors 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.

To establish ready status during commissioning 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 Pin 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-LK-S1. The STO function may 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-LK-S1).
- Make sure that movement of the actuator does not endanger anyone.
- Do not operate motor controller with unknown settings.
- 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 FE conductors, even for brief measuring and test purposes.
4. Establish an Ethernet connection with the PC (➔ Chapter 5.2).

After the power supply is switched on for the first time:
- Initial commissioning with web server (➔ Chapter 5.3) -or-
- Perform initial commissioning with FCT (➔ Chapter 5.4)

Each time after switching on the (logic) power supply
- Perform homing

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 permits a **direct connection** between the motor controller and an individual PC configured 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 commissioning, connect the motor controller directly to the PC via the Ethernet interface .
- Do **not** connect the motor controller to the networks as a DHCP server if another DHCP server is active in the network.
- To connect to a network, first change the IP configuration of the motor controller with FCT (➔ chapter 2.4.7).

Ethernet direct connection	
Requirements	– 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).
Make connection	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.
Test connection with the web server	• Call up the website of the web server in the web browser (➔ Chapter 5.3.1)
Test connection 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).

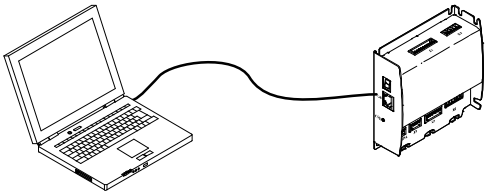


Fig. 5.1 Initial commissioning via direct connection (point-to-point connection)

Note

With communication problems

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

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

5.3 Commissioning with web server

Caution
Violation by accidental movements of the drive when the connection to the web browser is interrupted.
The motor controller cannot detect that the connection to the web browser has been interrupted. If the Ethernet connection is interrupted, movements previously started via the web browser can no longer be stopped through the web browser. To avoid injuries:
- 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 that have been generated or processed in the FCT are used for this purpose, for example, in replication of serial machines.

Positioning systems of the Optimised Motion Series (OMS)
Parameter files (*.fpf) tested by Festo with standard settings for positioning systems (OMS) are available in the Internet ➔ www.festo.com/sp
The most important settings are documented in the related parameter lists. Additional settings can be displayed with FCT, if required, after the file is imported (.e.g. maximum values for speed, acceleration, force). Optionally, all parameters can be changed with FCT and stored in the parameter file.

The standard values for direct jobs (speed, acceleration, limits, etc.) are preset for Festo components and can be changed in the web browser under the “Direct Mode” tab.

Requirements for commissioning
– The appropriate parameter file *.fpf for each drive is available.
– The website of the CMMO-ST is displayed in the web browser (calling up the web server ➔ Chapter 5.3.1)
– Required signals for achieving the ready status
  – Input signals STO1 and STO2 (24 V) at [X3.2/3]
  – Input signal ENABLE at [X1.6] with enable logic “DIN + control interface”
  – Enable via control interface or the connection that has master control.
  – No error

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. Test direct application ➔ Chapter 5.3.5
4. Conclude commissioning ➔ Chapter 5.3.6

5.3.1 Calling up web server

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 up 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...›).

If the password protection of the motor controller is activated, the password must be entered after entry of the IP address; the field “User name” in the query dialogue of the browser can remain empty, since it is not evaluated. ➔ Chapter 2.3.3, password protection.

If the online connection is established, the website of the motor controller is displayed in the browser. If a drive is not configured yet in the motor controller, configuration-dependent settings, such as maximum values for force, speed with factory setting (= 0) are initialised and the related status displays are active.

The initial values cannot be processed in the web server; the drive must be configured in the motor controller:
– through parameterisation in the FCT
– for OMS systems, through download of a parameter file ➔ Chap. 5.3.3

Tab	Functions

Information	– Status information e.g.
	  – Display of device type and firmware version
	  – Display of IP and MAC address
	  – Identification on the network (wave function)
	  – Current position
	  – Error display
	  – Temperature display
	  – Dimensional units for positioning (changeover)

Status[1)]	Functions: – Device control, controller enable – Start homing – Stop job – Acknowledge error Displays: – Display of operating messages (e.g. Motion Complete, Homing valid) – Display of the signal statuses of the I/O interface and reference switch input [X1A]
Control interface	Parameterisation of the controller interface: IO-Link, I-Port or Modbus
FHPP profile	Deactivation/activation of the FHPP FPC channel
Network	Parameterisation of the network IP address
Parameter	Upload/download of a parameter file
Direct mode	Parameterisation of the FHPP parameters for direct application
Test mode	Test of direct applications in the positioning, speed or force mode
Password	Specification of a password for protection from unauthorised access
Diagnostics	Reading and deleting the messages of the diagnostic memory.
Support	Hyperlinks to the Festo Support Portal, e.g. for download of the firmware, parameter files and technical documentation

1) Active signals are marked with a blue dot. Inactive signals are marked with a grey dot.

Tab. 5.2 Website of the motor controller

5.3.2 Access via web browser to the motor controller

Adoption of the device control

With the “Device Control” check box, write/read access to the motor controller via web browser is activated. If the drive is currently executing a command when activation takes place, the drive is stopped and stays stopped unregulated.

- To adopt device control, on the “Status” tab: activate “Device Control”.

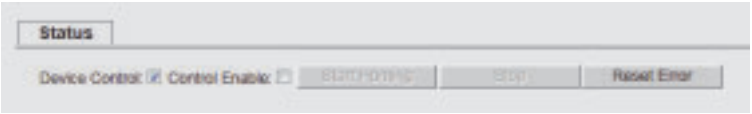


Fig. 5.3 Website “Status” tab - Device Control.

Recommendation:
Before leaving the website or web browser, deactivate “Device Control”. This returns master control to the control interface.

Controller enable via web browser

Caution
Errors during configuration or parameterisation can lead to unexpected behaviour from the motor controller if the controller is enabled.

- 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. Documentation for the parameter files *.pdf is available in the Internet ➔ www.festo.com/sp.

For enable, with parameterised enable logic “DIN + control interface”, activation via input signal DIN ENABLE =1 at [X1.6] is also required.

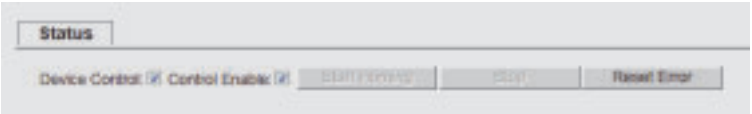


Fig. 5.4 Website “Status” tab - Control Enable (request controller enable

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

For enable via web browser on “Status” tab:

1. Activate “Device Control”.
2. Activate “Control Enable”.

5.3.3 Configuring and parameterising the drive

Note

To receive a parameter file from the Festo Server, the OMS-ID must be completely entered in accordance with the product labelling of the OMS system. Incomplete entry of the OMS-ID may result in malfunctions, uncontrolled behaviour and damage.

- Apply the parameter file selection via OMS-ID only for positioning systems (OMS) in the delivery status.
- After a change to the OMS system, such as a change in the attachment position of the motor: perform commissioning with FCT.

Adopting the Festo parameter file from the Internet

With an available Internet connection, the required parameter file from the Festo Parameter Cloud is stored on the PC:

1. Call up website in the web browser
2. Enter the OMS-ID completely on the “Parameter” tab.
3. Searching for a file: ‹Search›
4. Saving the file: ‹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. Adoption of the device control
2. Select file saved in the 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 at least 3 seconds between 2 parameter files.

5.3.4 Executing a homing run

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

Further information about homing:
- Dimensional reference system ➔ Chapter 2.5.1
- Homing ➔ Chapter 2.5.2

Requirements:
- The drive is completely configured and parameterised via a parameter file.
- For homing on a reference switch: the reference switch is connected to [X1].

Carrying out homing
1. Controller enable via web browser (Device Control + Control Enable)
2. Start homing: “Status” tab ‹Start Homing›
   After successful completion of the homing run, the drive is referenced in the dimension reference system
   (Status: “Homing valid”).

Check positioning behaviour:
1. On the “Direct Mode” tab, check the settings of the standard values for direct applications and adapt them, if necessary. Recommendation: First set 10 % of the maximum values for travel speed and acceleration.
2. Transfer changed settings temporarily to the motor controller with ‹Download›.
3. Enter positive or negative target values on the “Test Mode” tab, “Direct Mode Positioning” field, to move the drive a short distance in both directions:
4. Start direct application with ‹Start Positioning Mode›.
5. Check direction of rotation/travel of the drive.
   - Optional: Activate reversal of rotation direction with FCT.
   - After changing the direction of rotation: perform homing again.
6. Check displayed positions.
7. Check status displays (e.g. status of the digital I/O) on the “Status” tab
8. Travel to the limits of the positioning area and check the software end positions.

5.3.5 Parameterise and test direct applications

Requirement

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

Adapt standard values:

1. Check standard values for direct mode on the “Direct Mode” tab and adjust them for normal operation.
2. Transfer the settings temporarily in the motor controller with ‹Download›.
3. If required: Test jobs for positioning, speed or force mode on the “Test Mode” tab.
4. Permanently save standard values in the motor controller with ‹Save› on the “Direct Mode” tab.

5.3.6 Completing commissioning

Parameterisation and configuration of the control interface

- Observe notes on parameterisation and configuration of the control interface ➔ FHPP device profile: description GDCP-CMMO-ST-LK-C-HP-...

Integration into a network

Before integrating into a network:

- Change configuration on “Network” tab ➔ Chapter 2.4.7:
  - Assign IP address automatically (Obtain an IP address automatic)
  - Use the following IP address (Use the following IP address)

Creating a backup file

Creation of a backup file (recovery file) makes it possible:

– to parameterise a new motor controller quickly when replacing a device
– to commission several drives 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. Adopting device control in the web browser
2. Read parameter file from the permanent memory of the controller with ‹Upload parameter set to PC›
3. 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:

1. Adopt device control in the web browser
2. Select parameter file *. fpf with ‹Download parameter set to CMMO› via the displayed Windows dialogue.
3. Write parameter file to the permanent memory of the controller with ‹Save›
4. After the download: Restart motor controller (Power on/off).

Activating password protection

Through password protection, the motor controller is protected from unauthorised or unintentional change of the parameterisation and controlling access to the drive via FCT or web server is prevented.

1. Adopt device control in the web browser
2. Enter a password (“Password” tab):
   – Maximum length of the password: 16 characters
   – Permissible 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.

5.4 Commissioning with FCT (Festo Configuration Tool)

In commissioning with FCT, configuration and parameterisation take place through a page-oriented workflow. Compared to commissioning with a web server, FCT enables the following:
– Configuration of the entire Festo modular system of axes and motors
– Configuration of user-specific axes/ mechanicals
– Use of the maximum function range of the motor controller
– Extended status displays, diagnostics options and test functions

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 plug-in workflow: tasks with the CMMO-ST plug-in

Requirements 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 signals for achieving the ready status
  – Input signals STO1 and STO2 (24 V) at [X3.2/3]
  – Input signal ENABLE at [X1.6] with enable logic “DIN + control interface”
  – Enable via control interface or the connection that has master control.
  – No error

First commissioning
After installation of the FCT, the following steps must be carried out:
1. Configure and parameterise drive ➔ 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

The software is available in the Internet for download ➔ www.festo.com/sp, CMMO-ST.
Installation of software with the appropriate plug-in is performed by an installation program. Administrator rights are required for installation.

1. Observe the notes for the version (➔ Tab. 2).
2. Before installation, close all programs.
3. Follow the instructions in setup.exe (FCT assistant).

5.4.2 Configuring and parameterising the drive

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 drive configuration (Configuration Assistant)

If the drive comprises Festo components, component-specific parameters and limit values are preset in the plug-in during creation of the drive configuration. If the drive includes components of other manufacturers, the parameters and limit values for the drive must be determined and entered in the FCT, so that the safe load for the drive components is not exceeded, for example. Application-related parameters and limit values must be determined based on the application.

Plug-in workflow

Configuration and parameterisation of the drive 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 the end with ‹Next›.
3. Save project via FCT menu [Project] [Save].

To download the parameter file to the motor controller and to continue the commissioning 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 – Upload of parameters
Online connection + Device control	– Upload, download and comparison of parameters – Permanent storing of parameters in the controller – Teaching of positions
Online connection + Device control + Enable	– Moving/stopping the drive in jog mode – Executing homing – Teaching of positions – Executing command records – Creating and executing record sequences – Optimising controller parameters

Tab. 5.3 The most important online functions in the FCT

The motor controller detects when the connection to the FCT software has been interrupted. After a time limit has elapsed, the diagnostic message 0x32 is output.
The time limit (Time-out) can be parameterised with FCT. If the parameterised time=0, no special Time-out monitoring is activated; the TCP/IP protocol then registers failures typically after 1 s. But the waiting time can also be longer in slow networks, as it is dynamically adapted to the transmission rate.

Adoption of the device control

With the “FCT” check box, write/read access to the motor controller via FCT is activated. If the drive executes a command set during this enable sequence, the drive is stopped.
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, activate “FCT” under Device Control.
3. Synchronise data (upload, download, comparison)

Controller enable via FCT

Caution
Errors during configuration or parameterisation can lead to unexpected behaviour from the motor controller if the controller is enabled.
- 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.

For enable, with parameterised enable logic “DIN + control interface”, activation via input signal DIN ENABLE =1 at [X1.6] is also required.

Using check box “Enable” , the controller and power output stage can be enabled. This keeps the drive 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, activate “FCT” under Device Control.
   - Enable “FCT”.
   - Activate “Enable”.

5.4.4 Executing a homing run

During initial commissioning of a drive, also execute a homing run to determine the reference 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 dimension 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.

Further information about homing:
- Dimension reference system ➔ Chapter 2.5.1
- Homing ➔ Chapter 2.5.2

Requirements:

- The drive is completely configured.
- The dimension reference system is parameterised ➔ FCT [...] [Axis] [Measurements].
- Homing has been parameterised ➔ FCT [...] [Axis] [Homing].
- When homing on reference switch:
  - For homing on a reference switch: the reference switch is connected to [X1A].
  - The switch type used in the FCT is correctly configured.
- All parameter settings have been transmitted to the controller with FCT ‹Download›.

Carrying out homing

1. Enabling via FCT
2. During first commissioning: check functionality of the drive
   - Move drive manually in both directions (➔ FCT online tab “Manual Move”).
   - Check direction of rotation/direction of travel of the electromechanical drive.
     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 drive is referenced with the dimension reference system.

Check positioning behaviour:

1. Move drive with ‹Single Step› or ‹Jog› in both directions (➔ FCT online tab “Manual Move”)
2. Check direction of rotation/travel of the drive.
   - Optional: Activate reversal of rotation direction with FCT.
   - After changing the direction of rotation: perform homing again.
3. Check displayed positions.
4. Check status displays (e.g. status of the digital I/O).
5. Travel to the limits of the positioning area and check the software end positions.

5.4.5 Creating and testing command records (record selection)

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

Requirement

The drive is referenced in the dimension reference system (➔ Chapter 5.4.4)

Creating command records:

1. Select record type via FCT [...] [Controller] [Record Table] Basic Data (drop-down selection).
2. Enter target value.
   Optional for 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] Limits
   Recommendation: First set 10 % of the maximum values for travel speed and acceleration.
4. Enter additional command records.

Testing command records

1. Enable via FCT
2. With ‹Download›, command records are temporarily transferred to the motor controller.
3. Execute records with the start button of 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.
   - Transfer optimised controller settings to the project for saving with ‹Accept›.

Note

Damage to the device due to incorrect controller setting

- Only change controller default settings if absolutely necessary.
- Check settings carefully.

5.4.6 Completing commissioning

Parameterisation and configuration of the control interface

- Observe notes on parameterisation and configuration of the control interface ➔ FHPP device profile: description GDCP-CMMO-ST-LK-C-HP-...

Integration into a network

Before integrating into a network:

- Change configuration under FCT[Controller][Network properties] ➔ Chapter 2.4.7
  – Assign IP address automatically (Obtain an IP address automatic)
  – Use the following IP address (Use the following IP address)

Save parameterisation in the motor controller

1. Take over device control in the FCT (reset controller enable)
2. With ‹Store›, save the current parameterisation permanently in the motor controller.

Creating a backup file

Creation of a backup file (recovery 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. Store the current parameterisation in the motor controller.
2. Save device data with FCT menu [Component] [Online] [Backup Recovery ...]

Transferring a backup file

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

1. Select [Component] [Online] Backup Recovery ... “Recover” from the FCT menu.
2. After a restore: restart 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 ➔ FCT plug-in 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. Taking over device control in the FCT
2. Enter the password for the FCT menu [Component] [Online] [Password]):
   – Maximum length of password: 16 characters
   – Permissible 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.

For further information about password protection ➔ Chapter 2.3.3

5.5 Notes for operation

The motor unit is controlled via the control interface with the device profile FHPP
Additional information ➔ description GDCP-CMMO-ST-LK-C-HP-...

5.5.1 Online monitoring with FCT

After creating the online connection, FCT supports the following monitoring functions:
– Recording of measurement data over a defined time period in real-time, e.g. Speeds and following error during a movement
– Monitoring of control and status bits (FHPP monitor)
– Monitoring of the output stage temperature for 30 minutes
  Recommendation: After commissioning, check the long-term behaviour of the output stage temperature (FCT Online Register Monitoring).

5.5.2 Restore factory setting

FCT permits restoring the factory setting of the device. Here, all parameters are deleted and the parameter presettings from the factory are set. But firmware updates that have already been made are **not** reversed. However, the firmware as supplied from the factory can be reloaded to a device with FCT.

5.5.3 Loading firmware

FCT permits the firmware of the device to be updated (➔ FCT menu [Component] [Firmware Download]). If needed, an older version of the firmware can also be loaded into the motor controller.

Festo makes firmware versions available in the Internet (➔ www.festo.com/sp):
- Enter the part number or order code of the product in accordance with the product labelling
- Check whether a suitable firmware version is available
- Check whether an FCT plug-in corresponding to the firmware is available

When the firmware is loaded with the FCT, at first only identification data is transmitted 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:
- Before the firmware download, save the parameter file with the web server or FCT (backup file).
- After download of the firmware, download the backup file with the web server or FCT in the motor controller.

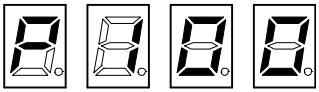
6 Diagnostics

6.1 Displays of the motor controller

6.1.1 7-segment display

Display of the operating mode and diagnostic messages

The 7-segment display of the motor controller reports the current operating mode, error and warnings. Four characters are always displayed in succession, followed by a space. The numbers of diagnostic messages of the category error or warning are coded **hexadecimally** (➔ Chap. 6.3.2).



Display	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)]	Error	2	Errors interrupt messages with a lower priority. Further information ➔ chap. 6.2 and 6.3
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. Further information ➔ Chap. 6.2 and 6.3
HHHH	STO – Safe Torque Off	4	The STO function has been requested. Additional information ➔ Description of the safety function GDCP-CMMO-ST-LK-S1-.
P000	Homing	5	Normal operation
P070	Jog positive		
P071	Jog negative		
P1xx[2)]	Positioning mode		
P2xx[2)]	Force mode		
P3xx[2)]	Speed mode		

1) xxx = Number of the diagnostic message, hexadecimal

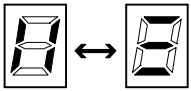
2) xx = Record number, decimal

Tab. 6.1 Messages on the 7-segment display

Messages with a higher priority interrupt messages with a lower priority.
Since diagnostic events occur faster and can also be acknowledged faster than they can be shown on the 7-segment display, it is possible that not all messages are displayed. To display all saved messages: read out diagnostic memory (➔ Chapter 6.2.3).

Display during a firmware update

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



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”.

Activate waving function with web server:

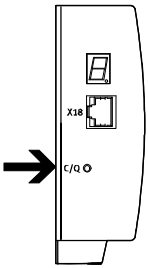
- “Info” tab: “Blinking decimal point (on/off)”

Activate waving function with FCT:

- In the FCT menu [Component] [FCT Interface], open the “FCT Interface” window.
- 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”.

6.1.2 Link/activity LED

The LED C/Q on the motor controller displays the status of the IO-Link/I-Port connection:

LED C/Q	Display	Significance
	Illuminated green	Connection made. Communication OK.
	Illuminated red	No connection, no data transfer, error in communication
	Off	Configured control interface is not IO-Link/I-Port

Tab. 6.2 Status indicator IO-Link/I-Port connection

6.2 Diagnostic messages

6.2.1 Classification and error responses

The diagnostic messages of the motor controller are classified as errors, warnings or information.

Type	Description
Error1) (Error)	When an error occurs, the motor controller changes to the error status (DOUT READY 1➔ 0). Errors always generate an error reaction that has an effect on the behaviour of the drive, e.g. stop behaviour, switching off the output stage (➔ Tab. 6.4). To restore the ready status, errors require: – elimination of the error cause – an acknowledgment or a restart (reset)
Warning1) (Warning)	Warnings have no influence on the behaviour of the actuator and do not need to be acknowledged. To avoid a subsequent error: Clarify the cause of the warning and eliminate it.
Information (Information)	Information messages have no influence on the behaviour of the drive and do not need to be acknowledged.

1) FHPP status with error or warning ➔ FHPP device profile: description GDCP-CMMO-ST-LK-C-HP-...

Tab. 6.3 Classification of the diagnostic messages

Error reaction	Description
Free run-out (Free-weeling)	– The output stage is switched off. – The drive then gradually comes to rest.
Quick stop deceleration (QS deceleration)	– The movement is stopped immediately with the parameterised quick stop deceleration. – There is the option of shutting down the output stage.
Job deceleration (Record deceleration)	– The movement is stopped immediately with the deceleration parameterised in the current job. – There is the option of shutting down the output stage.
Finish job (Finish record)	– The current job is executed until the target is reached (Motion Complete). – There is the option of shutting down the output stage.

Tab. 6.4 Error response (stop behaviour)

Parameterisable diagnostic messages can be adapted via the error management of the FCT ➔ FCT [...] [Controller] [Error Management]:

– Classification as error, warning or information
– Selection of the error reaction (stop behaviour, switching off of the output stage)
– Entry in the diagnostic memory

Notes on error response with switching off of the output stage

Caution

Injuries as a result of automatic movement of the passive actuators as a result of error responses that switch off the output stage. Falling loads if the drive is installed in an inclined or vertical position:

- Secure loads through external safety measures (e.g. toothed latches or moveable bolts). 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 of the holding brake with error response “A” (free run-out):

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.

6.2.2 Display of a diagnostic event

Dependent on the type of the corresponding message, a diagnostic event is shown through display of the device status or designation of the message or hex code ➔ Chapter 6.3.

Type	Display	
Error	7-segment	Hex code
	FCT	Online tab device status: status “error”, designation
	Web server	Status “error”
Warning	7-segment	Hex code
	FCT	Online tab device status: status “warning”, designation
	Web server	Status “warning”

Tab. 6.5 Display of a diagnostic message

Current errors or warnings can be read out with FHPP ➔ FHPP device profile: description GDCP-CMMO-ST-LK-C-HP-….
Additionally, diagnostic events can be read from the diagnostic memory. Messages of type “information” are not displayed and can only be read out via diagnostic memory. Additional information on the diagnostic memory ➔ Chapter 6.2.3.

6.2.3 Diagnostic memory

The motor controller has a permanent diagnostic memory for logging diagnostic messages. The diagnostic memory is designed as a ring memory with a capacity of 200 diagnostic messages.
The following information is included in the diagnostic messages of the diagnostic memory:

Information	Description
Counter (Counter)	Counter number of the diagnostic message.
Type (Type)	Classification of the diagnostic message (➔ Tab. 6.3)
Number (No.)	Hexadecimal number of the message (0x = hex prefix) ➔ Chap. 6.3.2
Message (Message)	Brief description of the diagnostic message
Timestamp (Timestamp)	Time of the diagnostic message in the form “HH.MM.SS:nnn (HH = hours, MM = minutes, SS = seconds, nnn = milliseconds). Time base is the respective switch-on time of the motor controller.
Additional information (Additional Info)	Additional information for Festo Service in case of complex faults

Tab. 6.6 Structure of diagnostic messages

The diagnostic messages are written one after the other in the diagnostic memory. The entry is optional for parameterisable diagnostic messages ➔ FCT [...] [Controller] [Error Management]. If the diagnostic message has reached the maximum capacity, the oldest diagnostic message is overwritten by the newest one. Access to the diagnostic memory is possible as follows:

Access via ...	
FCT[1)]	Online tab “Diagnosis”
Web server[1)]	“Diagnostics” tab
FHPP	➔ GDCP-CMMO-ST-LK-C-HP-...

1) The temporally most recent diagnostic message is displayed in the uppermost line and has the highest number.

Tab. 6.7 Access to the diagnostic memory

The diagnostic memory can be cleared as needed with web server, FCT or FHPP. During clearing, the switch-on event 3Dh (start-up event) is generated and entered in the diagnostic memory. The counter is not reset.

6.3 Fault detection and elimination

6.3.1 Acknowledge error

Acknowledgeable errors

For acknowledgeable errors, e.g. load voltage errors, the ready status can be restored after elimination of the cause of error by acknowledging the error (reset). Some errors, such as following error, do not require elimination of the cause of error and can be acknowledged immediately.

Acknowledge error via ...	
FCT	Button Reset Error
Web server	‹Reset Error› button
FHPP	➔ Device profile FHPP: description GDCP-CMMO-ST-LK-C-HP-...

Tab. 6.8 Acknowledge error

Non-acknowledgeable errors

For non-acknowledgeable errors, the ready status can be restored after elimination of the cause of error only through a restart of the motor controller:

– Restart via FCT or FHPP (software reset)
– Alternatively: Switch logic voltage off and back on.

Restart via ...	
FCT	Command [Component] [Online] [Restart Controller]
FHPP	➔ Device profile FHPP: description GDCP-CMMO-ST-LK-C-HP-...

Tab. 6.9 Restart of the motor controller (software reset)

6.3.2 Parameterisation of the diagnostic messages and fault clearance

Term	Significance
No.	Number of the diagnostic message in hexadecimal notation.
Classifiable as ...	**F**/W/I = Error/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 an error.
Diagnostic memory	Indicates whether an entry is made □□in the diagnostic memory or if this can be parameterised in FCT (always/optional).
Acknowledgement option	Includes information on an error's ability to be acknowledged: – Acknowledgeable Acknowledgement via FCT, web server or FHPP – Not acknowledgeable Restart of the motor controller required – Software reset – Alternatively: Switch logic voltage off and back on.
Error response	For every diagnostic message, provides the parameterisable error responses as code letters (A to G) (➔ Tab. 6.11). Code letters for the ex-factory response settings are printed in bold.

Tab. 6.10 Explanations of the tables of diagnostic messages

Code letters for the parameterisable error responses	
A	Free run-out – no braking ramp; turn off output stage
B	Quick-Stop deceleration – quick-stop braking ramp; turn off output stage
C	Job deceleration – braking ramp of the current job; turn off output stage
D	End job – carry out job up to Motion Complete; switch off output stage
E	Quick-stop deceleration – quick-stop braking ramp; do **not** turn off output stage
F	Job deceleration – braking ramp of the current job; do **not** turn off output stage
G	End job – continue to carry out job to Motion complete; do **not** switch off output stage

Tab. 6.11 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.		
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		
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.		

Diagnostic messages and fault clearance

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.		
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		

Diagnostic messages and fault clearance		
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.		
45h	**IO-Link system error**	Definable as: **F**/-/- Diagnostic memory: always
Error during initialization of the IO-Link protocol stack • Check the FHPP configuration with FCT. – Acknowledgeability: Error can only be acknowledged after eliminating the cause. Definable error response(s): A, **B**, C, D		

Diagnostic messages and fault clearance

46h	**IO-Link communication error**	Definable as: **F**/-/- Diagnostic memory: optional
Error during transmission of an IO-Link telegram • Repeat communication. Perform a software reset. If this error occurs frequently, check the IO-Link network. – Acknowledgeability: Error can only be acknowledged after eliminating the cause. Definable error response(s): **B**, C, E, F		
47h	**Modbus connection with master control**	Definable as: **F**/-/- Diagnostic memory: optional
The Modbus connection to the controller has been interrupted. • Check the connection and perform a reset. – Resettable: 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 connection to the controller is re-established.		
48h	**Modbus connection without master control**	Definable as: -/**W**/I Diagnostic memory: optional
There is no longer a connection to the controller, e.g. the cable was disconnected. • Check the connection and perform a reset. – For parameterisation as a warning: The warning disappears if the connection to the controller is re-established.		
4Ch	**Value is out of range**	Definable as: **F**/-/- Diagnostic memory: optional
The object value could not be written because the value lies outside the permitted range of values. • Write the object again, taking due account of the permitted range of values. – Resettable: Error can be reset immediately. Definable error response(s): B, C, D, **E**, F, G		
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 adjusted to each other.

Determine the IP configuration of the motor controller and change it

FCT enables the following:

– Search of the motor controller in the network
– Determination and change of the IP configuration

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” dialogue is displayed. With this dialogue, the IP configuration can be determined and changed (possible settings ➔ Tab. 2.23).

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

1. Select the Windows command [Start] [System Controller] [Network and Internet] [Network and Release Center] [Local Area Connection].
2. In the “Status” dialogue of [Local Area Connection], select the command “Properties”.
3. Mark in the following dialogue window [Internet protocol Version 4].
4. Select the command “Properties”. Then, 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 examples).

Example: Matching IP configurations to suit one another

The ex-factory IP configuration is particularly well suited to a direct connection. From the factory, the DHCP server of the motor controller is active (➔ Tab. 2.23). In this case, the motor controller has a firmly parameterised 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; Standard gateway: – (no address)).

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 controller from the 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.
	Internal device fuse burned through (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. 6.12 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 supply.
- Secure the power supplies against accidental reactivation.

Warning
Danger of burns from hot housing surfaces.
Contact with housing can cause burn injuries. This can frighten 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.

- Before replacement of the motor controller, save parameter file with the web server or FCT (backup file).
- After mounting the new motor controller, download backup file with the web server or FCT in the motor controller.

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.
You can find the technical data of the motor/encoder in the operating instructions of the motor or axis-motor combination from Festo ➔ www.festo.com/sp

The specified performance data relate to a max. 10 m length of length of cable for connection of the motor/encoder. For 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 LED C/Q (green/red)
Operating modes		
	Open-loop operation	Operating mode for motor without encoder, optionally adjustable for motor with encoder
	Closed-loop operation	Operating mode for motor with encoder
Parameterisation interface		Ethernet TCP/IP
Parameterisation		Festo Configuration Tool (FCT)
		Web server
Control interfaces		IO-Link/I-Port
		Ethernet: Modbus TCP
Communication profile		FHPP
Digital inputs/outputs (DIN/DOUT)		
	Switch logic I/O	PNP
	DIN (1)	ENABLE (controller enable)
	DOUT (3)	READY (ready for operation) DOUT1, DOUT2 (can be parameterised)
Rotary position encoder		Encoder RS422 connection
Protective functions		I^2t monitoring Temperature monitoring (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

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 (in accordance with 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]	
SL1	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 **UL** certified conditions if the product is operated in the USA or Canada can be found in the separate special 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 in accordance with EN60529		IP40 (plug connector inserted or fitted with protective cap)
Mains filter		Integrated
Design of plug connectors and lines		➔ Chapter 4.3

A.2.2 [X1.1] 24 V logic auxiliary supply		
Use		Provision of potential-free outputs of the PLC, e.g. of a potential-free relay contact for the ENABLE input
Nominal voltage	[V]	+24 V (OUT)
Maximum current	[mA]	100
Overload protection		No overload protection

A.2.3 [X1.3…6] Digital inputs/outputs

Signal level		Based 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)

A.2.4 [X1.9…11] IO-Link/I-Port

Interface		IEC 61131-9
Device description files (IODD)		FHPP (8 bytes I/O), device ID 0x10000 FHPP + FPC (16 bytes I/O), device ID 0x10001
Protocol version		Device V1.1
Permitted cable length	[m]	20
Minimum cycle time	[ms]	1
Communication		
Communication mode		COM3
Ports		Device 1 [IOL]
Device ID		0x10000 (FHPP), 0x10001 (FHPP+FPC)
Process data width		8 or 16 bytes
Process data content IN/OUT		FHPP or FHPP+FPC
Galvanic isolation		No

A.2.5 [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]	‹19.01)
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) Specification without provision of the digital outputs ➔ Chapter A.2.3

A.2.6 [X18] Ethernet interface

Bus interface		IEEE802.3
Transmission rate	[MBit/s]	10 or 100
Connection of plug connector		RJ45, 8-pin
Supported protocols		TCP/IP (UDP, HTTP), Modbus TCP
Cable type		Industrial Ethernet cable, screened
Transmission class		Category Cat 5
IP address		192.168.178.1 (private IP)
Subnetwork mask		255.255.255.0
EtherNet TCP/IP		
Connection length TCP/IP	[m]	Max. 30 (up to the next star point)
Standard port		502
FCT		7508
Web servers		80
Modbus TCP		
Bus interface		IEC 61158
Connection length Modbus TCP	[m]	Max. 30
Standard port		502

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