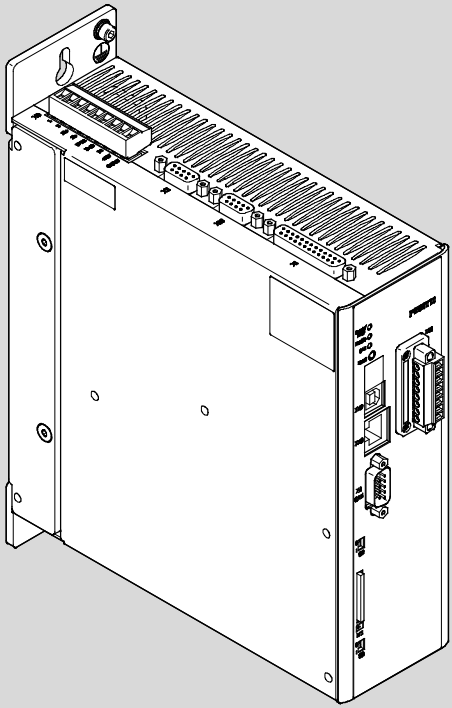
Motor controller

CMMP-AS-...-M0



FESTO

Description

Functional
description

for motor controller
CMMP-AS-...-M0
FW: 4.0.1501.1.2

8022067
1304NH

Translation of the original instructions
GDCP-CMMP-M0-FW-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.

Table of contents – CMMP-AS-...-M0

Instructions on this description

This document is intended to help you work safely with the CMMP-AS-...-M0 motor controllers.
It includes safety instructions that must be observed.
You will find more extensive information on the CMMP-AS-...-M0 motor controller ➔ Tab. 1.

- Unconditionally observe the general safety regulations for the CMMP-AS-...-M0.

The general safety regulations for the CMMP-AS-...-M0 can be found in the hardware description, GDCP-CMMP-AS-M0-HW-..., see Tab. 1.

Target group

This description is intended exclusively for technicians trained in control and automation technology, who have experience in installation, commissioning, programming and diagnosing of positioning systems.

Service

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

Product identification, versions

This description refers to the following versions:
– Motor controller CMMP-AS-...-M0 from Rev 01
– Firmware from Version 4.0.1501.1.2
– FCT-PlugIn CMMP-AS from Version 2.2.x.

This description does not apply to the older variants CMMP-AS-...

Note
With newer firmware versions, check whether there is a newer version of this description available:➔ www.festo.com

Documentation

You will find additional information on the motor controller in the following documentation:

User documentation on the motor controller CMMP-AS-...-M0	
Name, type	**Contents**
Hardware description, GDCP-CMMP-M0-HW-...	Mounting and installation of the motor controller CMMP-AS-...-**M0** for all variants/output classes (1-phase, 3-phase), pin assignments, error messages, maintenance.
Description of functions, GDCP-CMMP-M0-FW-...	Functional description (firmware) CMMP-AS-...**-M0**, instructions on commissioning.
Description of FHPP, GDCP-CMMP-M3/-M0-C-HP-...	Control and parameterisation of the motor controller via the FHPP Festo profile. – Motor controller CMMP-AS-...**-M3** with the following fieldbuses: CANopen, PROFINET, PROFIBUS, EtherNet/IP, DeviceNet, EtherCAT. – Motor controller CMMP-AS-...**-M0** with fieldbus CANopen.
Description of CiA 402 (DS 402), GDCP-CMMP-M3/-M0-C-CO-...	Control and parameterisation of the motor controller via the device profile CiA 402 (DS402) – Motor controller CMMP-AS-...**-M3** with the following fieldbuses: CANopen and EtherCAT. – Motor controller CMMP-AS-...**-M0** with fieldbus CANopen.
Description of CAM editor, P.BE-CMMP-CAM-SW-...	Cam disc function (CAM) of the motor controller CMMP-AS-...**-M3/-M0**.
Description of the safety function STO, GDCP-CMMP-AS-M0-S1-...	Functional safety engineering for the motor controller CMMP-AS-...**-M0** with the integrated safety function STO.
Help for the FCT plug-in CMMP-AS	User interface and functions of the CMMP-AS plug-in for the Festo Configuration Tool. ➔ www.festo.com

Tab. 1 Documentation on the motor controller CMMP-AS-...-M0

1 Safety and requirements for product use

1.1 Safety

1.1.1 Safety instructions for commissioning, repair and de-commissioning

Warning

Danger of electric shock.

– When cables are not mounted to the plugs [X6] and [X9].
– When connecting cables are disconnected when powered.

Touching live parts causes severe injuries and can lead to death.

The product may only be operated in a built-in status and when all protective measures have been initiated.

Before touching live parts during maintenance, repair and cleaning work and when there have been long service interruptions:

1. Switch off power to the electrical equipment via the mains switch and secure it against being switched on again.
2. After switch-off, wait at least 5 minutes discharge time and check that power is turned off before accessing the controller.

The safety functions do not protect against electric shock but only against dangerous movements!

Note

Danger from unexpected movement of the motor or axis.

– Make sure that the movement does not endanger any people.
– Perform a risk assessment in accordance with the EC machinery directive.
– Based on this risk evaluation, design the safety system for the entire machine, taking into account all integrated components. This also includes the electric drives.
– Bypassing safety equipment is impermissible.

1.1.2 Protection against electric shock through protective extra-low voltage (PELV).

Warning

- Use only PELV circuits in accordance with EN 60204-1 (Protective Extra-Low Voltage, PELV) for electric power supply.
  Also observe the general requirements for PELV circuits in accordance with EN 60204-1.
- Use only power sources which guarantee reliable electrical isolation of the operating voltage in accordance with EN 60204-1.

Through the use of PELV circuits, protection from electric shock (protection from direct and indirect contact) in accordance with EN 60204-1 is ensured (Electrical equipment of machines. General requirements).

1.1.3 Designated use

The motor controller CMMP-AS-...-M0 is intended for installation in machines or automated systems and may be used only as follows:

– in a faultless technical condition,
– in original status without unauthorised modifications,
– within the limits of the product defined by the technical data (➔ appendix A of the documentation GDCP-CMMP-AS-M0-HW-...),
– in an industrial environment.

Note

In the event of damage caused by unauthorised manipulation or other than intended use, the guarantee is invalidated and the manufacturer is not liable for damages.

1.2 Prerequisites for use

- Make this documentation available to the design engineer, installer and personnel responsible for commissioning the machine or system in which this product is used.
- Make sure that the specifications of the documentation are always complied with. Also consider the documentation for the other components and modules.
- Take into consideration the regulations applicable for the destination, as well as:
  – regulations and standards,
  – regulations of the testing organizations and insurers,
  – national specifications.
- For emergency stop applications, restart may take place only as intended under the control of a safety switching device.

1.2.1 Technical requirements

General conditions for the correct and safe use of the product, which must be observed at all times:

- Comply with the connection and environmental conditions of the motor controller specified in the technical data (➔ appendix A of the documentation GDCP-CMMP-AS-M0-HW-...) and of all connected components.
  Only compliance with the limit values or load limits permits operation of the product in accordance with the relevant safety regulations.
- Observe the instructions and warnings in this documentation.

1.2.2 Qualification of the specialists (requirements for the personnel)

The device may only be set into operation by a qualified electrotechnician who is familiar with:

– installation and operation of electrical control systems,
– the applicable regulations for operating safety-engineered systems,
– the applicable regulations for accident protection and occupational safety, and
– the documentation for the product.

1.2.3 Range of application and certifications

Standards and test values which the product complies with and fulfils can be found in the “Technical data” section (➔ appendix A of the documentation GDCP-CMMP-AS-M0-HW-...). The product-relevant EU directives can be found in the declaration of conformity.

Certificates and the declaration of conformity for this product can be found at www.festo.com.

2 Operating modes and functions

2.1 Overview

The following operating modes are available to support your application.

Operating mode/ functions	Description
Positioning mode (Profile Position Mode)	Operating mode for executing a positioning record (record selection) or a positioning task (direct mode). In addition to operation with speed control, a higher-level position controller (setpoint value generator) is active; it processes deviations between setpoint position and actual position and converts it into corresponding setpoint specifications for the speed controller. For position control, the current settings for speed, acceleration, deceleration, etc. are taken into account.
Speed-controlled operation (Profile Velocity Mode)	Operating mode for executing a positioning record (direct mode). Regulation in accordance with speed setpoint values and profiles. In speed-controller operation, current limitation can be activated through specification of a force/torque limit value.
Force/torque operation (Profile Force/ Torque Mode)	Operating mode for executing a positioning record (direct mode) with force/torque control (current control). This operating mode permits specification to the controller of an external force/torque setpoint value (relative to the motor current). All specifications on forces/torques refer to the motor nominal torque or the motor nominal current. Since force/torque are proportional to the motor current, only the current regulator is activated in this operating case. In addition, speed limiting can be activated through specification of a limit value.
Homing (Homing)	Positioning mode with a sequence established through the homing method for definition of the mechanical reference system (homing point).
Interpolated positioning mode (Interpolated position mode in accordance with CiA 402)	Positioning mode with a sequence established through the homing method for definition of the mechanical reference system (homing point) – Travelling along trajectory curves – Coupling of axes for multiple axis systems – Axis error compensation. The movement is parameterised for several axes in advance in the shape of data points (position, speed, time) and loaded into the motor controllers. Between the data points, the various axes interpolate automatically and work off the movement profile synchronously in time.

Tab. 2.1 Overview of operating modes

3 Control interfaces

3.1 Control interfaces

Control interfaces	Interface	Setpoint specification	Type of signal
Analogue	[X1]	±10 V	Analogue signal
Synchronisation	[X10]	5 V	A/B – tracking signals (RS422)
			CLK/DIR – pulse/direction
			CW/CCW – pulse
I/O	[X1]	24 V	Digital I/O – signals for control of record selection and jog mode
Fieldbus	[X4]	Digital	CANopen (FHPP/CiA 402)

Tab. 3.1 Control interfaces

3.1.1 Overview of interfaces

Control interface	Function	Operation Mode	Reference ➔
Analogue	Analogue setpoint specification	– Speed adjustment – Torque regulation	Chap. 6.5.1 47 ff
Synchronisation	– Flying saw – Synchronisation (slave) – Cam disc	–	Chap. 6.5.2 48 ff
I/O	– Record selection – Jog mode – Linked positioning records – Homing – Cam disc	– Position controller	Chap. 6.1.2 25 ff
Fieldbus	Depending on the fieldbus profile – FHPP – CiA 402	– Speed adjustment – Torque regulation – Position controller	Description – FHPP: GDCP-CMMP-M3/-M0-C-HP-... – CiA 402 GDCP-CMMP-M3/-M0-C-CO-...

Tab. 3.2 Interfaces

4 Fieldbus options

4.1 Supported fieldbuses

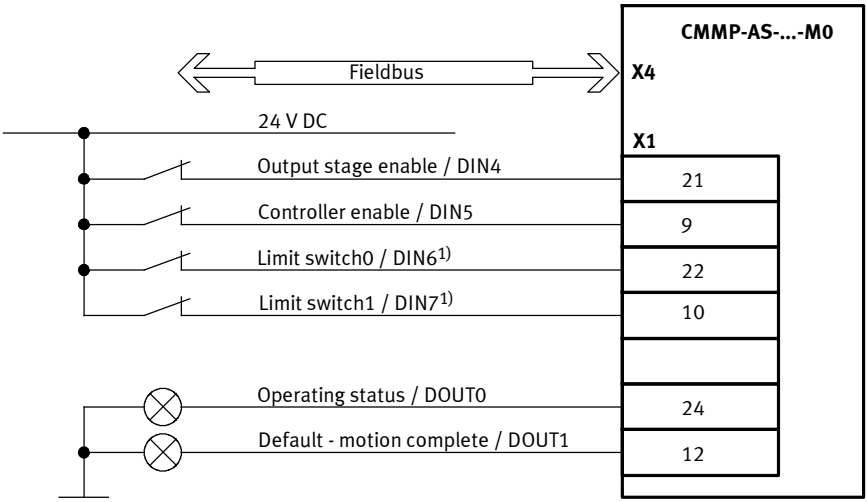
The motor controller CMMP-AS-...-M0 supports the fieldbuses CANopen and DriveBus through the integrated CAN interface [X4].
For CANopen and DriveBus, a communication protocol based on the CANopen profile in accordance with the CiA 301 and the drive profile in accordance with the CiA 402 has been implemented.
In addition, the Festo Profile for Handling and Positioning (FHPP) has been implemented as a communication protocol for CANopen.
Independent of the field bus, a factor group can be used so that application data can be transferred into user-specific units.

Fieldbus	Port	Documentation – type
CANopen	[X4]	GDCP-CMMP-M3-M0-C-CO-... (CiA 402) GDCP-CMMP-M3-M0-C-HP-... (FHPP)
DriveBus	[X4]	GDCP-CMMP-M3-M0-C-CO-... (CiA 402)

Tab. 4.1 Fieldbus support

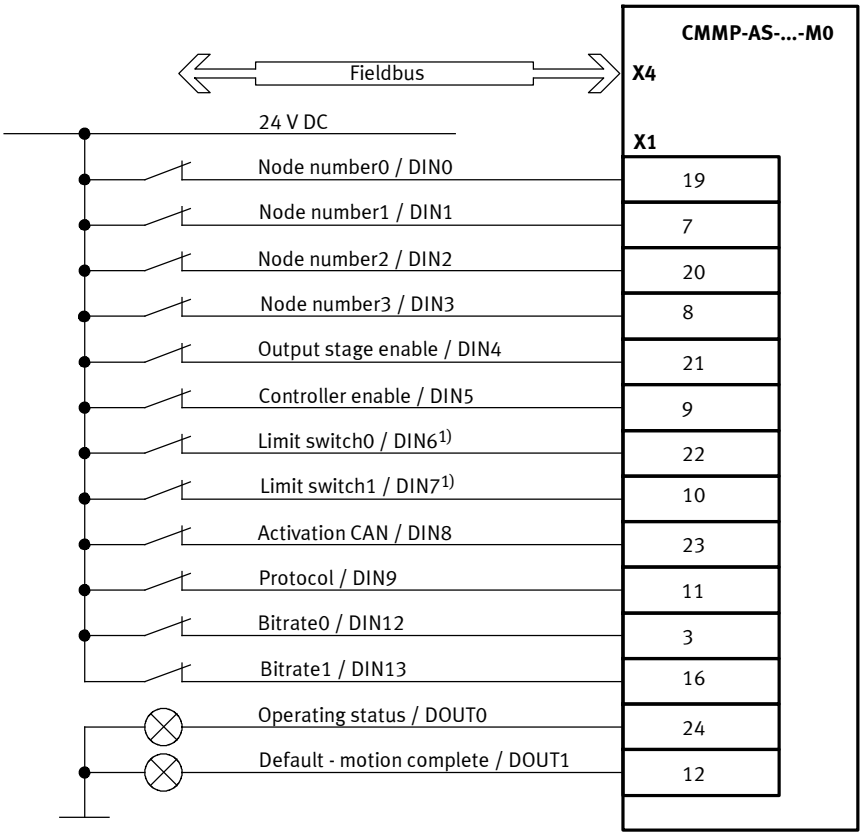
Fieldbus support files are included on the CD-ROM in the scope of delivery of the motor controller CMMP-AS-...-M0. Update via ➔ www.festo.com/download.

4.2 Required I/O connection for fieldbus control



The connection plan shows the switch position in the active operating state.
1) The limit switches are set by default to N/C contact (configuration over FCT)

Fig. 4.1 Connection diagram: required I/O interface without DINs for fieldbus parameterisation



The connection plan shows the switch position in the active operating status.
1) The limit switches are set by default to N/C contact (configuration over FCT)

Fig. 4.2 Connection diagram: required I/O interface with DINs for fieldbus setting

5 Service

5.1 Supported functions

Medium	Firmware		Parameter file	
	load	save	load	save
Memory card	X	–	X	X
Ethernet (TFTP)	X	–	X	X
FCT (Ethernet/USB)	X	–	X	X

Tab. 5.1 Supported functions

5.2 Memory card

Characteristic	Description
Functions	Copying (loading) a parameter set from the memory card to the CMMP-AS-...-M0.
	Copying (saving) a parameter set from the CMMP-AS-...-M0 to the memory card.
	Copying (loading) a firmware from the memory card to the CMMP-AS-...-M0.
Supported card types	MMC[1)] (version 3)
	SD[1)] (version 1 and 2)
	SDHC[1)] (from class 2)
Supported file systems	FAT16
	FAT32
Format filename	8.3

1) Recommended are industry-suitable memory cards from the Festo accessories programme.

Tab. 5.2 Characteristics of the memory card

Note
The filenames may only consist of upper case letters.
If lower case letters are used when the filename is issued, Windows automatically saves the file in the file format for long filenames!

Filename extension	Description	Example
.mot	Firmware file	FW_CMMP-AS-M0_4P0_2P0.MOT
.dco	Parameter file	CMMP01.DCO
.txt	Info file	INFO.TXT

Tab. 5.3 Filename extension

5.2.1 Load firmware via memory card

Procedure for loading firmware via the memory card:

1. Make sure that the output stage enable is switched off.
2. Shift the switch [S3] onto ON.
3. Insert the memory card with the firmware into the module [M1].
4. Actuate the reset button
5. The motor controller checks whether a memory card is plugged in and includes loadable firmware. Memory card plugged in and valid firmware version ➔ firmware is loaded.
6. The firmware update is displayed through “F.” on the 7-segments display.
7. The motor controller automatically starts the firmware by triggering a RESET.
8. The motor controller searches for the newest parameter file on the memory card and loads it into the motor controller.
9. Shift the switch [S3] to ON.

Errors may occur in firmware download. Possible causes for this are:

– Memory card not plugged in
– Invalid firmware version
– Firmware file includes lower case letters

If one of these points is applicable, the firmware update is cancelled and an error reported.

The decimal point in the 7-segments display is also displayed in case of errors that were detected or triggered through the bootloader.

If no memory card was found or there is no parameter set on the memory card, the parameter set valid before the firmware download is loaded.

If no memory card was found or there is no firmware on the memory card:

– Error 29-0 is reported
– The boot process is stopped (displayed through a decimal point on the 7-segments display).

It is recommended to have only one firmware file at a time on the SD card. In the case of several files, the newest one is always loaded!

If the newest firmware is already included on the motor controller, no update is carried out.

5.2.2 Load parameter set from memory card

Parameterisation in the FCT can establish whether a parameter set is loaded from the memory card when the motor controller is reset. Possible options:

– Use the newest parameter file.
– Load parameter file with specific name.

Loading of the parameter set is shown with a “d” on the 7-segments display.

5.3 Ethernet (TFTP)

5.3.1 Load firmware via Ethernet

Firmware can be loaded via the Ethernet interface [X18].
For computers that use Windows Vista or Windows 7 as operating system, the TFTP client and ports must be specially activated or opened for the firewall.
Procedure with the program TFTP.EXE:

1. Make sure that the output stage enable is switched off.
2. Start the program CMD.EXE
3. Call up the program TFTP.EXE with the following syntax
4. tftp -i ‹ip-address› PUT ‹FILENAME.MOT›
   ‹ip-address› = IP address of the motor controller
   ‹FILENAME.MOT› = Filename of the firmware
5. The PC copies the firmware file locally into the motor controller.
6. The motor controller checks whether the firmware is appropriate.
7. If yes, the firmware version is checked.
   Firmware version is the same -› error message “File already exists”
   Firmware version is different -› Firmware update is started.
8. The firmware update is displayed through “F.” on the 7-segments display.
9. The motor controller automatically starts the firmware by triggering a RESET.

A firmware download is also possible if the firmware programming has been cancelled and the controller does not have valid firmware. But observe that the controller in this case may have a different IP address (if it procures it through DHCP).

Errors may occur in firmware download. Possible causes for this are:

– The firmware to be loaded is unsuitable for the device! (see FW header)
– Faulty S record received.
– Error when programming the S record in FLASH.

The decimal point in the 7-segments display is also displayed in case of errors that were detected/triggered through the bootloader.

5.3.2 Load parameter set via Ethernet

A parameter set can be loaded via the Ethernet interface [X18].
For computers that use Windows Vista or Windows 7 as operating system, the TFTP client and ports must be specially activated or opened for the firewall.
Procedure with the program TFTP.EXE:

1. Make sure that the output stage enable is switched off.
2. Start the program CMD.EXE
3. Call up the program TFTP.EXE with the following syntax
4. tftp -i ‹ip-address› PUT ‹FILENAME.DCO›
   ‹ip-address› = IP address of the motor controller
   ‹FILENAME.DCO› = Filename of the parameter set
5. The PC copies the firmware file locally into the motor controller.
6. The motor controller checks the parameter set.
   Parameter set is the same -› Parameter set is not loaded
   Parameter set is different =› Parameter set update is started.
7. The parameter set update is displayed through “d” on the 7-segments display.
8. The motor controller automatically starts the firmware by triggering a RESET.

During Parameter set download, error 49-0 may occur. Possible causes for this are:

– Formatting error in the DCO file
– Faulty parameters in the DCO file (invalid value).
– Error during parameter access (read or write)

5.3.3 Save parameter set via Ethernet

A parameter set can be stored via the Ethernet interface [X18].
For computers that use Windows Vista or Windows 7 as operating system, the TFTP client and ports must be specially activated or opened for the firewall.
Procedure with the program TFTP.EXE:

1. Make sure that the output stage enable is switched off.
2. Start the program CMD.EXE
3. Call up the program TFTP.EXE with the following syntax
4. tftp -i ‹ip-address› GET ‹FILENAME.DCO›
   ‹ip-address› = IP address of the motor controller
   ‹FILENAME.DCO› = Filename of the parameter set
5. Through the GET command, creation of the DCO file is started.

Creation of the DCO file takes approx. 1-2 seconds. Therefore, the first GET command is answered with the error message “File not found”.

6. Enter the command “tftp -i ‹ip-address› GET ‹FILENAME.DCO›” again.
7. The motor controller copies the parameter set into the PC.

6 Functions

6.1 Position controller

6.1.1 Basic principles of the position controller

In the positioning mode, a certain position is specified to which the motor must move. The current position is obtained from the information gained from the internal encoder analysis. The position deviation is processed in the position controller and passed on to the speed regulator.
The integrated position controller allows jerk-limited or time-optimised positioning, either relative to the current position or absolute with respect to a reference point. It provides setpoint values to the position controller and, to improve the dynamic response, also to the speed regulator.
With absolute positioning, travel occurs directly to a defined target position. With relative positioning, travel occurs around a parameterised path. The positioning range of 2^{32} full rotations ensures that relative positioning can occur as often as desired in a given direction. After the positioning range is reached, the actual position runs over it without triggering an error. This overrunning must be taken into account by the controller.
The positioning controller is parameterised via a target table. This contains entries for parameterising a target via a communication interface and also target positions that can be access via the digital inputs. The positioning method, travel profile, acceleration and braking times, and maximum speed can be specified for every entry. All targets can be pre-parameterised. Positioning then only requires an entry to be selected and a start command to be issued.
With the motor controller CMMP-AS-...-M0 255 position records can be stored.
All position records have the following possible settings:
- Mode (relative or absolute positioning)
- Target position
- Speed
- Acceleration
- Braking deceleration
- Smoothing
- Start Condition
- Direction of rotation with modulo positioning
- Step criterion
- Record at digital input NEXT1
- Record at digital input NEXT2
- Ignore stop input
- End speed
- Synchronisation
- Remaining path message
- Torque feed forward
- Torque limitation
- Start Delay

The positioning records can be addressed via digital inputs, fieldbus or the parameterisation software FCT.

Absolute positioning linear/rotative axis
Here, the positioning target is moved to regardless of the current position. With absolute positioning the target position is a fixed (absolute) position relative to the zero point or reference point.

Absolute positioning, modulo axis
The target position of the positioning record is travelled to with modulo correction. Example: 490°
➔ for modulo 360, the axis is positioned to 130°.

Relative positioning, linear/rotative axis
With relative positioning, the target position is obtained by adding a value to the current position. Referencing is necessary to bring the drive into a defined position.
Concatenation of relative positioning can be used to continuously position in the same direction, such as for a trimming unit or conveyor (incremental dimensions). The following options are available:
– Relative reference to the last target position
– Relative reference to the current position (actual position)

Relative positioning, modulo axis
The target position of the positioning record is not travelled to with modulo correction. Example: 490°
➔ the axis travels positively around 490°.

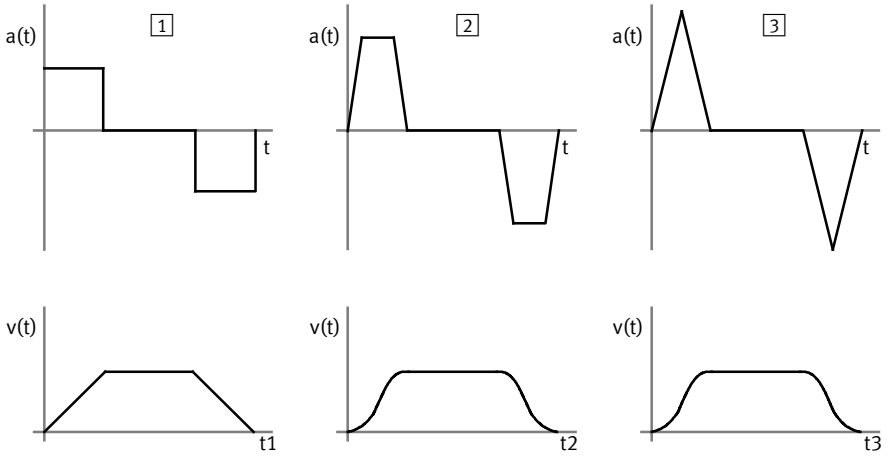
Positioning with analogue setpoint
The target position is determined through the analogue setpoint specification at AIN0 [X1]. The following options are available:
– Absolute reference to the project zero point
– Relative reference to the last target position
– Relative reference to the current position
– Continuous positioning corresponding to the analogue setpoint specification (joystick function)

Speed
The maximum speed at which movement to the position is to take place.

Acceleration
Setpoint value of acceleration for the positioning record.

Deceleration
Setpoint value of the positioning record deceleration.

Smoothing
With travel profiles, a distinction is made between time-optimised and jerk-limited positioning. With time-optimised positioning, motion occurs with the maximum specified acceleration and braking. The drive moves to the target in the shortest possible time, the speed sequence is trapezoidal and the acceleration sequence square. With jerk-limited positioning, the acceleration is trapezoidal and the speed curve is third-order. Since the acceleration constantly changes, the drive moves in a manner that is especially gentle to the mechanics.



1 Time-optimised = 0 %
2 Jerk-limited
3 Jerk-free = 100 %

Fig. 6.1 Positioning profiles

Start Condition

Start of a new positioning record with ongoing movement
- Ignore: Start command is not carried out
- Wait: Terminate current record and then start selected record
- Interrupt: Cancel current record and immediately start new record.

Direction

Establishment of the direction of rotation when modulo positioning is active in the mode “Direction of rotation from position record” is defined here. The following settings are possible:
- Positive: The direction of movement of the axis is always positive
- Negative: The direction of movement of the axis is always negative
- Auto: The direction of travel is determined automatically from the current position, target position and additional options (absolute, relative, relative related to last target, etc.).

Command (record continuation)

Record continuation consists of a defined sequence of positioning records. Each positioning record can be used as a record sequence through parameterisation of its subsequent position and continuation condition. The number of positions in a record sequence is limited only by the total number of positions available.

The continuation condition for the next positioning record is determined through the “Command” column of the positioning record table. The following commands are available:

Command	Function
END	No continuation takes place; the record sequence ends with this positioning record.
GoFP1	Continuation takes place after the current positioning record is completed and is always to the subsequent positioning record specified in Next1 (without evaluation of the digital input NEXT1).
IgnUTP	Continuation only takes place after completion of the current positioning record and a subsequent rising edge at the digital input NEXT1 or NEXT2 to the associated specified subsequent positioning record Next1 or Next2. Signal edges at NEXT1 and NEXT2 are ignored during the current positioning motion.
GoImm	Continuation takes place immediately in the event of a rising edge at the digital input NEXT1 or NEXT2 to the associated specified subsequent positioning record NEXT1 or NEXT2. Movement is not continued to the target position of the current positioning record.
GoAtp	Continuation only takes place after the current positioning record is completed. During the current positioning movement, the most recently detected rising edge at the digital input NEXT1 or NEXT2 decides the associated subsequent positioning record NEXT1 or NEXT2 to which continuation is made. This decision is made by the first detected edge after the current positioning motion is completed.
Additional parameters:	
StopIgn	Ignore STOP input. The signal of the digital input is ignored for this positioning record.
End speed	Specifies the end speed of the positioning record. Default = 0 (rest when the setpoint position is reached). The current positioning record is ended at the target position with the defined end speed. This enables the drive to execute a subsequent record with the same positioning speed without reducing the speed.

Tab. 6.1 Commands for record continuation

NEXT1/NEXT2

Subsequent positions of a positioning record for record continuation through positioning record number and digital inputs. Execution (travel to the subsequent position) corresponds to the logic operation of the digital inputs NEXT1 and NEXT2 through step enabling condition of the positioning record. The digital inputs NEXT1 and NEXT2 are evaluated only through the step enabling conditions GoImm, IgnUTP, GoATP.

Synchronisation
The “Sync.” (synchronisation) column is only shown when using the “Flying Saw” function.
If the “Flying Saw” function is active, synchronisation can be activated or deactivated by starting positioning records. When synchronisation is active, the position of the encoder (master) selected for the synchronisation is locked onto the setpoint position value. The drive thus follows the changes in position of the master drive.
The following settings are possible:

Command	Function
Sync	Synchronisation is activated when positioning is started, if it was not already. If the master is not stationary when positioning starts, the offset that occurs will be made up in a controlled manner. The positioning speed used for this corresponds to the speed of the master plus the positioning speed entered in the positioning record as an excessive increase in speed. The entries of the started positioning record are likewise used for the accelerations.
Sync Out	Synchronisation is deactivated when positioning is started, if it was not already. Positioning starts with the current synchronous positioning speed (rotational speed of the master). This results in controlled desynchronisation.
No Sync	Synchronisation is deactivated when positioning is started, if it was not already. Positioning starts with the values for speed and acceleration entered in the positioning record.

Tab. 6.2 Commands for synchronisation

Remaining Distance
Enter the amount for the remaining distance message.

TFF (torque feed forward)
This value is used to permit the motor greater dynamic response during acceleration when large loads are moved. The current required for approaching is increased by the set percentage (related to the nominal current of the motor) after the positioning record is started. The result is a higher starting torque that facilitates greater dynamic response. The value is determined experimentally.

Torque limitation
During standard positioning, the torque is limited only by the set nominal or peak currents. Torque limitation provides another way of further limiting the torque during active positioning. The value should be less than the set nominal current.

Start Delay
Waiting time until positioning starts.

6.1.2 Record selection through I/O

To address a command record, a record number with up to 8 bits can be agreed and thus the reference travel (record 0) and 255 command records addressed (via FHPP 250).
In the default settings of the motor controller CMMP-AS-...-M0 no digital inputs are pre-assigned for record selection, since they are intended for fieldbus parameterisation. Through reparameterisation in the FCT, 4 digital inputs DIN0 ... DIN 3 can be used for a maximum of 15 command records. The respective command record is selected via the binary code of the record numbers 1 ... 15.

Record	Bit 3	Bit 2	Bit 1	Bit 0
Record 0[1)]	0	0	0	0
Record 1	0	0	0	1
Record 2	0	0	1	0
...				
Record 15	1	1	1	1

1) Homing

Tab. 6.3 Bit pattern of the record number

The following I/O expansions are possible:
– 4 additional inputs (DIN10 ... 13) through corresponding reconfiguration of digital outputs or analogue inputs possible with FCT

6.1.3 Start of the record selection

After setting the START signal, the number of the selected positioning record is taken over and the drive carries out the record.

6.1.4 Stop of the record selection through “digital halt”

The digital halt stops in positioning mode with the parameterised ramp of the positioning record.
After that, the drive is controlled (brake is opened).

6.1.5 Record selection with record continuation

Function

Record continuation consists of a defined sequence of positioning records. Each positioning record can be used as a record sequence through parameterisation of its subsequent position and continuation condition. The number of positions in a record sequence is limited only by the total number of positions available.

Process

The continuation condition for the next positioning record is determined through the “Command” column of the positioning record table. Through the continuation condition of the positioning records, the following record continuation sequences can be set:
– Linear sequence with established subsequent position NEXT1 of the positioning record
– Conditional branching to the subsequent position NEXT1 or NEXT2 of the current positioning record
– Cyclical process (repetition of the sequence, infinite loop...).

Continuation takes place dependent on:
– The continuation condition set for the current positioning record,
– The logical status of the digital inputs with the assignment NEXT1 or NEXT2.

Starting the process
The start is made through:
– a rising edge at the digital input “travel to the START position”

Stopping the process
Record continuation is terminated when
– a positioning record is executed with the option END or
– a stop signal is present at the STOP input.

The Stop signal at the STOP input is not executed if the continuation condition “StopIgn” has been set for the current positioning record.

Sequence control

DIN	Function
START	Set positioning records for the Home or Start position. When the START signal is set ($0 \rightarrow 1$), confirmation follows via the ACK signal ($1 \rightarrow 0$). The MC signal (Motion Complete) is reset ($1 \rightarrow 0$),; the drive carries out the homing run. When the START signal is reset ($1 \rightarrow 0$), confirmation follows via the ACK signal ($0 \rightarrow 1$). After completion of the positioning job, the MC signal is set again ($0 \rightarrow 1$).
HOME	
NEXT1/2	Subsequent positions of a positioning record for record continuation through positioning record number and digital inputs. Execution (travel to the subsequent position) corresponds to the logic operation of the digital inputs NEXT1 and NEXT2 through the step enabling condition of the positioning record. The digital inputs NEXT1 and NEXT2 are evaluated only through the step enabling conditions GoImm, IgnUTP, GoATP.
STOP	Stop record continuation $0 \rightarrow 1$: Record continuation is stopped. The ongoing positioning is still ended in any case. Note: If the positioning record has the setting “StopIgn”, despite the set STOP input the positioning record of the subsequent position is started. The MC signal (Motion Complete) is set ($0 \rightarrow 1$), the READY signal is reset ($1 \rightarrow 0$).
Combined START/STOP	$0 \rightarrow 1$: START position of the record continuation is approached. $1 \rightarrow 0$: activates Stop function of record continuation

Tab. 6.4 Sequence control via I/O

Example

For positioning record “4”, the following are established as subsequent positions:

– NEXT1 := “19” (≙ DIN0 → 1)
– NEXT2 := “20” (≙ DIN1 → 1)

Through the I/O configuration, the subsequent positions are logically linked to the digital inputs DIN0 and DIN1. Corresponding to the established continuation condition, the following positioning behaviour results:

Command	Continuation condition (example)
END	After position 4 is reached, record continuation is ended.
GoFP1	Signal edges 0 → 1 at input DIN0 or DIN1 are not evaluated. After position 4 is reached, position 19 is travelled to immediately.
IgnUTP	As long as position 4 has not been reached yet, edge changes at DIN0 and DIN1 are ignored. If position 4 is reached, a rising edge at input – NEXT1(DIN0 0 → 1) causes approach of the target position 19 – NEXT2 (DIN1 0 → 1) an approach of the target position 20.
GoImm	Signal edges 0 → 1 at input DIN0 or DIN1 are evaluated during the positioning process. With an active positioning edge at input NEXT1 or NEXT2, the ongoing positioning is cancelled and – NEXT1(DIN0 0 → 1) causes approach of the target position 19 – NEXT2(DIN1 0 → 1) causes the target position 20 to be approached.
GoATP	– As long as position 4 has not been reached yet, edge changes at DIN0 and DIN1 are recorded; positioning is not interrupted. During the ongoing positioning, first a signal edge appears at DIN0 0 → 1, after that an edge at DIN1 0 → 1. After target position 4 is reached, positioning is started to Pos. 20. – If position 4 is reached before an edge occurs, a rising edge at input: – NEXT1(DIN0 0 → 1) causes approach of the target position 19 – NEXT2 (DIN1 0 → 1) an approach of the target position 20.

Tab. 6.5 Continuation condition (example)

6.1.6 Modulo positioning

“Modulo” positioning can be performed for timed endless movements (e.g. conveyor belts, rotary indexing tables). This enables endless movements to be implemented without losing the position reference to the zero point of the measuring reference system.

Selection for the modulo positioning is possible for the following axis configurations:

– Rotative axis with unlimited positioning range
– User-defined linear axis - type “conveyor belt”

Direction of movement

For modulo positioning, the direction of movement of the positioning motion is specified through the following selection: In the case of the “Direction of rotation always positive/negative” mode, the setting also applies to setpoints outside the interval (i.e. position specification prefixes are ignored in the position record table). The “Shortest Patch” setting only applies for absolute positioning within the specified interval. Outside the interval and for relative positioning, the direction of movement is taken from the positioning record table.

Observe that with an unlimited drive that always moves in the same direction, it is possible for the actual position to be overrun. There is no limitation of the range of values. The actual position is incremented up to overflow.

Option	Function	
Shortest path (for absolute positioning within the interval)	Both directions of movement are permitted. Positioning takes place by the shortest path, optimised for direction. Example: The positioning interval is defined from 0 R ... 5 R. The current actual position is 4.5 R. The new setpoint position is 0.5 R. => The motor controller does not travel four revolutions in the negative direction but instead one revolution in the positive direction as this is the shortest path to reach its destination.	
Direction of rotation from positioning record	The direction of rotation is not universally defined, but can be individually defined for each positioning record. The following settings are possible in the positioning record:	
	positive	The direction of movement of the axis is always positive. (Absolute and relative positioning)
	negative	The direction of movement of the axis is always negative. (Absolute and relative positioning)
	auto	The direction of travel is determined automatically from the current position, target position and additional options (absolute, relative, relative related to last target, etc.).
Direction of rotation always positive (Absolute and relative positioning)	The direction of movement of the axis is always positive.	
Direction of rotation always negative (Absolute and relative positioning)	The direction of movement of the axis is always negative.	
Range limit positive/negative (interval)	By specifying an interval, the actual value only runs through values within the specified limits. The position range is not influenced by specifying the interval (unlimited, software limit switch not active).	

Tab. 6.6 Options modulo positioning

If the actual value exceeds the lower limit of the interval, it assumes the upper limit value. If the actual value reaches the upper limit of the interval, it displays the lower limit value. The lower limit of the interval is contained in the range of values; the upper limit does not belong to this, i.e. the highest value is never shown, as it is physically at the same position as the lowest value. Example: An interval of precisely one revolution is to be defined:
Incorrect: 0 R ... 0.99999 R
Correct: 0 R ... 1 R.

Note
Setpoints outside the interval (incl. the upper interval limit) are always approached again, even if the drive is already at the position.

Note
When the cam disc function is activated, modulo positioning can only be used for the master.

6.2 Homing

For absolute positioning, homing must be executed and the dimensional reference system defined at initial commissioning. If the drive does not use a multi-turn absolute encoder, homing must be repeated at each switch-on or reset.

To be able to travel to an absolute, unique position in the positioning range, the drive must be referenced to a measuring reference system.
Homing of the drive comprises:
– Homing
– Establishment of the axis zero point
– Definition of the dimensional reference system.

With homing, the correct zero position is determined by means of a reference signal. The reference signal trigger defines the reference point of the dimensional reference system. The reference point is the absolute point of reference for the axis zero point. In the factory setting, the axis zero point = project zero point.
The reference signal supplies, for example, a switch that is triggered at a known, unique position on the travel path. Also, dependent on the motor encoder, additional signals (e.g. encoder zero track) can be evaluated to increase accuracy. You establish the used signals via the homing method.

6.2.1 Homing methods

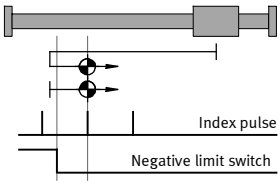
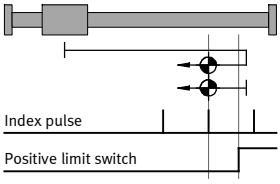
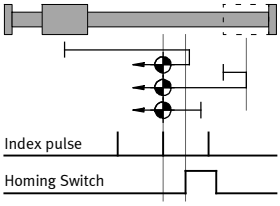
The homing methods are oriented on CiA 402.

With some motors (those with absolute encoders, single- or multi-turn), the drive may be permanently referenced. In such cases, methods involving homing to an index pulse (= zero pulse) might not cause homing to be carried out; rather the drive will move directly to the axis zero point (if it has been entered in the parameters).

The drive homes against a stop, a limit switch or a reference switch. The motor current increases when the drive reaches a stop. Since the drive must not continuously home against the stop, it must move at least one millimetre back into the stroke range.

Procedure:

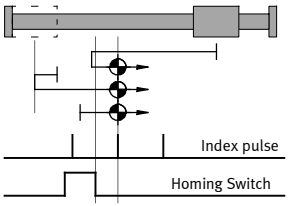
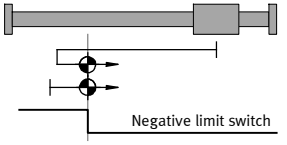
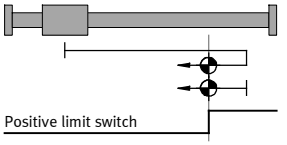
1. Search for the homing point corresponding to the configured method.
2. Run relative to the reference point around the “Offset axis zero point”.
3. Set at the axis zero point: Current position = 0 – offset project zero point.

Homing methods			
hex	dec	Description	
01h	1	**Negative limit switch with index pulse[1)]** 1. If negative limit switch inactive: Run at search speed in negative direction to the negative limit switch. 2. Travel at creep speed in a positive direction until the limit switch becomes inactive, then continue to the first index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
02h	2	**Positive limit switch with index pulse[1)]** 1. If positive limit switch inactive: Run at search speed in positive direction to the positive limit switch. 2. Travel at creep speed in negative direction until the limit switch becomes inactive, then continue to the first index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point	
07h	7	**Reference switch in positive direction with index pulse[1)]** 1. If reference switch inactive: Travel at search speed in positive direction to the reference switch. If the stop or limit switch is approached: Travel at search speed in positive direction to the reference switch. 2. Travel at creep speed in negative direction until the homing switch becomes inactive, then continue to the first index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	

1) Only possible for motors with encoder/resolver with index pulse.

2) Limit switches are ignored during travel to the stop.

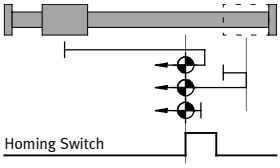
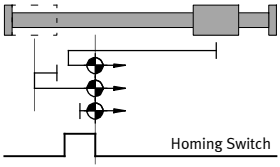
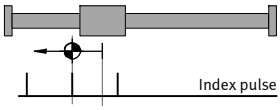
3) Since the axis is not to remain at the stop, the travel to the axis zero point must be parameterised and the axis zero point offset must be ≠ 0.

Homing methods			
hex	dec	Description	
0B	11	**Reference switch in negative direction with index pulse[1)]** 1. If reference switch inactive: Travel at search speed in negative direction to the reference switch. If the stop or limit switch is approached: Travel at search speed in positive direction to the reference switch. 2. Travel at creep speed in positive direction until the homing switch becomes inactive, then continue to the first index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
11h	17	**Negative limit switch** 1. If negative limit switch inactive: Run at search speed in negative direction to the negative limit switch. 2. Travel at creep speed in positive direction until the limit switch becomes inactive. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
12h	18	**Positive limit switch** 1. If positive limit switch inactive: Run at search speed in positive direction to the positive limit switch. 2. Travel at creep speed in negative direction until the limit switch becomes inactive. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	

1) Only possible for motors with encoder/resolver with index pulse.

2) Limit switches are ignored during travel to the stop.

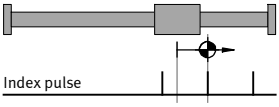
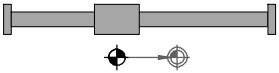
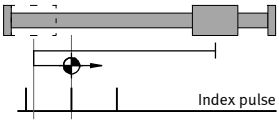
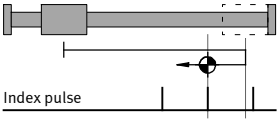
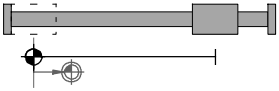
3) Since the axis is not to remain at the stop, the travel to the axis zero point must be parameterised and the axis zero point offset must be ≠ 0.

Homing methods			
hex	dec	Description	
17h	23	**Reference switch in positive direction** 1. If reference switch inactive: Travel at search speed in positive direction to the reference switch. If the stop or limit switch is approached: Travel at search speed in positive direction to the reference switch. 2. Travel at creep speed in negative direction until the homing switch becomes inactive. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
1Bh	27	**Reference switch in negative direction** 1. If reference switch inactive: Travel at search speed in negative direction to the reference switch. If the stop or limit switch is approached: Travel at search speed in positive direction to the reference switch. 2. Travel at creep speed in positive direction until the homing switch becomes inactive. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
21h	33	**Index pulse in negative direction**[1)] 1. Travel at creep speed in negative direction until the index pulse. This position is taken as the homing point. 2. If this is parameterised: travel at positioning speed to the axis zero point.	

1) Only possible for motors with encoder/resolver with index pulse.

2) Limit switches are ignored during travel to the stop.

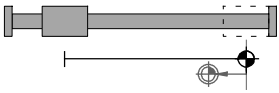
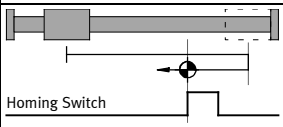
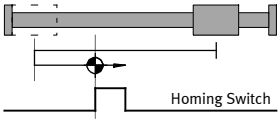
3) Since the axis is not to remain at the stop, the travel to the axis zero point must be parameterised and the axis zero point offset must be ≠ 0.

Homing methods			
hex	dec	Description	
22h	34	**Index pulse in positive direction**[1)] 1. Travel at creep speed in positive direction until the index pulse. This position is taken as the homing point. 2. If this is parameterised: travel at positioning speed to the axis zero point.	
23h	35	**Current position** 1. The current position is taken as the reference position. 2. If this is parameterised: travel at positioning speed to the axis zero point. Note: Through shifting of the reference system, travel to the limit switch or fixed stop is possible. For that reason this method is mostly used for axes of rotation.	
FFh	-1	**Negative stop with index pulse**[1)2)] 1. Travel at search speed in negative direction to the stop. 2. Travel at creep speed in positive direction until the next index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
FEh	-2	**Positive stop with index pulse**[1)2)] 1. Travel at search speed in positive direction to the stop. 2. Travel at creep speed in negative direction until the next index pulse. This position is taken as the homing point. 3. If this is parameterised: travel at positioning speed to the axis zero point.	
EFh	-17	**Negative stop**[1)2)3)] 1. Travel at search speed in negative direction to the stop. This position is taken as the homing point. 2. If this is parameterised: travel at positioning speed to the axis zero point.	

1) Only possible for motors with encoder/resolver with index pulse.

2) Limit switches are ignored during travel to the stop.

3) Since the axis is not to remain at the stop, the travel to the axis zero point must be parameterised and the axis zero point offset must be ≠ 0.

Homing methods			
hex	dec	Description	
EEh	-18	**Positive stop**[1)2)3)] 1. Travel at search speed in positive direction to the stop. This position is taken as the homing point. 2. If this is parameterised: travel at positioning speed to the axis zero point.	
E9h	-23	**Reference switch in positive direction with travel to stop or limit switch.** 1. Run at search speed in positive direction to stop **or limit switch**. 2. Travel at search speed in negative direction to the reference switch. 3. Travel at creep speed in negative direction until the homing switch becomes inactive. This position is taken as the homing point. 4. If the axis zero point ≠ 0: Travel at positioning speed to the axis zero point.	
E5h	-27	**Reference switch in negative direction with travel to stop or limit switch** 1. Run at search speed in negative direction to stop **or limit switch**. 2. Travel at search speed in positive direction to the reference switch. 3. Run at crawl speed in positive direction until reference switch becomes active. This position is taken as the homing point. 4. If this is parameterised: travel at positioning speed to the axis zero point.	

1) Only possible for motors with encoder/resolver with index pulse.
2) Limit switches are ignored during travel to the stop.
3) Since the axis is not to remain at the stop, the travel to the axis zero point must be parameterised and the axis zero point offset must be ≠ 0.

Tab. 6.7 Overview of homing methods

6.2.2 Homing - options

Option	Function
Travel to axis zero point after homing	After finding the reference point, the drive runs automatically to the axis zero point.
Homing with output stage and controller enable	Automatic execution of homing with a positive edge at the digital input controller enable if output stage and controller enable were previously off. For permanently referenced absolute value encoders, homing is not restarted in I/O operation if it has taken place once and the output stage enable has not been removed.
No homing after commutation	Suppresses automatic homing after determination of the commutation position. This option is only effective for a drive without commutation signals (e.g. motor type ELGL). In the basic setting, homing is automatically started after successful definition of the commutation position. This option must be marked to suppress this.
No synchronisation during homing	Suppresses switching off of the synchronised position during homing [X10].
No encoder emulation during Homing	During homing, no encoder signals are output at [X11].
Reference switch at index pulse of [X2B]	Evaluation of a reference pulse of the shaft encoder at [X2B] for determination of the reference point. If this option is activated, an index pulse from [X2B] is evaluated as a reference signal.
Timeout monitoring	If the parameterised maximum time for homing is reached without the homing point being found, homing is terminated with an error message: “Time-out in homing”.
Limit search distance	Path monitoring of homing: If the specified search distance (e.g. effective stroke) is run without the homing point being found, homing is terminated with an error message: “Homing: End of search path reached”
Torque threshold	Requirement: Homing method “Stop” Optional specification of a torque for identification of the stop in the homing method.

Tab. 6.8 Homing – options

6.2.3 Homing parameters

The following parameters must be set for homing:

Parameter	Description
Speed	The parameter setting applies for: – Searching travel to the primary destination – Crawl travel for identification of the switching point in the homing method “Limit switch” or “reference switch” – Travel to the axis zero point.
Acceleration/ delay	
Smoothing	
Axis zero point	Definition of the axis zero point Default values as a function of the set search direction Linear axes ±3.00 mm (±0.100 in) Axis of rotation ±10° (±0.030 R)

Tab. 6.9 Homing parameters

– Select the speed so that the reference mark can be detected by the controller. This sometimes requires very low travel speeds.
– Set deceleration sufficiently high so that the motor controller does not overrun the targets too much during search travel.

6.2.4 Secure zero point shift

Single-turn encoders that are set to permanently homed are already permanently homed on delivery. The absolute zero point is stored by the manufacturer in the EEPROM of the encoder.

Note

Incorrect positioning of the axis.

Drives with absolute value encoders are always homed at switch-on to the absolute encoder zero point stored in the encoder. For comparison between the homing point of the current measuring reference system and the mounting-related absolute zero point of the motor encoder, the resulting offset in the EEPROM of the encoder must be stored. The value is used for conversion of the actual position measured by the encoder.

- Carry out homing first
- Observe the subsequent special features for saving the zero offset.

Multi-turn encoder

Absolute value encoders supply directly after switch-on an absolute position that is unique throughout the entire travel distance of an axis. Such an encoder is calibrated on the measuring reference system one time through homing and through a position offset stored in the EEPROM of the encoder (saving the zero point offset).

Single-turn encoder

Single-turn encoders supply a unique position only within one motor revolution (partial-absolute encoder). At commissioning, the encoder is calibrated on the measuring reference system through homing and through zero point offset. Despite this, the absolute position is undefined after a RESET in most cases (> 1 revolution), that is, homing is fundamentally required after each switch-on.

You can permanently home the drive for specific applications (e.g. for modulo positioning 0 ... 1 R), so that the status “referenced” is automatically set at switch-on. Homing at switch-on can then be optionally eliminated, as with the multi-turn encoder.

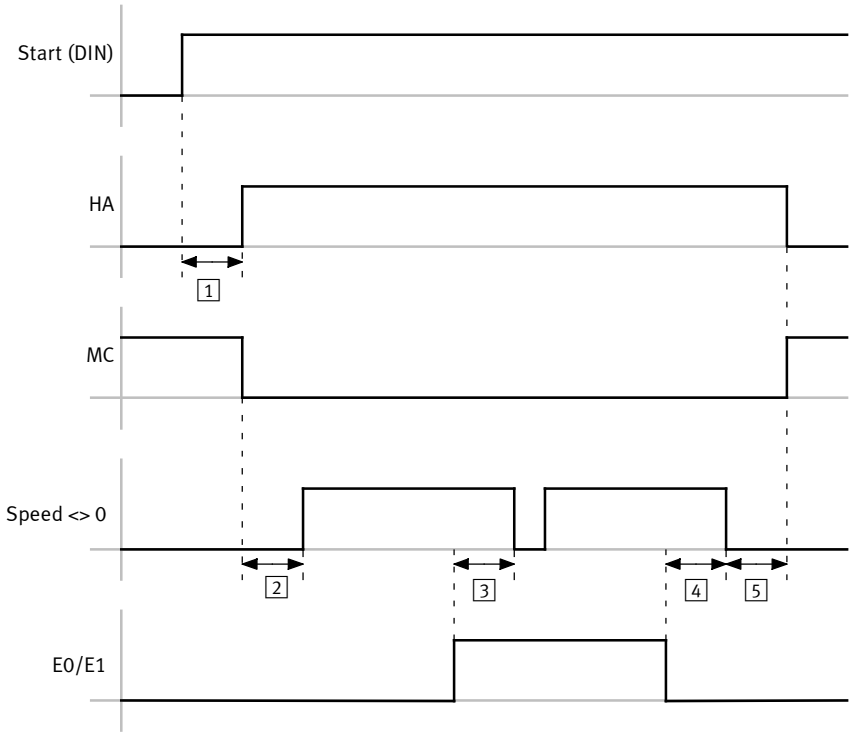
6.2.5 Homing via I/O

Homing via I/O can be started through the following methods.

A requirement in both cases is an active output stage and controller enable.

– Activation through the assigned digital input “Start homing”
– Selection of the positioning record 0 and activation of the assigned digital input “position selector - start”.

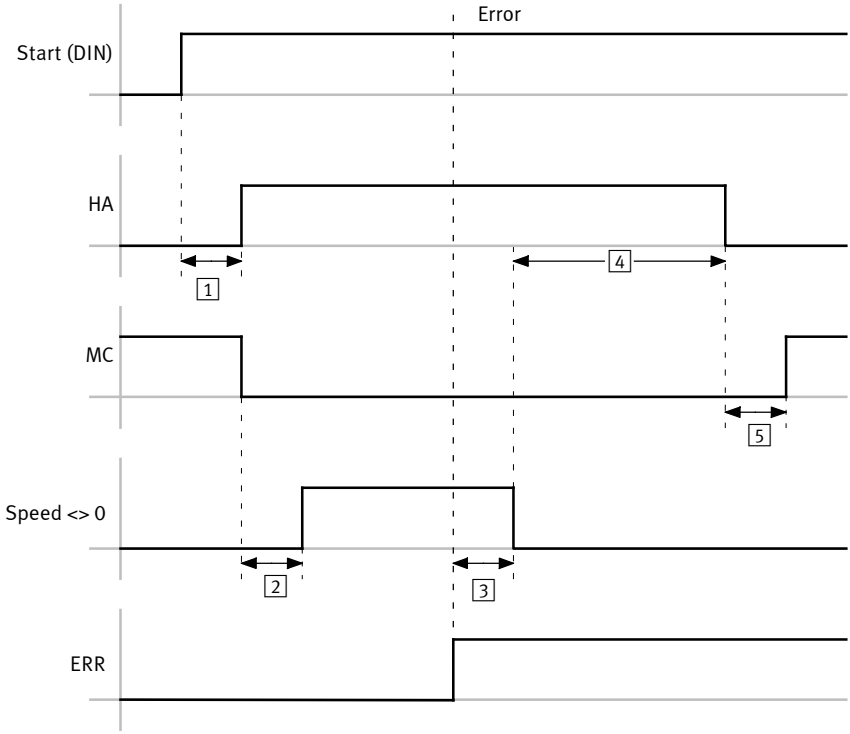
6.2.6 Timing diagrams



HA: HOMING_ACTIVE
MC: MOTION COMPLETE
E0: Limit switch 0
E1: Limit switch 1

1 0 ... 10 ms
2 20 ms
3 Dependent on braking ramp
4 Dependent on braking ramp
5 20 ms

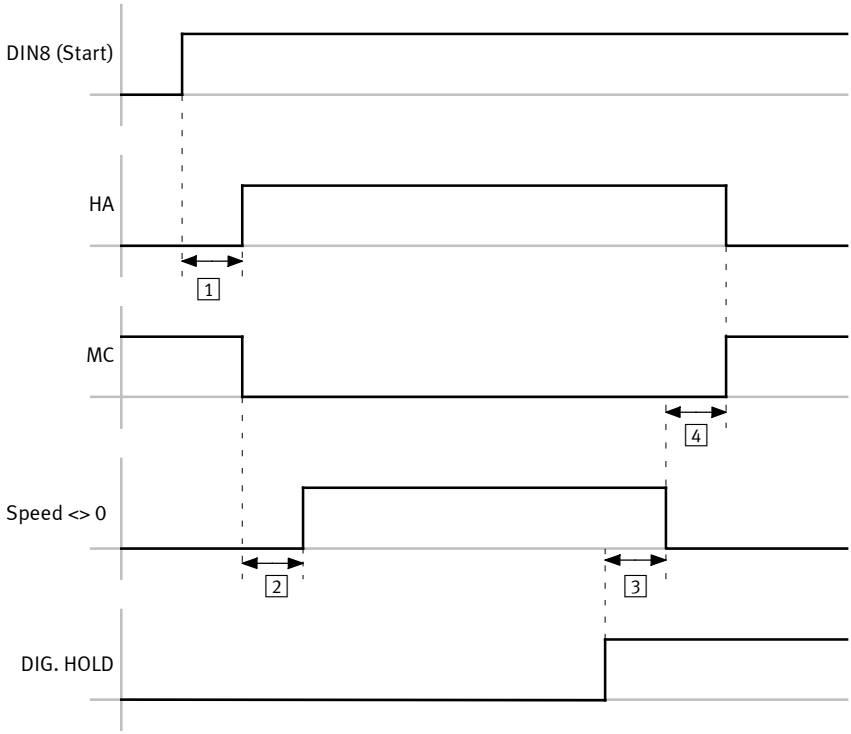
Fig. 6.2 Timing diagram: homing without error



HA: HOMING_ACTIVE
MC: MOTION COMPLETE
ERR: Error

1 0 ... 10 ms
2 20 ms
3 Dependent on braking ramp
4 50 ms + x (x = delay until brake locked)
5 0 ... 10 ms

Fig. 6.3 Timing diagram: homing with error



HA: HOMING_ACTIVE
MC: MOTION COMPLETE

1 0 ... 10 ms
2 20 ms
3 Dependent on braking ramp
4 0 ... 10 ms

Fig. 6.4 Timing diagram: homing with digital halt

6.3 Jog mode

6.3.1 Function

In the “Operation enabled” status, the drive can be travelled through jogging in a positive or negative direction.

This function is usually used for:

– Moving to teach positions
– Drive free running (e.g. after a system malfunction)
– Manual travel as a normal operating mode (manually operated feed).

The jog mode can be controlled as follows:

– Fieldbus/FHPP (jog mode)
– I/O interface through the parameterised digital inputs

6.3.2 Process

When one of the signals Jog positive/Jog negative is set, the drive starts to move slowly. Due to the slow speed (creep speed), a position can be defined very accurately.

If the signal remains set for longer than the configured “creeping period” the speed is increased until the configured maximum speed is reached. In this way large strokes can be traversed quickly.

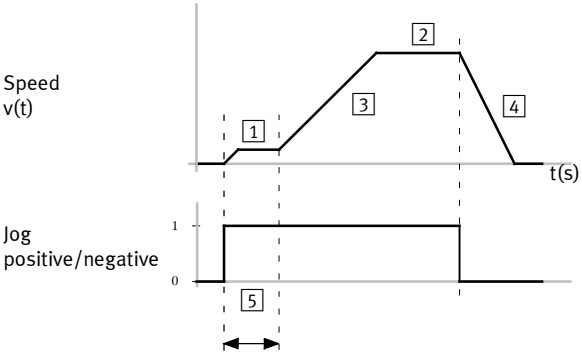
If the signal changes to 0, the drive is braked with the pre-set maximum deceleration.

To protect the mechanics, smoothing can also be parameterised. All parameters can be set separately for positive and negative travel direction.

If the drive is referenced:

The drive stops automatically if it reaches a software end position. The software end position is not over-travelled; the path for stopping is taken into account according to the ramp set. The jog mode can also only be exited here again after Jogging = 0.

[1] Low speed phase 1 (slow travel).
[2] Maximum speed for phase 2
[3] Acceleration
[4] Deceleration
[5] Time period phase 1 (creeping duration)



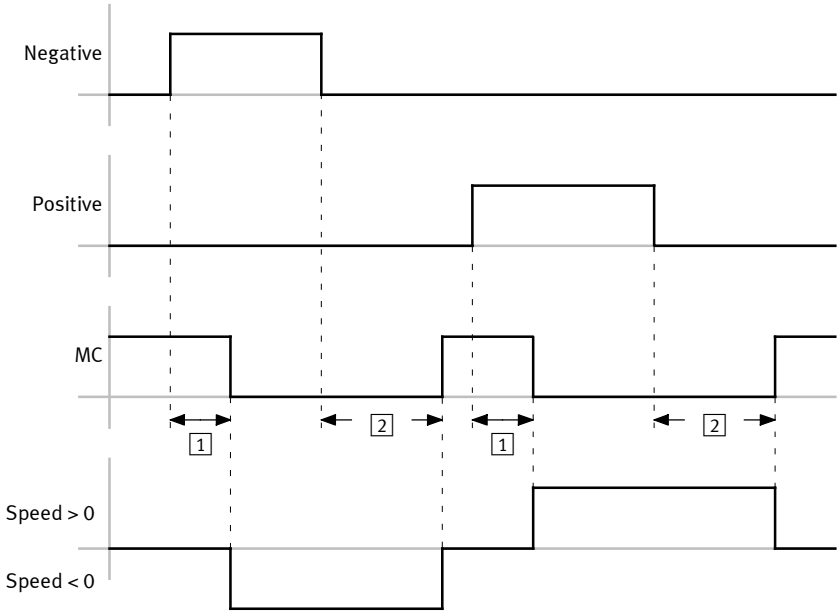
Tab. 6.10 Sequence chart for jog mode

6.3.3 Jog mode parameters

The following parameters must be set for jog mode:

Parameter	Function
Crawling speed	Speed during the crawl period. Acceleration takes place with the ramp defined under “Acceleration” and “Smoothing”. ➔ Tab. 6.10 1
Slow moving time	Duration of crawling - until the shift to maximum speed. ➔ Tab. 6.10 5
Max. speed	Maximum speed during jog mode. Acceleration takes place with the ramp defined under “Acceleration” and “Smoothing”. ➔ Tab. 6.10 2
Acceleration	Setpoint for acceleration of the drive during jog movements. ➔ Tab. 6.10 3
Deceleration	Setpoint for deceleration of the drive during jog movements. ➔ Tab. 6.10 4
Smoothing	Smoothing in acceleration value in % (default = 0 %). – 0 % no smoothing – 100 % jerk-free approach or jerk-free braking

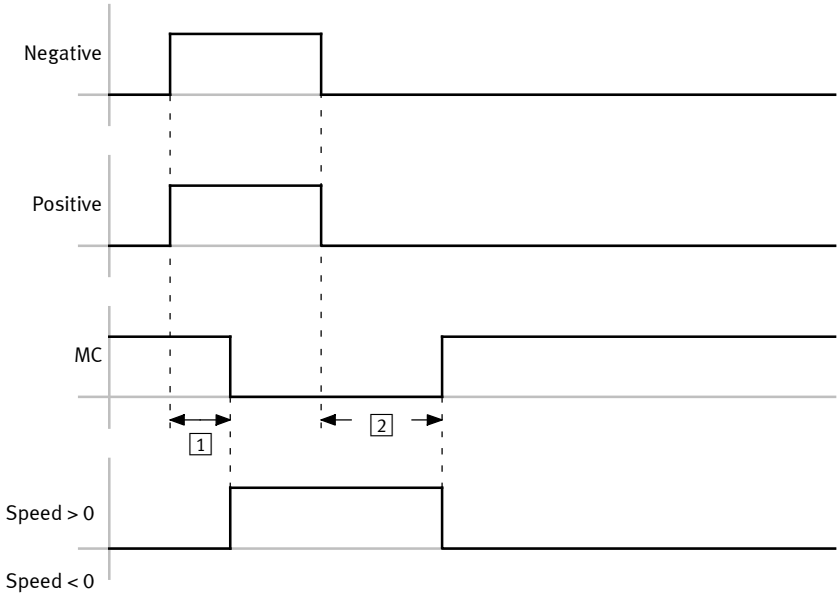
Tab. 6.11 Parameters for jog mode



MC: MOTION COMPLETE

1 0 ... 10 ms
2 Dependent on braking ramp

Fig. 6.5 Timing diagram. Jog positive/negative



MC: MOTION COMPLETE

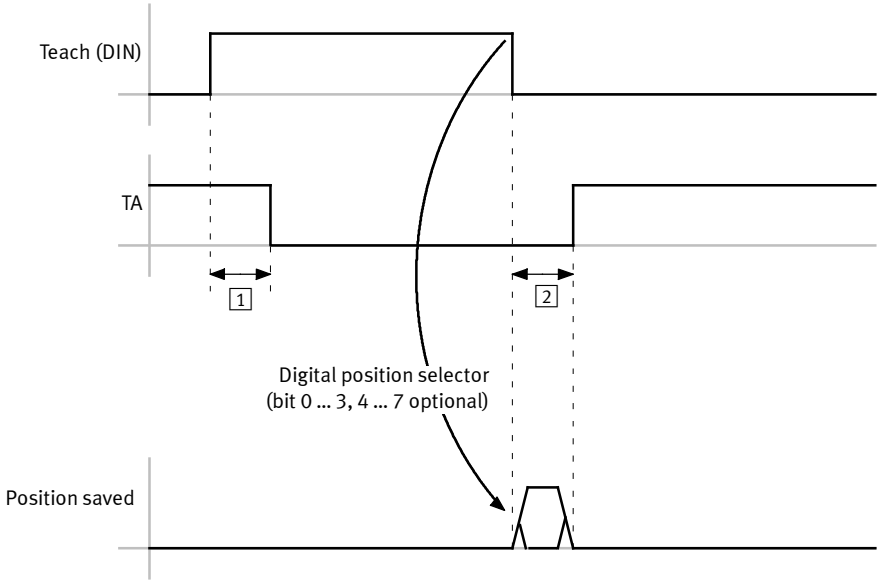
1 0 ... 10 ms
2 Dependent on braking ramp

Fig. 6.6 Timing diagram: Jog positive/negative (simultaneously)

6.4 Teach-in function

The teach procedure is started with the rising edge at the parameterised teach input. With the falling edge, the actual position is temporarily stored in the position record selected via digital inputs.
To accept all temporarily saved position data, a positive edge at the parameterised “Save position” input is required. The parameterised output “Saving process is running” goes to High at the start of the saving process. Completion of the saving process is signaled through a Low signal at the “Saving process is running” output.

Data are temporarily stored in the volatile main memory of the motor controller and are immediately effective in the motor controller. These data are lost when the power supply is switched off or in the event of a power failure. Data are stored permanently in the permanent memory of the motor controller and remain available even after a failure or switch-off of the power supply.



TA: TEACH_ACKNOWLEDGE

1 0 ... 10 ms
2 0 ... 10 ms

Fig. 6.7 Timing diagram: Teach

6.5 Setpoint specification

6.5.1 Analogue setpoint

Through the analogue inputs, setpoint values can be specified as controller input data via a correspondingly scaled input signal.
The setting of the function is dependent on the number of inputs used, the selected control interface and the selected operating mode/function.

Setpoint value	AIN0	AIN1	AIN2
Torque/force	x	x	x
Speed	x	x	x
Position	x	–	–

Tab. 6.12 Setpoint value via analogue inputs

Scaling
Specify in the FCT which value of the respective input variables corresponds to an input voltage of 10 V.
The scaled range corresponds to a linear characteristic curve symmetric to the zero point (e.g. –1000 R/min ... +1000 R/min).

Zero balancing
With an externally specified voltage 0 volt, an undesired setpoint value can still be generated due to voltage differences. For zero balancing, you can manually enter an offset in the FCT or execute synchronisation automatically (recommendation).
Through zero balancing, the scaled range is divided asymmetrically (example Fig. 6.8: –750 ... +1250 R/min).

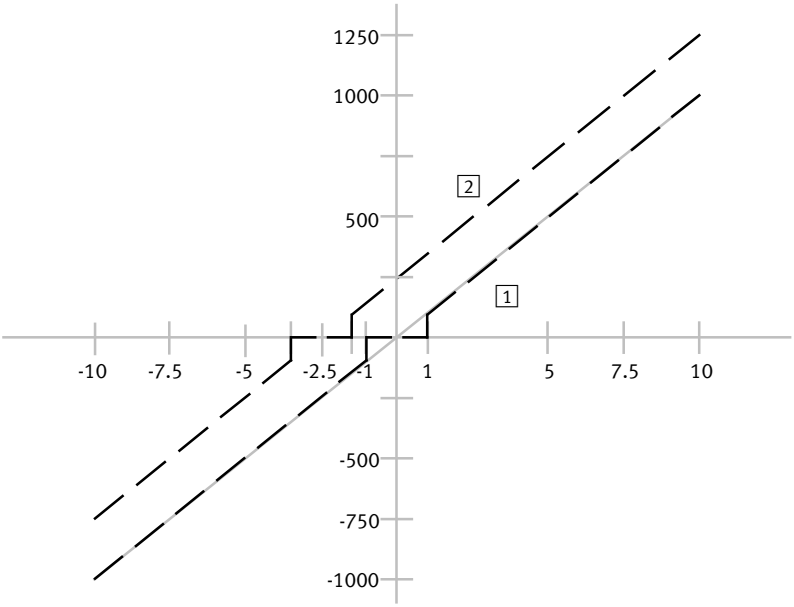
Safe Zero
Threshold value of the input voltage, up to which the setpoint value = 0 is set to achieve a defined rest of the drive, for example in the speed control mode, independently of offset fluctuations, noise, etc.

- Enter the threshold value U0 > 0 V an. If the input voltage UIN is in the range +U0 ... –U0, the setpoint value = 0 is output. The offset set for zero balancing is taken into consideration.

Note that specifying the threshold value means that an appropriate setpoint range is no longer available for the application.

Filter time constant
AIN0 is a 16-bit input. Due to the high resolution, a digital filter is activated.

- Specify the time constant to be used to filter the input voltage.



1 Safe Zero = 1 V

2 Safe zero = 1 V and Offset = 2.5 V

Fig. 6.8 Analogue setpoint value processing

6.5.2 Digital nominal value

Through the input [X10], the motor controller receives the signals of an encoder, e.g. a second motor controller of type CMMx as synchronous setpoint value.
The interpretation of the setpoint value corresponds to the setting of the operating mode of the CMMP-AS-...-M0. The switch takes place automatically in positioning mode, and through setpoint value selector in the speed-controlled mode and force/torque mode.

Deactivate

Through a configured input (DIN) or FHPP, synchronisation can be switched on and off.

Function	Description
Position-synchronous operation with speed pilot control	Signal at [X10] (= synchronous position) is taken over directly as setpoint value (special case: control interface = synchronisation) or added to the setpoint value Applications: – Flying saw – CAM (cam disc)
Speed-synchronous operation with torque limitation	Signal at [X10] = synchronous speed. Switch-on takes place via setpoint selector: Selector A ‹synchronous speed› Selector B ‹torque limiting›
Force-/torque-controlled operation with synchronous speed limiting	Signal at [X10] = speed limiting. Switch-on takes place via setpoint selector: Selector B ‹speed limiting›

Tab. 6.13 Synchronisation CMMP-slave (function)

Fundamentally, speed pilot control of the speed controller takes place in position-synchronous operation. The motor controller CMMP-AS-...-M0 can calculate the speed pilot control itself.

Position-synchronous with setpoint value addition
In the position-synchronous mode, the signal of the encoder interface [X10] is automatically added to the setpoint value.

Position-synchronous without setpoint value addition
The synchronous value is taken over directly from the input [X10] as setpoint value. Setpoint value input through record selection, direct mode or analogue input is blocked. No setpoint value addition takes place.

Instructions on further position-synchronous applications with special settings can be found in the subsequent chapters under:
– Flying saw (➔ chapter 6.5.4)
– CAM (cam disc) (➔ chapter 6.5.5)

In applications, it may occur that the sensor that gives the trigger signal (that is, registers the master position which should be travelled to position-synchronously) lies outside the possible travel range of the slave. The slave should then wait until the synchronous position of the master is in the travel range of the slave. For this, the section between the sensor and the start of the travel path of the slave should be known.
This is entered as position lead. The Start can already exist before the travel range of the master position is reached. In this case, the drive does not start until positioning when the position lead has been covered.

Accidental positioning may occur here. If a start command is generated without a prior trigger signal, the diagnostic event 41-0 is triggered:
(Record continuation: Start of synchronisation without prior sampling pulse: Check parameterisation of the pre-stop section)

Through the input SAMPLE, the current actual position of the master system can be recorded (trigger event). At each trigger event, the current master position of the input [X10] is saved.
After that, synchronisation can be started through the digital input START. A new synchronisation is not initiated until a new start command, whereby the destination is calculated using the stored synchronous position.
The advantage of this procedure is a more exact determination of the synchronisation destination, since jitters at the start of synchronisation are reduced.

Speed-synchronous torque limitation
The setpoint speed is transferred to the slave by the master via the encoder interface [X10] and added as synchronous speed via setpoint selector A. You can optionally activate a torque limitation via selector B.

Synchronous speed limiting in torque-controlled operation
Torque-controlled operation with speed limitation via the encoder interface [X10]. The speed is transferred to the slave by the master via the encoder interface [X10] and activated as speed limitation via setpoint selector B.

Required parameters

Parameter	Description
Electronic gear unit	Through parameterisation of the gear ratios, exact translation ratios between a master and slave drive are achievable. The default setting is 1 (number of lines of the slave : number of lines of the master). A transmission ratio › 1 is a “reduction” ratio. The drive speed (master) would therefore be bigger than the output speed (slave).
Speed filter	Filter time constant of the synchronous speed This describes the scanning rate (time slot pattern) used to refresh the incoming signals at the synchronous input [X10].
Input tracks	Depending on the encoder design, there are various signal inputs available at [X10]. Alternatively, the following signals can be connected in accordance with RS422 specification: – Differential inputs with TTL level A-B-(N), – Differential inputs for SSI pulse/direction encoder (CLK/DIR) or upward/downward counter (CW/CWW).
Number of lines	The line count corresponds to the number of full periods in a track per revolution. (Value must be between 1 and 2^{28}). The incremental input always uses four-fold evaluation. Accordingly the resolution is higher than the line count itself by a factor of 4.

Tab. 6.14 Increment generator input parameter

The line count can normally be found in a data sheet or the name plate for the shaft encoder. Observe that specification of the line count is dependent on the track signals.
A/B-(N):
– A/B (quadrature evaluation): The line count of the master is entered with reference to one revolution.
– Zero track: If the zero track is used, the specified line count must correspond to the number of lines between index pulses.

CLK/DIR (pulse/direction):
– The number of lines of the master must be entered here related to 90° due to the motor controller's four-fold evaluation method.

CW/CCW (upward/downward counter):
– The number of lines of the master must be entered here related to 90° due to the motor controller's four-fold evaluation method.

After a change of the encoder data, you must save the data following download and perform a restart with interruption of the power supply.

Tracking signals[1)]	**Description**	**Option**
A/B-(N) Quadrature evaluation	Standard incremental signals. Two rectangular track signals whose phases are offset by 90° are evaluated. A defined pulse is output once per revolution (=zero index). The zero index can be used for definition of a switching point, for counting revolutions or for synchronisation of a following counter.	– A/B track switch-off: The incremental signals A/B are ignored ("encoders standing still"). – Zero track switch-off (ignore zero pulse): The zero pulse generates a position jump if necessary if individual increments of the A/B track are not correctly detected during operation. If the index pulse results in malfunctions, the signal can be suppressed.
CLK/DIR	Pulse-direction interface. The controller can also be controlled from stepper motor controller cards through these signal inputs.	– Counting signals switch-off: The signals CLK/DIR are ignored ("encoders standing still").
CW/CCW	Clockwise/counterclockwise counters Two signals each separately supply the change in position for a direction of rotation. This means that when there is a pulse train on one signal line, the other signal line should be quiet.	– Counting signals switch-off: The signals CLK/CCW are ignored ("encoders standing still").

1) In accordance with RS 422 specification, specifications must be taken from the data sheet of the encoder.

Tab. 6.15 Track signals (slave, input [X10])

6.5.3 Master-slave

The motor controller CMMP-AS-...-M0 permits a master-slave operation, which is subsequently designated synchronisation. The motor controller can function both as master and as slave.
If the motor controller CMMP-AS-...-M0 operates as master, it can provide a slave with the current rotor position at the incremental encoder output [X11].
If the motor controller CMMP-AS-...-M0 is to operate as slave, the [X10] input is available for synchronisation. The motor controller CMMP-AS-...-M0 can calculate the speed pilot control itself. All inputs can be activated/deactivated. The internal encoder can be switched off optionally if another input is used as the actual value encoder. This also applies in the speed adjustment operating mode.
The external inputs can be weighted with gear ratios. The various inputs can be used individually and also simultaneously.

6.5.4 Flying saw

“Flying saw” designates position-synchronous applications in which synchronisation is activated or deactivated, dependent on the positioning record. The setpoint value at the synchronisation input is added to the setpoint position value in the selected record only.

Prerequisites

The following settings must be parameterised:
1. Control interface I/O or fieldbus
2. Selection of the following operating modes/functions
   – Positioning mode
   – Synchronisation ([X10]/slave)
   – Flying saw
3. Set the parameters of the encoder interface [X10].

Function

– Synchronous positioning records for synchronisation with the rotation of the master
– Non-synchronous positioning records for travel to the rest position/wait position
– Upward and downward synchronisation so that not jerking movements are generated.

Activate

If the “Flying Saw” function is set, synchronisation can be activated or deactivated by starting command records.

- Set synchronisation for the respective positioning record via the “Positioning record” dialog:

Synchronisation activated (Sync):

With synchronisation active, the current position of the master drive is switched onto the position setpoint value of the motor controller via the encoder at connection [X10]. The drive thus follows the changes in position of the master drive.

Synchronisation is activated when positioning is started, if it was not already. If the master is not stationary when positioning starts, the offset that occurs will be made up in a controlled manner. The positioning speed used for this corresponds to the speed of the master plus the positioning speed entered in the positioning record as an excessive increase in speed. The entries of the started positioning record are likewise used for the accelerations.

Synchronisation deactivated (No Sync):

Synchronisation is deactivated when positioning is started, if it was not already. Positioning starts with the current setpoint speed, that is, with the speed of the master. This results in controlled desynchronisation.

Synchronisation deactivated (Sync Out):

Synchronisation is deactivated when positioning is started, if it was not already. Positioning starts with the current synchronous positioning speed (rotational speed of the master). This results in controlled desynchronisation.

Note

Observe the following:

When positioning with synchronisation is activated, the digital halt only stops the positioning record, but not necessarily the movement of the drive, since synchronisation remains active!

Synchronisation must be explicitly terminated by starting a new positioning record without synchronisation or by using the digital input “Disconnect sync.”.

6.5.5 Scope of functions for cam discs (CAM)

The term “electronic cam disc” designates applications in which an input angle or an input position is depicted through a function as an angle setpoint value or a setpoint position. These applications are typically master-slave applications.

The CMMP-AS-...-M0 has the option of processing 16 cam discs each with 4 assigned cam tracks. The CMMP-AS-...-M0 provides the following functionality for this purpose via FHPP:

– Slave with synchronisation operation onto external input with cam disc
– Virtual master (internal) with cam disc.

A requirement is the positioning mode operating mode (record selection or direct mode). Additional information on parameterisation can be found in the Help for the CMMP-AS plug-in. For complete information on the cam disc function, see the special cam disc manual P.BE-CMMP-CAM-SW-....

6.6 Second measuring system

6.6.1 Technology

Purpose

A second measuring system is used if the displacement measurement integrated into the motor is not sufficient. There are 2 main reasons for this:

– Double safety (for instance, at safely reduced speed)
  Inclusion of a displacement encoder for secure applications is not described further here.
– The accuracy is not sufficient
  For instance, if the resolution of the motor encoder is not sufficiently large. But more frequently, it is the mechanics between the motor and positioned unit (for instance, slide of a toothed belt axis) that is not precise enough.

Absolute positioning accuracy

Most frequently, a second displacement encoder is used to improve the absolute positioning accuracy. Here, an absolute reference is used directly for the moving mass. The second measuring system corrects inaccuracies between the motor encoder and the moving mass.

The relative positioning accuracy results from the system of all components (motor, gear unit, coupling, axis,...) and is used, for example, when teaching positions. For most applications, a high relative positioning accuracy, also called repetition accuracy, is sufficient.

Since a second displacement encoder means expense, both mechanically and in parameterisation, the accuracies of common systems are compared in the following:

6.6.2 Example, toothed belt axis

Component	Type
Motor	EMMS-AS-70-M-Rx
Gear unit	EMGA-60-P-G3-SAS-70
Axis	EGC-80-2000-TB-KF-0H-GK (real feed constant 90.2 mm/R)

Tab. 6.16 Toothed belt axis components

Parameterisation		Repetition accuracy	Approx. absolute accuracy
Standard parameterisation	[mm]	0.08	4.44
Parameters with real feed constant	[mm]	0.08	0.44
External displacement encoder	[mm]	< 0.08[1)]	< 0.10[1)]

1) Depending on the system used (possible loose gears or gear backlash are compensated with the 2nd measuring system and thus improve the absolute accuracy.)

Tab. 6.17 Repetition accuracy of toothed belt axis

6.6.3 Example, spindle axis

Component	Type
Motor	EMMS-AS-70-M-Rx
Axis	EGC-80-2000-BS10-KF-0H-Mx-GK-S (Feed constant = 10 mm/R)

Tab. 6.18 Spindle axis components

Parameterisation		Repetition accuracy	Approx. absolute accuracy
Standard parameterisation	[mm]	0.02	0.05
External displacement encoder	[mm]	< 0.02	< 0.05

Tab. 6.19 Repetition accuracy of spindle axis

6.6.4 Function in the motor controller

In the motor controller, the position actual value of the external displacement encoder is evaluated instead of that of the motor encoder. Both commutation and speed adjustment continue to be made through the encoder in the motor.

Through encoder difference monitoring, an adjustable offset between the motor encoder and external measuring system is detected and reported. Errors, for instance mechanical offset, failure of external encoders or torn toothed belt, result in stopping with a corresponding error message.

6.6.5 Inclusion of a second displacement encoder

On the CMMP-AS-...-M0 position actual values can be read in through 3 interfaces. Observe here that the motor encoder already occupies one interface:

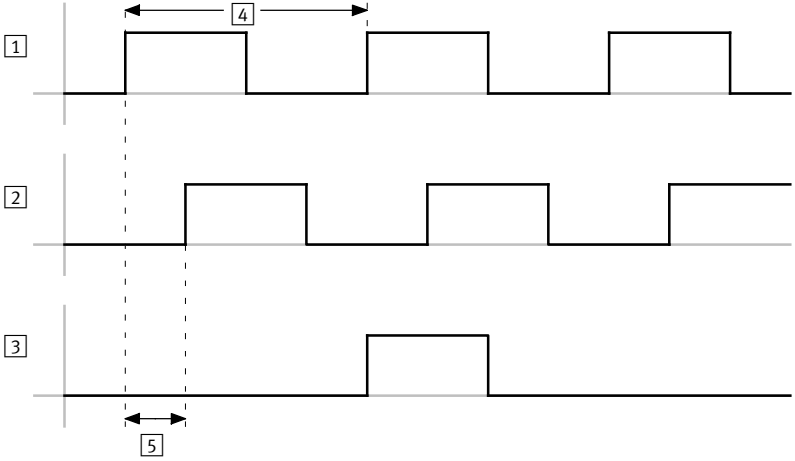
Motor with encoder type	Used interface	Free interfaces
Encoder	[X2B]	[X2A], [X10]
Resolver	[X2A]	[X2B], [X10]

Tab. 6.20 Interface assignments

The second displacement encoder must first be parameterised in the FCT software, independently of the motor and encoder type.

6.6.6 2nd measuring system at the incremental encoder input [X10]

The incremental encoder input [X10] can be used both for motors with encoder and for motors with resolver. After switch-on (24V voltage off or reset), homing must be executed first.
The interface [X10] supports all commonly available incremental encoders with 5 volt level.
The A/B tracks are thereby evaluated fourfold through edge detection.



1 Track A
2 Track B
3 Zero track
4 Increment distance/signal period
5 Resolution through fourfold evaluation

Fig. 6.9 Timing diagram: evaluation of incremental encoder

Alternatively, pulse-direction signals or upward-downward counters can be evaluated at [X10], likewise with 5 volt level.

For the cable, a screened line that twists together the data pairs A and A#, B and B#, N and N# (twisted pairs) must be used. The outer screening must always be connected on both sides to the motor the controller on the plug housing. Only with the recommended cable can reliable transmission with higher frequencies be ensured.

The 2nd displacement encoder must be activated in the FCT. In parameterisation, differentiation is made between linear and rotative incremental encoders.
With linear measuring systems, the signal period, that is, the increment distance, is entered.
The real line count for rotative encoders or the real resolution (➔ signal period) for linear encoders must be parameterised; this corresponds to the value before the quadrature evaluation.
For linear systems, in addition to the signal period, the reference signal (distance between two adjacent zero-pulse signals) must be parameterised.
Through the selection of reversal of direction, the counting direction of the 2nd displacement encoder can be turned. With activated encoder difference monitoring, the permissible encoder difference is specified in °.
The error E 171 (deviation between position actual value and commutation encoder too large) is output if the actual position of the motor deviates by x° from the actual position of the external displacement encoder. In particular for toothed belt axes, the value must not be selected too small, since an offset always occurs due to expansion of the toothed belt under load.
In the case of rotative incremental encoders, it is not the signal period, but the line count per revolution of the external encoder that is specified. In addition, a transmission ratio (standard 1:1) can be configured. The line count always refers to one revolution of the motor.
With the values to be entered here for an “electronic gear unit”, the transmission ratio between the commutation encoder (in the motor) and the 2nd encoder as position encoder is compensated for.
Enter here the inverse of the multiplicative product of the gear unit present between the two encoders.
All other parameters must be set as with the linear system.

6.6.7 EGC-...-M at [X10]

For EGC axes with type code –M, an incremental displacement encoder is already attached.
The sensor of the 2nd displacement encoder of an EGC-...-M axis has the following technical data:

Axis		Signal period	Reference signal
EGC-...-M1	[mm]	0.01	5
EGC-...-M2	[mm]	0.04	5

Tab. 6.21 Signal period EGC

As part of the normal parameterisation, the 2nd displacement encoder must be activated.
Through the selection of reversal of direction, the counting direction of the 2nd displacement encoder can be turned.
Parameters to be set:
– Signal period (➔ Tab. 6.21)
– Encoder difference
– Reference signal
The encoder difference of 60° represents a start value that is operational in most cases. But it must be adjusted, depending on the application.

6.6.8 2nd measuring system at input [X2A]

The input [X2A] can only be used for motors with encoder. After switch-on (24 V voltage off or reset), homing must be executed first.
The interface [X2A] supports all commonly available incremental resolvers, single-pole or multipolar.

6.6.9 Commissioning

After parameterisation, the system is commissioned.
Before the first enable, the counting direction of the motor and of the external encoder must be checked.
To do this, shift the moving mass by hand and observe the change in the FCT (online area – operate). The actual position is recorded by the external encoder, and the speed is calculated from the encoder in the motor. Both values change as a result of shifting by hand. The direction of the system can be selected freely and is usually simply selected corresponding to the application. After selection of a suitable zero point, shift the axis by hand in a positive direction. If the actual position becomes smaller rather than larger, the direction of the 2nd measuring system must be changed. If the speed is negative, the direction of rotation of the motor must be reversed.
After each change, download, save and restart must be done.
For motors with integrated brake, the brake can be manually opened with the button Release brake.

Note
For vertical axes, the moving masses must be secured against falling.

After that, the customary commissioning is continued.
Usually, the controller data must be adjusted manually to achieve a good positioning. For longer toothed belt axes, reinforcement of the position controller must not be too large, since the system would otherwise swing up.

6.7 Additional functions

6.7.1 Encoder emulation

The output [X11] of the motor controller can simulate an encoder that can be used by another device as an input signal.

The output [X11] is active even if the function has not been activated in the FCT.

In the FCT, the following configurations can be made.

Option	Description
Encoder Data	
Number of lines	Number or lines (increments) per revolution. Track A and track B are offset by 90°. As a result, the connected incremental input can increase the resolution with a fourfold evaluation. The result is, the number of increments per revolution is increased by the factor 4.
Offset Angle	Additive correction value in the range from -180° to +180° for electronic adjustment of the zero position.
Options	
Disable track A,B	The incremental signals are not output (“encoders standing still”).
Suppress zero pulse	The emulated incremental encoder does not output a zero pulse.
Inverse rotation polarity	The phase position of tracks A and B is rotated by 180° (right rotation field -> left rotation field)
Encoder output	
Position virtual master	Only for activated cam disc function with virtual master.
Actual position	– With cam disc function: actual value of slave position. – Without cam disc function: actual position of the motor controller.
Setpoint value position	– With cam disc function: setpoint position of the slave. – Without cam disc function: setpoint position of the motor controller.

Tab. 6.22 Configuration of the encoder emulation

6.7.2 Brake control and automatic brake

Function

The motor controller CMMP-AS-...-M0 can directly control a 24 V holding brake integrated into the motor.

Caution

If the maximum permissible connected loads are not complied with:

– The controller can be destroyed
– The functioning of the holding brake is not reliable.
- For correct connection and reliable control of the brake (safe stop, emergency stop), observe the instructions in the hardware description
- In the case of higher current needs, the brake must be switched via a coupling relay, if necessary with interference suppression.

Note

The holding brake must not be used to brake moving masses. Braking masses in movement leads to increased wear and the functional failure of the holding brake:

– The brake must be opened before a new positioning motion begins.
– The drive must stand still before the brake is closed.
- Pay attention to the required time delays (brake delay time), in particular for holding brakes with high mechanical inertia.

With longer time delays between command records, the automatic function of the holding brake closes the brake and switches off the controller output stage (less temperature rise).

Note

In certain applications (e.g in synchronous mode), the automatic function can damage the brake and/or the system.

In the case of parameterisation via the FCT software, the automatic brake can therefore not be activated for synchronous operation.

- Check the operating conditions in your application before you activate the automatic brake.

If no command record is executed in the specified time, for axes under load:

– The current setpoint value is set to zero
– The brake is engaged
– The controller end stage is switched off.

Example

In this example, the activation time of the automatic brake starts to run after the completion of a positioning record (MC). After the activation time has expired, the brake is closed and the switch-off delay runs simultaneously. After the switch-off delay has expired, the controller end stage is switched off (less warming).

After the start of a new positioning record, the drive moves only after the switch-on delay has expired.

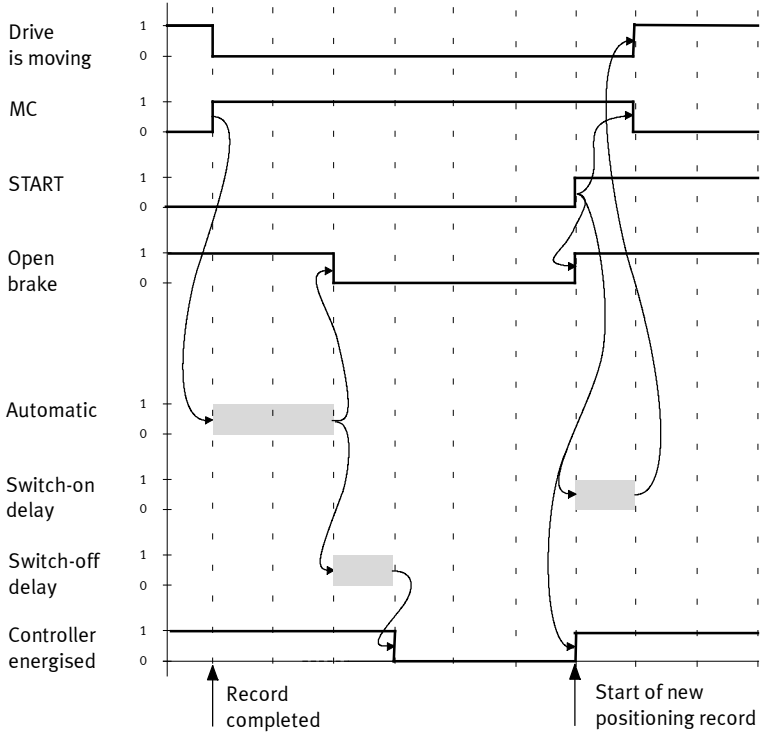


Fig. 6.10 Pulse-time diagram - holding brake with automatic function

Parameters

Parameter	Function
Switch-on delay	Required time to complete opening of the brake with: – Setting of the controller enable (DIN5 0 → 1) – START signal (if the automatic brake is activated) and the start of a positioning motion. The configured brake output is set immediately; the brake opens. Correct setting ensures that the drive does not run against the closed brake. With a START signal before the switch-on delay expires, the motor controller starts the positioning motion only after the switch-on delay has expired completely.
Switch-off delay	Required time until complete closing of the brake with: – Removal of controller enable (DIN5 1 → 0) – Expiration of the activation time of the automatic brake. Correct setting ensures that the drive is maintained in the current position until the holding brake has achieved its full holding torque. The controller is only switched off after the switch-off delay has expired.
Activation time of the automatic brake	Time in [ms] between the completion of a positioning motion (“Motion complete”) and the resetting of the brake output (providing in this period of time there is no new START signal). The switch-off delay follows after the activation time. Value = 0 deactivates the automatic brake.

Tab. 6.23 Parameter safe brake control

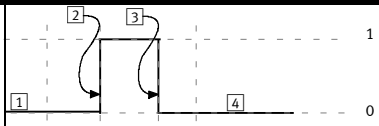
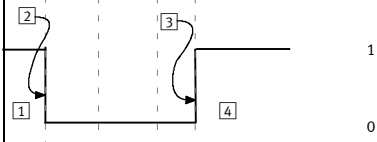
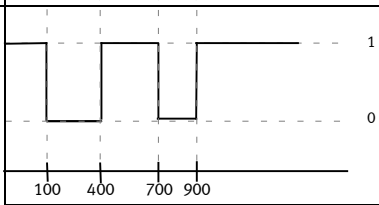
6.7.3 Position trigger

The position triggers can be used to pass on information about the logical statuses of position switches, rotor position switches and cam controller units (only when the cam disc function is activated) to digital outputs. Four position triggers can be configured to this end.

With specified trigger levels, the position triggers can:

– implement the actual position of the commutation encoder corresponding to the value pair (switch) in binary signals (1/0)
– output the binary signals logically linked with OR to the assigned digital outputs.

A maximum of four value pairs for positions or four value pairs for rotor locations must be assigned to each position trigger. To depict the information on a digital output, the function of a digital output must be set to “position trigger 1” ... “4”.

Example	Position trigger
Trigger signal switch 1: – Position 1 = 400 mm – Position 2 = 700 mm	
Trigger signal switch 2: – Position 1 = 100 mm – Position 2 = 900 mm – **Signal inverted**	
Position trigger 1/DOUT: – Logical OR operation of the trigger signals	

Tab. 6.24 Position trigger

6.7.4 Inputs for option “flying measurement”

The local digital inputs can be used as quick sampling inputs. Setting of the digital input takes place in the FCT. The inputs DIN8 or DIN9 can be selected.
With every rising and falling edge at the configured sample input, the current position value is written into a register of the motor controller and can afterwards be read out through the higher-order controller (PLC/IPC). Additional information on the available parameters can be found in the documentation for FHPP (GDCP-CMMP-M3/-M0-C-HP-...) or CANopen (GDCP-CMMP-M3/-M0-C-CO-...).

6.7.5 Software limit switch

The permissible positioning range (effective stroke) is limited by setting the software end positions. The software end positions refer to the axis zero point. If the target position of a positioning command lies outside of the software limits, the positioning command will not be processed and an error status will be set.

6.7.6 Input for digital halt

The control port “Digital halt” is high active (default). It immediately stops all movements. Other start signals do not work as long as this input is active.
The following delay ramp is run, dependent on the active operating mode:

Operating mode	Deceleration ramp
Positioning mode	Ramp of the positioning record
Speed regulation	Set speed ramp
Torque regulation	Set torque ramp

Tab. 6.25 Delay ramp dependent on the operating mode

All available digital inputs can be assigned. After a “Halt”, there must always be a “Start”.
The polarity of the input can be switched via FCT.

Note

Note the following when using the “Flying Saw” function in combination with “Digital I/O” as the control interface:

– When positioning with synchronisation is activated, the digital halt only stops the positioning record, but not necessarily the movement of the drive, since synchronisation remains active!
– Synchronisation must be explicitly terminated by starting a new positioning record without synchronisation or by using the digital input “Disable sync”.

6.7.7 Digital and analogue inputs/outputs [X1]

Standard assignment and extension of the digital I/Os

The motor controllerCMMP-AS-...-M0has as standard 10 digital inputs (DIN0...DIN9) and 4 digital outputs (DOUT0...3). In addition, the digital inputs DIN 12 and DIN13 are activated, which through reconfiguration can also be used as analogue inputs. The existing digital inputs are already assigned for typical applications through basic logic functions:

– The inputs DIN0...DIN3, DIN8, DIN9, DIN12 and DIN13 are pre-assigned for fieldbus parameterisation (CAN).
  The factory setting can be changed, if needed, to correspond to the application.
– Fixed functions are assigned to the inputs DIN4 ... DIN7 and the output DOUT0. This assignment is not configurable.

The following I/O expansions are possible:

– Two additional inputs (DIN10, DIN11) are possible through corresponding reconfiguration of digital outputs with FCT

Digital I/O	Function
Standard DIN	
DIN 0...DIN3	CAN node number; configurable
DIN 4	Fix: Output stage enable (POWER ENABLE)
DIN 5	Fix: Controller enable (CONTROLLER ENABLE)
DIN 6	Fix: Limit switch negative (LIMIT 0)
DIN 7	Fix: Limit switch positive (LIMIT 1)
DIN 8	Activation of CAN bus; configurable
DIN 9	Shift of CAN communication profile (CiA 402 or FHPP); configurable
Standard DOUT	
DOUT0	Fix: Motor controller ready for operation (READY)
DOUT1	Configurable
DOUT2	Configurable (optional: DIN10)
DOUT3	Configurable (optional: DIN11)
Additional DIN	
DIN10 (DOUT2)	Configurable
DIN11 (DOUT3)	Configurable
DIN12 (AIN1)	CAN bit rate (in combination with DIN13); configurable
DIN13 (AIN2)	CAN bit rate (in combination with DIN12); configurable

Tab. 6.26 Assignment DIN/DOUT

Activated signal inputs require calculation time of the motor controller.
Therefore, do not deactivate required signal inputs.

Functions of the digital inputs

Note
Multiple assignments of digital inputs are tolerated by the firmware.
Execution of the function with multiple assignment depends on the respectively set operating mode.
- Check carefully whether your combination of input signals makes sense.

Function assignment is dependent on:
– the control interface used
– the selected operating mode
– the number of freely usable inputs.

To control additional functions via digital inputs, you can change the factory-set assignment of the digital inputs present at the basic unit.

Function	Description	Polarity
General		
Detecting the actual position (sampling)	The current actual position is saved in the internal memory with rising or falling flank of the input in order to transfer it to an external controller over fieldbus (see also “Flying measurement”).	Positive and negative edge
Setup mode	By setting the input, the maximum speed is limited directly to the setup speed set.	Low active
Release brake	Input for releasing the holding brake with deactivated controller enable.	High active
Switch off synchronisation	With this, a previously activated synchronisation (e.g.: Flying saw) must be switched off. Synchronisation is switched off with a falling edge at the parameterised input.	Low active
Record selection/positioning		
Record selection (position selector)	Selection of the positioning records 1 ... 255 Selection of the reference travel (positioning record 0) The signals must be securely applied if the START edge is set.	High active
Start record	After setting the START signal, the number of the active positioning record is taken over and the drive carries out the record.	High active
Digital halt	In positioning mode, the drive brakes with the ramp of the active positioning record. After that, the drive is controlled (brake is opened).	Can be parameterised
Homing		
Homing Switch	Input that supplies the reference signal.	Can be parameterised
Start homing	After setting the START signal ($0 \rightarrow 1$), the drive carries out homing. After completion of homing, positioning procedures can be carried out.	High active
Jog mode		
Negative travel direction	Jog mode enables manual travel of the drive. In the “Operation enabled” status, the drive can be travelled over the positive/negative inputs.	High active
Positive travel direction		High active

Function	Description	Polarity
Teach/save position		
Teach position	The teach procedure is started with the rising edge at the parameterised teach input. With the falling edge, the actual position is temporarily stored in the position record selected via digital inputs.	Start teach high active Target transfer low active
Save position	To permanently accept all temporarily saved position data, a positive edge at the parameterised “Save position” input is required.	High active
Start/stop record sequence		
Run to HOME position	The input starts the positioning record “HOME-Position”.	High active
Run to the Start position	The input starts the positioning record “START position”.	High active
Stop	If the digital input is activated, the path program is stopped. The ongoing positioning is still ended in any case. In the position records, it can still be specified whether the path program may or may not be stopped at the end of this record. In this case, despite setting of the Stop input, the subsequent chained positioning is started.	Low active
Combined start/stop	Through this function, starting and stopping of a path program can be controlled through a unique digital input. The general START position of the path program is thereby approached on the rising edge of the digital input. On the falling edge, the already described Stop function of the path program is activated.	Start high active Stop low active
Sequence control		
Digital input NEXT1	Subsequent positions of a positioning record for record continuation through positioning record number and digital inputs. Execution (travel to the subsequent position) corresponds to the logic operation of the digital inputs NEXT1 and NEXT2 through step enabling condition of the positioning record. The digital inputs NEXT1 and NEXT2 are evaluated only through the step enabling conditions GoImm, IgnUTP, GoATP.	High active
Digital input NEXT2		High active

Tab. 6.27 Function overview of the digital inputs

Function of the digital outputs

The function can be determined for the available outputs DOUT1, DOUT2 and DOUT3 as follows:

Function	Description	Polarity
Off	The output is always low.	–
On	The output is always high.	–
Group “Enabled”		
Brake vented	The output is active as soon as the brake is released.	High active
Output stage active	The output is active if the output stage enable has been granted (power enable present, motor energised).	High active
Setpoint lock active	The output is active as soon as one or both setpoint locks is triggered by a limit switch.	High active
Linear motor identified	This output is active if the commutation position has been found. For angle encoders without commutation signals, the commutation position is determined by means of an automatic function. Starting a positioning movement, for example, only makes sense once this process is complete.	High active
Reference position valid	The output is active if the drive is homed.	High active
Collective status Ready for controller enable	Signals the status that no error is present and the motor controller is ready for controller enable.	High active
Output stage release level	Returns the level of the output stage enable digital input DIN4. The condition is fulfilled if the level at DIN4 = HIGH.	High active
Group “Movement”		
Position Xsetpoint = Xdest	The setpoint position is within the tolerance window of the target position.	High active
Position Xact = Xdest	The actual position is within the tolerance window of the target position.	High active
Remaining Distance	The output is active if the deviation between the target and actual position has fallen below the set value for the remaining distance message.	High active
Reference run active	The output is active as long as homing is active.	High active
Reference speed reached	The actual speed corresponds to the parameterised comparison speed in the “Speed reached” message, taking into consideration the specified tolerance window.	High active
Following error	The deviation between the nominal and actual position exceeds the set value.	High active

Function	Description	Polarity
Alternative target reached	This output is active if a positioning movement has been terminated, for example by reaching a comparison torque. The condition Xact = Xdest is then not satisfied.	High active
Comparison torque reached	The actual torque corresponds to the comparison torque parameterised in the “Torque reached” message, taking into consideration the specified tolerance window.	High active
Acknowledge for start positioning	Start-Ack (low active)	High active
Destination reached with handshake	Destination reached with handshake for the dig. start. The output is not set as long as START is on HIGH level.	High active
Speed 0	The output is active if the actual speed is equal to 0. The tolerance window is the message window for the message “Speed 0”.	High active
MC[1)]	=0: Positioning job active =1: Positioning job completed, possibly with error	High active
Active when positioning record running	Signals that a positioning record is currently being executed.	High active
Cam disc (CAM)		
Cam disc active	The output is active as soon as a cam disc has been activated.	High active
CAM-IN movement in operation	The output is active as soon as a CAM-IN movement is executed.	High active
CAM-CHANGE	Like CAM-IN, but for a change between 2 cam discs.	High active
CAM-OUT movement in operation	The output is active from deactivation of a cam disc until the final standstill of the drive.	High active
Cam disc start point reached	The output is active if the start position of the selected cam disc is reached. The tolerance window is the message window for the message “Target reached”.	High active
Error		
I^2t motor monitoring active	The output is active as soon as the motor or output stage workload is in the critical range.	High active
Undervoltage intermediate circuit	The output is active if an undervoltage occurs in the intermediate circuit.	High active
Common error active	Signals that one or more errors are active.	High active

1) When a cam disc is active, the MC signal always relates to the movement of the master (physical or virtual), i.e. to the setpoint for the active cam disc.

Function	Description	Polarity
Position trigger		
Position trigger 1 ... 4	The position triggers can be used to pass on information about the logical status of position triggers, rotor position triggers and cam controller units to the digital outputs.	High active
Teach		
Acknowledge teach	The signal goes to Low with the rising edge at the Teach input and back to High with the falling edge at the Teach input.	Low active
Saving process in operation	The signal goes to High as soon as a saving procedure is started and is extinguished automatically after the saving process has been completed.	High active
Functional safety		
STO active	Signals that safe status STO (Safe torque off) is active.	High active
STO requested	Signals that safe status STO (Safe torque off) has been requested.	High active

Tab. 6.28 Function overview of the digital outputs

The digital outputs “STO active” and “STO requested” must not be used in a safety-directed manner.

Analogue inputs

Through the analogue inputs, setpoint values can be specified as controller input data via a correspondingly scaled input signal.

In the factory settings, AIN1 and AIN2 are not available, since they are pre-assigned with other functions as DIN12 or DIN13.

Analogue inputs — configuration

Input	Resolution	Level
AIN0	16 bit, high resolution, differential (digital filter)	+10 V DC...–10 V DC
AIN1 (optional)	10 bit, single-ended	
AIN2 (optional)	10 bit, single-ended	

Tab. 6.29 Analogue inputs

The specified value defines how the relevant input signal is converted into a torque, a speed or a positioning setpoint value. Input voltages in the value range from –10 V ... +10 V are processed.

- Specify in the respective registers in the FCT which value of the respective input variables corresponds to an input voltage of 10 V. The scaled range corresponds to a linear characteristic curve symmetric to the zero point (e.g. –1000 R/min ... +1000 R/min).

Correction

With an externally specified voltage 0 volt, an undesired setpoint value can still be generated due to voltage differences. For zero balancing, you can manually enter an offset in the FCT or execute synchronisation automatically (recommendation).

Through zero balancing, the scaled range is divided asymmetrically (example Fig. 6.8: –750 ... +1250 R/min).

Procedure for “Automatic offset calibration”:

1. Connect the input with the potential corresponding to the setpoint value = 0.
2. Now carry out the “Automatic offset calibration” via FCT.

Analogue outputs

To configure the analogue outputs (AOUT):

- Select the respective desired output signal, e.g. setpoint or actual value of the controlled variable in the FCT.
- Adjust the required settings and values (scaling, numerical overflow limitation) of the outputs used.

Analogue monitor

The motor controller has two analogue outputs AOUT 0 and AOUT 1 for output, e.g. of controlled variables, which can be represented with an external oscilloscope. The output voltage lies in the range of -10 V to +10 V.

- Select the output variable that should be output through the analogue monitor.
- For output variable “Fixed clamping value”: In the “spanning value” field, set the voltage that should remain constant at the output.
- For other output variables: In the “Scaling” field, set which value of the selected size corresponds to an output voltage of 10 V.

Output variables (AOUT0, AOUT1)	
Axis variables	– Speed setpoint value – Speed actual value – Position setpoint – Position actual value
Values for current	– Effective current setpoint – Effective current actual value – Reactive current setpoint value – Reactive current actual value – Phase Current
Additional signals	– Rotor Position – Intermediate circuit voltage – Fixed voltage level

Tab. 6.30 Output variables

Overflow limitation activated

The numerical overflow limitation limits the voltage values U calculated corresponding to the scaling to the range +10 V ... -10 V.

Overflow limitation not activated

In case of overflow of the range limit +10 V, the output voltage jumps to (–10 V +ΔU).
In case of overflow of the range limit -10 V, the output voltage jumps (+10 V -ΔU).

6.7.8 Supported encoder systems

The following encoder systems are supported by the motor controllerCMMP-AS-...-M0:

Type	Remark	Protocol	Interface
Heidenhain Endat encoder			
ROC 400 ECI 1100/1300 ECN 100/400/1100/1300	Single-turn absolute encoder with/ without analogue signal	EnDat 2.1 (01/21) EnDat 2.2 (22)	[X2B]
ROQ 400 EQI 1100/1300 EQN 100/400/1100/1300	Multi-turn absolute encoder with/ without analogue signal	EnDat 2.1 (01/21) EnDat 2.2 (22)	[X2B]
LC 100/400	Absolute length measurement equipment	EnDat 2.1 (01) EnDat 2.2 (22)	[X2B]
Stegmann HIPERFACE Encoder			
SCS60/70 SCM60/70	Single-/multi-turn encoder with analogue incremental signals. Sine/cosine periods 512. Max. revolutions multi-turn: +/- 2048 R.	HIPERFACE	[X2B]
SRS50/60/64 SCKxx SRM50/60/64 SCLxx	Single-/multi-turn encoder with analogue incremental signals. Sine/cosine periods 1024. Max. revolutions multi-turn: +/- 2048 R	HIPERFACE	[X2B]
SKS36 SKM36	Single-/multi-turn encoder with analogue incremental signals. Sine/cosine periods 128. Max. revolutions multi-turn: +/- 2048 R	HIPERFACE	[X2B]
SEK37/52 SEL37/52	Single-/multi-turn encoder with analogue incremental signals. Sine/cosine periods 16. Max. revolutions multi-turn: +/- 2048 R	HIPERFACE	[X2B]

Type	Remark	Protocol	Interface
L230	Absolute linear encoder with analogue incremental signal. Measurement step: 156.25 µm. Measurement length max. approx. 40 m	HIPERFACE	[X2B]
Yaskawa Σ-ENCODER			
Σ (sigma 1)	Digital incremental encoder with zero pulse	Yaskawa OEM protocol	[X2B]
Analogue incremental encoders			
ROD 400 ERO 1200/1300/1400 ERN 100/400/1100/1300	Heidenhain, encoder with zero impulse and reference signal	–	[X2B]
Digital incremental encoders			
CDD50	Stegmann encoder with Hall sensors	–	[X2B]
Resolver			
Standard	Transmission ratio 0.5 +/– 10 %, Excitation voltage. 7 Vrms	–	[X2A]

Tab. 6.31 Supported encoder systems

7 Dynamic response

7.1 PFC for increased intermediate circuit voltage

The motor controllers CMMP-AS-C2-3A-M0 and CMMP-AS-C5-3A-M0 with single-phase supply are intended for connection to the 230 V AC mains grid and are equipped with an active PFC step (Power Factor Control). The PFC stage is an active mains power converter that is required for compliance with the relevant standards for limiting mains grid harmonics. The PFC stage also performs active regulation of the intermediate circuit voltage. The PFC step operates using the boost chopper principle and provides a regulated nominal intermediate voltage of 380 V DC. This voltage is independent of the quality of the mains voltage, also when the mains voltage fluctuates or there is undervoltage in the mains grid. This is a significant advantage when selecting the servo motor because, compared to a device with passive mains feed, higher speeds are achievable or a higher torque constant can be selected. Further, due to the active PFC step, the device is also appropriate for wide-range operation down to 100 V AC mains voltage, but the limitation of the effective power consumption due to the permissible maximum current of the PFC step must be observed.

Note
The PFC step of all motor controllers connected to the intermediate circuit must be disabled if motor controllers are coupled via the intermediate circuit.

Note
It must be ensured that the reference potential (N) is switched before or simultaneously with the phase (L1). This can be achieved through:
– unswitched reference potential (N)
– use of fuses with leading N when switching of the reference potential is not specified.

7.1.1 Switch-on behaviour

As soon as the motor controller is provided with mains voltage, the intermediate circuit is charged (< 1 s) via the braking resistors, with the intermediate circuit relay deactivated. The PFC stage is not switched on at this point.
After the intermediate circuit has been successfully pre-charged, the relay engages and the intermediate circuit is “hard” connected to the mains supply. The PFC stage is then activated and the intermediate stage is loaded with the full voltage.
If the intermediate circuit voltage is too low after successful charging, because the mains input voltage lies below the permissible level for PFC operation, the PFC stage remains blocked and a warning is displayed on the 7-segments display.
If the motor controller is supplied with less than the nominal voltage of 230 V AC, after pre-loading is completed, a power reduction for the PFC step is calculated based on the achieved intermediate circuit voltage.

7.1.2 Behaviour under normal operation and control properties

In operation, the power consumption of the motor controller from the mains network is monitored via the PFC step. The mains current is regulated by an analogue control circuit so that the shape of the curve reflects that of the mains voltage sinewave and the phase shift is 0°. The amplitude is adjusted according to the specified effective power.

A higher-level digital controller regulates the intermediate circuit voltage to an average value of approx. 360 V DC. To relieve the relatively sluggish voltage regulation under load changes (acceleration/braking of the drive), the effective power delivered to the motor from the motor controller is measured and used to pre-control the PFC step.

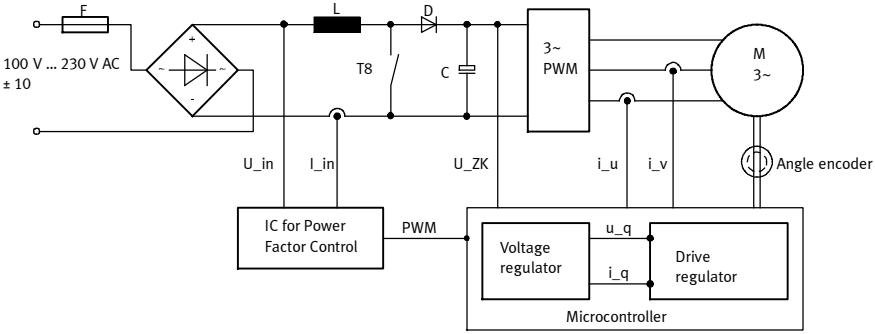


Fig. 7.1 Schematic structure of the PFC step

Control encompasses the following variables:

- Digital control of the intermediate circuit voltage to an average of approx. 380 V DC
- Analogue control of the mains input current
- Maintenance of a sine-wave mains current under stationary load conditions
- Operation with cosφ 0.97 at rated operation (at the rated output of the PFC step)

The parameterisation program can be used to switch the PFC control on or off. When the PFC is deactivated, the intermediate circuit behaves like a normal intermediate circuit with an upstream bridge rectifier.

The intermediate circuit voltage is usually regulated to a constant average value that, under stationary load conditions, is independent of the specified effective power of the motor.

7.2 Extended sine modulation for increased output voltage

With the motor controller CMMP-AS-...-M0 the cycle rate in the current regulator circuit is set to a cycle time of 125 µs or 62.5 µs. To decrease switching losses, the pulse-width modulation cycle rate can be set to half the frequency of the current regulator circuit.
The motor controller CMMP-AS-...-M0 also has a sine-wave modulation or, alternatively, an extended sine-wave modulation (with third harmonic wave). This increases the effective converter output voltage. The modulation type can be selected using the parameterisation software. The standard setting is extended sine-wave modulation.

7.3 Variable cycle times, current, speed and position controller

The motor controller's CMMP-AS-...-M0 permit a switchable current control cycle time. From these settings are derived the cycle times for the speed and position controller as well as the interpolation time. Faster cycle times permit lower reaction times and an improved control dynamic (depending on the application, higher possible closed-loop gain or lower "overshooting" of the position actual values).
The following table contains the PWM frequencies and related cycle times that the CMMP-AS-...-M0 supports:

PWM frequency	Scanning frequency of current control	Cycle time of current control	Cycle time of speed adjustment	Cycle time of position control	Interpolation time
4 kHz	8 kHz	125 µs	250 µs	500 µs	1000 µs
8 kHz	8 kHz	125 µs	250 µs	500 µs	1000 µs
8 kHz	16 kHz	62.5 µs	125 µs	250 µs	500 µs
16 kHz	16 kHz	62.5 µs	125 µs	250 µs	500 µs

Tab. 7.1 PWM frequencies and cycle times

The PWM frequency can be set in the parameterisation software FCT with the option "Half output stage frequency".

With higher PWM frequencies, the result is reduced nominal/peak currents of the power sections. Derating tables ➔ Technical data GDCP-CMMP-M0-HW-....

8 Service functions and diagnostic messages

8.1 Protective and service functions

8.1.1 Overview

The motor controller CMMP-AS-...-M0 has complex sensors that monitor proper functioning of the motor controller section, power output stage, motor and external communication. All diagnostic events which occur are saved in the internal diagnostic memory. The diagnostic memory in the motor controller has a two-stage design:

– All messages since the motor controller was last switched on are saved in the temporary memory (these are lost in the event of a power failure).
– In the permanent memory of the motor controller CMMP-AS-...-M0 the messages are permanently saved (secure in the event of a mains failure). This memory consists of 2 segments that are filled one after the other. When both segments are full, the older segment is automatically cleared. This means that a sort of ring memory is available for the permanently saved messages.

Most errors cause the motor controller section to switch off the motor controller and the power output stage. The motor controller can only be switched on again when the error has been eliminated and then acknowledged.

For some of the diagnostic messages, the behaviour of the motor controller can be parameterised. Possible reactions:

– PS off Switch off power section immediately
– MCStop Stop with maximum peak current
– QStop Quick stop with the deceleration specified on the “Axis” (FCT) page
– Warn Output of a warning
– Ignore No message, only entry in diagnostic memory
– NoLog No message and no entry in diagnostic memory.

A complex system of sensors and numerous monitoring functions ensure operational reliability:

– Measurement of the motor temperature
– Measurement of the power output stage temperature
– Earth fault detection (PE)
– Detection of short-circuits between two motor phases
– Detection of overvoltages in the intermediate circuit
– Detection of faults in the internal voltage supply
– Collapse of supply voltage

8.1.2 Phases and mains failure detection with 3-phase motor controllers

The motor controller CMMP-AS-...-M0 detects a phase failure in three-phase operation (phase failure detection) or failure of several phases (mains failure detection) of the mains supply at the device.

8.1.3 Overload current and short-circuit monitoring

Overload current and short-circuit monitoring detects short circuits between two motor phases and short circuits at the motor output terminals against the positive and negative reference potential of the intermediate circuit and against PE. If the error control detects overload current, the power output stage shuts down immediately, guaranteeing protection against short circuits.

8.1.4 Overvoltage monitoring for the intermediate circuit

The overvoltage monitoring for the intermediate circuit takes effect as soon as the intermediate circuit voltage exceeds the operating voltage range. The power output stage is then deactivated.

8.1.5 Temperature monitoring for the heat sink

The heat sink temperature of the output end stage is measured with a linear temperature sensor. The temperature limit varies from device to device. A temperature warning is triggered at about 5 °C below the limit value.

8.1.6 Monitoring of the motor

To monitor the motor and the connected shaft encoder, the motor controllerCMMP-AS-...-M0has the following protective functions:

Protective function	Description
Monitoring the shaft encoder	An error of the shaft encoder causes the power output stage to be switched off. With the resolver, the tracking signal is monitored, for example. For incremental encoders, the commutation signals are checked. In general, for intelligent encoders, their various error messages are evaluated and reported at the CMMP-AS-...-M0 as common error E 08-8.
Measurement and monitoring of the motor temperature	The motor controller CMMP-AS-...-M0 has a digital and an analogue input for recording and monitoring the motor temperature. The following temperature sensors can be selected: – [X6]: Digital input for PTCs, N/C contacts and N/O contacts. – [X2A] and [X2B]: N/C contact and KTY series analogue sensors. (Only for parameterisation of user-defined motors)

Tab. 8.1 Protective functions of the motor

8.1.7 I^2t monitoring

The motor controller CMMP-AS-...-M0 has an I^2t monitoring to limit the average power dissipation in the power output stage and the motor. Since the power loss that occurs in the power electronics and the motor can, in the worst case, grow at a rate equal to the square of the flowing current, the squared current value is taken as a measure for the power loss.

8.1.8 Power monitoring for the brake chopper

The braking resistors are monitored on the firmware side through the function I^2t brake chopper. When the output monitoring reaches “I^2t brake chopper” of 100 %, the output of the internal braking resistor is switched back to rated output.
As a result of this switch back, the error “E 07-0” “Overvoltage in the intermediate circuit” is generated if the braking process is not yet finished and (too much) energy is fed back to the motor controller.
In addition, the brake chopper is protected by means of overcurrent detection. If a short circuit is detected via the braking resistor, the brake chopper controller is switched off.

8.1.9 Commissioning status

Motor controllers sent to Festo for servicing are loaded with other firmware and parameters for testing purposes.
Before a new commissioning takes place at the end customer, the motor controller CMMP-AS-...-M0 must be parameterised. The parameterisation software queries the commissioning status and prompts the user to parameterise the motor controller. In parallel, the device signals through the visual indicator “A” on the 7-segments display that, although it is ready for operation, it has not been parameterised yet.

8.1.10 Rapid discharge of the intermediate circuit

When a mains supply failure is detected, the intermediate circuit is quickly discharged within the safety time specified in EN 60204-1.
Delayed connection of the brake chopper by power class in parallel operation and when a mains failure occurs ensures that the main energy during rapid discharge of the intermediate circuit is taken over through the braking resistors of the higher power classes.

But the rapid discharge can be ineffective in certain device constellations, especially when several motor controllers are connected in parallel in the intermediate circuit or a brake resistance is not connected. The motor controllers may carry dangerous voltage for up to 5 minutes after being switched off (capacitor residual charge).

8.2 Operating mode and error messages

8.2.1 Operating mode and error display

The motor controller CMMP-AS-...-M0 has on the front side three LEDs and a 7-segments display for display of the operating statuses.

Element	LED colour	Function
7-segments display	–	Displays the operating mode and a coded error number in case of error.
LED1	Green	Operating status
	Red	Error
LED2	Green	Controller enable
LED3	Yellow	CAN bus status display
RESET button	–	Hardware reset for the processor

Tab. 8.2 Display components and RESET pushbutton

8.2.2 7-segments display

The display and the meaning of the symbols shown are illustrated in the following table:

Display[1]		Significance
	A	The motor controller must still be parameterised.
	F	Signals that firmware is currently being loaded into the flash.
	. (flashes)	Bootloader active (only the point flashes).
	d	Signals that a parameter set is currently being loaded from the SD card to the motor controller.
	H (flashes)	"H": The motor controller is in the "safe status". This does not have the same meaning as the information on the status of the safety function STO (Safe Torque Off).
	H E L L O	Display for the function "Identify Controller".
	(rotating)	The outer segments are displayed "rotating" in the speed adjustment operating mode. The display depends on the actual position or speed. The middle bar is only active when controller enable is active.
	I	Controlled torque mode.
	P x x x	Positioning ("xxx" stands for the record number, see below).
	000	No positioning active.
	001...255	Positioning record 001 ... 255 active.
	259/260	Jog positive/negative.
	262	CAM-IN / CAM-OUT (cam disc).
	264/265	Direct records for manual travel via FCT or FHPP direct operation.
	P H x	Homing ("x" stands for the homing phase, see below).
	0	Phase "Search for reference point".
	1	Phase "Crawl".
	2	Phase "Approach zero point".
	E x x y	Error message with main index "xx" and sub-index "y".
	- x x y	Warning message with main index "xx" and sub-index "y". A warning is shown at least twice on the 7-segments display.

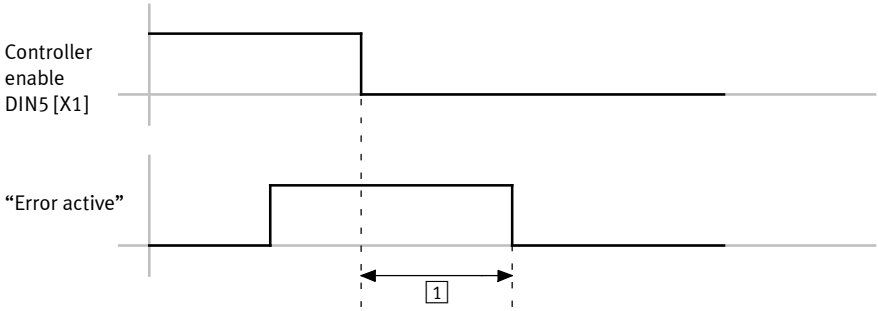
1) Several characters are displayed one after the other.

Tab. 8.3 Operating mode and error display

8.2.3 Acknowledgement of error messages

Error messages can be acknowledged through:

– the parametrisation interface
– the fieldbus (control word)
– a decreasing edge at DIN5 [X1]



1 ≈ 80 ms

Fig. 8.1 Timing diagram: acknowledge error

Diagnostic events which are parametrised as warnings are automatically acknowledged when the cause is no longer on hand.

8.2.4 Diagnostic messages

The significance and their measures for diagnostic messages are summarised in the following chapter: (➔ chapter A Diagnostic messages).

A Diagnostic messages

If an error occurs, the motor controller CMMP-AS-...-M0 displays a diagnostic message cyclically in the 7-segments display. An error message consists of an E (for Error), a main index and a sub-index, e.g.: **- E 0 1 0 -**.
Warnings have the same number as an error message. In contrast to error messages, however, warnings are preceded and followed by hyphens, e.g. **- 1 7 0 -**.

A.1 Explanations of the diagnostic messages

The following table summarises the significance of the diagnostic messages and the actions to be taken in response to them:

Terms	Significance
No.	Main index (fault group) and sub-index of the diagnostic message. Display in the indicator, in FCT or diagnostic memory via FHPP.
Code	The Code column includes the error code (Hex) via CiA 301.
Message	Message that is displayed in the FCT.
Cause	Possible causes for the message.
Action	Action by the user.
Reaction	The Reaction column includes the error response (default setting, partially configurable): – PS off (switch off output stage), – MCStop (fast stop with maximum current), – QStop (fast stop with parameterised ramp), – Warn (warning), – Ignore (No message, only entry in diagnostic memory), – NoLog (No message and no entry in diagnostic memory).

Tab. A.1 Explanations of the diagnostic messages

A complete list of the diagnostic messages corresponding to the firmware statuses at the time of printing of this document can be found in section A.2.

A.2 Diagnostic messages with instructions for troubleshooting

Fault group 00		**Invalid message or information**		
No.	Code	Message		Reaction
00-0	-	**Invalid error**		Ignore
		Cause	Information: An invalid error entry (corrupted) was found in the diagnostic memory marked with this error number. The system time entry is set to 0.	
		Measure	–	
00-1	-	**Invalid error detected and corrected**		Ignore
		Cause	Information: An invalid error entry (corrupted) was found in the diagnostic memory and corrected. The additional information contains the original error number. The system time entry contains the address of the corrupted error number.	
		Measure	–	
00-2	-	**Error cleared**		Ignore
		Cause	Information: Active errors were acknowledged.	
		Measure	–	

Fault group 01		**Stack overflow**		
No.	Code	Message		Reaction
01-0	6180h	**Stack overflow**		PS off
		Cause	– Incorrect firmware? – Sporadic high processor load due to cycle time being too short and special compute-bound processes (save parameter set, etc.).	
		Measure	• Load an approved firmware. • Reduce the processor load. • Contact Technical Support.	

Fault group 02		**Intermediate circuit**		
No.	Code	Message		Reaction
02-0	3220h	**Undervoltage in intermediate circuit**		Configurable
		Cause	Intermediate circuit voltage falls below the parameterised threshold (➔ additional information). Error priority set too high?	
		Measure	• Quick discharge due to switched-off mains supply. • Check power supply. • Couple intermediate circuits if technically permissible. • Check intermediate circuit voltage (measure). • Check undervoltage monitor (threshold value).	
		Additional information	Additional information in PNU 203/213: Top 16 bits: Status number of internal state machine Bottom 16 bits: Intermediate circuit voltage (internal scaling approx. 17.1 digit/V).	

Fault group 03		**Motor overtemperature**		
No.	Code	Message		Reaction
03-0	4310h	**Analogue motor overtemperature**		QStop
		Cause	Motor overloaded, temperature too high. – Motor too hot? – Incorrect sensor? – Sensor defective? – Broken cable?	
		Measure	• Check parameterisation (current regulator, current limits). • Check the parameterisation of the sensor or the sensor characteristics. If the error persists when the sensor is bypassed: device defective.	
03-1	4310h	**Digital motor overtemperature**		Configurable
		Cause	– Motor overloaded, temperature too high. – Suitable sensor or sensor characteristics parameterised? – Sensor defective?	
		Measure	• Check parameterisation (current regulator, current limits). • Check the parameterisation of the sensor or the sensor characteristics. If the error persists when the sensor is bypassed: device defective.	

Fault group 03		**Motor overtemperature**		
No.	Code	Message		Reaction
03-2	4310h	**Analogue motor overtemperature: wire break**		Configurable
		Cause	The measured resistance value is above the threshold for wire break detection.	
		Measure	• Check the connecting cables of the temperature sensor for wire breaks. • Check the parameterisation (threshold value) for wire break detection.	
03-3	4310h	**Analogue motor overtemperature: short circuit**		Configurable
		Cause	The measured resistance value is below the threshold for short circuit detection.	
		Measure	• Check the connecting cables of the temperature sensor for wire breaks. • Check the parameterisation (threshold value) for short circuit detection.	

Fault group 04		**Intermediate circuit/power unit over-temperature**		
No.	Code	Message		Reaction
04-0	4210h	**Power end stage overtemperature**		Configurable
		Cause	Device is overheated – Temperature display plausible? – Device fan defective? – Device overloaded?	
		Measure	• Check installation conditions; are the control cabinet fan filters dirty? • Check the drive layout (due to possible overloading in continuous duty).	
04-1	4280h	**Intermediate circuit overtemperature**		Configurable
		Cause	Device is overheated – Temperature display plausible? – Device fan defective? – Device overloaded?	
		Measure	• Check installation conditions; are the control cabinet fan filters dirty? • Check the drive layout (due to possible overloading in continuous duty).	

Fault group 05		**Internal voltage supply**		
No.	Code	Message		Reaction
05-0	5114h	**Failure of internal voltage 1**		PS off
		Cause	Monitoring of the internal power supply has detected under-voltage. This is either due to an internal defect or an overload/ short circuit caused by connected peripherals.	
		Measure	• Check digital outputs and brake output for short circuit and/or specified load. • Separate device from the entire peripheral equipment and check whether the error is still present after reset. If it is, then there is an internal defect ➔ Repair by the manufacturer.	
05-1	5115h	**Failure of internal voltage 2**		PS off
		Cause	Monitoring of the internal power supply has detected under-voltage. This is either due to an internal defect or an overload/ short circuit caused by connected peripherals.	
		Measure	• Check digital outputs and brake output for short circuit and/or specified load. • Separate device from the entire peripheral equipment and check whether the error is still present after reset. If it is, then there is an internal defect ➔ Repair by the manufacturer.	
05-2	5116h	**Failure of driver supply**		PS off
		Cause	Monitoring of the internal power supply has detected under-voltage. This is either due to an internal defect or an overload/ short circuit caused by connected peripherals.	
		Measure	• Check digital outputs and brake output for short circuit and/or specified load. • Separate device from the entire peripheral equipment and check whether the error is still present after reset. If it is, then there is an internal defect ➔ Repair by the manufacturer.	
05-3	5410h	**Undervoltage dig. I/O**		PS off
		Cause	Overloading of I/Os? Defective peripheral device?	
		Measure	• Check connected peripherals for short circuit or specified load. • Check connection of the brake (connected incorrectly?).	
05-4	5410h	**Overload current dig. I/O**		PS off
		Cause	Overloading of I/Os? Defective peripheral device?	
		Measure	• Check connected peripherals for short circuit or specified load. • Check connection of the brake (connected incorrectly?).	
05-5	-	**Voltage failure interface Ext1/Ext2**		PS off
		Cause	Defect on the plugged-in interface.	
		Measure	• Replace interface ➔ Repair by the manufacturer.	

Fault group 05		**Internal voltage supply**		
No.	Code	Message		Reaction
05-6	-	**Voltage failure [X10], [X11]**		PS off
		Cause	Overloading through connected peripherals.	
		Measure	• Check pin allocation of the connected peripherals. • Short circuit?	
05-7	-	**Safety module internal voltage failure**		PS off
		Cause	Defect on the safety module.	
		Measure	• Internal defect ➔ Repair by the manufacturer.	
05-8	-	**Failure of internal voltage 3**		PS off
		Cause	Defect in the motor controller.	
		Measure	• Internal defect ➔ Repair by the manufacturer.	
05-9	-	**Encoder supply defective**		PS off
		Cause	Back measurement of the encoder voltage not OK.	
		Measure	• Internal defect ➔ Repair by the manufacturer.	

Fault group 06		**Overcurrent**		
No.	Code	Message		Reaction
06-0	2320h	**Short circuit in output stage**		PS off
		Cause	– Faulty motor, e.g. winding short circuit due to motor overheating or short to PE inside motor. – Short circuit in the cable or the connecting plugs, i.e. short circuit between motor phases or to the screening/PE. – Output stage defective (short circuit). – Incorrect parameterisation of the current regulator.	
		Measure	Dependent on the status of the system ➔ Additional information cases a) to f).	
		Additional information	Measures: a) Error only with active brake chopper: Check external braking resistor for short circuit or insufficient resistance value. Check circuitry of the brake chopper output at the motor controller (bridge, etc.). b) Error message immediately when the power supply is connected: Internal short circuit in the output stage (short circuit of a complete half-bridge). The motor controller can no longer be connected to the power supply; the internal (and possibly external) fuses are tripped. Repair by the manufacturer is necessary. c) Short circuit error message only when the output stage or controller enable is issued. d) Disconnection of motor plug [X6] directly on the motor controller. If the error still occurs, there is a fault in the motor controller. Repair by the manufacturer is necessary. e) If the error only occurs when the motor cable is connected: Check the motor and cable for short circuits, e.g. with a multimeter. f) Check parameterisation of the current regulator. Oscillations in an incorrectly parameterised current regulator can generate currents up to the short-circuit threshold, usually clearly audible as a high-frequency whistling. Verification, if necessary, with the trace in the FCT (actual active current value).	
06-1	2320h	**Overload current brake chopper**		PS off
		Cause	Overload current at the brake chopper output.	
		Measure	• Check external braking resistor for short circuit or insufficient resistance value. • Check circuitry of the brake chopper output at the motor controller (bridge, etc.).	

Fault group 07		**Overvoltage in intermediate circuit**		
No.	Code	Message		Reaction
07-0	3210h	**Overvoltage in intermediate circuit**		PS off
		Cause	Braking resistor is overloaded; too much braking energy, which cannot be dissipated quickly enough. – Resistor capacity incorrect? – Resistor not connected correctly? – Check design (application).	
		Measure	• Check the design of the braking resistor; resistance value may be too great. • Check the connection to the braking resistor (internal/external).	

Fault group 08		**Angle transducer error**		
No.	Code	Message		Reaction
08-0	7380h	**Resolver angular encoder error**		Configurable
		Cause	Resolver signal amplitude is faulty.	
		Measure	Step-by-step approach ➔ Additional information cases a) to c).	
		Additional information	a) If possible, test with a different (error-free) resolver (replace the connecting cable as well). If the error still occurs, there is a fault in the motor controller. Repair by the manufacturer is necessary. b) If the error occurs only with a special resolver and its connecting cable: Check resolver signals (carrier and SIN/COS signals), see specification. If the signals do not comply with the signal specifications, replace the resolver. c) If the error recurs sporadically, check the screen bonding or check whether the resolver simply has an insufficient transmission ratio (standard resolver: A = 0.5).	

Fault group 08		**Angle transducer error**		
No.	Code	Message		Reaction
08-1	-	**Sense of rotation of the serial and incremental position evaluation is not identical**		Configurable
		Cause	Only encoder with serial position transmission combined with an analogue SIN/COS signal track: The direction of rotation of encoder-internal position determination and incremental evaluation of the analogue track system in the motor controller are the wrong way around ➔ Additional information.	
		Measure	Swap the following signals on the [X2B] angle encoder interface (the wires in the connecting plug must be changed around), observing the technical data for the angle encoder where applicable: – Swap SIN/COS track. – Swap the SIN+/SIN- or COS+/COS- signals, as applicable.	
		Additional information	The encoder counts internally, for example, positively in clockwise rotation while the incremental evaluation counts in negative direction with the same mechanical rotation. The interchange of the direction of rotation is detected mechanically at the first movement of over 30° and the error is triggered.	
08-2	7382h	**Error in incremental encoder tracking signal Z0**		Configurable
		Cause	Signal amplitude of the Z0 track at [X2B] is faulty. – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check configuration of angle encoder interface: a) Z0 evaluation activated, but no track signals connected or present ➔ Additional information. b) Encoder signals faulty? c) Test with another encoder. ➔ Tab. A.2, Page 118.	
		Additional information	e.g. EnDat 2.2 or EnDat 2.1 without analogue track. Heidenhain encoder: order codes EnDat 22 and EnDat 21. With these encoders there are no incremental signals, even when the cables are connected.	

Fault group 08		**Angle transducer error**		
No.	Code	Message		Reaction
08-3	7383h	**Error in incremental encoder track signals Z1**		Configurable
		Cause	Signal amplitude of the Z1 track at X2B is faulty. – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check configuration of angle encoder interface: a) Z1 evaluation activated but not connected. b) Encoder signals faulty? c) Test with another encoder. ➔ Tab. A.2, Page 118.	
08-4	7384h	**Digital incremental encoder track signals error [X2B]**		Configurable
		Cause	Faulty A, B, or N track signals at [X2B]. – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check the configuration of the angle encoder interface. a) Encoder signals faulty? b) Test with another encoder. ➔ Tab. A.2, Page 118.	
08-5	7385h	**Error in incremental encoder of Hall-effect encoder signals**		Configurable
		Cause	Hall encoder signals of a dig. inc. at [X2B] faulty. – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check the configuration of the angle encoder interface. a) Encoder signals faulty? b) Test with another encoder. ➔ Tab. A.2, Page 118.	

Fault group 08		**Angle transducer error**		
No.	Code	Message		Reaction
08-6	7386h	**Angle encoder communication fault**		Configurable
		Cause	Communication to serial angle encoders is disrupted (EnDat encoders, HIPERFACE encoders, BiSS encoders). – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check configuration of the angle encoder interface; procedure corresponding to a) to c): a) Serial encoder parameterised but not connected? Incorrect serial protocol selected? b) Encoder signals faulty? c) Test with another encoder. ➔ Tab. A.2, Page 118.	
08-7	7387h	**Signal amplitude of incremental tracks faulty [X10]**		Configurable
		Cause	Faulty A, B, or N track signals at [X10]. – Angle encoder connected? – Angle encoder cable defective? – Angle encoder defective?	
		Measure	Check the configuration of the angle encoder interface. a) Encoder signals faulty? b) Test with another encoder. ➔ Tab. A.2, Page 118.	
08-8	7388h	**Internal angle encoder error**		Configurable
		Cause	Internal monitoring of the angle encoder [X2B] has detected an error and forwarded it via serial communication to the controller. – Declining illumination intensity with visual encoders? – Excess rotational speed? – Angle encoder defective?	
		Measure	If the error occurs repeatedly, the encoder is defective. ➔ Replace encoder.	

Fault group 08		**Angle transducer error**		
No.	Code	Message		Reaction
08-9	7389h	**Angle encoder at [X2B] is not supported**		Configurable
		Cause	Angle encoder type read at [X2B], which is not supported or cannot be used in the desired operating mode. – Incorrect or inappropriate protocol type selected? – Firmware does not support the connected encoder variant?	
		Measure	Depending on the additional information of the error message ➔ Additional information: • Load appropriate firmware. • Check/correct the configuration for encoder analysis. • Connect an appropriate encoder type.	
		Additional information	Additional information (PNU 203/213): 0001: HIPERFACE: Encoder type is not supported by the firmware ➔ Connect another encoder type or load more recent firmware. 0002: EnDat: The address space in which the encoder parameters would have to lie does not exist with the connected EnDat encoder ➔ Check the encoder type. 0003: EnDat: Encoder type is not supported by the firmware ➔ Connect another encoder type or load more recent firmware. 0004: EnDat: Encoder rating plate cannot be read from the connected encoder. ➔ Change encoder or load more recent firmware, if applicable. 0005: EnDat: EnDat 2.2 interface parameterised, but connected encoder supports only EnDat 2.1. ➔ Replace encoder type or reparameterise to EnDat 2.1. 0006: EnDat: EnDat2.1 interface with analogue track evaluation parameterised, but according to rating plate the connected encoder does not support track signals. ➔ Change encoder or switch off Z0 track signal evaluation. 0007: Code length measuring system with EnDat2.1 connected, but parameterised as a purely serial encoder. Purely serial evaluation is not possible due to the long response times of this system. Encoder must be operated with analogue track signal evaluation ➔ Connect to analogue Z0 track signal evaluation.	

Fault group 09		**Error in the angle encoder parameter set**		
No.	Code	Message		Reaction
09-0	73A1h	**Old angle encoder parameter set**		Configurable
		Cause	Warning: An encoder parameter set in an old format was found in the EEPROM of the connected encoder. This has been converted and saved in the new format.	
		Measure	No action necessary at this point. The warning should not re-appear when the 24 V supply is switched back on.	
09-1	73A2h	**Angle encoder parameter set cannot be decoded**		Configurable
		Cause	Data in the EEPROM of the angle encoder could not be read completely, or access to it was partly refused.	
		Measure	The EEPROM of the encoder contains data (communication objects) which are not supported by the loaded firmware. The data in question are then discarded. • The parameter set can be adapted to the current firmware by writing the encoder data to the encoder. • Load alternatively appropriate (more recent) firmware.	
09-2	73A3h	**Unknown version of angle encoder parameter set**		Configurable
		Cause	The data saved in EEPROM are not compatible with the current version. A data structure was found which is unable to decode the loaded firmware.	
		Measure	• Save the encoder parameters again in order to delete the parameter set in the encoder and replace it with a readable set (this will, however, delete the data in the encoder irreversibly). • Load alternatively appropriate (more recent) firmware.	
09-3	73A4h	**Defective data structure in angle encoder parameter set**		Configurable
		Cause	Data in EEPROM do not match the stored data structure. The data structure was identified as valid but may be corrupted.	
		Measure	• Save the encoder parameters again in order to delete the parameter set in the encoder and replace it with a readable set. If the error still occurs after that, the encoder may be faulty. • Replace the encoder as a test.	
09-4	-	**EEPROM data: Erroneous custom specific configuration**		Configurable
		Cause	Only with specialised motors: The plausibility check returns an error, e.g. because the motor was repaired or replaced.	
		Measure	• If motor repaired: Carry out homing again and save in the angle encoder, after that (!) save in the motor controller. • If motor exchanged: Parameterise the motor controller again, then carry out homing again and save in the angle encoder, after that (!) save in the motor controller.	

Fault group 09		**Error in the angle encoder parameter set**	
No.	Code	Message	Reaction
09-7	73A5h	**Read-only EEPROM angle encoder**	Configurable
		Cause: Data cannot be saved in the EEPROM of the angle encoder. Occurs with Hiperface encoders.	
		Measure: A data field in the encoder EEPROM is read-only (e.g. after operation on a motor controller of another manufacturer). No solution possible, encoder memory must be unlocked with an appropriate parameterisation tool (from manufacturer).	
09-9	73A6h	**Angle encoder's EEPROM too small**	Configurable
		Cause: It is not possible to save all the data in the EEPROM of the angle encoder.	
		Measure: • Reduce the number of data records to be saved. Please read the documentation or contact Technical Support.	

Fault group 10		**Excessive speed**	
No.	Code	Message	Reaction
10-0	-	**Overspeed (spin protection)**	Configurable
		Cause: – Motor racing ("spinning") because the commutation angle offset is incorrect. – Motor is parameterised correctly, but the limit for spinning protection is set too low.	
		Measure: • Check the commutation angle offset. • Check the limit value setting in the parameters.	

Fault group 11		**Homing error**	
No.	Code	Message	Reaction
11-0	8A80h	**Error when homing is started**	Configurable
		Cause: Controller enable missing.	
		Measure: Homing can only be started when closed-loop controller enable is active. • Check the condition or sequence.	
11-1	8A81h	**Error during homing**	Configurable
		Cause: Homing was interrupted, e.g. by: – Withdrawal of controller enable. – Reference switch is beyond the limit switch. – External stop signal (a phase was aborted during homing).	
		Measure: • Check homing sequence. • Check arrangement of the switches. • If applicable, lock the STOP input during homing if it is not desired.	

Fault group 11		**Homing error**	
No.	Code	Message	Reaction
11-2	8A82h	**Homing: No valid zero pulse**	Configurable
		Cause: Necessary zero pulse missing for homing.	
		Measure: • Check the zero pulse signal. • Check the angle encoder settings.	
11-3	8A83h	**Homing: timeout**	Configurable
		Cause: The parameterised maximum time for the homing run was exceeded before the homing run was completed.	
		Measure: • Check the time setting in the parameters.	
11-4	8A84h	**Homing: wrong / invalid limit switch**	Configurable
		Cause: – Relevant limit switch not connected. – Limit switches swapped? – No reference switch found between the two limit switches. – Reference switch is at the limit switch. – Current position with zero pulse method: limit switch active in the area of the zero pulse (not permissible). – Both limit switches active at the same time.	
		Measure: • Check whether the limit switches are connected in the correct direction of travel or whether the limit switches have an effect on the intended inputs. • Reference switch connected? • Check configuration of the reference switches. • Move limit switch so that it is not in the zero pulse area. • Check limit switch parameterisation (N/C contact/N/O contact).	
11-5	8A85h	**Homing: I^2t / following error**	Configurable
		Cause: – Acceleration ramps not suitably parameterised. – Change of direction due to premature triggering of following error; check parameterisation of following error. – No reference switch reached between the end stops. – Zero pulse method: end stop reached (not permissible here).	
		Measure: • Parameterise the acceleration ramps so they are flatter. • Check connection of a reference switch. • Method appropriate for the application?	
11-6	8A86h	**Homing: End of search path**	Configurable
		Cause: The maximum permissible path for the homing run has been travelled without reaching the point of reference or the homing run destination.	
		Measure: Malfunction in switch detection. • Switch for homing defective?	

Fault group 11		**Homing error**		
No.	Code	Message		Reaction
11-7	-	**Homing: error in encoder difference monitoring**		Configurable
		Cause	Deviation between the actual position value and commutation position is too great. External angle encoder not connected or faulty?	
		Measure	• Deviation fluctuates, e.g. due to gear backlash; cut-off threshold may need to be increased. • Check connection of the actual value encoder.	

Fault group 12		**CAN error**		
No.	Code	Message		Reaction
12-0	8180h	**CAN: double node number**		Configurable
		Cause	Node number assigned twice.	
		Measure	• Check the configuration of the CAN bus participants.	
12-1	8120h	**CAN: Communication error, bus OFF**		Configurable
		Cause	The CAN chip has switched off communication due to communication errors (BUS OFF).	
		Measure	• Check cabling: cable specification adhered to, wire break, maximum cable length exceeded, correct terminating resistors, cable screening earthed, all signals connected? • Replace device on a test basis. If a different device works without errors with the same cabling, send the device to the manufacturer for checking.	
12-2	8181h	**CAN: communication error during transmission**		Configurable
		Cause	The signals are corrupted when transmitting messages. Device boot up is so fast that no other nodes on the bus have yet been detected when the boot-up message is sent.	
		Measure	• Check cabling: cable specification adhered to, wire break, maximum cable length exceeded, correct terminating resistors, cable screening earthed, all signals connected? • Replace device on a test basis. If a different device works without errors with the same cabling, send the device to the manufacturer for checking.	
12-3	8182h	**CAN: communication error during reception**		Configurable
		Cause	The signals are corrupted when receiving messages.	
		Measure	• Check cabling: cable specification adhered to, wire break, maximum cable length exceeded, correct terminating resistors, cable screening earthed, all signals connected? • Replace device on a test basis. If a different device works without errors with the same cabling, send the device to the manufacturer for checking.	

Fault group 12		**CAN error**	
No.	Code	Message	Reaction
12-4	-	**CAN: node guarding**	Configurable
		Cause: Node guarding telegram not received within the parameterised time. Signals corrupted?	
		Measure: • Compare the cycle time of the remote frames with that of the controller. • Check: failure of the controller?	
12-5	-	**CAN: RPDO too short**	Configurable
		Cause: A received RPDO does not contain the parameterised number of bytes.	
		Measure: The number of parameterised bytes does not match the number of bytes received. • Check the parameterisation and correct.	
12-9	-	**CAN: Protocol error**	Configurable
		Cause: Faulty bus protocol.	
		Measure: • Check the parameterisation of the selected CAN bus protocol.	

Fault group 13		**Timeout CAN-Bus**	
No.	Code	Message	Reaction
13-0	-	**CAN bus timeout**	Configurable
		Cause: Error message from manufacturer-specific protocol.	
		Measure: • Check the CAN parameterisation.	

Fault group 14		**Error identification**	
No.	Code	Message	Reaction
14-0	-	**Insufficient power supply for identification**	PS off
		Cause: Current regulator parameters cannot be determined (because of insufficient supply).	
		Measure: The available intermediate circuit voltage is too low to carry out the measurement.	
14-1	-	**Identification of current regulator: measurement cycle insufficient**	PS off
		Cause: Too few or too many measurement cycles required for the connected motor.	
		Measure: Automatic determination of parameters has supplied a time constant outside the parameterisable range of values. • The parameters must be optimised manually.	
14-2	-	**Output stage enable could not be granted**	PS off
		Cause: The output stage has not been enabled.	
		Measure: • Check the connection of DIN4.	

Fault group 14		**Error identification**		
No.	Code	Message		Reaction
14-3	-	**Output stage switched off prematurely**		PS off
		Cause	Output stage enable was switched off while identification was in progress.	
		Measure	• Check the sequence control.	
14-5	-	**Zero pulse could not be found**		PS off
		Cause	The zero pulse could not be found following execution of the maximum permissible number of electrical revolutions.	
		Measure	• Check the zero pulse signal. • Angle encoder parameterised correctly?	
14-6	-	**Hall signals invalid**		PS off
		Cause	Hall signals faulty or invalid. The pulse train and/or segmenting of the Hall signals is inappropriate.	
		Measure	• Check connection. • Refer to the technical data to check whether the encoder shows three Hall signals with 1205 or 605 segments; if necessary, contact Technical Support.	
14-7	-	**Identification not possible**		PS off
		Cause	Angle encoder at a standstill.	
		Measure	• Ensure sufficient intermediate circuit voltage. • Encoder cable connected to the right motor? • Motor blocked, e.g. holding brake does not release?	
14-8	-	**Invalid number of pairs of poles**		PS off
		Cause	The calculated number of pole pairs lies outside the parameterisable range.	
		Measure	• Compare result with the technical data specifications for the motor. • Check the parameterised number of lines.	

Fault group 15		**Invalid operation**	
No.	Code	Message	Reaction
15-0	6185h	**Division by 0**	PS off
		Cause: Internal firmware error. Division by 0 when using the math library.	
		Measure: • Load factory settings. • Check the firmware to make sure that approved firmware has been loaded.	
15-1	6186h	**Range exceeded**	PS off
		Cause: Internal firmware error. Overflow when using the math library.	
		Measure: • Load factory settings. • Check the firmware to make sure that approved firmware has been loaded.	
15-2	-	**Counter underrun**	PS off
		Cause: Internal firmware error. Internal correction factors could not be calculated.	
		Measure: • Check the setting of the factor group for extreme values and change, if necessary.	

Fault group 16		**Internal error**	
No.	Code	Message	Reaction
16-0	6181h	**Error in program execution**	PS off
		Cause: Internal firmware error. Error during program execution. Illegal CPU command found in the program sequence.	
		Measure: • In case of repetition, load firmware again. If the error occurs repeatedly, the hardware is defective.	
16-1	6182h	**Illegal interrupt**	PS off
		Cause: Error during program execution. An unused IRQ vector was used by the CPU.	
		Measure: • In case of repetition, load firmware again. If the error occurs repeatedly, the hardware is defective.	
16-2	6187h	**Initialisation error**	PS off
		Cause: Error in initializing the default parameters.	
		Measure: • In case of repetition, load firmware again. If the error occurs repeatedly, the hardware is defective.	
16-3	6183h	**Unexpected status**	PS off
		Cause: Error during periphery access within the CPU or error in the program sequence (illegal branching in case structures).	
		Measure: • In case of repetition, load firmware again. If the error occurs repeatedly, the hardware is defective.	

Fault group 17		**Contouring error exceeded**	
No.	Code	Message	Reaction
17-0	8611h	**Following error monitoring**	Configurable
		Cause: Comparison threshold for the limit value of the contouring error exceeded.	
		Measure: • Enlarge error window. • Parameterise acceleration so it is lower. • Motor overloaded (current limitation from I²t monitoring active?).	
17-1	8611h	**Encoder difference monitoring**	Configurable
		Cause: Deviation between the actual position value and commutation position is too great. External angle encoder not connected or faulty?	
		Measure: • Deviation fluctuates, e.g. due to gear backlash; cut-off threshold may need to be increased. • Check connection of the actual value encoder.	

Fault group 18		**Temperature warning threshold**	
No.	Code	Message	Reaction
18-0	-	**Analogue motor temperature**	Configurable
		Cause: Motor temperature (analogue) greater than 5° below T_max.	
		Measure: • Check parameterisation of current regulator and/or speed regulator. • Motor permanently overloaded?	

Fault group 21		**Error in current measurement**	
No.	Code	Message	Reaction
21-0	5280h	**Error 1 current measurement U**	PS off
		Cause: Offset for current measurement 1 phase U is too great. The controller carries out offset compensation of the current measurement every time its controller enable is issued. Tolerances that are too large result in an error.	
		Measure: If the error occurs repeatedly, the hardware is defective.	
21-1	5281h	**Error 1 current measurement V**	PS off
		Cause: Offset for current measurement 1 phase V is too great.	
		Measure: If the error occurs repeatedly, the hardware is defective.	
21-2	5282h	**Error 2 current measurement U**	PS off
		Cause: Offset for current measurement 2 phase U is too great.	
		Measure: If the error occurs repeatedly, the hardware is defective.	
21-3	5283h	**Error 2 current measurement V**	PS off
		Cause: Offset for current measurement 2 phase V is too great.	
		Measure: If the error occurs repeatedly, the hardware is defective.	

Fault group 25		**Device type/function error**	
No.	Code	Message	Reaction
25-0	6080h	**Invalid device type**	PS off
		Cause: Device coding not recognised or invalid.	
		Measure: This fault cannot be fixed by the user. • Send motor controller to the manufacturer.	
25-1	6081h	**Device type not supported**	PS off
		Cause: Device coding invalid, not supported by the loaded firmware.	
		Measure: • Load up-to-date firmware. • If newer firmware is not available, the problem may be a hardware defect. Send motor controller to the manufacturer.	
25-2	6082h	**Technology module: hardware revision not supported**	PS off
		Cause: The controller's hardware version is not supported by the loaded firmware.	
		Measure: • Check the firmware version; update the firmware to a more recent firmware design, if necessary.	
25-3	6083h	**Device function restricted!**	PS off
		Cause: Device is not enabled for this function.	
		Measure: Device is not enabled for the desired functionality and may need to be enabled by the manufacturer. The device must be sent to Festo for this purpose.	
25-4	-	**Invalid power stage type**	PS off
		Cause: – Power section in the EEPROM is unprogrammed. – Power section is not supported by the firmware.	
		Measure: • Load appropriate firmware.	

Fault group 26		**Internal data error**	
No.	Code	Message	Reaction
26-0	5580h	**Missing user parameter set**	PS off
		Cause: No valid user parameter set in the flash memory.	
		Measure: • Load factory settings. If the error remains, the hardware may be defective.	
26-1	5581h	**Checksum error**	PS off
		Cause: Checksum error of a parameter set.	
		Measure: • Load factory settings. If the error remains, the hardware may be defective.	
26-2	5582h	**Flash: Write error**	PS off
		Cause: Error when writing the internal flash memory.	
		Measure: • Execute the last operation again. If the error appears again, the hardware may be faulty.	

Fault group 26		**Internal data error**		
No.	Code	Message		Reaction
26-3	5583h	**Flash: error during deletion**		PS off
		Cause	Error during deletion of the internal flash memory.	
		Measure	• Execute the last operation again. If the error appears again, the hardware may be faulty.	
26-4	5584h	**Flash: Internal flash error**		PS off
		Cause	The default parameter set is corrupted / data error in the FLASH area where the default parameter set is located.	
		Measure	• Load firmware again. If the error appears again, the hardware may be faulty.	
26-5	5585h	**Missing calibration data**		PS off
		Cause	Factory-set calibration parameters incomplete / corrupted.	
		Measure	This fault cannot be fixed by the user.	
26-6	5586h	**Missing user position data sets**		PS off
		Cause	Position data records incomplete or corrupt.	
		Measure	• Load factory settings or • save the current parameters again so that the position data is written again.	
26-7	-	**Error in the data tables (CAM)**		PS off
		Cause	Data for the cam disc is corrupted.	
		Measure	• Load factory settings. • Reload the parameter set if necessary. If the error persists, contact Technical Support.	

Fault group 27		**Contouring error warning threshold**		
No.	Code	Message		Reaction
27-0	8611h	**Contouring error warning threshold**		Configurable
		Cause	– Motor overloaded? Check sizing. – Acceleration or braking ramps are set too steep. – Motor blocked? Commutation angle correct?	
		Measure	• Check the parameterisation of the motor data. • Check parameterisation of the following error.	

Fault group 28		**Operating hour counter error**		
No.	Code	Message		Reaction
28-0	FF01h	**Missing hours-run meter**		Configurable
		Cause	No record for an hours-run meter could be found in the parameter block. A new hours-run meter was created. Occurs during initial start-up or a processor change.	
		Measure	Warning only, no further action required.	
28-1	FF02h	**Hours-run meter: write error**		Configurable
		Cause	The data block in which the hours-run meter is stored could not be written to. Cause unknown; possibly problems with the hardware.	
		Measure	Warning only, no further action required. If the error occurs again, the hardware may be faulty.	
28-2	FF03h	**Hours-run meter corrected**		Configurable
		Cause	The hours-run meter has a backup copy. If the controller's 24 V power supply fails precisely when the hours-run meter is being updated, the written record may be corrupted. In such cases, the controller restores the hours-run meter from the intact backup copy when it restarts.	
		Measure	Warning only, no further action required.	
28-3	FF04h	**Hours-run meter converted**		Configurable
		Cause	Firmware was loaded in which the hours-run meter has a different data format. The next time the controller is switched on, the old hours-run meter record is converted to the new format.	
		Measure	Warning only, no further action required.	

Fault group 29		**MMC/SD card**		
No.	Code	Message		Reaction
29-0	-	**MMC/SD card not available**		Configurable
		Cause	This error is triggered in the following cases: – If an action should be carried out on the memory card (load or create DCO file, firmware download), but no memory card is plugged in. – The DIP switch S3 is set to ON but no card is plugged in after the reset/restart.	
		Measure	Insert appropriate memory card in the slot. Only if expressly desired!	

Fault group 29		**MMC/SD card**	
No.	Code	Message	Reaction
29-1	-	**MMC/SD card: initialisation error**	Configurable
		Cause	This error is triggered in the following cases: – The memory card could not be initialised. Card type may not be supported! – File system not supported. – Error in relationship with the shared memory.
		Measure	• Check card type used. • Connect memory card to a PC and format again.
29-2	-	**MMC/SD card: parameter set error**	Configurable
		Cause	This error is triggered in the following cases: – A load or storage process is already running, but a new load or storage process is requested. DCO file ›› Servo – The DCO file to be loaded has not been found. – The DCO file to be loaded is not appropriate for the device. – The DCO file to be loaded is defective. – Servo ›› DCO file – The memory card is read-only. – Other error while saving the parameter set as a DCO file. – Error in creating the file “INFO.TXT”.
		Measure	• Execute load or storage process again after waiting 5 seconds. • Connect memory card to a PC and check the files included. • Remove write protection from the memory card.
29-3	-	**MMC/SD card full**	Configurable
		Cause	– This error is triggered while saving the DCO or “INFO.TXT” file if the memory card is discovered to be already full. – The maximum file index (99) already exists. That is, all file indexes are assigned. No filename can be issued!
		Measure	• Insert another memory card. • Change filenames.
29-4	-	**MMC/SD card: firmware download**	Configurable
		Cause	This error is triggered in the following cases: – No firmware file on the memory card. – The firmware file is not appropriate for the device. – Other error during firmware download, e.g. checksum error with an SRecord, error with flash memory, etc.
		Measure	• Connect memory card to PC and transfer firmware file.

Fault group 30		**Internal mathematical error**		
No.	Code	Message		Reaction
30-0	6380h	**Internal mathematical error**		PS off
		Cause	Range exceeded for internal scaling factors, which are dependent on the parameterised controller cycle times.	
		Measure	• Check whether extremely short or extremely long cycle times were set in the parameters.	

Fault group 31		**I2t- error**		
No.	Code	Message		Reaction
31-0	2312h	**Motor I²t**		Configurable
		Cause	I²t monitoring of the motor has been triggered. – Motor/mechanics blocked or sluggish. – Motor under-sized?	
		Measure	• Check power dimensioning of drive package.	
31-1	2311h	**I²t-error controller**		Configurable
		Cause	The I²t monitoring responds frequently. – Motor controller under-sized? – Mechanics sluggish?	
		Measure	• Check project engineering of the motor controller, • Possibly use a more powerful type. • Check mechanics.	
31-2	2313h	**PFC I²t**		Configurable
		Cause	PFC power rating exceeded.	
		Measure	• Parameterise operation without PFC (FCT).	
31-3	2314h	**Braking resistor I²t**		Configurable
		Cause	– Overloading of the internal braking resistor.	
		Measure	• Use external braking resistor. • Reduce resistance value or use resistor with higher pulse load.	

Fault group 32		**Intermediate circuit error**		
No.	Code	Message		Reaction
32-0	3280h	**Intermediate circuit charging time exceeded**		Configurable
		Cause	The intermediate circuit could not be charged after the mains voltage was applied. – Fuse possibly defective or – Internal braking resistor defective or – In operation with external resistor, the resistor is not connected.	
		Measure	• Check interface to the external braking resistor. • Alternatively, check whether the jumper for the internal braking resistor is set. If the interface is correct, the internal braking resistor or the built-in fuse is probably faulty. On-site repair is not possible.	
32-1	3281h	**Undervoltage for active PFC**		Configurable
		Cause	The PFC cannot be activated at all until an intermediate circuit voltage of approx. 130 V DC is reached.	
		Measure	• Check power supply.	
32-5	3282h	**Brake chopper overload. Intermediate circuit could not be discharged.**		Configurable
		Cause	The extent of utilisation of the brake chopper when quick discharge began was already in the range above 100 %. Quick discharge took the brake chopper to the maximum load limit and was prevented/aborted.	
		Measure	No action required.	
32-6	3283h	**Intermediate circuit discharge time exceeded**		Configurable
		Cause	Intermediate circuit could not be quickly discharged. The internal braking resistor may be faulty or, in the case of operation with an external resistor, that resistor is not connected.	
		Measure	• Check interface to the external braking resistor. • Alternatively, check whether the jumper for the internal braking resistor is set. If the internal resistor has been activated and the jumper has been positioned correctly, the internal braking resistor is probably faulty.	
32-7	3284h	**Power supply missing for controller enable**		Configurable
		Cause	Controller enable was issued when the intermediate circuit was still in its charging phase after mains voltage was applied and the mains relay was not yet activated. The drive cannot be enabled in this phase, because the drive is not yet firmly connected to the mains (mains relay).	
		Measure	• In the application, check whether the mains supply and controller enable signals were sent quickly one after the other.	

Fault group 32		**Intermediate circuit error**		
No.	Code	Message		Reaction
32-8	3285h	**Power supply failure during controller enable**		QStop
		Cause	Interruptions / failure in the power supply while the controller enable was activated.	
		Measure	• Check power supply.	
32-9	3286h	**Phase failure**		QStop
		Cause	Failure of one or more phases (only in the case of three-phase supply).	
		Measure	• Check power supply.	

Fault group 33		**Encoder emulation following error**		
No.	Code	Message		Reaction
33-0	8A87h	**Encoder emulation following error**		Configurable
		Cause	The critical frequency for encoder emulation was exceeded (see manual) and the emulated angle at [X11] was no longer able to follow. Can occur if very high numbers of lines are programmed for [X11] and the drive reaches high speeds.	
		Measure	• Check whether the parameterised number of lines may be too high for the speed being represented. • Reduce the number of lines if necessary.	

Fault group 34		**Synchronisation fieldbus error**		
No.	Code	Message		Reaction
34-0	8780h	**No synchronisation via fieldbus**		Configurable
		Cause	When activating the interpolated position mode, the controller could not be synchronised to the fieldbus. – The synchronisation messages from the master may have failed or – The IPO interval is not correctly set to the synchronisation interval of the fieldbus.	
		Measure	• Check the settings for the controller cycle times.	
34-1	8781h	**Fieldbus synchronisation error**		Configurable
		Cause	– Synchronisation via fieldbus messages during ongoing operation (interpolated position mode) has failed. – Synchronisation messages from master failed? – Synchronisation interval (IPO interval) set too small/too large?	
		Measure	• Check the settings for the controller cycle times.	

Fault group 35		**Linear motor**		
No.	Code	Message		Reaction
35-0	8480h	**Linear motor spinning protection**		Configurable
		Cause	Encoder signals are corrupt. The motor may be racing (“spinning”) because the commutation position has been shifted by the faulty encoder signals.	
		Measure	• Check to ensure the installation conforms to EMC recommendations. • In the case of linear motors with inductive/optical encoders with separately mounted measuring tape and measuring head, check the mechanical clearance. • In the case of linear motors with inductive encoders, make sure that the magnetic field of the magnets or the motor winding does not leak into the measuring head (this effect usually occurs when high accelerations = high motor current).	
35-5	-	**Error during the determination of the commutation position**		Configurable
		Cause	The rotor position could not be identified clearly. – The selected method may be inappropriate. – The selected motor current for identification may not be set appropriately.	
		Measure	• Check the method for determining the commutation position ➔ Additional information.	
		Additional information	Notes on determining the commutation position: a) The alignment method is inappropriate for locked or sluggish drives or drives capable of low-frequency oscillation. b) The microstep method is appropriate for air-core and iron-core motors. As only very small movements are carried out, it works even when the drive is on elastic stops or is locked but can still be moved elastically to some extent. Due to the high excitation frequency, however, the method is very susceptible to oscillations in the case of poorly damped drives. In such cases, you can attempt to reduce the excitation current (%). c) The saturation method uses local occurrences of saturation in the iron of the motor. Recommended for locked drives. Air-core drives are by definition not suitable for this method. If the (iron-core) drive moves too much when locating the commutation position, the measurement result may be adulterated. If this is the case, reduce the excitation current. In the opposite case, if the drive does not move, the excitation current may not be strong enough, causing the saturation to be insufficient.	

Fault group 36		**Parameter error**	
No.	Code	Message	Reaction
36-0	6320h	**Parameter was limited**	Configurable
		Cause: An attempt was made to write a value which was outside the permissible limits, so the value was limited.	
		Measure: • Check the user parameter set.	
36-1	6320h	**Parameter was not accepted**	Configurable
		Cause: An attempt was made to write to an object which is “read only” or is not write-capable in the current status (e.g. with controller enable active).	
		Measure: • Check the user parameter set.	

Fault group 40		**Software limit switch**	
No.	Code	Message	Reaction
40-0	8612h	**Negative software limit switch**	Configurable
		Cause: The position setpoint has reached or exceeded the negative software limit switch.	
		Measure: • Check target data. • Check positioning area.	
40-1	8612h	**Positive software limit switch**	Configurable
		Cause: The position setpoint has reached or exceeded the positive software limit switch.	
		Measure: • Check target data. • Check positioning area.	
40-2	8612h	**Target position behind the negative software limit switch**	Configurable
		Cause: Start of a positioning task was suppressed because the target lies behind the negative software limit switch.	
		Measure: • Check target data. • Check positioning area.	
40-3	8612h	**Target position behind the positive software limit switch**	Configurable
		Cause: The start of a positioning task was suppressed because the target lies behind the positive software limit switch.	
		Measure: • Check target data. • Check positioning area.	

Fault group 41		**Position set forwarding: synchronisation error**	
No.	Code	Message	Reaction
41-0	-	**Position set forwarding: synchronisation error**	Configurable
		Cause: Start of synchronisation without prior sampling pulse.	
		Measure: • Check parameterisation of the lead section.	

Fault group 42		**Positioning error**		
No.	Code	Message		Reaction
42-0	8680h	**Positioning: no follow-up positioning: stop**		Configurable
		Cause	The positioning target cannot be reached through the positioning or parameters options.	
		Measure	• Check parameterisation of the relevant position records.	
42-1	8681h	**Positioning: reversing direction of rotation not allowed: stop**		Configurable
		Cause	The positioning target cannot be reached through the positioning or parameters options.	
		Measure	• Check parameterisation of the relevant position records.	
42-2	8682h	**Positioning: reversing after halt not allowed**		Configurable
		Cause	The positioning target cannot be reached through the positioning or parameters options.	
		Measure	• Check parameterisation of the relevant position records.	
42-3	-	**Start positioning rejected: wrong operating mode**		Configurable
		Cause	Switching of the operating mode by means of the position record was not possible.	
		Measure	• Check parameterisation of the relevant position records.	
42-4	-	**Start positioning rejected: homing required**		Configurable
		Cause	A normal positioning record was started, but the drive needs a valid reference position before starting.	
		Measure	• Execute new homing run.	
42-5	-	**Modulo positioning: direction of rotation not allowed**		Configurable
		Cause	– The positioning target cannot be reached through the positioning or parameters options. – The calculated direction of rotation is not permitted for the modulo positioning in the set mode.	
		Measure	• Check the selected mode.	
42-9	-	**Error when starting the positioning task**		Configurable
		Cause	– Acceleration limit value exceeded. – Position record blocked.	
		Measure	• Check parameterisation and sequence control, correct if necessary.	

Fault group 43		**Hardware limit switch error**	
No.	Code	Message	Reaction
43-0	8081h	**Limit switch: negative setpoint value blocked**	Configurable
		Cause: Negative hardware limit switch reached.	
		Measure: • Check parameterisation, wiring and limit switches.	
43-1	8082h	**Limit switch: positive setpoint value blocked**	Configurable
		Cause: Positive hardware limit switch reached.	
		Measure: • Check parameterisation, wiring and limit switches.	
43-2	8083h	**Limit switch: positioning suppressed**	Configurable
		Cause: – The drive has left the intended range of motion. – Technical defect in the system?	
		Measure: • Check the intended range of motion.	

Fault group 44		**Cam disc error**	
No.	Code	Message	Reaction
44-0	-	**Fault in the cam disc tables**	Configurable
		Cause: Cam disc to be started not available.	
		Measure: • Check transferred cam disc no. • Correct parameterisation. • Correct programming.	
44-1	-	**Cam disc: general homing error**	Configurable
		Cause: – Start of a cam disc, but the drive is not yet referenced.	
		Measure: • Execute a homing run.	
		Cause: – Start of homing with active cam disc.	
		Measure: • Deactivate cam disc. Then restart cam disc, if necessary.	

Fault group 47		**Setting-up timeout**	
No.	Code	Message	Reaction
47-0	-	**Error in setting-up: timeout expired**	Configurable
		Cause: The speed required for setting-up was not fallen below on time.	
		Measure: Check processing of the request on the control side.	

Fault group 48		**Homing required**	
No.	Code	Message	Reaction
48-0	-	**Homing required**	QStop
		Cause: An attempt is being made to switch to the speed control or torque control operating mode or to issue the controller enable in these operating modes, although the drive requires a valid reference position for this.	
		Measure: • Execute a homing run.	

Fault group 50		**CAN error**	
No.	Code	Message	Reaction
50-0	-	**Too many synchronous PDOs**	Configurable
		Cause	More PDOs have been activated than can be processed in the underlying SYNC interval. This message also appears if only one PDO is to be transmitted synchronously, but a high number of other PDOs with a different transmission type have been activated.
		Measure	• Check the activation of PDOs. If the configuration is appropriate, the warning can be suppressed using error management. • Extend the synchronisation interval.
50-1	-	**SDO errors have occurred**	Configurable
		Cause	An SDO transfer has caused an SDO abort. – The data exceeds the range of values. – Access to non-existent object.
		Measure	• Check the command sent.

Fault group 51		**Safety function error**	
No.	Code	Message	Reaction
51-0	-	**Safety function: driver function defective (error cannot be acknowledged)**	PS off
		Cause	Internal voltage error of the STO circuit.
		Measure	• Protection circuit defective. No action possible, please contact Festo. If possible, replace with another motor controller.

Fault group 52		**Safety function error**	
No.	Code	Message	Reaction
52-1	-	**Safety function: Discrepancy time has elapsed**	PS off
		Cause	– Control ports STO-A and STO-B are not actuated simultaneously.
		Measure	• Check discrepancy time.
		Cause	– Control ports STO-A and STO-B are not wired in the same way.
		Measure	• Check discrepancy time.
52-2	-	**Safety function: Failure of driver supply with active PWM control**	PS off
		Cause	This error message does not occur with equipment delivered from the factory. It can occur through the use of user-specific device firmware.
		Measure	• The safe status was requested with approved power output stage. Check inclusion in the safety-oriented interface.

Fault group 70		**FHPP protocol error**		
No.	Code	Message		Reaction
70-1	-	**FHPP: mathematical error**		Configurable
		Cause	Overrun/underrun or division by zero during calculation of cyclic data.	
		Measure	• Check the cyclic data. • Check the factor group.	
70-2	-	**FHPP: factor group invalid**		Configurable
		Cause	Calculation of the factor group leads to invalid values.	
		Measure	• Check the factor group.	
70-3	-	**FHPP: invalid operating mode change**		Configurable
		Cause	Changing from the current to the desired operating mode is not permitted. – The error occurs if the OPM bits in the S5 status “Reaction to fault” or S4 status “Operation enabled” are changed. – Exception: a change between “Record select” and “Direct Mode” is permissible in the SA1 status “Ready”.	
		Measure	• Check your application. It may be that not every change is permissible.	

Fault group 71		**FHPP protocol error**		
No.	Code	Message		Reaction
71-1	-	**FHPP: invalid receive telegram**		Configurable
		Cause	Too little data is being transmitted by the control system (data length too short).	
		Measure	• Check the data length parameterised in the control system for the controller’s received telegram. • Check the configured data length in the FHPP+ Editor of the FCT.	
71-2	-	**FHPP: invalid response telegram**		Configurable
		Cause	Too much data is set to be transmitted from the motor controller to the control system (data length too great).	
		Measure	• Check the data length parameterised in the control system for the controller’s received telegram. • Check the configured data length in the FHPP+ Editor of the FCT.	

Fault group 80		**IRQ overflow**	
No.	Code	Message	Reaction
80-0	F080h	**Current regulator IRQ overflow**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	
80-1	F081h	**Speed regulator IRQ overflow**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	
80-2	F082h	**Overflow position controller IRQ**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	
80-3	F083h	**Interpolator IRQ overflow**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	

Fault group 81		**IRQ overflow**	
No.	Code	Message	Reaction
81-4	F084h	**Low-Level IRQ overflow**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	
81-5	F085h	**MDC IRQ overflow**	PS off
		Cause: The process data could not be calculated in the set current/velocity/position interpolator cycle.	
		Measure: • Please contact Technical Support.	

Fault group 82		**Sequence control**	
No.	Code	Message	Reaction
82-0	-	**Sequence control**	Configurable
		Cause: IRQ4 overflow (10 ms low-level IRQ).	
		Measure: • Internal process control: process was interrupted. • For information only - no action required.	
82-1	-	**Multiple-started CO write access**	Configurable
		Cause: Parameters in cyclical and acyclic operation are used concurrently.	
		Measure: • Only one parameterisation interface can be used (USB or Ethernet).	

Fault group 84		**Conditions for controller enable not fulfilled**		
No.	Code	Message		Reaction
84-0	-	**Conditions for controller enable not fulfilled**		Warn
		Cause	One or more conditions for controller enable are not fulfilled. These include: – DIN4 (output stage enable) is off. – DIN5 (controller enable) is off. – Intermediate circuit not yet loaded. – Encoder is not yet ready for operation. – Angle encoder identification is still active. – Automatic current regulator identification is still active. – Encoder data is invalid. – Status change of the safety function not yet completed. – Firmware or DCO download via Ethernet (TFTP) active. – DCO download onto memory card still active. – Firmware download via Ethernet active.	
		Measure	• Check status of digital inputs. • Check encoder cables. • Wait for automatic identification. • Wait for completion of the firmware or DCO download.	

Fault group 90		**Internal error**		
No.	Code	Message		Reaction
90-0	5080h	**Missing hardware components (SRAM)**		PS off
		Cause	External SRAM not detected / not sufficient. Hardware error (SRAM component or board is defective).	
		Measure	• Please contact Technical Support.	
90-2	5080h	**Error at FPGA boot-up**		PS off
		Cause	The FPGA (hardware) cannot be booted. The FPGA is booted serially when the device is started, but in this case it could not be loaded with data or it reported a checksum error.	
		Measure	• Switch on the device again (24 V). If the error appears again, the hardware is faulty.	
90-3	5080h	**Error at SD-ADU start**		PS off
		Cause	SD-ADUs cannot be started (hardware). One or more SD-ADUs are not supplying any serial data.	
		Measure	• Switch on the device again (24 V). If the error appears again, the hardware is faulty.	

Fault group 90		**Internal error**		
No.	Code	Message		Reaction
90-4	5080h	**SD-ADU synchronisation error after start**		PS off
		Cause	SD-ADU (hardware) not synchronous after starting. During operation, the SD-ADUs for the resolver signals continue running with strict synchronisation once they have been initially started synchronously. The SD-ADUs could not be started at the same time during that initial start phase.	
		Measure	• Switch on the device again (24 V). If the error appears again, the hardware is faulty.	
90-5	5080h	**SD-ADU not synchronous**		PS off
		Cause	SD-ADU (hardware) not synchronous after starting. During operation, the SD-ADUs for the resolver signals continue running with strict synchronisation once they have been initially started synchronously. This is checked continually during operation and an error may be triggered.	
		Measure	• Possibly massive EMC coupling. • Switch on the device again (24 V). If the error appears again, the hardware is faulty.	
90-6	5080h	**IRQ0 (current regulator): trigger error**		PS off
		Cause	The output stage is not triggering the software IRQ, which then operates the current regulator. Very likely to be a hardware error on the board or in the processor.	
		Measure	• Switch on the device again (24 V). If the error appears again, the hardware is faulty.	
90-9	5080h	**DEBUG firmware loaded**		PS off
		Cause	A development version compiled for the debugger was loaded as normal.	
		Measure	• Check the firmware version; update the firmware if necessary.	

Fault group 91		**Initialisation error**		
No.	Code	Message		Reaction
91-0	6000h	**Internal initialisation error**		PS off
		Cause	Internal SRAM too small for the compiled firmware. Can only occur with development versions.	
		Measure	• Check the firmware version; update the firmware if necessary.	
91-1	-	**Memory error when copying**		PS off
		Cause	Firmware parts were not copied correctly from the external FLASH into the internal RAM.	
		Measure	• Switch on the device again (24 V). If the error occurs repeatedly, check the firmware version and update the firmware if necessary.	

Fault group 91		**Initialisation error**		
No.	Code	Message		Reaction
91-2	-	**Error when reading the controller/power section coding**		PS off
		Cause	The ID-EEPROM in the controller or power section could either not be addressed at all or does not have consistent data.	
		Measure	• Switch on the device again (24 V). If the error occurs repeatedly, the hardware is faulty. No repair possible.	
91-3	-	**Software initialisation error**		PS off
		Cause	One of the following components is missing or could not be initialised: a) Shared memory not available or defective. b) Driver library not available or defective.	
		Measure	• Check firmware design; update if necessary.	

Instructions regarding actions for error messages 08-2 ... 08-7	
Measure	Notes
• Check whether encoder signals are faulty.	– Check the wiring, e.g. are one or more phases of the track signals interrupted or short-circuited? – Check to ensure the installation complies with EMC recommendations (cable screening on both sides?). – Only with incremental encoders: With TTL single-ended signals (HALL signals are always TTL single-ended signals): Check whether there might be an excessive voltage drop on the GND line; in this case = signal reference. Check whether there might be an excessive voltage drop on the GND line; in this case = signal reference. – Check the level of supply voltage on the encoder. Sufficient? If not, change the cable diameter (connect unused lines in parallel) or use voltage feedback (SENSE+ and SENSE-).
• Test with other encoders.	– If the error still occurs when the configuration is correct, test with a different (error-free) encoder (replace the connecting cable as well). If the error still occurs, there is a fault in the motor controller. Repair by the manufacturer is necessary.

Tab. A.2 Instructions regarding error messages 08-2 ... 08-7

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