Motor controllers

FESTO

Description

Assembly and
installation
Type
CMMS-ST-.-G2

Description
573 125
en 1008NH
[754 125]

Edition _____en 1008

Name _____P.BE-CMMS-ST-G2-HW-EN

Order no. _____573 125

Internet: http://www.festo.com
E-mail: service_international@festo.com

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1. General data

1.1 Documentation

This product manual is meant to promote safe work with the CMMS-ST-series stepping motor controller. It contains safety instructions which must be followed.

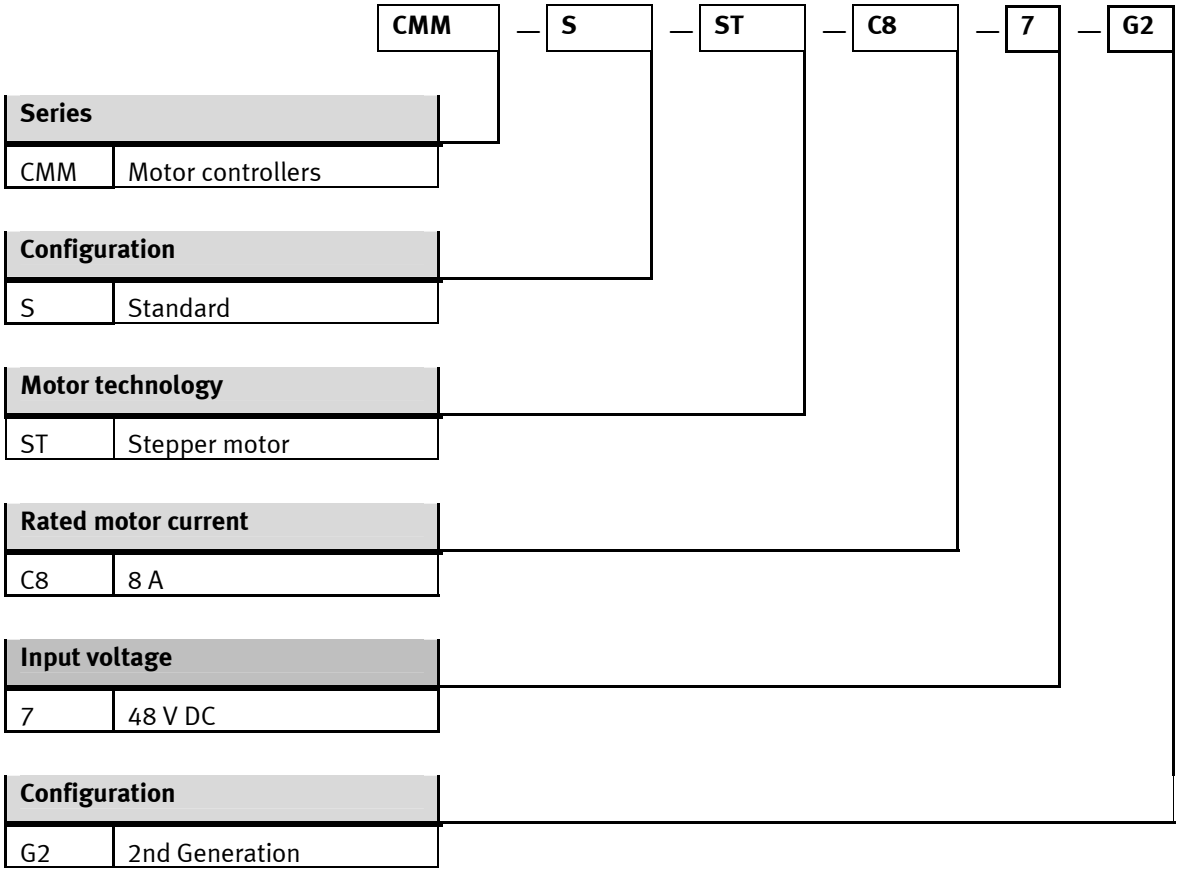
This document provides information on:

- mechanical fitting
- electrical installation and an
- overview of the range of functions.

See the following manuals on the CMMx product family for further information:

- CANopen manual “P.BE-CMMS-CO-...”: Description of the implemented CANopen protocol as per CiA DSP 402
- PROFIBUS manual “ P.BE-CMMS-FHPP-PB-...”: Description of the implemented PROFIBUS-DP protocol.
- DeviceNet manual “P.BE-CMMS-FHPP-DN-...”: Description of the implemented DeviceNet protocol.
- FHPP manual “P.BE-CMM-FHPP-...”: Description of the implemented Festo profiles for handling and positioning.

1.2 Type key CMMS-ST-C8-7-G2



1.3 Scope of delivery

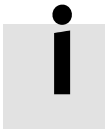
The delivery includes:

Number	Delivery
1	CMMS-ST-C8-7-G2 stepping motor controller
1	CD (configuration software, documentation, S7 module, GSD, EDS, firmware)
1	Brief description
1	NEKM-C-1 plug assortment

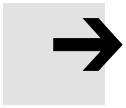
Table 1.1 Scope of delivery

2. Safety instructions for electric drives and controllers

2.1 Icons used



Information



Note

Important information and remarks.

Caution

Failure to comply can result in severe material damage.

Warning

Failure to comply can result in material damage and personal injury.

Warning

DANGER!

Considerable material damage and personal injury can occur if these instructions are not observed.

Warning

Dangerous voltage!

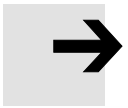
The safety instructions contain reference to dangerous voltages which may occur.

Accessories

Environment

2.2 General Information

Festo AG & Co.KG is not liable for damage caused by failure to observe the warning instructions in these operating instructions.

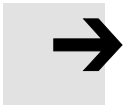


Note

Before commissioning, the Safety instructions for electric drives and controllers must be read from page 12 and the chapter 6.5 Instructions on safe and EMC-compliant installation page 114.

If the documentation in the language in question cannot be understood fully, please contact your vendor and inform them.

In order for the stepping motor controller to operate without problems and safely, it must be transported, stored, mounted, planned properly and correctly, taking the risks and protection and emergency measures into account, as well as operated and maintained with due care.



Note

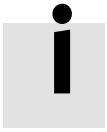
Only trained and qualified personnel should be allowed to handle the electric systems.

Trained and qualified personnel

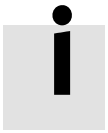
For the purpose of this manual and the warning instructions on the product itself, technicians working with this product must be adequately familiar with the setting up, mounting, commissioning and operation of the product as well as with all warnings and precautionary measures in accordance with the operating instructions in this product manual, and must be sufficiently qualified for this task:

- Training and instructions on or authorization to switch on and switch off devices/systems in accordance with technical safety standards, and to earth and mark them appropriately in accordance with the application requirements.
- Training or instructions in using and maintaining suitable safety equipment in accordance with technical safety standards.
- Training in first aid.

The following instructions must be read before the system is commissioned for the first time to prevent injury and/or material damage:

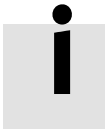


These safety instructions must be observed at all times.



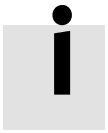
- Do not attempt to install or commission the stepping motor controller until you have read all safety instructions related to electrical drives and control systems in this document.

These safety instructions and all other user instructions must be read before performing any work with the stepping motor controller.

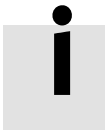


If you do not have user instructions for the stepping motor controller, contact your local sales representative.

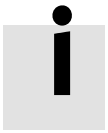
- Ask them to send the documents to the person responsible for safe operation of the stepping motor controller immediately.



If the stepping motor controller is sold, rented and/or passed on in any other way, these safety instructions must also be passed on with it.



The operator may not open the stepping motor controller for safety and warranty reasons.



Correct planning is required for the stepping motor controller to function properly.

Warning

DANGER!

Incorrect use of the stepping motor controller, failure to follow the warnings in this manual and improper manipulation of safety equipment can cause material damage, injury, electric shock, and in extreme cases, even be fatal.

2.3 Hazards due to improper use

Warning

DANGER!

High electric voltage and high operating current!

Danger of death or serious bodily injury due to electric shock!

Warning

DANGER!

High electric voltage due to incorrect connection!

Danger of death or bodily injury due to electric shock!

Warning

DANGER!

Surfaces of the device housing may be hot!

Danger of injury! Danger of burning!

Warning

DANGER!

Hazardous motion

Danger of death, serious bodily injury or damage to property due to unintentional movement of the motors!

2.4 Safety instructions

2.4.1 General safety instructions

Warning

The stepping motor controller conforms to protection class IP20 and contamination class 1.

- Ensure that the working environment also complies with this protection/contamination class.

Warning

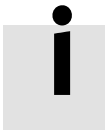
- Use only accessories and spare parts which are approved by the manufacturer.

Warning

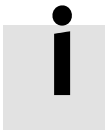
- In accordance with the EN standards and the VDE regulations, the stepping motor controllers must be connected to the grid in such a way that they can be disconnected using appropriate isolating equipment (e.g. main switch, contactor, circuit breaker).

Warning

Gold contacts or contacts with high contact pressure should be used to connect the control contacts.



Precautionary measures must be taken to prevent interference to switching systems, e.g. Connecting protective switches and relays with RC elements or diodes.

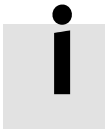


You must observe the safety regulations and directives of the country in which the device is to be used.

Warning

- The environmental conditions specified in the product documentation must be observed.

Safety-critical applications are not permitted if unless explicitly approved by the manufacturer.



- See Chapter 6.5 Instructions on safe and EMC-compliant installation (Page 114) for the instructions for EMC-compliant installation.

The manufacturer of the system or machine is responsible for ensuring that the limit values required by the national regulations are observed.

Warning

See this product manual for the specifications, connection and installation conditions for the stepping motor controller and absolutely must be observed.

Warning

DANGER!

- The general installation and safety regulations for working on high-current systems (e.g. DIN, VDE, EN, IEC or other national and international regulations) must be observed.

Failure to observe these regulations can lead to bodily injury, death or considerable damage to property.

The following precautionary measures also apply without claim to completeness:

VDE 0100	Regulations for setting up high-voltage systems up to 1,000 volts
EN 60204	Electrical equipment for machines
EN 50178	Equipping high-voltage systems with electronic devices
EN ISO 12100	Safety of machines – basic concepts, general guidelines
EN 1050	Safety of machines – guidelines for risk evaluation
EN 1037	Safety of machines – avoiding unintentional starting up
EN ISO 13849-1	Safety-relevant parts of controllers
EN 61800-5-2	Variable-speed electric drives - functional safety requirements

2.4.2 Safety instructions for assembly and maintenance

For assembling and maintaining the system, the relevant DIN, VDE, EN and IEC regulations , as well as all national and local safety and accident prevention regulations must always be observed. The system manufacturer or the user is responsible for ensuring that the following regulations are observed:

Warning

The stepping motor controller may only be operated, maintained and/or serviced by persons qualified and trained to work on or with electrical devices.

Avoiding accidents, bodily injury and/or material damage:

Warning

The motor holding brake supplied as standard or an external motor-holding brake controlled by the drive controller alone are not suitable for protecting human beings.

- Vertical axes must be additionally secured against falling or sliding down when the motor is switched off with, for example,
  - mechanical locking of the vertical axis,
  - external braking, safety catch or clamping devices or
  - sufficient weight compensation of the axis.

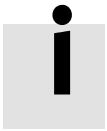
Warning

During operation and up to several minutes after the stepping motor controller is deactivated, the internal brake resistance can cause dangerous intermediate circuit voltage. If touched, this can lead to fatal or serious injuries.

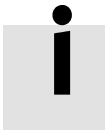
- Before carrying out maintenance work, make sure that the power supply is switched off and locked and that the intermediate circuit is discharged.
- Switch the electrical equipment free of voltage via the main switch and make sure that it cannot be switched on again. Wait until the intermediate circuit is discharged after
  - maintenance work and repairs
  - cleaning
  - long periods out of use

Warning

Proceed carefully when mounting. Ensure that no drilling chips, metal dust or mounting material (screws, nuts, wire cuttings) fall into the stepping motor controller during mounting work and subsequent operation.



Ensure that the external power supply of the controller (24 V) is switched off.



The intermediate circuit or the load voltage must always be switched off before the 24 V control voltage is switched off.

Warning

- Other work in the vicinity of the machine must only be carried out when the AC or DC supply is switched off and locked.

Deactivated output stages or deactivated controller enable are not suitable locking conditions. In the event of a fault, this could lead to unintentional movement of the drive.

Warning

Commission the device with a free-running motor, in order to avoid mechanical damage, e.g. due to incorrect direction of rotation.

Warning

Electronic devices are never fail-proof.

The user is responsible for ensuring that his system is brought into a safe status if the electric device fails.

Warning

DANGER!

The stepping motor controller and, in particular, the braking resistor can become very hot, and can cause serious burns if touched.

2.4.3 Protection against touching electric components

This section concerns only devices and drive components with voltages over 60 V. It is dangerous to touch components with voltages of more than 60 V, as this can cause an electric shock. When electric devices are operated, certain components in these devices are always under dangerous tension.

Warning

Dangerous voltage!

High voltage!

Danger of death or serious bodily injury due to electric shock!

For operation the relevant DIN, VDE, EN und IEC regulations, as well as all national and local safety and accident prevention regulations must always be observed. The system manufacturer or the user is responsible for ensuring that the following regulations are observed:

Warning

- Before switching the device on, fit the covers and protective screens so that the device cannot be touched.

For built-in devices, make sure that there is an external housing, such as a control cabinet, to ensure that the electric components cannot be touched.

Regulations BGVA3 must be observed.

Warning

Ensure that the minimum copper cross section is observed for the entire length of the protective earth conductor in accordance with standard EN 60617.

Warning

- Before commissioning, also for brief measuring and test purposes, always connect the protective conductor to all electric devices or connect to an earth cable in accordance with the connection diagram.

Otherwise, high voltages may occur on the housing. These could cause an electric shock.

Warning

Do not touch the electrical connection points of the components when the device is switched on.

Warning

- Before touching electric components with voltages over 60 V, disconnect the device from the mains or voltage source.
- Protect the device against being switched on again.

Warning

- During installation, note the amount of intermediate circuit voltage, especially with regard to insulation and protective measures.

Make sure that the earthing, the cross section size of the conductor and the corresponding short-circuit protection are correct.

2.4.4 Protection by low voltage (PELV) against electric shock

All connections and terminals with voltages from 5 to 60 volts on the stepping motor controller are PELVs which are designed to be safe to touch in accordance with the following standards:

Standards
- International: IEC 60364-4-41
- European countries in the EU: EN 50178/1998, section 5.2.8.1.

Warning

DANGER!

High electric voltage due to incorrect connection!

Danger of bodily injury or death due to electric shock

Devices, electrical components and cables may only be connected to connections and terminals from 0 to 60 V, providing they have protective low voltage (PELV = Protective Extra Low Voltage).

Connect only voltages and current circuits which have reliable separation of dangerous voltages. Such separation is achieved e.g. with isolating transformers, reliable optocouplers or battery operation separate from the mains network.

2.4.5 Protection against dangerous movements

Dangerous movements can be caused by incorrect control of connected motors. There are various causes:

Causes

- Unsafe or faulty circuitry or cabling
- Faults in operating the components
- Faults in the measured value and signal generators
- Faults or non-EMC-compliant components
- Faults in the software in the higher-order control system
- Removal of end-stage enable

These faults can occur immediately after the device is switched on or after an indeterminate period of operation.

The monitoring functions in the drive components exclude to a large extent the possibility of incorrect operation of the connected drives. With regard to the protection of human beings, especially the danger of bodily injury and/or material damage, one must not rely on this fact alone. Until the fitted monitoring functions become effective, you must reckon with at least one incorrect drive movement, the extent of which depends on the type of control and on the operating state.

Warning

DANGER!

Hazardous motion

Danger of injury or death, serious bodily injury or material damage.

For the above-mentioned reasons, the protection of human beings must be ensured with the aid of monitoring systems or by measures which are of higher order than the system. These measures are incorporated depending on the specific findings of a danger and fault analysis by the system manufacturer. The safety regulations applicable to the system must be observed here as well. Undesired movements of the machine or other incorrect functions can occur as a result of switching off, avoiding or failing to activate safety devices.

2.4.6 Protection against touching hot components

Warning

DANGER!

Surfaces of the device housing may be hot!

Danger of injury! Danger of burning!

Warning

Danger of burning!

- Do not touch the surface of the housing in the vicinity of heat sources.
- After switching devices off, leave them for 10 minutes to cool down before touching them.

If you touch hot parts of the device such as the housing, which contains the heat sink and resistors, you may burn yourself.

2.4.7 Protection when handling and assembling

Handling and assembling certain components in an unsuitable manner can cause injuries under unfavourable circumstances.

Warning

DANGER!

Danger of injury as a result of incorrect handling!

Bodily injury caused by squeezing, shearing, cutting, impact!

The following safety measures apply here:

Warning

- Observe the general regulations on setting up and safety when handling and mounting.
- Use suitable mounting and transport devices.
- Take suitable measures to prevent clamping and crushing.
- Use only suitable tools. If specified, use special tools.
- Use lifting devices and tools in a correct manner.
- If necessary, use suitable protective equipment (e.g. protective glasses, safety shoes, safety gloves).
- Do not stand under hanging loads.
- Wipe up spilt liquids on the floor to avoid slipping.

3. Product description

3.1 General data

The CMMS-ST stepping motor controller is a fully digital positioning controller for activating two-phase hybrid stepping motors.

The CMMS-ST is intended for activating hybrid stepping motors with a maximum current of up to 8 A, in particular the MTR-STand EMMS-STseries by Festo.
The MTR-ST and EMMS-ST series motors without encoders are controlled in an open control circuit (open loop).

The EMMS-ST series motors with encoders are operated in a closed control circuit (closed loop).

The device can be operated via digital and analogue control signals and networked via the integrated CAN bus. Other fieldbus systems can also be implemented via the technology module slot.

The parameterisation tool FCT (Festo Configuration Tool) makes possible simple operation and start-up of the servo positioning controller. Graphic depictions and pictograms make intuitive parameterisation possible.

3.2 Performance characteristics

Compactness

- Small dimensions
- Complete integration of all components for controller und power section, including
- RS232/485 and CANopen interface
- Integrated brake chopper
- Integrated EMC filters
- Automatic actuation for a holding brake integrated in the motor
- Conformance to the current CE and EN standards without additional external measures (motor cable length up to 25m)

Input/output

- Freely programmable I/Os
- High-resolution 12-bit analogue input
- Jog/Teach mode
- Simple coupling to a higher-level controller via I/O
- Synchronous operation
- Master/slave mode

Extension and field bus module

- PROFIBUS-DP (P.BE-CMMS-FHPP-PB-...)
- DeviceNet (P.BE-CMMS-FHPP-DN-...)

Integrated CANopen interface

- Open interface in accordance with CANopen
- Festo Handling and Positioning Profile (FHPP)
- Protocol in accordance with the CANopen standards CiA DS 301 and CiA DSP 402
- Contains “Interpolated position mode” for multiple-axis applications

Motion control

- Can be operated as a torque, speed or position controller
- Integrated positioning controller
- Time-optimised (trapezoidal) or jerk-free (S-shaped) positioning
- Absolute and relative movements
- Point-to-point positioning
- Position synchronisation
- Electronic gear unit
- 64 Position sets
- 8 travel profiles
- Wide range of homing methods

Integrated sequence control

- Automatic sequence of position sets without a higher-level controller
- Linear and cyclic position sequences
- Adjustable delay times
- Waiting positions and conditional jump targets
- Definable stop positions for uncritical standstill points

Interpolating multi-axis movement

With a suitable controller, the CMMS-ST can perform path movements with interpolation via CAN-open.

The controller specifies setpoint position values in a fixed time pattern to this end. In between, the positioning controller independently interpolates the data values between two data points.

Parametrisation program “Festo Configuration Tool FCT”

- Simplest start-up and diagnosis
- Configuration of motor controller, motor and axis
- Automatic adjustment of all controller parameters with use of Festo Mechanics

- 2-channel oscilloscope function
- English and German

3.3 Interfaces

3.3.1 Control interfaces

Control interfaces	Signal type
Analogue	Analogue signal
Frequency signals	A/B - tracking signals (RS422)
	CLK/DIR – pulse/direction
	CW/CCW – pulse
I/O	Digital I/O – signals for control of record selection and jog mode
Fieldbus	CANopen (FHPP/CiA DSP 402)
	PROFIBUS-DP (FHPP)
	DeviceNet (FHPP)

Table 3.1 Control interfaces

3.3.2 Overview of interfaces

Setpoint interface / Interface	Setpoint specification via	Function	Operating mode	Reference
Analogue	X1 (± 10V)	Analogue setpoint specification	Speed control Torque control	3.3.3 Table 6.2 ff
Pulse / direction of interface	X1 (24 V / Mode 3) X10 (5 V)	CW/CCW CLK/DIR	Synchronisation	3.3.4 Table 6.5 Table 6.14
A/B signals + I/O mode 3 (start synchronisation)	X10 (5 V)	Master/slave (slave)	Synchronisation	3.3.4 Table 6.14 Table 6.5
I/O	X1 (24V / Mode 0/1/2)	Record selection Jog mode Linked positio-ning records	Positioning controller	3.3.5 Table 6.2 ff

Setpoint interface / Interface	Setpoint specification via	Function	Operating mode	Reference
CANopen field bus	X4 (CAN)	Direct application Homing run Jog mode Record selection Interpolated position mode (CiA DSP 402)	Speed control Torque control Positioning control	3.4.2 Table 6.8

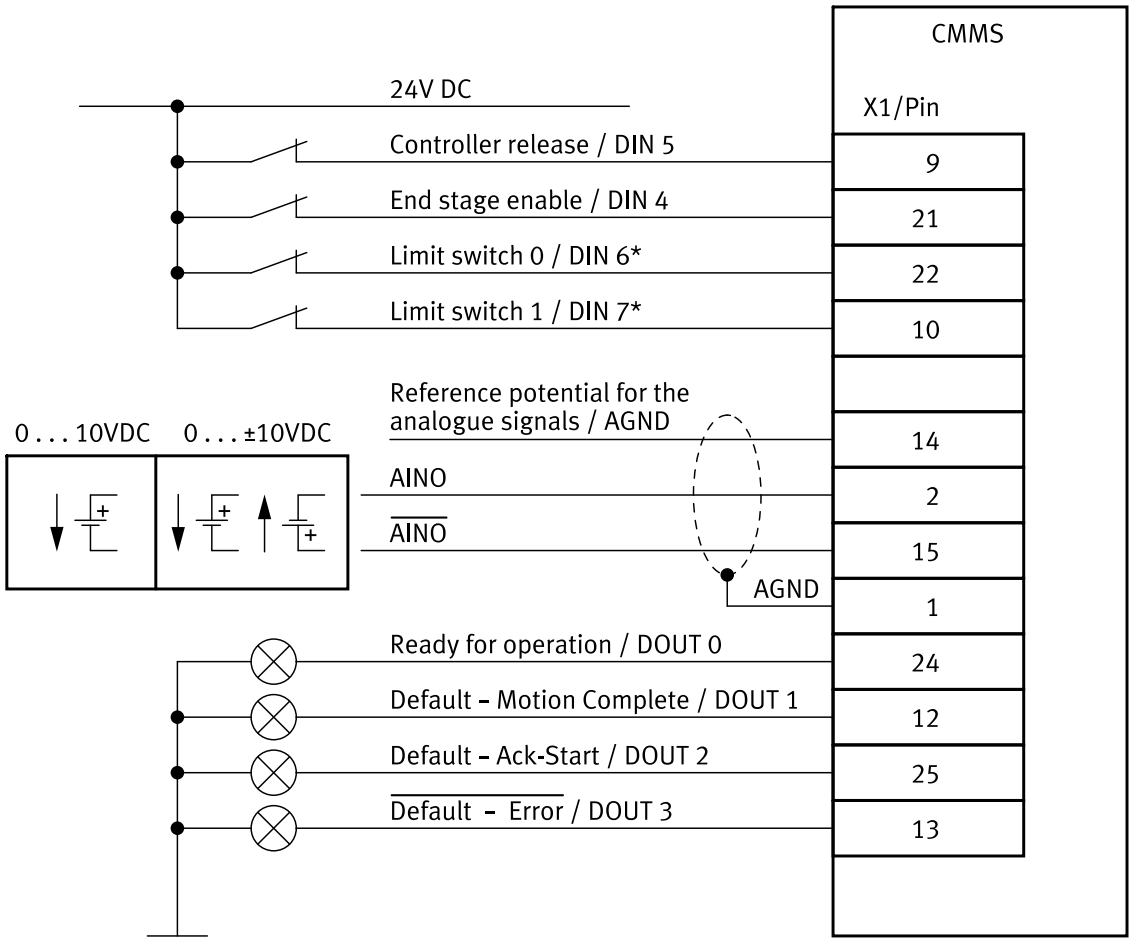
Table 3.2 Interfaces

3.3.3 Analogue setpoint specification

The analogue setpoint specification +/- 10VDC can be configured as setpoint specification for

- Speed setpoint value
- Torque setpoint value

Required connection with analogue setpoint specification



The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

3.3.4 Interfaces for direct synchronous operation

The motor controller permits a master-slave mode, which hereafter is designated synchronisation. The controller can function either as a master or slave.

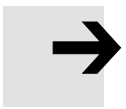
If the motor controller works as master, it can provide (RS422) A/B signals to the increment generator output [X10].

When the motor controller is to operate as a slave, various inputs and signal forms are available for synchronisation.

[X10] (5V RS422)	A/B, CW/CCW, CLK/DIR
[X1] (24V):	CW/CCW, CLK/DIR.

Using software, the increment generator interface can be configured as both output and input (master or slave). Additionally, two inputs for the connection of 5V pulse-direction signals (CLK/DIR), (CW/CCW) are planned on the plug connector.

24 VDC pulse-direction signals are carried out via [X1] DIN2 and DIN3.

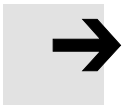


Note

5V DC	Pulse-direction signals over [X10] max. 150 kHz
24V DC	Pulse-direction signals over [X1] max. 20 kHz

Output: Generation of increment generator signals [X10]

Based on the encoder data, the motor controller generates the tracking signals A, B as well as the zero pulse of an increment generator. The number of lines can be set in the FCT plug-in with values between 32 ... 1024. As from FCT plug-in V1.1, values up to 2048 can be set.



Note

For Firmware 1.2.0.1.1:

To avoid rounding errors, the number of lines per revolution should contain the factor 2^n. (32, 64 ...) 1024

Changes to this interface only become effective after a “Reset”.

(download, secure, reset)

An RS422 power driver provides the signals to [X10] differentially.

Input: Processing of frequency signals [X10]

The signals are evaluated optionally as A / B tracking signals of an increment generator or as pulse / direction signals (CW/CCW or CLK/DIR) of a stepping motor control. The signal form is selected in the FCT. The number of steps per revolution can be parameterised. Beyond that, an additional electronic gear can be parameterised.

The following signals can be evaluated:

- A/B tracking signals
- CLK/DIR – pulse/direction
- CW/CCW pulse

Input: Processing of pulse-direction signals 24 V DC [X1]

- CLK/DIR – pulse/direction
- CW/CCW pulse

24 V DC pulse-direction signals are carried out via X1 DIN2 and DIN3.

Cycle rate pulse-direction signals

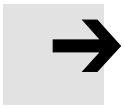
Voltage	Input	Cycle rate
5 V	[X10]	150 kHz
24 V	[X1]	up to 20 kHz

Table 3.3 Maximum input frequency

Activation of synchronisation

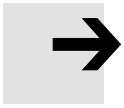
Synchronisation can be set in various ways.

- With the FCT parameterisation software, through selection of the control interface “Synchronisation” on the “Application data” page in the “Operating modes selection” tab
- Via [X1] (digital I/O interface) through selection of mode 3



Note

With setting of synchronisation via FCT, the controller only reacts via the synchronisation interface. All other functions of the positioning operating mode are no longer available.



Note

After the change of configuration via FCT, the changed configurations must be loaded into the motor controller using the “Download” buttons and saved permanently with the “Save” button.

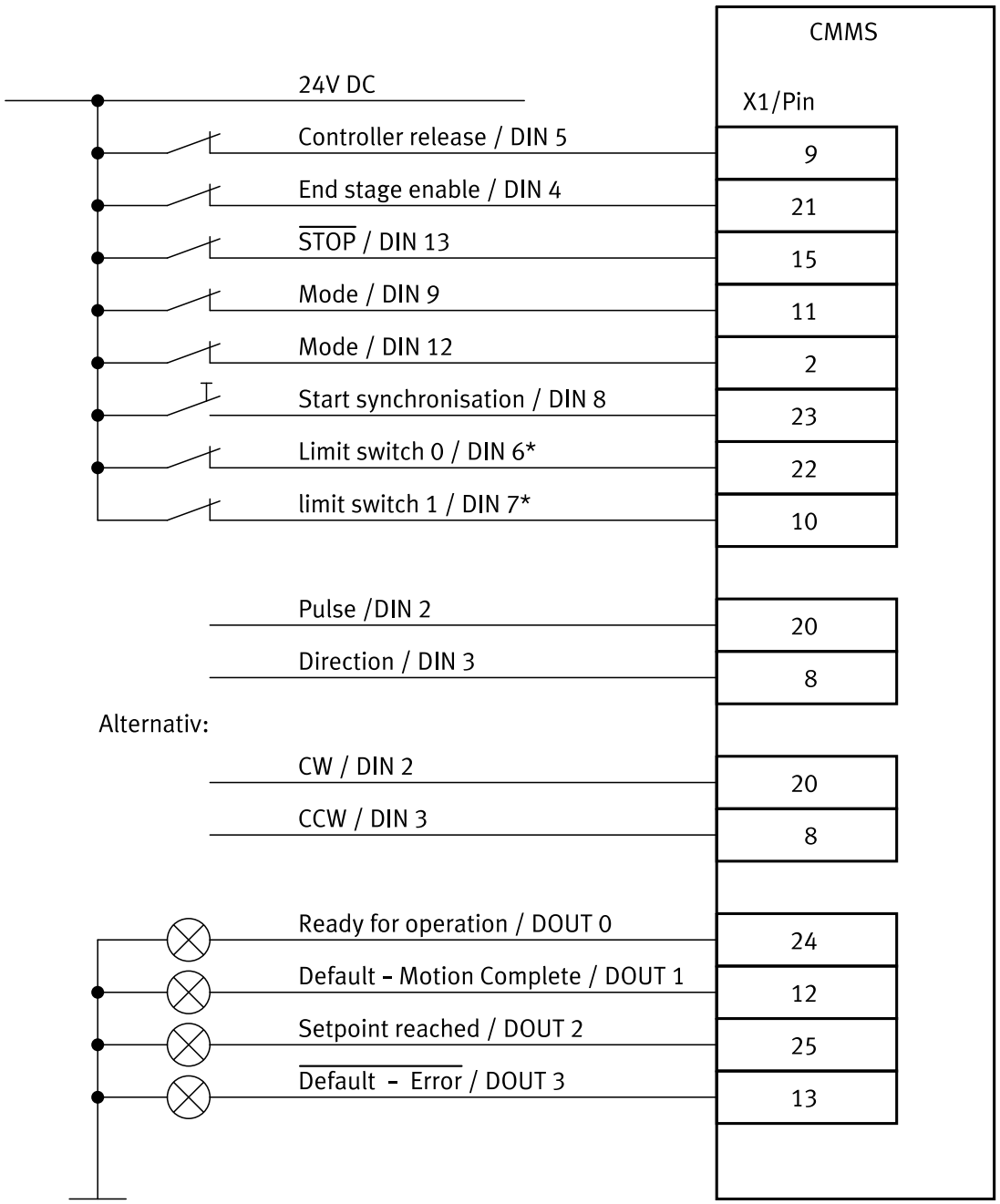
With a “Reset” (or switching off and back on) of the motor controller, the new configuration is activated.

To ensure flexibility of the controller, synchronisation should be switched on over the I/O interface.

Necessary I/O triggering during synchronisation via FCT

- DIN4 Output stage enable
- DIN5 Controller enable
- DIN6 Limit switch 0
- DIN7 Limit switch 1

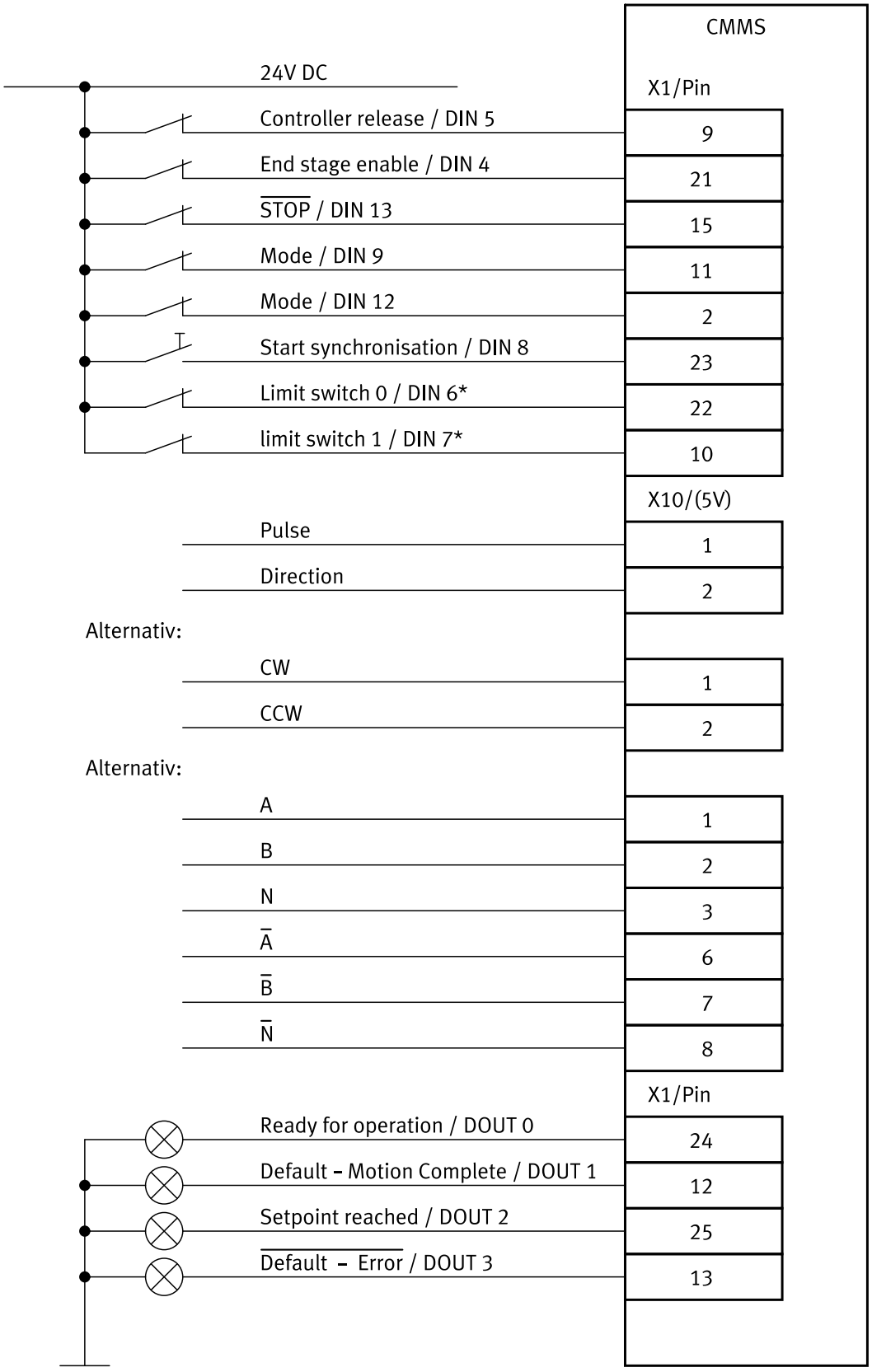
Required I/O triggering during synchronisation via mode switchover with 24 VDC frequency signals



The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

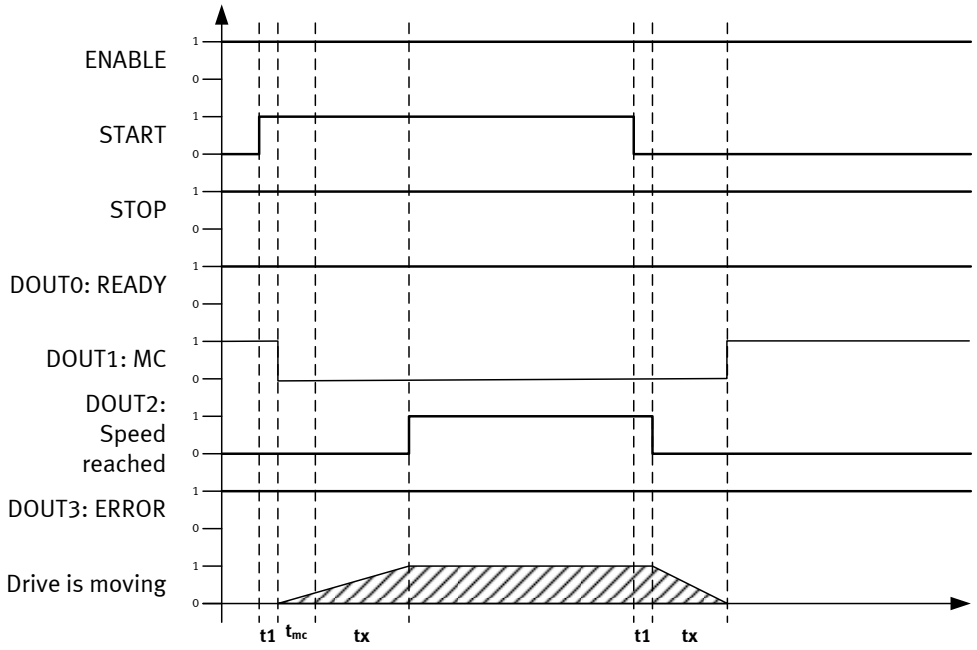
Required I/O triggering during synchronisation via mode switchover with 5 VDC frequency signals



The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

I/O timing diagrams



t1 = 1.6 ms

tx = x ms (dependent on ramps)

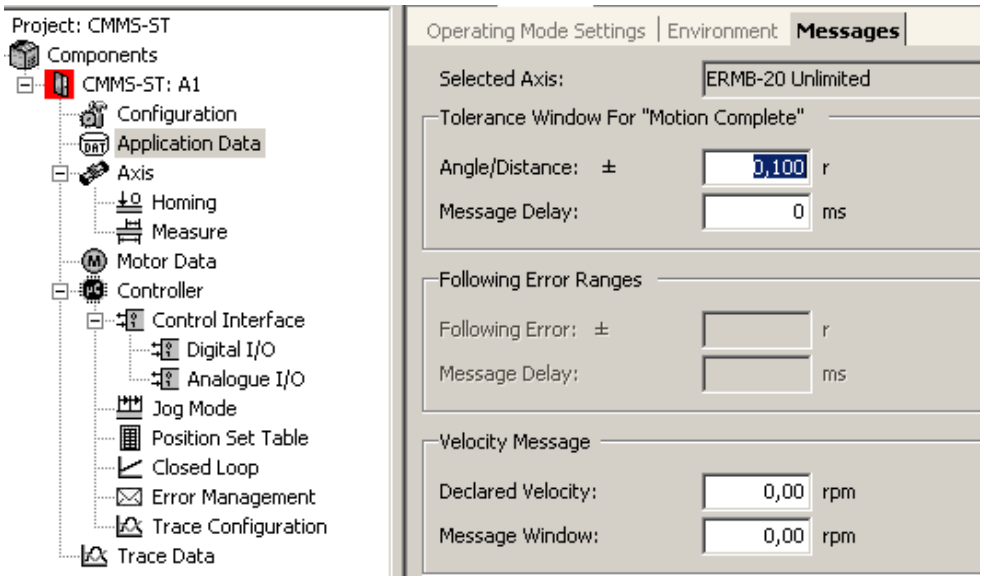
tmc = x ms (dependent on MC window)

Fig. 3.1 Signal sequence with Synchronisation selection operation mode / with activation of synchronisation through START (DIN8)

Note

Starting with Firmware 1.3.0.1.7, the message “Position synchronised” is output at DOUT2.

The signal MC is set as long as the drive is at a standstill during active synchronisation (DIN8:START set). That is, the MC signal is set as long as the window for “DZ = 0” has not been left.



For the feedback message “Speed reached”, the comparison speed is set to zero and only a message range is placed in the message window.

General information

- The general limitations and settings via FCT are also valid during synchronisation.
- Axle limitations, speeds, message windows, etc.
- When catching up to a leading master, the motor accelerates to the power limit.
- Up to **FW 1.2.0.1.2:** During resynchronisation on a forward-running master, the message “Setpoint reached” comes as soon as the speed within the set message window is reached. If overshooting occurs during the catch-up phase or the message window is set too low, the message may come several times or flicker.
- Starting with **FW 1.3.0.1.7**, the message “Position synchronized” is output at DOUT2. The deviation is configured via the tolerance window for “Motion Complete” in the FCT.

3.3.5 I/O functions and device control

Limit switch

The limit switches serve to limit the range of motion for safety reasons. During homing, one of the two limit switches can serve as reference points for positioning control.

Sample input

If a field bus is used for activation, a high-speed sampling input is available for time-critical tasks for various applications (position sensing, special applications, ...).

Analogue input

The CMMS-ST stepping motor controller has an analogue input for input levels ranging from +10 VDC to -10 VDC. The input is a differential input (12 bit), ensuring a high degree of protection against interference. The analogue signals are quantified and digitalised by the analogue-digital converter at a resolution of 12 bits. These analogue signals serve to specify setpoints (speed or torque) for the control.

MODE switching

The analogue input AIN0 is also available as a digital input for use of further functions such as the jog function, record linking and synchronisation. MODE switching allows you to switch between the following default settings:

Mode	Function
Mode 0	Positioning
Mode 1	Jog function
Mode 2	Set linking
Mode 3	Synchronisation

Table 3.4 Mode switching

3.3.6 RS232 interface (diagnosis/parameterisation interface)

The RS232 interface is intended as a configuration interface.

Parameters	
Signal level	In accordance with RS232 specification or RS-485 specification
Baud rate	9600 baud to 115 kBaud
ESD protection	ESD protected (16 kV) driver
Port	Null modem standard, [X5]
Port	over [X5] / DSUB 9 pin / pin

Table 3.5 Parameters of the RS232 interface

The RS-485 interface is on the same plug connector as the RS232 interface. Communication must be activated separately by the user. RS232 messages can also be received when RS-485 communication is activated, which means that the device can be accessed for configuration at all times.

After reset, the serial interface always has the following basic settings.

Parameters	Value
Baud rate	9600 baud
Data bits	8
Parity	None
Stop bits	1

Table 3.6 Default parameters

To be able to operate an interface with a terminal program, such as for test purposes, the following settings are required (recommendations):

Parameters	Value
Flow control	None
Emulation	VT100
ASCII configuration	- Sent characters finish with line feed - Output entered characters locally (local echo) - During reception, attach line feed to the end of the line

Table 3.7 Setting for terminal program

Please note that, immediately after a reset, the motor controller independently issues a bootup message via the serial interface. A reception program on the controller must either process or reject these received characters.

General commands

Command	Syntax	Response
New initialisation of the positioning controller	RESET!	None (bootup message)
Save the current parameter set and all position sets in the non-volatile flash memory.	SAVE!	DONE
Setting the baud rate for serial communication	BAUD9600 BAUD19200 BAUD38400 BAUD57600 BAUD115200	
Unknown command	Any	ERROR!
Read the version number of the CM (Configuration Management) release of the firmware	VERSION?	2300:VERSION:MMMM.SSSS*)
*)MMMM: Main version of the CM release (hexadecimal format) SSSS: Subversion of the CM release (hexadecimal format)		

Table 3.8 General commands

Parameter commands

The exchange of parameters and data takes place over “communication objects” (CO). They are used in a fixed syntax. Special return values are defined for errors in a write or read access.

Command	Syntax	Response
Reading a CO	OR:nnnn	nnnn:HHHHHHHH or OR:EEEEEEEE
Writing a CO	OW:nnnn:HHHHHHHH	OK! or OW:EEEEEEEE
Reading a lower limit of a CO	ON:nnnn	nnnn:HHHHHHHH or ON:EEEEEEEE
Reading an upper limit of a CO	OX:nnnn	nnnn:HHHHHHHH or OX:EEEEEEEE
Reading an actual value of a CO	OI:nnnn	nnnn:HHHHHHHH or OI:EEEEEEEE
*)nnnn: Number of the communication object (CO), 16 bit (hexadecimal format) HHHHHHHH: 32 bit data / values (hexadecimal format) EEEEEEEE: Return value in case of an access fault		

Table 3.9 Parameter commands

The meaning of the return values is the following.

Return value	Meaning
0x0000 0002	Data are less than the lower limit, data were not written
0x0000 0003	Data are greater than the upper limit, data were not written
0x0000 0004	Data are less than the lower limit, the data were limited to the lower limit and then accepted
0x0000 0005	Data are greater than the upper limit, the data were limited to the upper limit and then accepted
0x0000 0008	Data are outside the valid value range and were not written
0x0000 0009	Data are currently outside the valid value range and were not written

Table 3.10 Return values

Function commands

Command	Syntax	Response
Activate controller enable. To do this, the controller enable logic must be set to “DIN5 and RS232”.	OW:0061:00000001	OK! or OW:EEEEEEEE[1)]
Deactivate controller enable. To do this, the controller enable logic must be set to “DIN5 and RS232”.	OW:0061:00000002	OK! or OW:EEEEEEEE[1)]
Deactivate end stage. To do this, the controller enable logic must be set to “DIN5 and RS232”.	OW:0061:00000003	OK! or OW:EEEEEEEE[1)]
Acknowledge error	OW:0030:00010000	OK!
1) Faulty return values can be called up due to an inappropriately set controller enable logic, an intermediate circuit that is not loaded, etc.		

Table 3.11 Function commands

Setting the operating mode

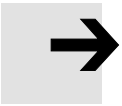
Due to a necessary synchronisation of internal processes, the change of operation mode can require some cycle times of the controller. We therefore recommend that you always verify and wait for reception of the desired operation mode.

Operating mode	Syntax	Response
Regulating torque	OW:0030:00000004	OK! or OW:EEEEEEEE
Speed adjustment	OW:0030:00000008	
Positioning	OW:0030:00000002	

Table 3.12 Operating mode

Faulty return values can be called up due to invalid values that do not come from the above-named group. The current operation mode can be read by using the “OR” command.

Control via RS-485



Note

Before activating the RS-485 interface, please make sure that you are using a completely wired null modem cable. All pins of the cable must be occupied according to the following specification (also see chapter 6.4.5).

Pin	Brief description	Name	Signal direction	Description
1	DCD	Data carrier detect	Transfer device --› end device	Data carrier signal was recorded by transfer device.
2	RxD	Receive (x) Data	Transfer device --› end device	Line at the end device that receives a data bit from the transfer device.
3	TxD	Transmit (x) Data	End device --› Transfer device	Line at the end device that sends a data bit to the transfer device.
4	DTR	Data terminal ready	End device --› Transfer device	End device is ready for use.
5	GND	Ground (earth)	None	Reference potential at 0 V.
6	DSR	Data set ready	Transfer device --› end device	Transfer device is ready for use.
7	RTS	Request to send	End device --› Transfer device	End device displays that the remote station should send (send request).
8	CTS	Clear to send	Transfer device --› end device	Transfer device shows reception readiness (send permission).

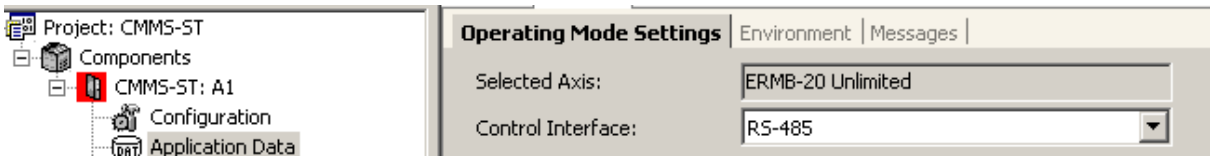
Pin	Brief description	Name	Signal direction	Description
9	RI	Ring indicator	Transfer device --> end device	Transfer device receives a ring – or call sign on the telephone line

Table 3.13 Design of a null modem line

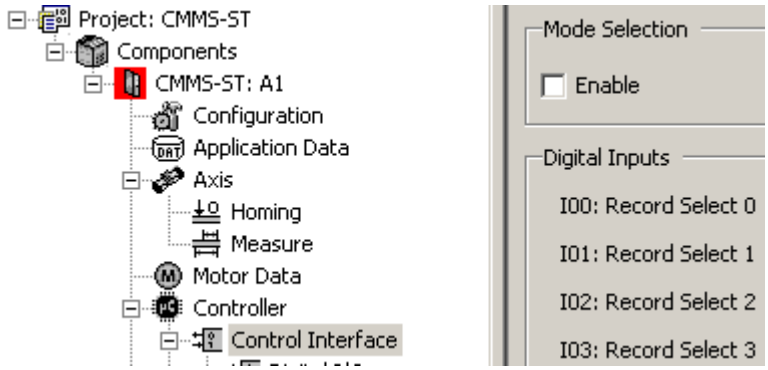
Configuration in the FCT

For configuration, the following settings are required in the “Work station” window:

- On the “Application Data” page in the “Operating Mode Settings” tab, set the control interface to “RS-485”.



- On the page “Controller, control interface”, do not activate the mode selection



Then, with the “Download” buttons, load the changed configurations into the motor controller and save them permanently with the “Save” button.

With a “Reset” (or switching off and back on) of the motor controller, the new configuration is activated.

Command syntax under RS-485

Control of the motor controller via RS-485 takes place with the same objects as with RS232. Only the syntax of the commands to read/write the objects is expanded in comparison to the RS232.

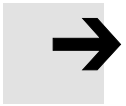
Syntax: XTnn:HH.....HH:CC

Meanings:

XT: Fixed constants

nn: Node number, identical to the CANopen node number (setting via DIP switch)

HH.....HH: Data (normal command syntax)



Note

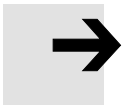
- The reply sends the following characters to the first five positions: “XRnn:” with nn = node number of the device
- All devices react to the node number 00 as “Broadcast”. In this way, each device can be addressed without knowing the node number.
- The commands of type “OW”, “OR” etc. support an optional check sum. This check sum is formed without the first five characters.
- The bootup message of the boot loader as well as the bootup message of the firmware are sent in the RS232 mode.

Example "Profile position mode" via RS-485

If the CMMS-ST-...-G2 is operated via RS-485, control can take place just as with operation via RS232; see chapter Example "Profile position mode" via RS232 (page 38). If required, the node number is simply written in front of the command. The node number is set via the DIP switches.

Command: **XT07:=607A00:000A0000** Target position 10 revolutions send to node 7

Example "Profile position mode" via RS232



Note

If you want to perform a positioning, a homing run must be performed once each time the controller is switched on. You can do this via FCT or as described in chapter “Example “Homing Mode” via RS232”.

With the CAN access simulated via RS232, the motor controller can also be operated in the CAN “Profile position mode”. The following describes the sequence in principle.

1. Changing of the controller enable logic

The controller enable logic can be changed via the COB 6510_10. Since the simulation of the CAN interface over RS232 can be completely taken over, the enable logic can also be changed to DINs + CAN.

Command: =651010:0002

As a result, the release can be granted via the CAN control word (COB 60040_00).

Command: =604000:0006 Command “Shutdown”

Command: =604000:0007 Command “Switch on / Disable Operation”

Command: =604000:000F Command “Enable Operation”

2. Activation of the “Profile position mode”

   The positioning mode is activated via the COB 6060_00 (Mode of Operation). This must be written once, since all internal sectors must be set correctly thereby.

   Command: =606000:01 Profile Position Mode

3. Write position parameters

   The target position can be written over the COB 607A_00 (target position). The target position is thereby written in “position units”. That means, it depends on the set CAN factor group. The default setting here is 1 / 2^{16} revolutions. (16 bit portion before the point, 16 bit portion after the point.

   Command: =607A00:00058000 Target position 5.5 revolutions

   The speed of travel can be written via the COB 6081_00 (profile velocity), the final speed via the COB 6082_00 (end velocity).

   The speeds are thereby written in “speed units”. That means, they depend on the set CAN factor group.

   The default setting here is 1 / 2^{12} revolutions/min. (20 bit portion before the point, 12 bit portion after the point.

   Command: =608100:03E80000 Speed of travel 1000 RPM

   The acceleration can be written via the COB 6083_00 (profile acceleration), the deceleration via the COB 6084_00 (profile deceleration) and the quick stop ramp via the COB 6085 (quick stop deceleration).

   The acceleration is thereby written in “acceleration units”. That means, they depend on the set CAN factor group.

   The default setting here is 1 / 2^{8} revolutions/min/s. (24 bit portion before the point, 8 bit portion after the point.

   Command: =608300:00138800 Acceleration 5000 RPM/s

4. Start positioning

   Positioning is started via the CAN control word (COB 6040_00):

   1. Controller enable is controlled via bit 0..3 (see above).
   2. The positioning is started over a rising edge at bit 4.
      The following settings are taken over thereby.
   3. Bit 5 establishes whether an ongoing positioning is ended first before the new positioning task is taken over (0), or whether the ongoing positioning should be cancelled (1)
   4. Bit 6 establishes whether the positioning should be carried out

absolutely (0) or relatively (1).

Command: **=604000:001F** Start absolute positioning or

Command: **=604000:005F** Start relative positioning

5. After positioning has been ended, the condition of the controller is reset so a new positioning can be started.
6. **Command:** **=604000:000F** Bring controller into “Ready” state

Example “Homing Mode” via RS232

With the CAN access simulated via RS232, the CMMS-ST can also be operated in the CAN “Homing Mode”. The following describes the sequence in principle.

1. Changing of the controller enable logic
2. The controller enable logic can be changed via the COB 6010_10. Since the simulation of the CAN interface over RS232 can be completely taken over, the enable logic can also be changed to DINs + CAN.
3. **Command:** **=651010:0002**
4. As a result, the release can be granted via the CAN control word (COB 6040_00).

   Command: **=604000:0006** Command “Shutdown”

   Command: **=604000:0007** Command “Switch on / Disable Operation”

   Command: **=604000:000F** Command “Enable Operation”
5. Activation of the “Homing mode”
6. The homing mode is activated via the COB 6060_00 (Mode of Operation).
7. **Command:** **=606000:06** Homing Mode
8. Start homing
9. Homing is started via the CAN control word (COB 6040_00):
10. - Controller enable is controlled via BIT 0 ... 3.
11. - The homing run is started via a rising edge at bit 4.
12. **Command:** **=604000:001F**
13. After homing has been ended, the condition of the controller must be reset.
14. **Command:** **=604000:000F** Bring controller into “Ready” state

3.3.7 Multi-firmware strategy

A firmware update can be achieved using any desired customer firmware through the built-in SD card reader. See chapter 3.3.13 SD memory card.

3.3.8 Increment generator input

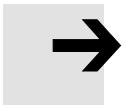
An optional increment generator mounted on the motor shaft is used to record the actual

speed and position for EMMS-ST series motors. The actual speed is determined based on the measured rotor position. The rotor position is smoothed via a configurable PT_1 filter.

The position counter for positioning has a data width of 32 bits. The position within a motor rotation is resolved to max. 16 bits. This results in a maximum possible positioning range of ±32767 rotations.

3.3.9 Brake chopper

A brake chopper with a braking resistor is integrated in the power output stage. If the permitted load capacity of the intermediate circuit is exceeded during the energy recovery, the braking energy may be converted to heat by the internal braking resistor. The brake chopper is actuated with software control. The internal braking resistor is protected against overloading via software and hardware.



Note

If the maximum braking energy of the braking resistor is exceeded, the message “070 – Overvoltage in intermediate circuit” is output and the end stages switched off.

3.3.10 Control interface [X1]

The control interface [X1] is designed as D-Sub 25-pin. The following signals are available:

Pin	Name	Mode 0 (DIN12=0)	Mode 1 (DIN12=1)	Mode 2 (DIN9=1 & DIN12=0)	Mode 3 (DIN9=1 & DIN12=1)
1	AGND	Screen for analogue signals			
14	AGND	Reference potential for analogue signals			
2	AIN0 DIN12	Setpoint input 0 Mode switchover	"1"	"0"	"1" slave synch.
15	#AIN0 DIN13	Stop input (low active)	STOP	STOP	STOP
3	DIN10	Record selection 4 (high active)	Jog +	Next 1	-
16	DIN11	Record selection 5 (high active)	Jog -	Next 2	-
4	+VREF	Reference output for setpoint potentiometer			
17	AMON0	Analogue monitor output 0			
5	Unassigned	Unassigned	Unassigned	Unassigned	Unassigned
18	+ 24 V	24 V supply carried out			

Pin	Name	Mode 0 (DIN12=0)	Mode 1 (DIN12=1)	Mode 2 (DIN9=1 & DIN12=0)	Mode 3 (DIN9=1 & DIN12=1)
6	GND24	Reference potential for digital I/Os			
19	DIN0	Record selection 0 (high active)	Record selection 0	Record selection 0	
7	DIN1	Record selection 1 (high active)	Record selection 1	Record selection 1	
20	DIN2	Record selection 2 (high active)	Record selection 2	Record selection 2	CLK_24
8	DIN3	Record selection 3 (high active)	Record selection 3	Stop record linking	DIR_24
21	DIN4	End stage enable (high active)	Output stage enable	Output stage enable	Output stage enable
9	DIN5	Controller enable (high active)	Controller enable	Controller enable	Controller enable
22	DIN6	Limit switch 0	Limit switch 0	Limit switch 0	Limit switch 0
10	DIN7	Limit switch 1	Limit switch 1	Limit switch 1	Limit switch 1
23	DIN8	Start for positioning procedure	Teach	Start record linking	Start record synchronisation
11	DIN9	High-speed input	“0” = jog mode	“1” = record linking	“1” = slave synchronisation
24	DOUT0	Ready for operation output (high active)			
12	DOUT1	Default motion complete output (high active)			Speed 0 reached
25	DOUT2	Default start ack output (low active)	Teach ack	Default start ack	Position synchronised
13	DOUT3	Default error output	Error	Error	Error

Table 3.14 Interface assignments

Signal:	Description
AMON AIN0 / #AIN0	Analogue output for monitor purposes Differential analogue input with 12 bit resolution. Alternatively, the differential analogue input can be parameterised with the function Mode and Stop. (DIN12 and DIN13) (dependent on the parameterised control interface).
DOUT0...DOUT3	Digital outputs with 24 V level, DOUT0 is permanently occupied with the function “Ready for operation”. Additional outputs can be configured (Target reached, Axis in motion, Target speed achieved.....)

Signal:	Description
DIN0...DIN13	Digital inputs for 24 V level, following functions: (the inputs are occupied in their function, depending on the mode selection) 1 x end-stage enable (DIN4) 1 x controller enable / acknowledge error (DIN5) 2 x limit switch (DIN6 + DIN7) Mode 0: 6 x position selection (DIN0-3, DIN10, 11) 1 x start positioning (DIN8) 2 x MODE switchover (DIN9, 12) 1x stop (DIN13) Mode 1: 2 x jog mode (DIN10, 11) 1x teach (DIN8) Mode 2: 1x stop record linking (DIN3) 1x start record linking (DIN8) 2x next for record linking step criterion (DIN 10, 11) Mode 3: 2x pulse/direction (CLK/DIR or CW/CCW on DIN2, 3) 1x start sync (DIN8)

Table 3.15 Control interface [X1]

The digital inputs are designed to be configurable:

Mode	DIN9	DIN12	Function
0	0	0	Positioning
1	0	1	Jog mode
2	1	0	Record linking
3	1	1	Synchronisation

Table 3.16 Mode switching

To be able to switch between different I/O configurations, DIN12 and DIN9 can also be configured as selector signals.

As a result, a maximum of four different I/O assignments can be selected. These are described in the tables

- Table 6.2 Pin allocation: I/O interface [X1],
- Table 6.3 Pin allocation: I/O interface [X1],
- Table 6.4 Pin allocation: I/O interface [X1] Mode 2,
- Table 6.5 Pin allocation: I/O interface [X1] Mode 3.

3.3.11 Serial parameterisation interface RS232 and RS-485- [X5]

It permits parameterisation of the controller as well as downloading of the parameter set and firmware through an RS232 zero modem interface with up to 115 KBit/s.

The interface can be used either as an RS232 interface or alternatively as an RS -485 interface. Simultaneous use is not possible, since both interfaces use the same UART in the DSP.

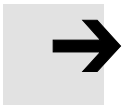
3.3.12 SD cardholder – [X12]

To permit saving of control parameters as well as the complete controller firmware, a connection possibility for an SD memory card (popular storage medium for digital cameras) has been incorporated. The connection is designed as a “push-push” holder for reasons of quality perception.

3.3.13 SD memory card

Via the SD memory card, parameter sets can be loaded or firmware can be downloaded.

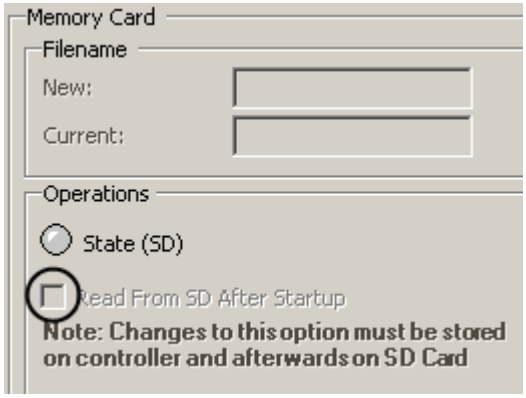
A menu in the configuration software allows you to specify a set of parameters on the memory card, and load it or save it.



Note

When a parameter set is loaded from the memory card, the newest parameter set is always loaded.

Also, the parameter set can be used to specify whether firmware and/or a parameter set is to be loaded from the memory card automatically on activation.



If automatic firmware download (DIP switch 8 = 1) is activated or there is no valid firmware in the controller, a check is performed at initialisation whether an SD memory card is inserted, and if so, initialises it. If there is a firmware file on the card, it is checked first (device type, checksum). If no fault is found, the firmware is transferred from the card to the controller and saved in the FLASH program.

If the Load automatic parameter set is activated via the commissioning software, the system checks whether a card is inserted when the firmware is started and it is initialised if applicable.

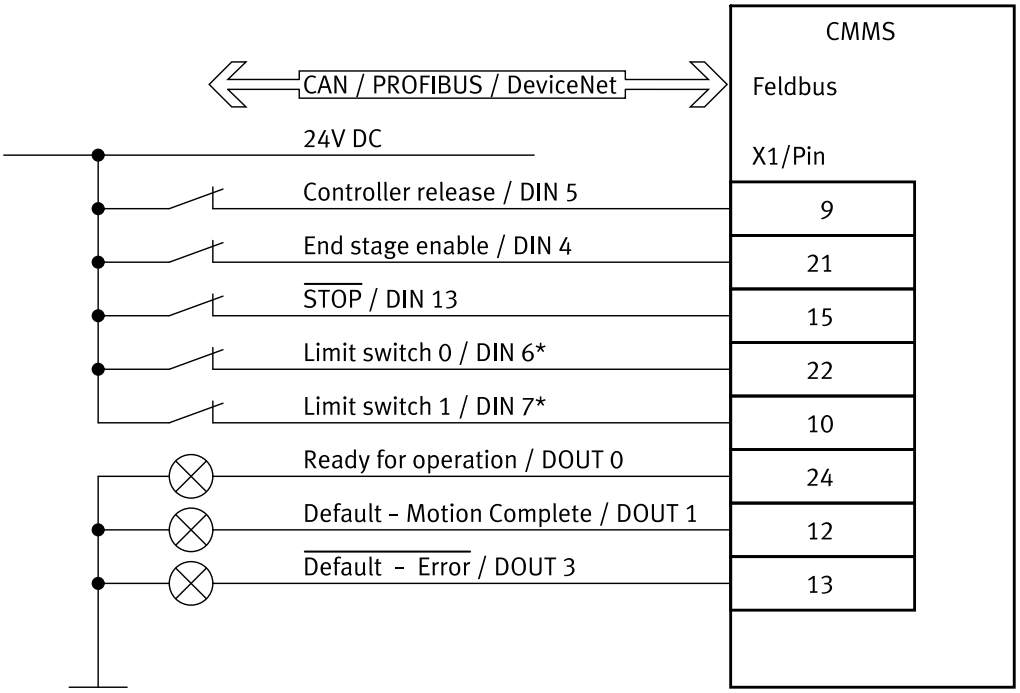
3.4 Fieldbus interface

With CMMS-ST, different field buses can be used. By default, the CAN bus is permanently integrated in the controller with the CMMS-ST. Optionally, the PROFIBUS or DeviceNet can be used via plug-in modules. But only one field bus can be active at any given time.

For all field buses, the Festo Profile for Handling and Positioning (FHPP) has been implemented as the communication protocol. Additionally, for the CAN bus, the communication protocol based on the CANopen profile in accordance with the CiA Draft Standard DS301 and the drive profile in accordance with the CiA Draft Standard Proposal DSP402 have been implemented.

Independent of the field bus, a factor group can be used so that application data can be transferred into user-specific units.

Required I/O connection for field bus control



The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

3.4.1 FHPP

FHPP makes it possible to achieve a uniform control concept regardless of the field bus used. The user therefore no longer be concerned with the specific characteristics of the respective buses or controllers (PLC), but receives a preparameterised profile in order to place his drive into operation in the shortest possible time and control it.

Among the operation types, FHPP distinguishes between record selection and direct operation.

With record selection, the position records stored in the controller are used.
In direct operation,

- the positioning mode,
- speed control or
- force control

can be used.
These can be dynamically switched over in direct operation as needed.
Additional information can be found in the FHPP manual P.BE CMM FHPP SW DE.

3.4.2 CAN bus

Communication

The CAN bus is permanently integrated in the controller and can be parameterised and activated/deactivated via the DIP switches on the front side. With the DIP switches, the node address and baud rate can be set visibly from the outside. In addition, a termination resistor can be connected and the CAN bus switched on or off. The controller supports baud rates up to 1 Mbit/s.
If the communication protocol FHPP is used, the above-mentioned operating modes are available.
Alternatively, if the CANopen protocol in accordance with CiA DS 301 with application profile CiA DSP 402 is activated, then

- the positioning mode (CiA: profile position mode),
- homing mode (CiA: homing mode),
- interpolated position mode (CiA: interpolated position mode)
- speed control (CiA: profile velocity mode) and
- force mode (CiA: torque profile mode)

can be used.
Communication can take place optionally over SDOs (service data objects) and/or PDOs (process data objects). Two PDOs are available for each sending direction (transmit/receive).

Path control with linear interpolation

With the “interpolated position mode”, a contour control can be implemented in a multi-axis application of the controller. For this, position setpoints are specified by a higher-order control system in a fixed time slot pattern. If the time slot pattern of the position setpoints is greater than the internal position controller cycle time of the controller, the controller automatically interpolates the data values between two prescribed position setpoints. The controller also calculates a corresponding speed pilot control.

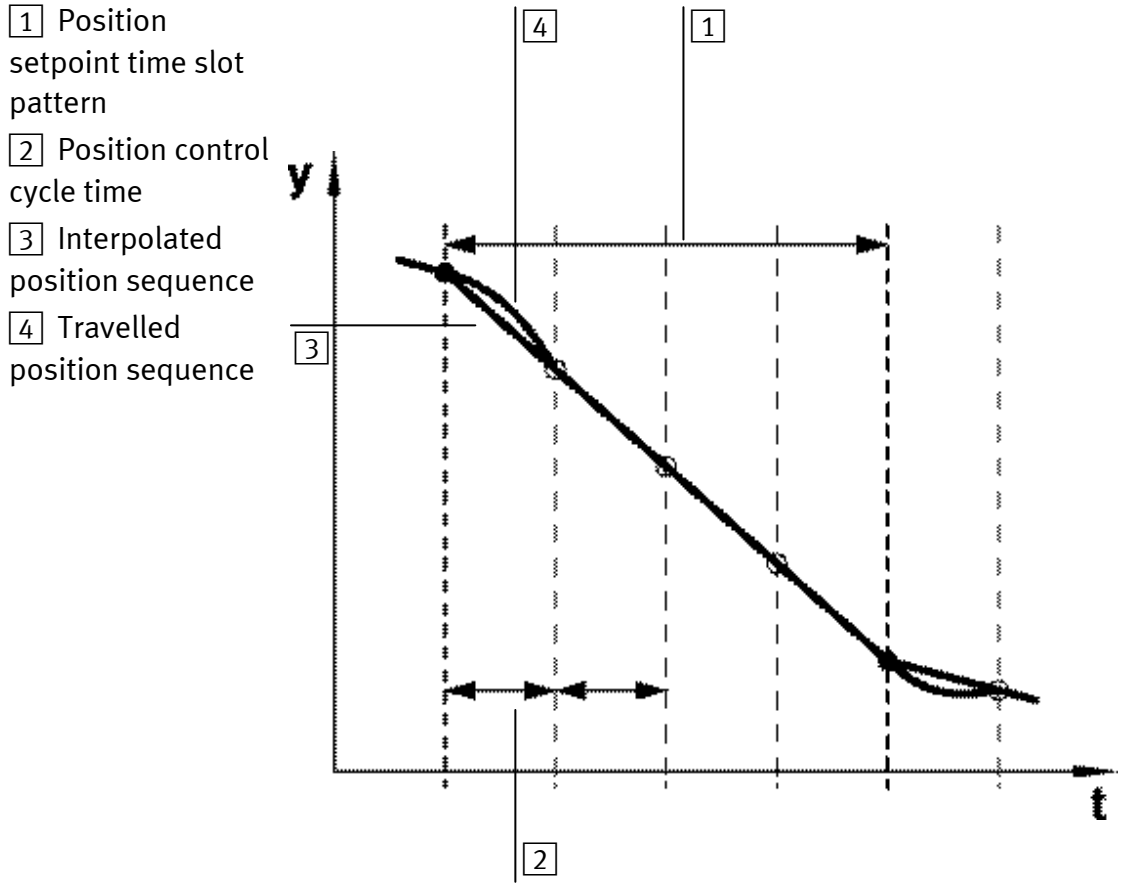


Fig. 3.2 Interpolated position mode

3.4.3 PROFIBUS

The controller is connected to the PROFIBUS with a corresponding expansion module (CAMC-PB), which can be plugged into the expansion slot X7. If the module is plugged in, it automatically becomes active the next time the controller is switched on.

The slave address is configured over the DIP switches on the front side of the controller.

Baud rates up to 12MBaud are supported.

FHPP with the above-described control and operating modes is used as communication protocol.

3.4.4 DeviceNet

The controller is connected to the DeviceNet network with a corresponding expansion module (CAMC-PB), which can be plugged into the expansion slot X7. If the module is plugged in, it automatically becomes active the next time the controller is switched on.

The MAC-ID and baud rate are configured over the DIP switches on the front side of the controller.

Baud rates up to 500 kBaud are supported.

FHPP with the above-described control and operating modes is used as communication protocol.

3.4.5 MTR-ST series stepper motors

The MTR-ST series stepper motors are two-phase hybrid stepper motors. They are designed for controlled operation (open-loop).

3.4.6 EMMS-ST series stepper motors

The EMMS ST ... S**E**/ S**E**B is equipped with an encoder (500 lines/R), which is used for current, speed and position control. Commutation of the motor is also controlled with the encoder.

Step loss is avoided by building up a drag interval in case of overload and monitoring takes place up to a maximum set amount.

In combination with the controller CMMS ST, 'Servo Light' operation is made possible (closed loop).

The EMMS ST ... S**B**/ SE**B** possesses an integrated holding brake.

3.5 Function overview

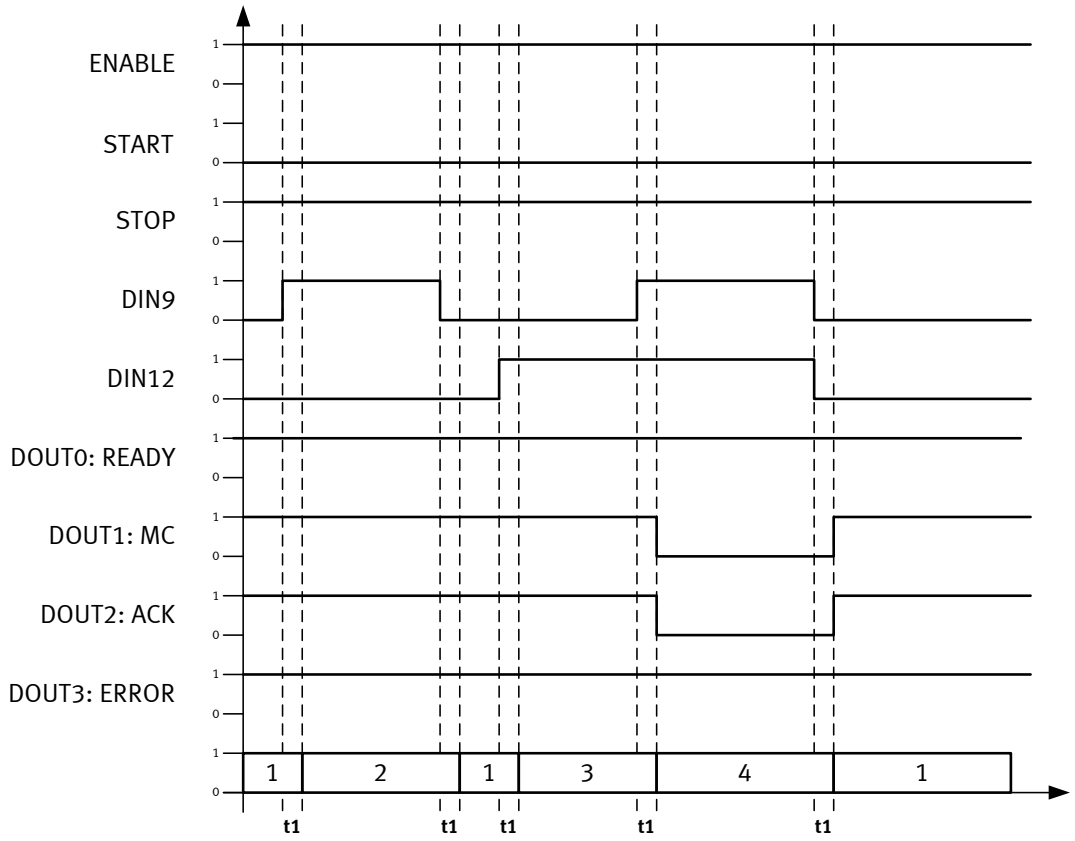
3.5.1 Operating modes

- Setpoint specification via increment generator signals, suitable for frequencies up to 150 kHz
- Analogue speed specification with 12-bit resolution
- Move to reference point
- Simple connection via digital I/Os to a higher-order control system, e.g. a PLC.
- Jolt-limited or time-optimised positioning absolutely or relative to a reference point via the integrated trajectory generator.
- Position specification via the integrated fieldbus CANopen with automatic interpolation between the setpoints.

Operating mode	Function	Setpoint interface / Interface	Setpoint specification via
Regulating torque		Analogue setpoint	[X1]
		Fieldbus	Direct mode
Speed adjustment		Analogue	[X1]
		CW/CCW signals	[X1] (24V / Mode3) [X10] (5 V)
		CLK/DIR Pulse/direction signals	[X1] (24V / Mode3) [X10] (5 V)
		Fieldbus	Direct mode
	Master/Slave	A/B signals + I/O (start synchronisation)	[X10] [X1] (Mode3)
Positioning controller		I/O	Record selection
		Fieldbus	Direct mode
		Fieldbus	Record selection
	Homing	I/O	Record selection
		Fieldbus	Direct mode
		Fieldbus	Record selection
	Jog mode	I/O	
		Fieldbus	Direct mode
	Teach-in function	via I/O	

Table 3.17 Operating modes

3.5.2 Timing diagram operation mode switchover



t1 =1.6 ms

1) Position

2) Sequences / Record linking

3) Jog / Teach

4) Synchronisation

Fig. 3.3 Timing for activation of the individual operating modes

3.5.3 Setpoint processing

Through setpoint selection, an additional setpoint can be plugged in via the correction value with the control interface RS-485.

Depending on the prefix, the speed setpoint is disabled via the signal of the corresponding limit switch input. The limit switch inputs also affect the ramp generator for the speed setpoint.

The speed setpoint is converted by the controller into the corresponding frequency to actuate the stepper motors.

The speed setpoint (without the correction value) is reached via a setpoint ramp. Four acceleration ramps can be configured in the range of one controller cycle of up to approx. 10 s. The setpoint ramp can be deactivated.

3.5.4 Suppression of ranges

When speeds close to the mechanical natural resonance are reached, there is a speed jump so that the resonance is skipped. The mechanical natural resonance and the bandwidth (hysteresis) can be set. Up to three speed ranges can be hidden.

3.5.5 I²t function

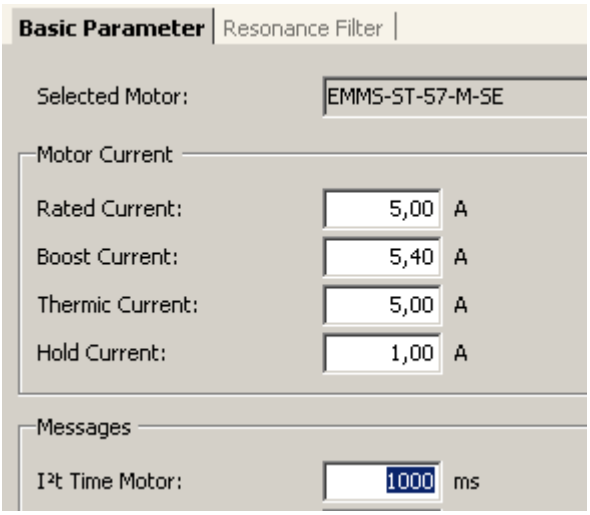
An integrator monitors the current²-time integral of the CMMS-ST controller. As soon as the parameterised time is exceeded, a warning message is output and the maximum current is limited to the rated current.

Note

With a threshold of I²t = 80%, the warning message “0190 - I²t at 80%” occurs and the maximum current is limited to the rated current.

With a threshold of I²t = 100%, the warning message “0310 - I²t fault motor” occurs and the maximum current is limited to the rated current.

The I²t time of the motor can be set via the FCT parameterisation software.



3.5.6 Positioning controller

A positioning control system is set above the current controller. Up to 64 positions (homing + 63 positions) can be selected and run via a trajectory generator. There are also volatile position data records for positioning via the field bus.

The position records are made up of a position value and a motion profile. The following parameters can be set for the eight motion profiles:

- Travel speed
- Acceleration
- Deceleration
- Smoothing
- Time

- Start delay
- Final speed
- Wait for current positioning, reject or ignore initial instruction.

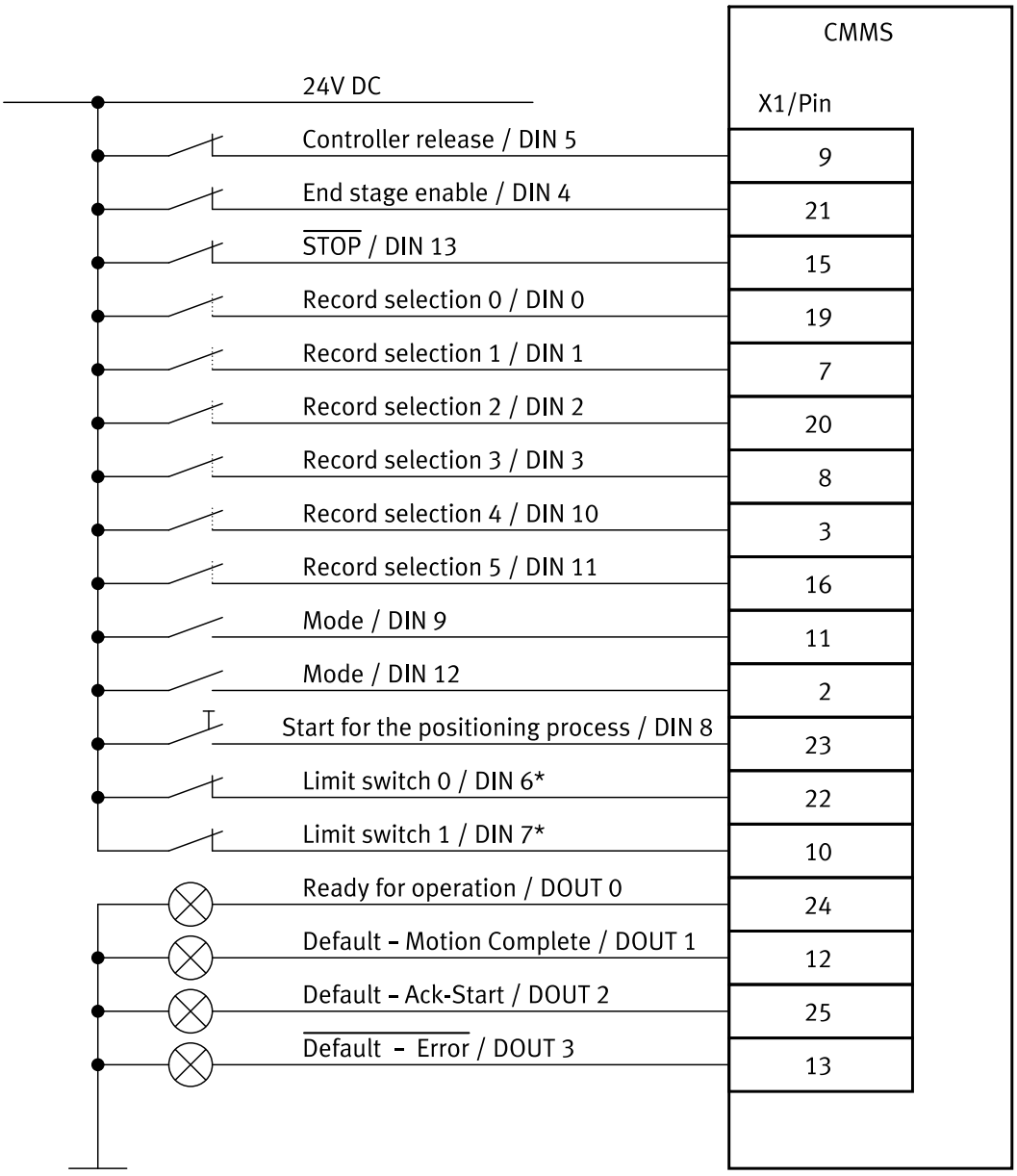
From every position record, any other position record can be started directly. You can transition to a new position record without first coming to a standstill.

The parameter sets can be called up via:

- Digital inputs (position record 0 ... 63)
- RS232 interface (for test purposes only) or a
- Fieldbus interface

.

Required I/O connection for positioning



The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

3.5.7 Homing

Note

Homing via I/O controller only in mode 0: positioning.

The following methods can be chosen for the homing run.

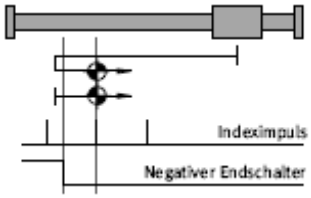
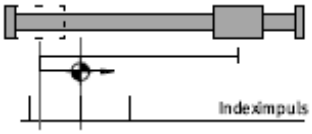
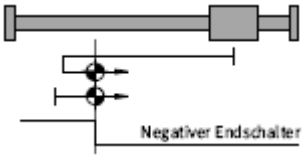
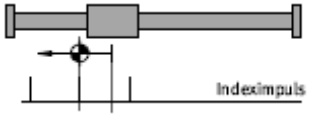
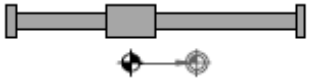
Run to	Positive method		Negative method		Graphical representation
	Dec	Hex	Dec	Hex	
Limit switch with zero pulse evaluation	2	02	1	01	
Fixed stop with zero pulse evaluation	-2	FE	-1	FF	
Limit switch	18	12	17	11	
Fixed stop	-18	EE	-17	EF	
Zero pulse	34	22	33	21	
Save current position	35	23	35	23	

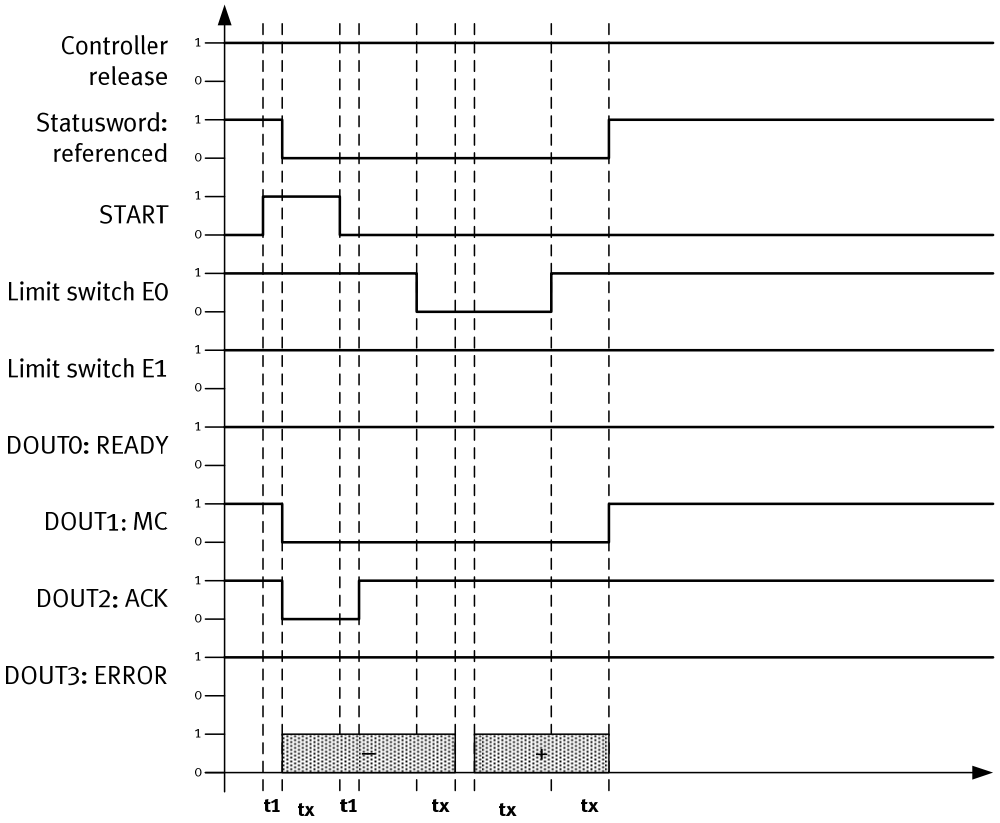
Table 3.18 Homing methods

Homing method	
1	Negative limit switch with index pulse. If negative limit switch inactive: Run at search speed in negative direction to the negative limit switch. Run at crawl speed in positive direction until the limit switch becomes inactive, then on to first index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
2	Positive limit switch with index pulse. If positive limit switch inactive: Run at search speed in positive direction to the positive limit switch. Run at crawl speed in negative direction until the limit switch becomes inactive, then on to first index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
-1	Negative stop with index pulse Run at search speed in negative direction to stop. Run at crawl speed in positive direction to next index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
-2	Positive stop with index pulse Run at search speed in positive direction to stop. Run at crawl speed in negative direction to next index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
17	Negative limit switch If negative limit switch inactive: Run at search speed in negative direction to the negative limit switch. Run at crawl speed in positive direction until limit switch becomes inactive. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
18	Positive limit switch If positive limit switch inactive: Run at search speed in positive direction to the positive limit switch. Run at crawl speed in negative direction until limit switch becomes inactive. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
-17	Negative stop Run at search speed in negative direction to stop. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.

Homing method	
-18	Positive stop Run at search speed in positive direction to stop. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
33	Index pulse in negative direction Run at crawl speed in negative direction to index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
34	Index pulse in positive direction Run at crawl speed in positive direction to index pulse. This position is saved as the reference point. If configured: Run at travel speed to axis zero point.
35	Current position The current position is saved as the reference point. If configured: Run at travel speed to axis zero point. Note: if the reference system is shifted, runs to a limit switch or fixed stop are possible. They are therefore generally used for rotating axes.

Table 3.19 Explanation of the homing methods

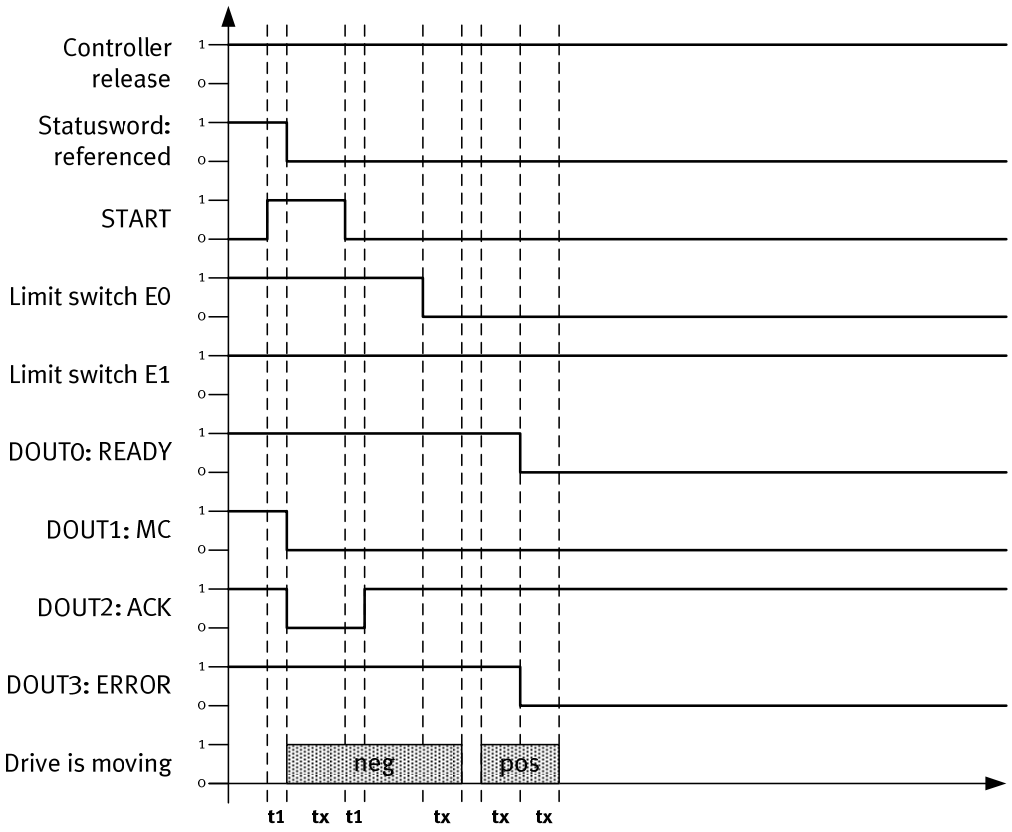
3.5.8 Timing diagrams for homing run



t1 = 1.6 ms

tx = x ms (dependent on ramps)

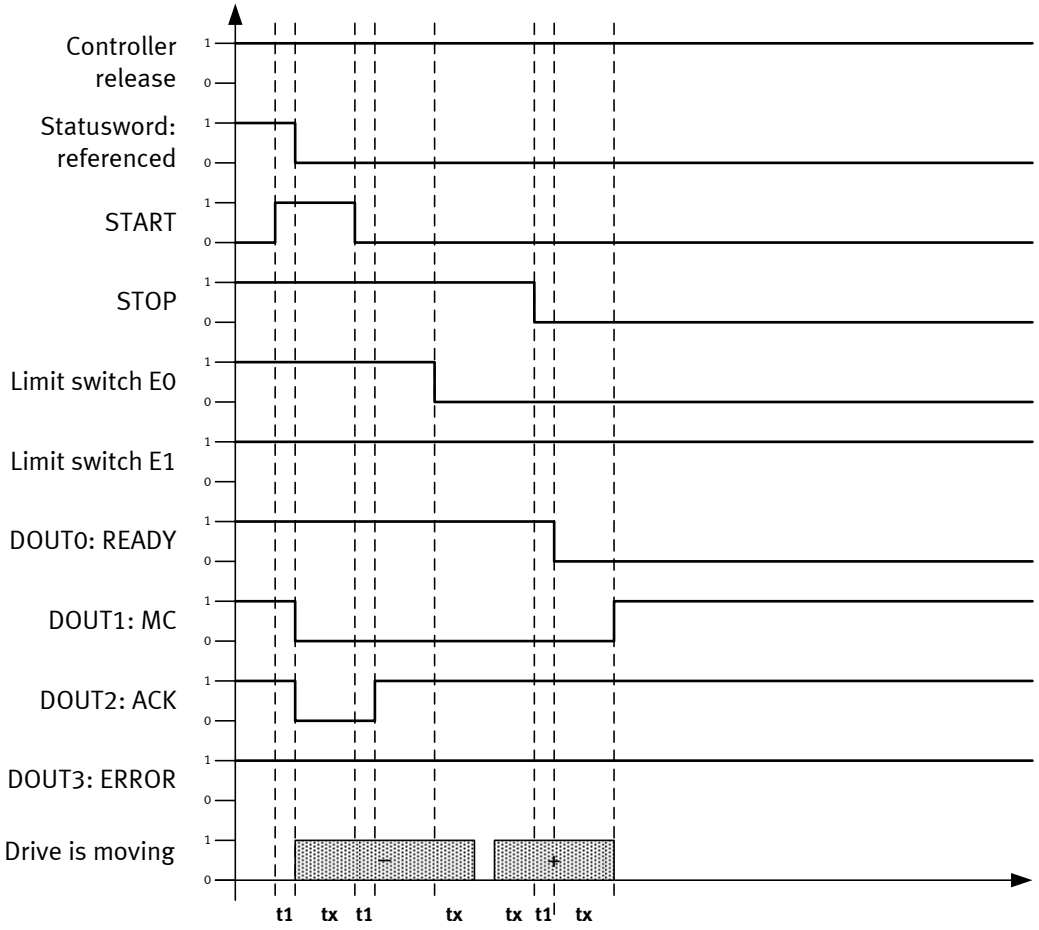
Fig. 3.4 Signal sequence with start of the homing run and with positive design



t1 = 1.6 ms

tx = x ms (dependent on ramps)

Fig. 3.5 Signal sequence with faulty interruption (contour error, ...)



t1 = 1.6 ms

tx = x ms (dependent on ramps)

Fig. 3.6 Signal sequence with interruption through STOP input

3.5.9 Trajectory generator

For a start signal for a positioning record via DIN8, fieldbus or RS232 interface, the selected positioning record is loaded to the trajectory generator.

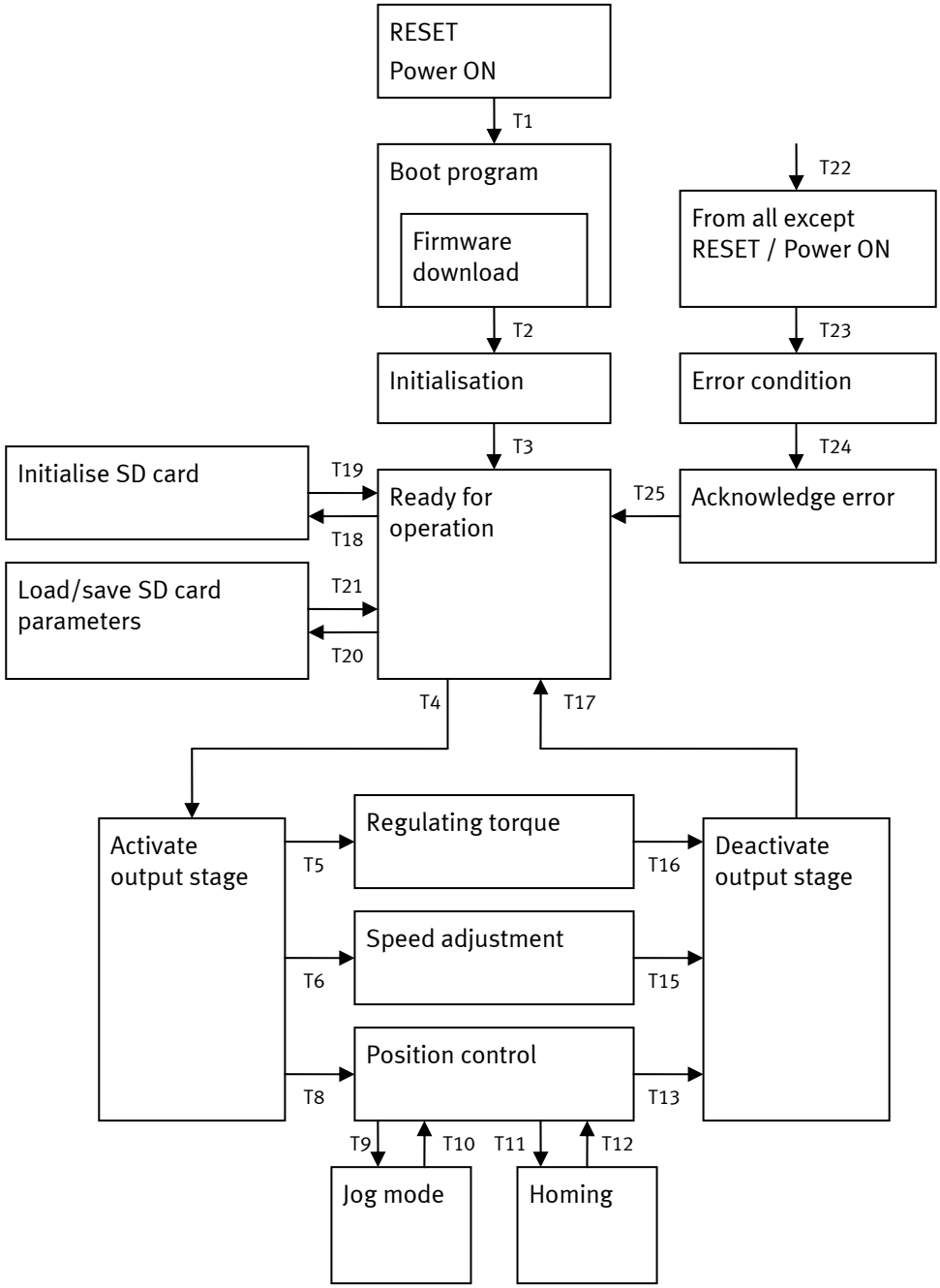
Based on the data record loaded, a necessary internal pre-calculation is made. The pre-calculations can take from 1.6 to 5 ms. The following configurable options are available for processing the start signal.

- After a start signal is detected during a current positioning run, the run continues to the target position.
- After a start signal is detected, positioning is cancelled and the drive runs at a constant speed. After pre-calculation is completed, the drive runs to the new target position.

The trajectory generator sends the following messages:

- Target reached, (Default: digital output DOUT1 – MC)
- Remaining distance reached.
-

3.5.10 I/O sequence control



T	Transition condition	Actions of the user
T1	RESET / Power ON	
T2	Time out has expired or the firmware download is complete.	
T3	The initialisation has been carried out successfully.	
T4		DIN4=1 and DIN5=1
T5	“Torque control” was selected in the commissioning software.	Setpoint specification via AIN0/AGND

T	Transition condition	Actions of the user
T6	“Speed control” was selected in the commissioning software.	Setpoint specification via AIN0/AGND
T8	“Positioning” was selected in the commissioning software.	Set selection via DIN0 ... DIN3, DIN10, DIN11 Start for the positioning process: DIN8=1
T9	All parameters for the jog mode were set in the commissioning software (e.g. max. speed, acceleration ...).	Selection I/O mode: DIN9=0, DIN12=1 Jog +: DIN10=1 Jog -: DIN11=1
T10		Selection I/O mode: DIN9=0, DIN12=1
T11	Selection of the homing method and configuration of the speeds and accelerations in the commissioning software.	Selection I/O mode: 0 DIN9=0, DIN12=0 Selection of positioning record 0 Start for positioning process: DIN8=1
T12	Drive is referenced.	
T13		DIN5=0
T15		DIN5=0
T16		DIN5=0
T17		DIN4=0
T18		Write or read request to SD card such as: - Load parameters - Save parameters - Firmware download.
T19	The SD card was initialised successfully.	
T20	“Load from SD after restart” was selected in the commissioning software.	
T21	Parameter record was loaded	
T22	A fault has occurred which causes the end stage to be switched off	
T23		
T24		Edge controlled fault acknowledgement DIN5: 1 - 0
T25	The error was acknowledged and no other errors are pending.	

Table 3.20 I/O sequence control

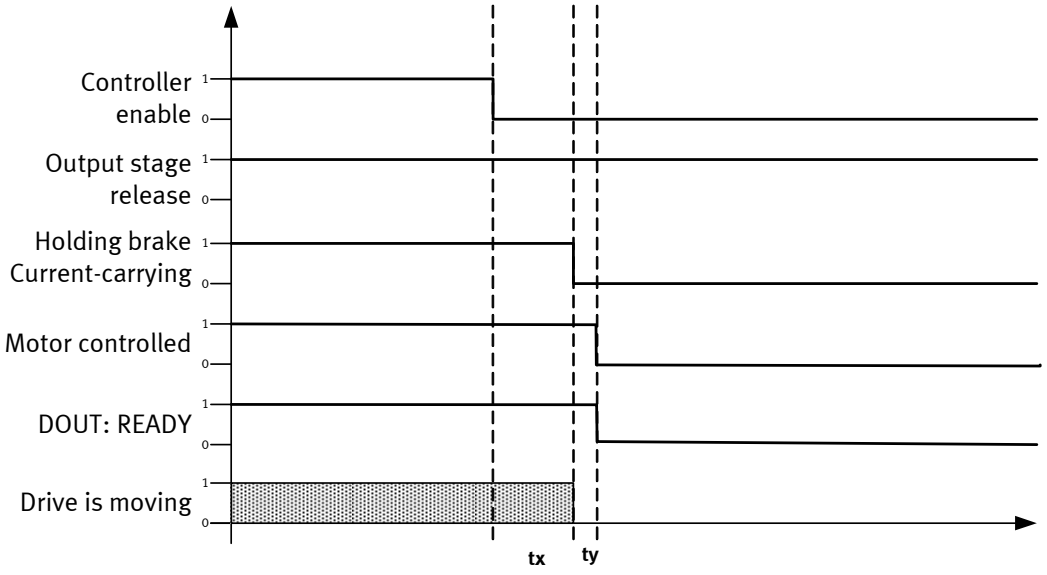
3.5.11 Error messages

The following conditions are monitored for safe operation of the CMMS-ST:

- End stage temperature,
- Intermediate circuit voltage to minimum and maximum value,
- Initialisation errors,
- Check-sum error on parameter transfer,
- Communication error,
- Contouring error (with increment generator only)
- Homing run,
- Overload current / short circuit in the power end stage,
- Encoder system,
- Watchdog (processor monitoring).

All error messages are documented in chapter 8.2.2 Error messages.

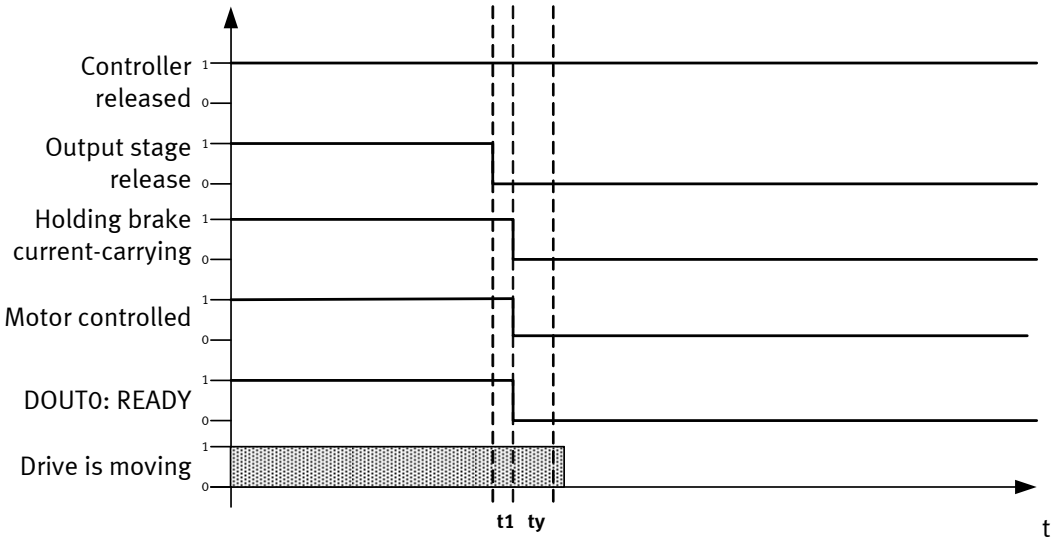
3.5.12 Behaviour when switching off enable



tx = x ms (dependent on brake ramps)

ty = x ms (dependent on set switch-off delay)

Fig. 3.7 Behaviour when switching off controller enable



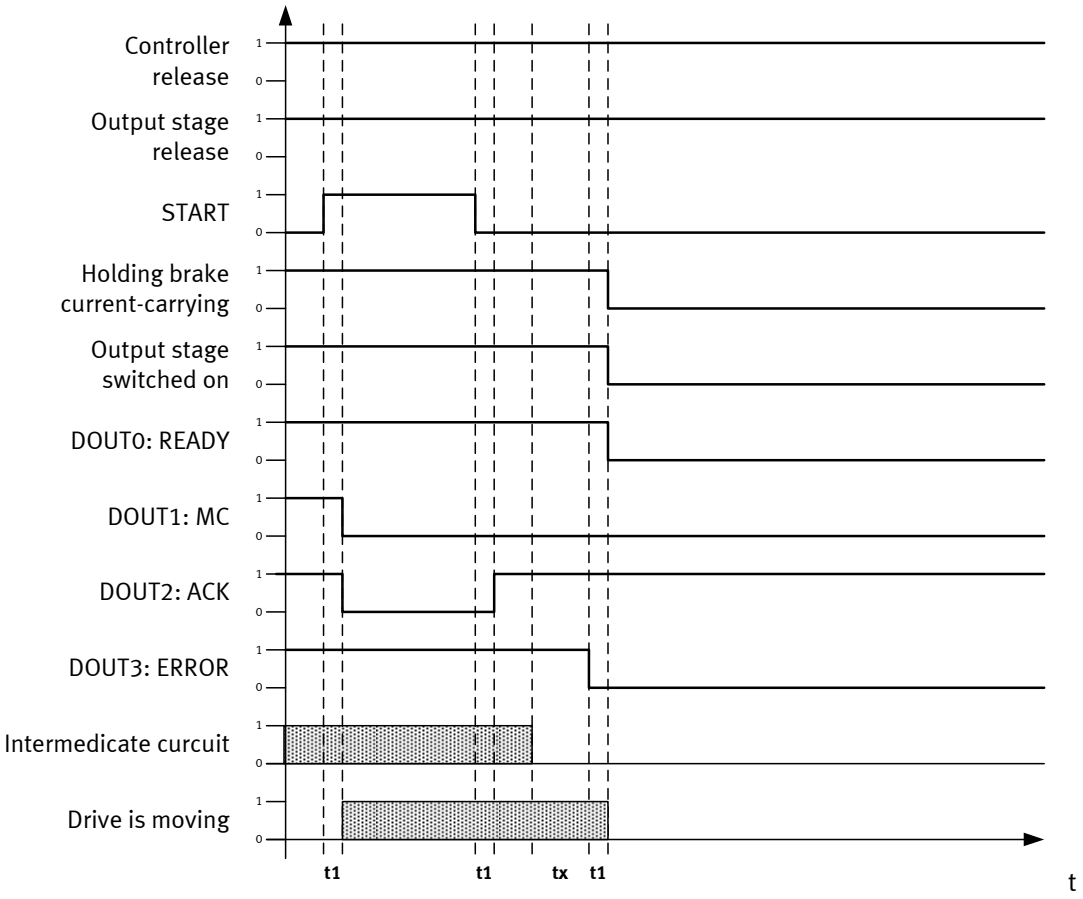
1 = 1.6 ms

ty = x ms (dependent on set switch-off delay)

Fig. 3.8 Behaviour when switching off end-stage enable

Note

The holding brake of the EMMS-ST-...-S**B**/-SE**B** is not suitable for braking the motor.



1 = 1.6 ms

tx = x ms (ZK discharges)

Fig. 3.9 Behaviour during interruption of the intermediate circuit supply (error: end stage off immediately)

Note

The holding brake of the EMMS-ST-?S**B**/-SE**B** is not suitable for braking the motor.

3.5.13 Oscilloscope function

The implemented oscilloscope function is an important aid to help the commissioning party optimise the controller settings without using a separate measuring device. The function allows important signal sequences to be recorded over time. It consists of three blocks:

- The initialisation section which runs at low priority and performs pre-calculations for the actual measurement process.
- The measuring section runs at a high priority in the rule interrupt and records the measuring channels. If the trigger condition occurs, the measurement process is cancelled after a defined number of scan steps.

- The data transfer section also has low priority. It is integrated in the time slice of the serial communication.

Two channels with 256 16-bit values each can be recorded. The following can be configured:

- Trigger source (current, speed, position, controller release, proximity switch)
- Trigger level
- Trigger option (auto, normal, force, rising / falling edge)
- Measurement frequency

3.5.14 Jog and teach function I/O

The jog / teach mode is parameterised via the parameterisation surface (FCT) or via the CANopen object. It can then be activated via the digital inputs for MODE 1. If the jog / teach mode is activated, two additional digital inputs are used to control the motor. The jog control overrides the current control system in this mode.

With position control, the motor is run continuously with the parameterised profile (jog mode) (positive / negative) if there is a positive signal to the digital input.

The digital input DIN8 serves to take over the set target position. The status of the digital position inputs DIN0-DIN3, DIN10 and DIN11 is thereby evaluated and the target position saved at the corresponding location.

General information

All positions of the positioning record table can be taught. (Pos.1-63) With falling edge of DIN8, the current position is taken over into the positioning record, which is selected with DIN0–DIN3, DIN10 and DIN11.

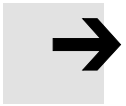
The following sequence must be observed:

- Switch on mode 1
- Jog with DIN10 and DIN11 into desired position
- Switch on DIN8
- Select the postions to be taught with DIN0 - DIN3, DIN10 and DIN11
- Switch off DIN8 Store the position in the positioning record table with falling edge DIN8

Final saving of the taught positions in the permanent memory takes place with falling edge from DIN5 controller enable.

Note

Make sure that the taught positions are written in the permanent memory before the controller is switched off.. Incorrect storing can make the parameter file invalid.



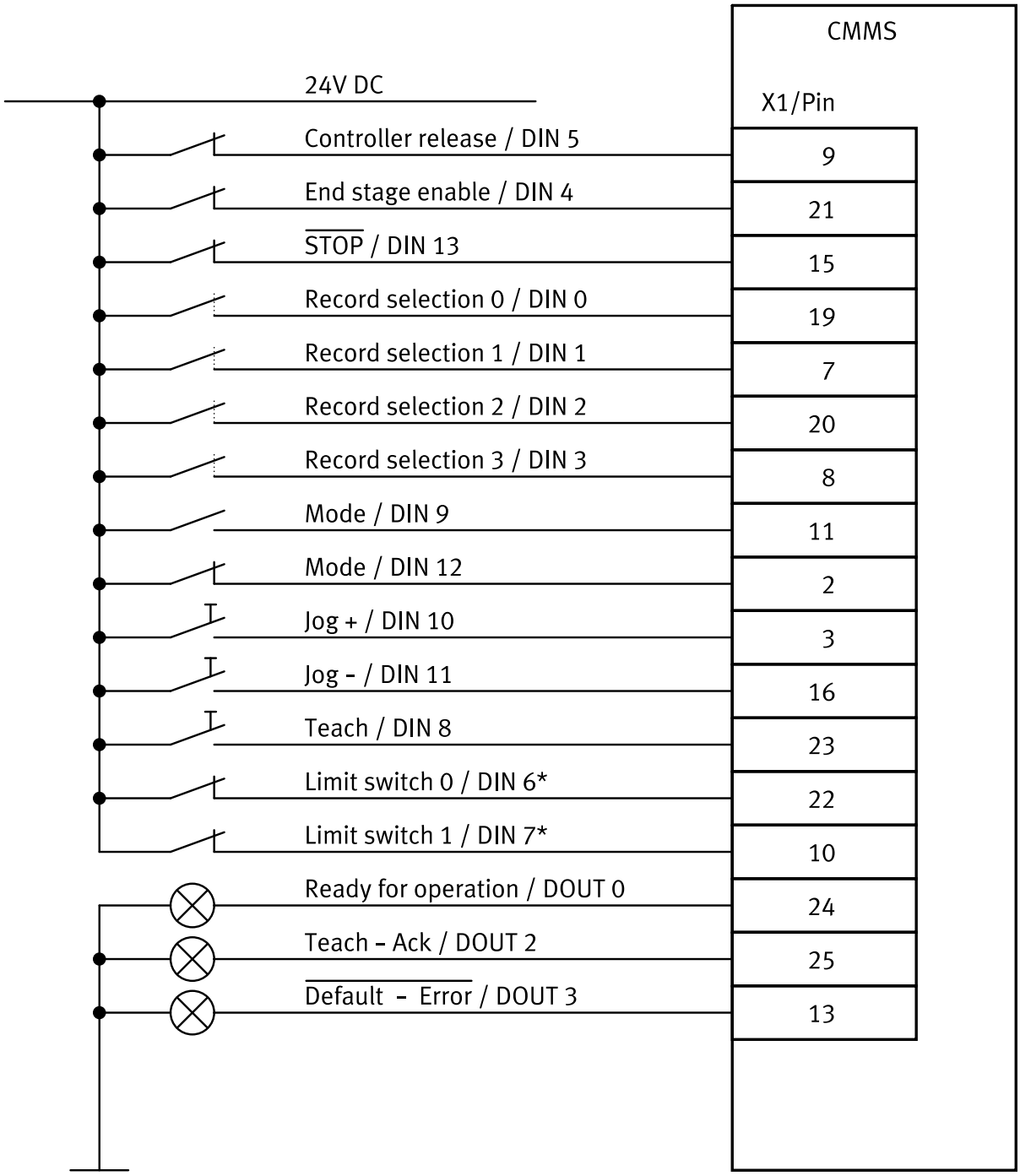
Note

The positions are saved on the SD card only through FCT. And so when jog/teach (without FCT) is used, an SD card may not be plugged in or “Read from SD after restart” must be inactive; otherwise, when the controller is restarted, the old values will be read off the SD card again.

Activating jog/teach function

The jog/teach function is started in I/O operation through selection of mode 1.

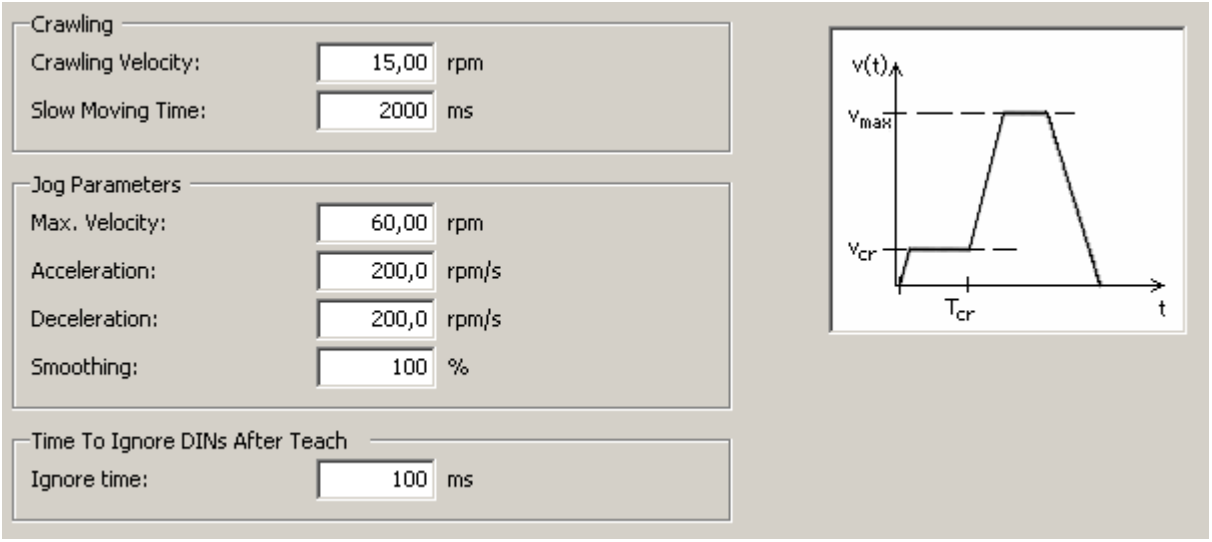
Necessary I/O connection with jog/teach



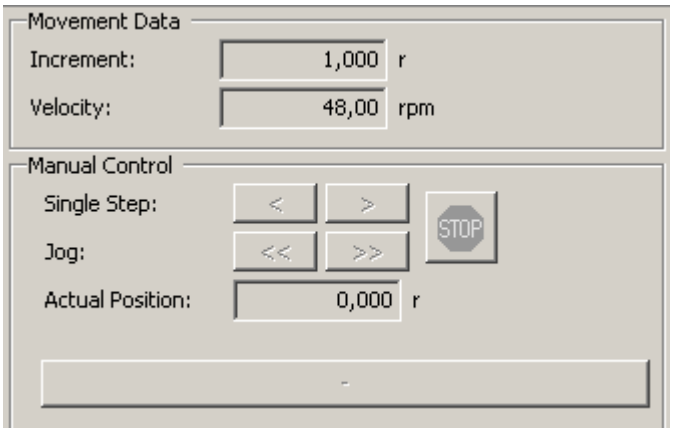
The connection plan shows the switch position in the active operating state.

*) The limit switches are set by default to opener (configuration over FCT)

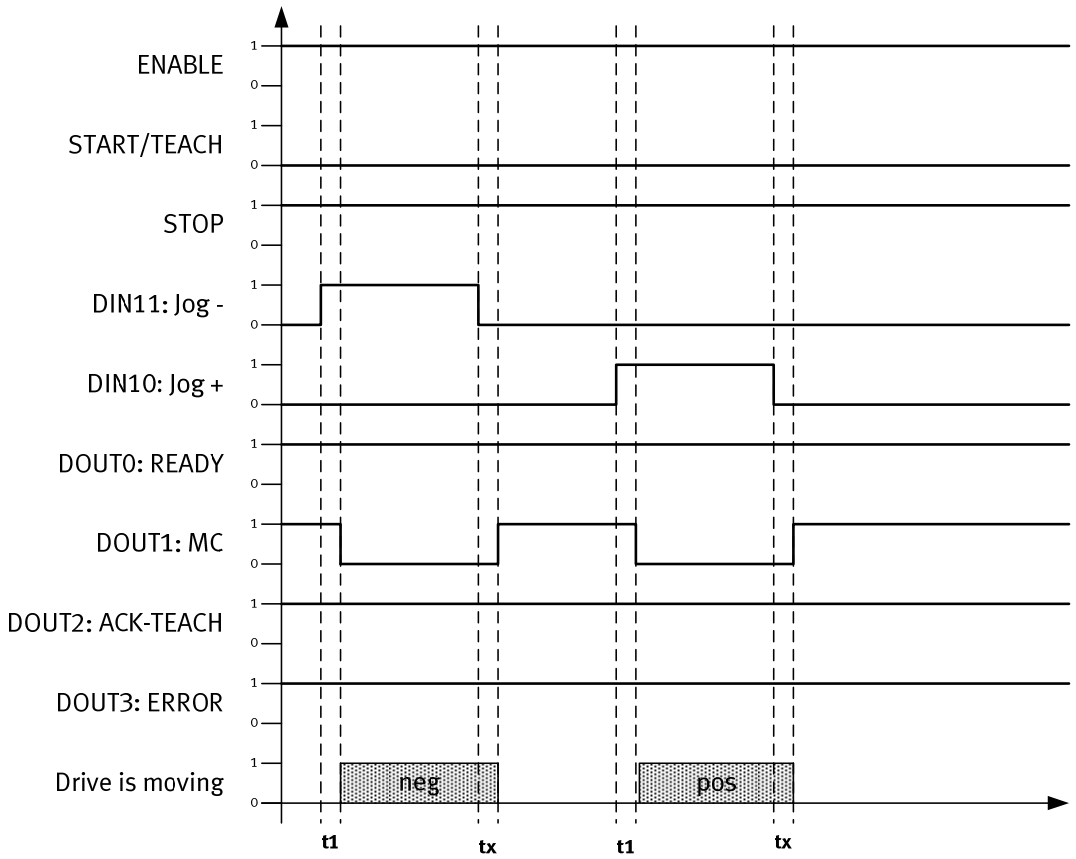
Settings in the FCT



The parameters set here are valid for jogging via I/O interface, jogging via FCT and for jogging/teaching via field bus if no other values are specified via the field bus. The acceleration also applies with “individual step” via FCT.



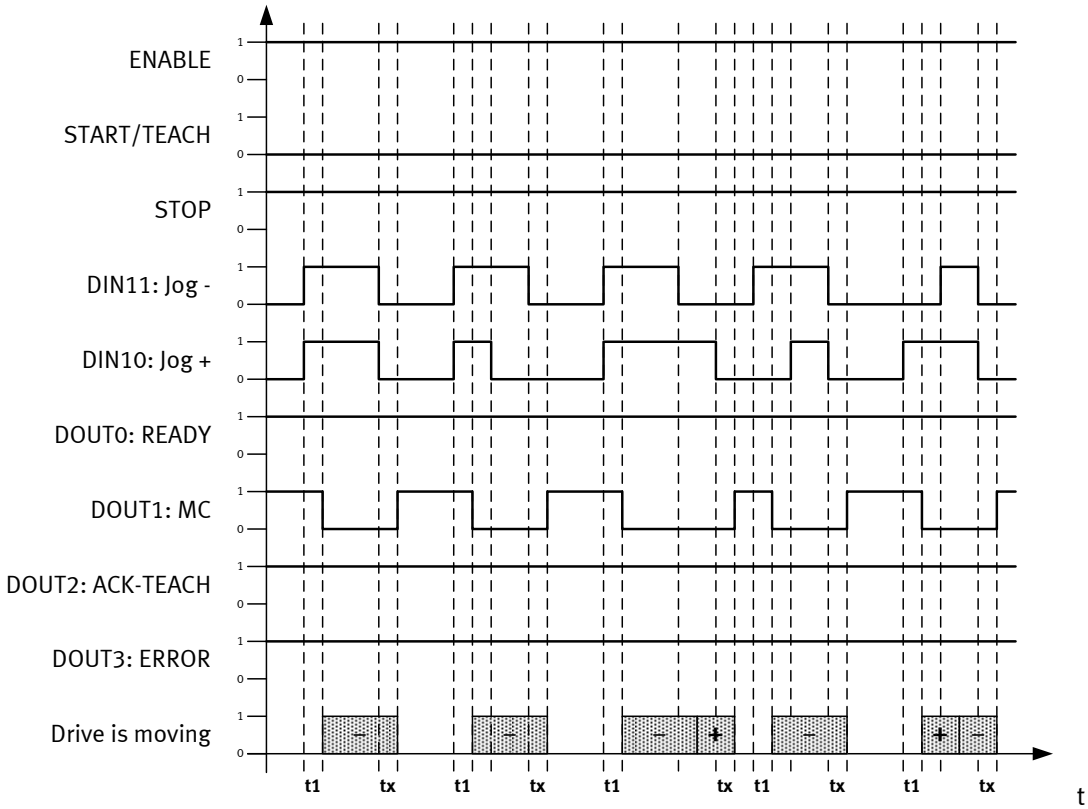
I/O timing diagrams



t1 = 1.6 ms

tx = x ms (dependent on brake ramps)

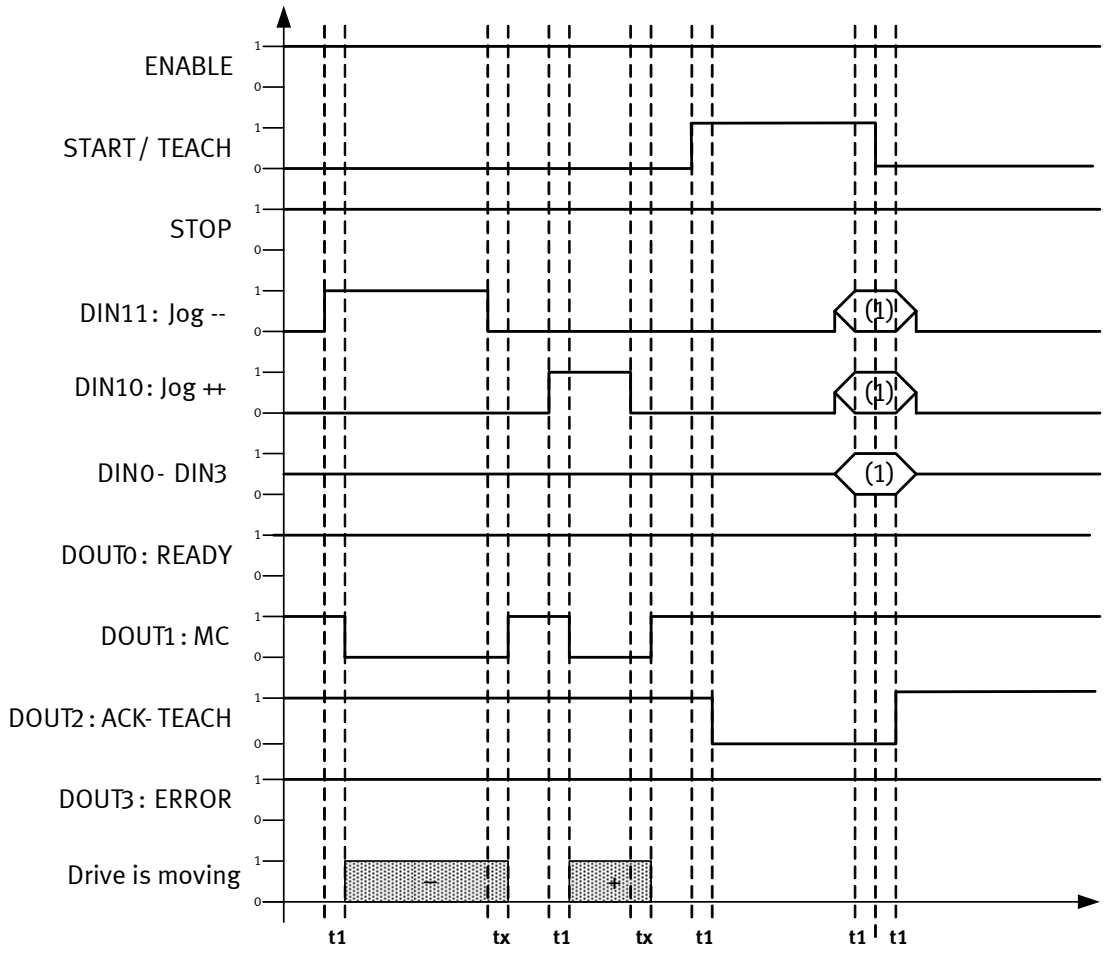
Fig. 3.10 Signal sequence with jogging positive and negative



1 = 1.6 ms

tx = x ms (dependent on brake ramps)

Fig. 3.11 Signal sequence when both signals are activated simultaneously / briefly staggered



t1 = 1.6 ms

tx = x ms (dependent on brake ramps)

(1) Setting of the target position to be programmed

Fig. 3.12 Behaviour with teach input

3.5.15 Position record linking with positioning/torque control switching

Positioning record linking allows multiple positioning jobs to be linked in a sequence. These positions are travelled to one after another. The characteristics of positioning record linking are:

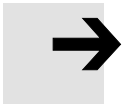
- All 63 position records of the position record table can be set.
- Besides linear sequences, ring-shaped linkages are also allowed. (endless linkage)
- For each step, a free following position can be set.
- As step criterion, 2 digital inputs are available as NEXT 1 and NEXT 2.
- There are 7 possibilities to jump into position record linking with I/O control, that is, 7 different sequences are possible. Under FHPP, the entry is freely selectable and the number limited only by the maximum number of position sets.
- The program lines are worked off every 1.6 ms. This ensures that a set output remains set for at least 1.6 ms.

- Position record linking can be controlled via digital inputs. Digital inputs in which the levels (high/low) are evaluated must remain stable for at least 1.6 ms (cycle time of the sequence control for position record linking).
- From every position record, any other position record can be started directly. You can transition to a new position record without first reaching end speed = 0.

Step criteria

Value	Condition	Abb.	Description
0	-	End	No automatic continuation.
1	Motion Complete	MC	Continues when the motion complete condition is fulfilled (tolerance window). Thus, during positioning, the axis is at a standstill for a moment if “0.00” min^{-1} (RPM) was entered.
4	Standstill	STS	Continues when the drive reaches a standstill and the programmed time for bridging the acceleration phase has expired. Standstill here does not just mean the end of the position record (MC), but also running to the block at any desired location. Time measurement starts when the position record starts.
5	Time	TIM	Continues when the programmed time has expired. Time measurement begins with the start of the position record.
6	NEXT (positive edge)	NRI	Continues immediately after a positive edge at DIN10 (NEXT1) or DIN11 (NEXT2).
7	NEXT (negative edge)	NFI	Continues immediately after a negative edge at DIN10 (NEXT1) or DIN11 (NEXT2).
9	NEXT (positive edge) waiting	NRS	Continues after the motion complete message and a positive edge on DIN10 (NEXT1) or DIN11 (NEXT2).
10	NEXT (negative edge) waiting	NFS	Continues after the motion complete message and a negative edge on DIN10 (NEXT1) or DIN11 (NEXT2).

Table 3.21 Step criteria



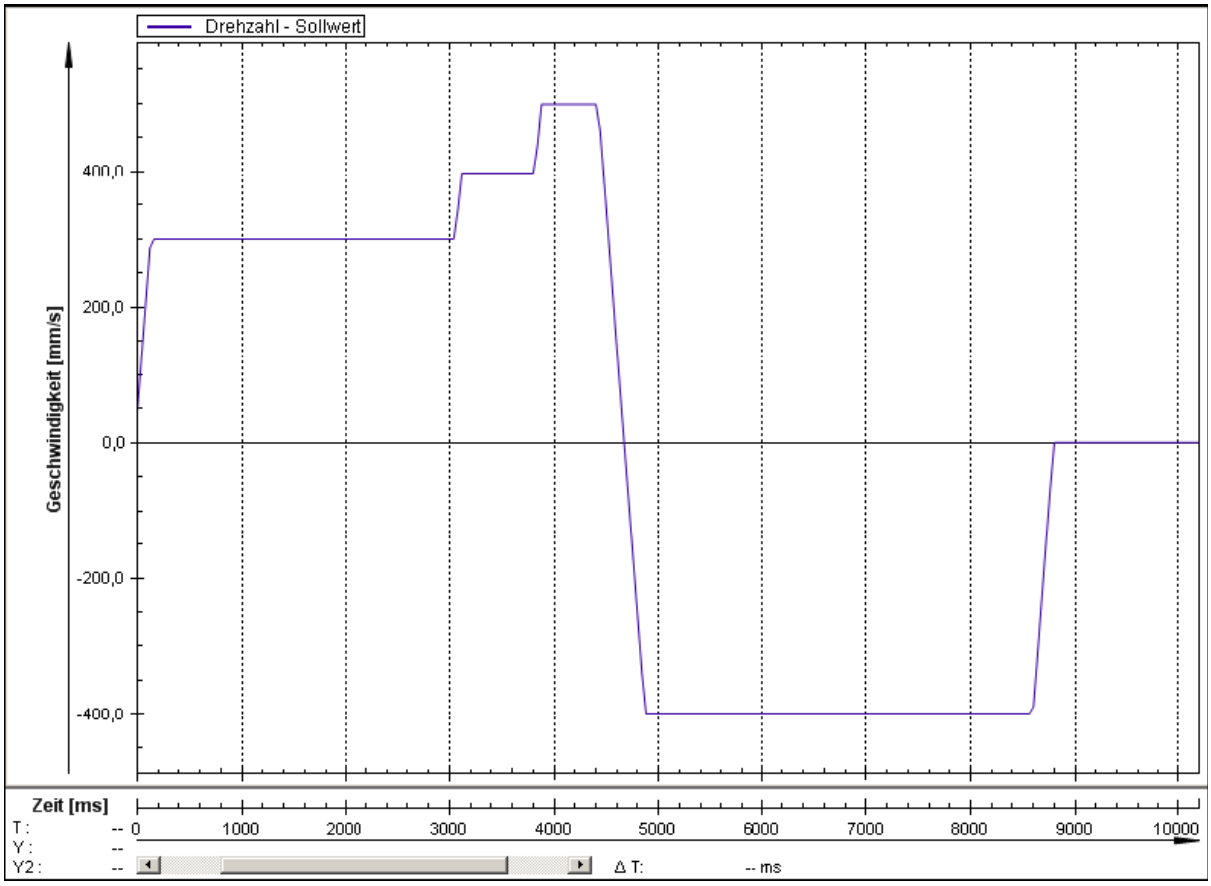
Note

The time specification for STS and TIM is the time entered in the motion profile. The time begins with execution of the position record.

Speed profiles with end speed ‹› 0

Position List | **Position Profiles**

No.	Vel. [rpm]	Accel. [rpm/s]	Decel. [rpm/s]	Smooth [%]	Time [ms]	Start D. [ms]	Fin.Vel. [rpm]	Startcond.	Comment
0	200,00	2000,0	2000,0	0	3000	0	0,00	Ignore	
1	240,00	2000,0	2000,0	0	0	0	200,00	Ignore	
2	60,00	60,0	60,0	0	0	0	0,00	Ignore	
3	60,00	60,0	60,0	0	0	0	0,00	Ignore	
4	60,00	60,0	60,0	0	0	0	0,00	Ignore	
5	60,00	60,0	60,0	0	0	0	0,00	Ignore	
6	60,00	60,0	60,0	0	0	0	0,00	Ignore	
7	60,00	60,0	60,0	0	0	0	0,00	Ignore	



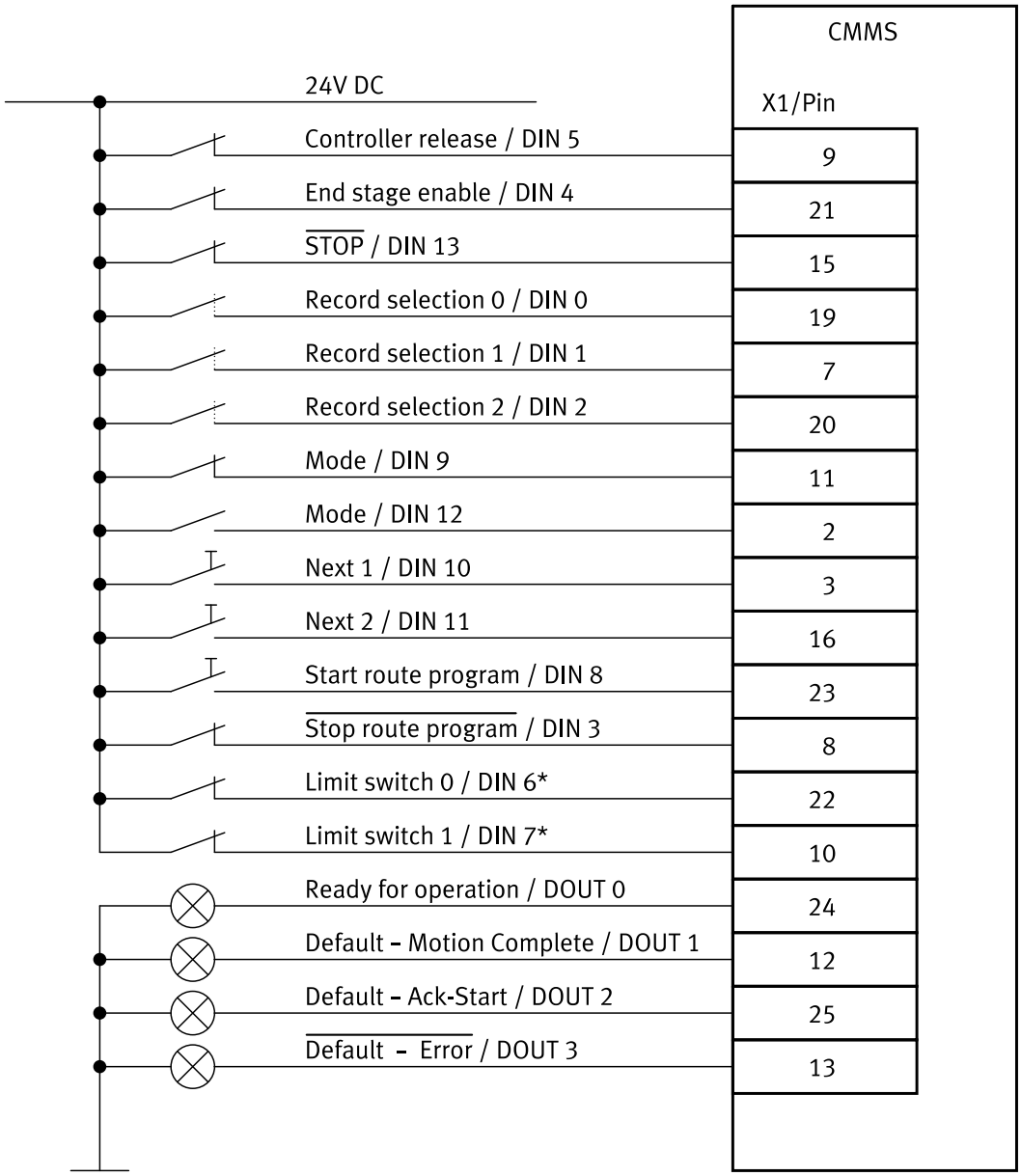
Note

Position record profiles that contain an end speed ‹› 0 must **NOT** be used for individual records, since the drive would continue to run uncontrolled.

Activation of record linking

Record linking is started in I/O operation through selection of mode 2.

Required I/O connection for record linking



The connection plan shows the switch position in the active operating state.

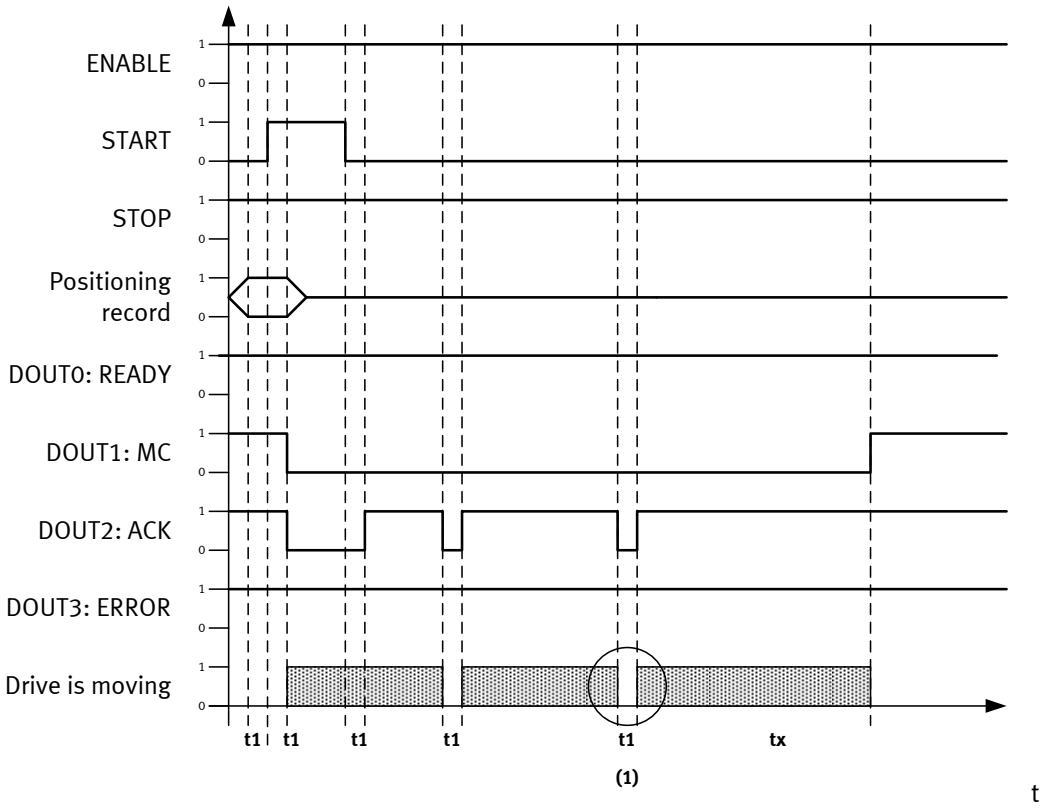
*) The limit switches are set by default to opener (configuration over FCT)

With removal of DIN3 “Halt record linking”, the ongoing record linking is stopped at the current position. If DIN3 returns, the record linking is automatically continued from this position.

With removal of DIN9 “Mode switchover”, the ongoing record linking is ended. The ongoing position record is still run to the end.

With removal of DIN13 “Stop”, record linking is interrupted. Record linking must then be initialised again.

I/O timing diagrams

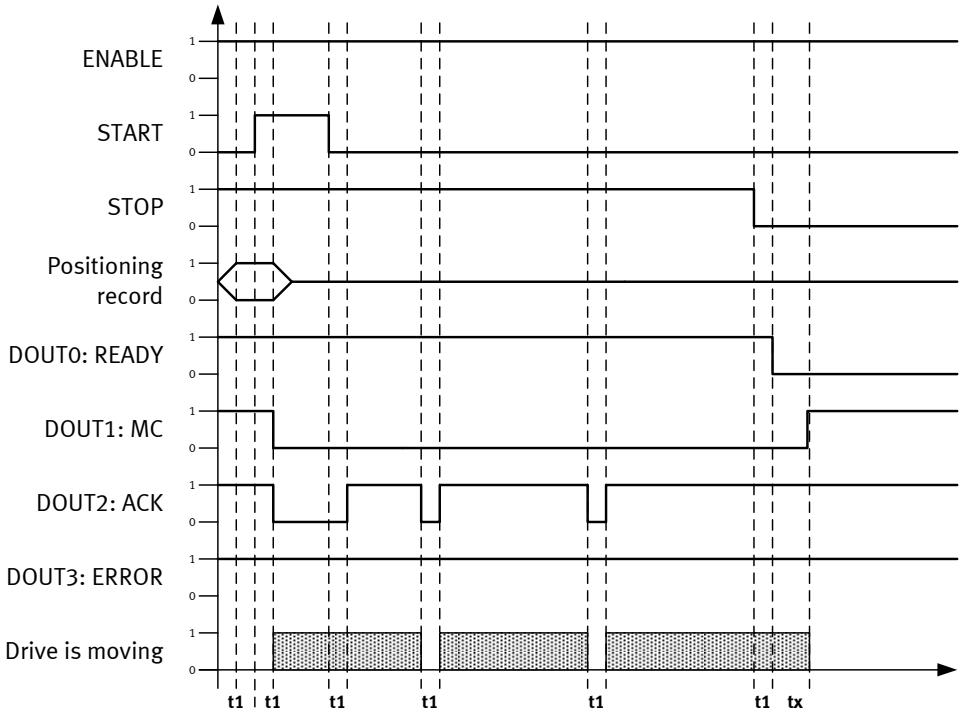


1 = 1.6 ms

tx = x ms (dependent on positioning)

(1) Applies for positioning records with end speed = 0

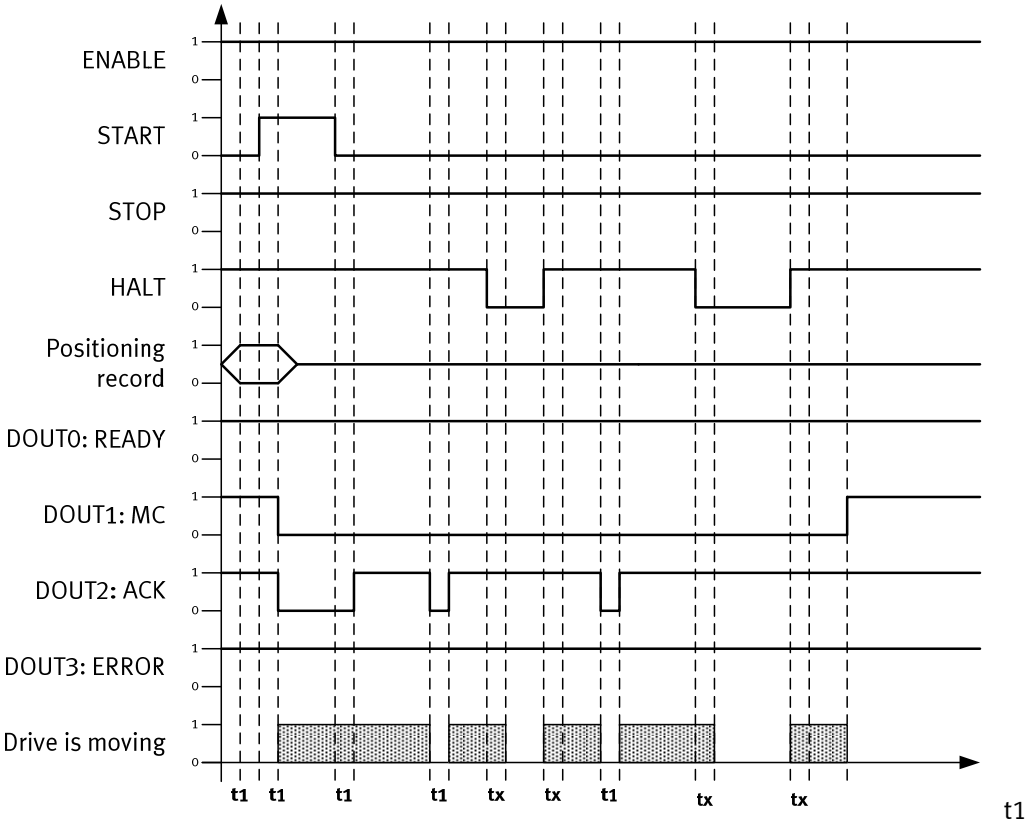
Fig. 3.13 Signal sequence at the start of a sequence with DIN0 ... DIN2 (positioning record 1 ... 7)



t1 = 1.6 ms

tx = x ms (dependent on brake ramps)

Fig. 3.14 Signal sequence with interruption through Stop input



= 1.6 ms

tx = x ms (dependent on brake ramps)

Fig. 3.15 Signal sequence with interruption and continuation through HALT input

3.5.16 On-the-fly measurement

This function offers the possibility to save the actual position value on the rising or falling edge of the digital input DIN9. This actual position value can then be read out for calculation within a controller, for example.

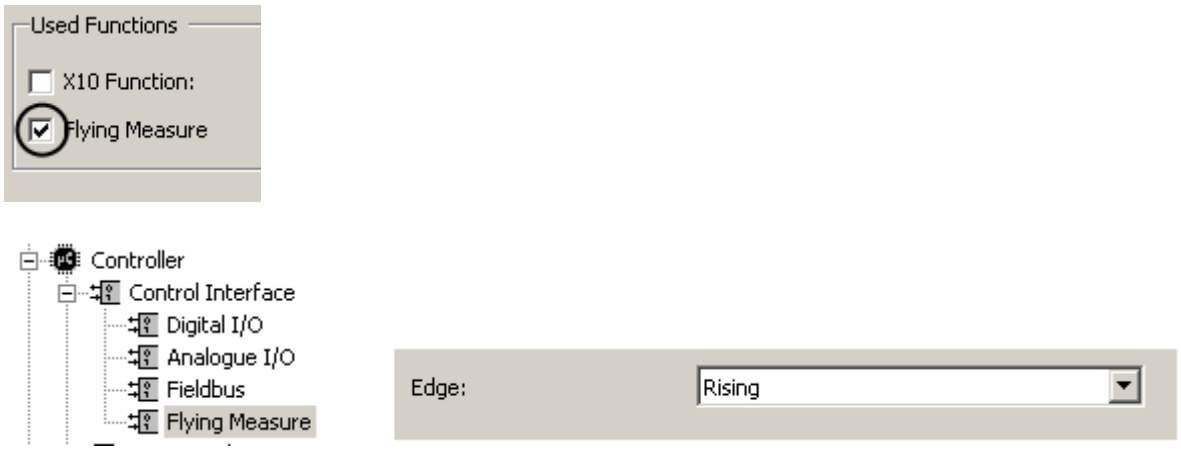
FHPP

PNU 350_1	sample_position_rising_edge
PNU 350_2	sample_position_falling_edge

CANopen

Object 204A_05	sample_position_rising_edge
Object 204A_06	sample_position_falling_edge

The function is activated during configuration, and the edge to be monitored is selected.



The On-the-Fly Measurement function supports continuous sampling, i.e. the configured edge is monitored and the stored actual position values are overwritten with each sample event.

3.5.17 Endless positioning

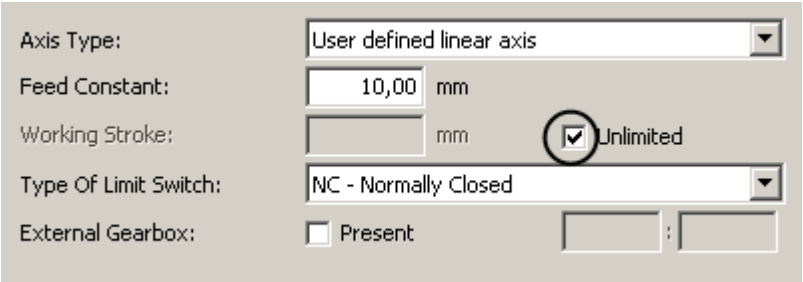
For applications such as “synchronised conveyor belt” or rotary indexing table, endless positioning is possible in one direction via relative positioning records.

No endless positioning is possible in jog mode, since absolute positions are always used as target here.

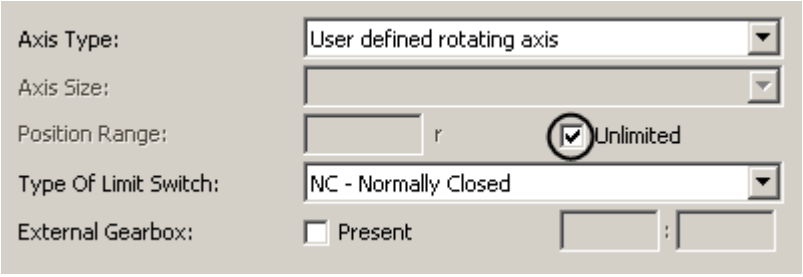
For relative position records, an overrun of the position counter is possible. That is, the position counter jumps from +32767 revolutions to -32768 revolutions, for example.

To be able to use the Endless Positioning function, the following settings must be made during configuration.

For linear axes:



For rotational axes:



The function Endless Positioning is selected by checking “Work stroke / positioning range unlimited”. The selection is currently supported only for user-defined linear and rotating axes.

Note

- Hardware limit switches can be used with unlimited axes only for the homing run.
- Software limit stops are deactivated.

3.5.18 Relative positioning records

When using relative positioning records, observe the following.

The controller is a 16-bit controller. That means, the controller calculates internally with 65536 increments per revolution. The controller calculates with whole numbers (integers). For positioning records that do not have a whole number as the result, the controller rounds up to the next whole number. This can result in deviations with endless positioning.

Example: rotary indexing table

4 positions. (90°) 65536:4= 16384 ----› Integer

6 positions. (60°) 65536:6= 10922,666 ----› The controller positions at 10923.

4. Functional safety engineering

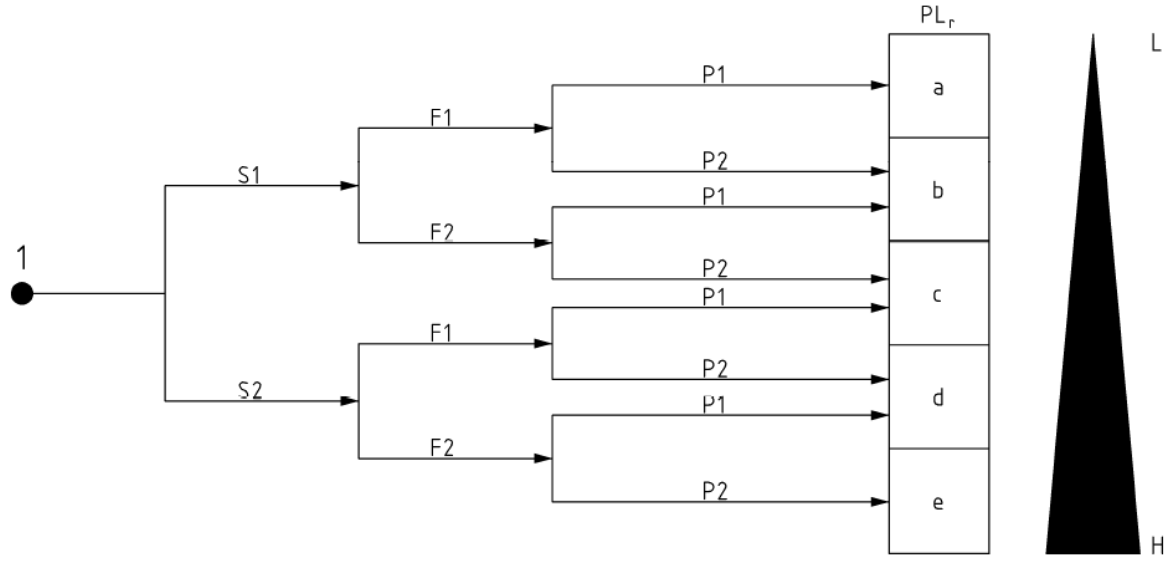
4.1 General remarks and intended use

The CMMS-ST-G2 family of position controllers supports the “Safe torque off (STO)” and “Safe Stop 1 (SS1)” safety function, providing protection against unexpected starting up as per the requirements of the standard EN 61508, SIL 2 as well as EN ISO 13849 1, PL d.

Bringing the machine to a standstill must be carried out and ensured by the machine control system. This especially applies to vertical axes without automatic-locking mechanics or counterbalancing.

The machine manufacturer must carry out a risk assessment as per the EC machinery directive 2006/42/EC. On the basis of this risk assessment, the machine manufacturer must design the safety system for the entire machine, including all integrated components. This also includes the electric drives.

The new EN ISO 13849 standard uses a changed risk graph for risk assessment and a deviating principle to achieve the requirements when compared to EN 954.



1 Starting point for evaluation of the risk reduction contribution

L Low contribution to risk reduction

H High contribution to risk reduction

PL_r Required performance level

Risk parameter

S Severity of injury

S1 Slight (generally reversible injury)

S2 Serious (generally irreversible injury, including death)

F Frequency and/or duration of the exposure to hazard

F1 Seldom to less often and/or the time of the exposure to hazard is short

F2 Frequent to continuous and/or the time of the exposure to hazard is long

P Possibility to avoid the hazard or limit the damage

P1 Possible under certain conditions

P2 Scarcely possible

Fig. 4.1 Risk graph for definition of the PL_r

Among other issues, the EN 60204-1 standard deals with the handling of emergencies and defines the terms EMERGENCY OFF and EMERGENCY STOP (see table).

Handling	Definition (EN 60204-1)	Danger case
EMERGENCY OFF	Electrical safety in case of emergency by switching off the electrical energy to all or part of the installation.	EMERGENCY OFF is to be used where a risk of electric shock or other electrical risk exists.
EMERGENCY STOP	Functional safety in an emergency by bringing a machine or movable parts to a standstill.	EMERGENCY STOP is used to stop a process or a motion if this creates a danger.

Table 4.1 EMERGENCY OFF and EMERGENCY STOP as per EN 60204-1

The standard EN 61800-5-2 describes various safety functions that can be used dependent on the application.

For the position controllers of the CMMS-ST-G2 family, the STO and SS1 safety functions have been implemented through external circuitry.

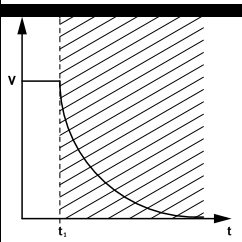
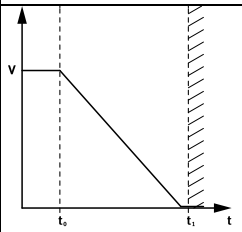
Safety function as per EN 61800-5-2		PILZ* component	Switch-off behaviour	Stop category as per EN 60204-1
STO	Safe torque off	PNOZ X2P (Relay outputs forced: – 2 safety contacts no delay Connection options for: – EMERGENCY OFF pushbuttons – Protective door limit switches – Start button)		0
SS1	Safe Stop 1	PNOZ XV2P (Relay outputs forced: – 2 safety contacts no delay – 2 safety contacts relapse delayed Connection options identical to X2P; Fixed or adjustable relapse delay; Cancelling the time delay via Reset button)		1
*or comparable safety switch device with corresponding safety contacts				

Table 4.2 Overview of the safety function in accordance with EN 61800-5-2

An overview of the various stop categories is provided by the Table 4.3.

Stop category	Type	Handling
0	Uncontrolled shutdown through immediate switching off of the energy.	EMERGENCY OFF or EMERGENCY STOP
1	Controlled shutdown through switching off of the energy when a standstill has been reached.	EMERGENCY STOP
2	Controlled shutdown without switching off the energy in standstill.	Not suitable for EMERGENCY OFF or EMERGENCY STOP

Table 4.3 Stop categories

4.2 Integrated function “STO”

Warning

The general safety functions do not provide protection from electric shock but only from dangerous movements!

4.2.1 General remarks / description of “STO Safe Torque Off”

With the Safe Torque Off function (STO), the power supply to the motor is securely interrupted through switching off of the end stage enable and of the power supply to the output stage. The drive cannot generate torque or any force and so cannot make any dangerous movements. If the STO function is activated with a moving drive, the motor starts to run out in an uncontrolled manner after at most 3.2 ms. At the same time, the automatic brake control is activated. If you use motors with a holding brake, each STO disconnection places wear and tear on the brake. Therefore, use the SS1 function for STO motors without holding brakes. A description of the SS1 function can be found in the next chapter 4.3. Application examples for the STO function are manual actions during setup, changeover and error resolution.

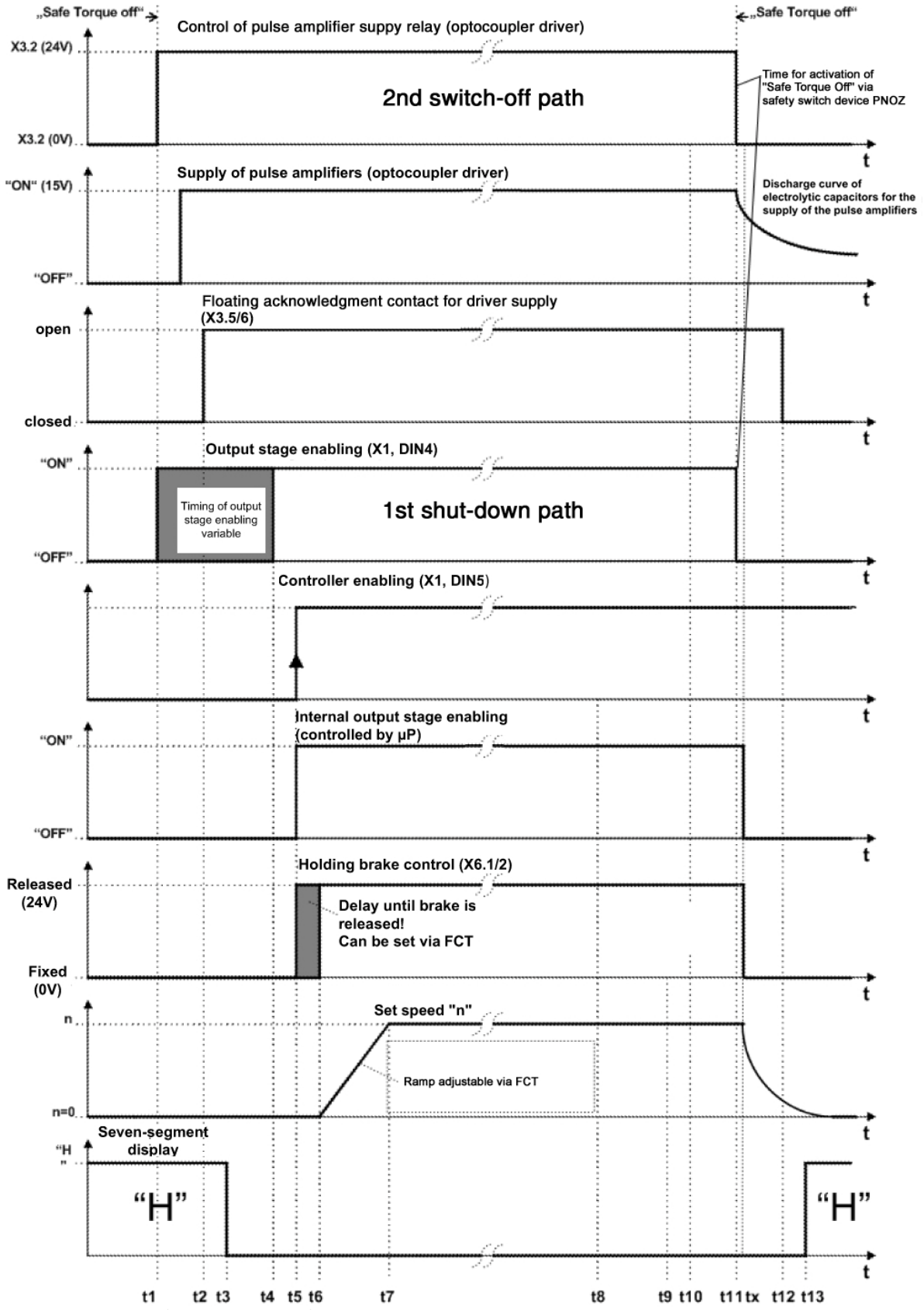
The use of the integrated solution offers several advantages:

Advantages

- Fewer external components, e.g. circuit breakers
- Less cabling effort and less space required in the control cabinet
- And so lower cost

Another advantage is the availability of the system. The integrated solution allows the intermediate circuit of the controller to remain charged. This means no significant waiting time when the system is restarted.

4.2.2 STO timing diagram



tx = 1.6 ms (controller cycle time)

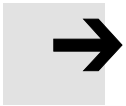
Fig. 4.2 Timing diagram for the STO safety function

Restart after activated “Safe standstill”

Before switching it on again, make sure that all hazards have been eliminated and the system can be safely placed in operation again. If there are areas inside that can be entered, a manual acknowledgement must be made via the optional S2 button (see switching example).

In order to switch the end stage of the CMMS-ST-G2 controller active again and thus operate the connected motor, the following steps must occur:

1. The relay control for switching the end stage driver power supply (2nd switch-off path) must be supplied with 24V between pin 2 and pin 3 of [X3] at time t1.
2. The driver supply is then charged.
3. The potential-free feedback contact ([X3] Pins 5 and 6) for plausibility checking of the driver supply relay control opens a maximum of 20 ms after t1 (t2-t1) and the driver supply is switched off.
4. Approx. 10 ms after the acknowledgment contact opens, the “H” on the display goes out at time t3.
5. The time for the end stage enable ([X1], DIN4) is largely freely selectable (t4-t1). The enable may occur at the same time as the relay is controlled, but it must occur approx.10 衽 (t5-t4) before the rising edge of the controller enable ([X1], DIN5), depending on the application.
6. The rising edge of the controller enable at time t5 releases the motor holding brake (if present) and the end stage enable occurs. The brake can only be released when the relay for switching the driver supply is engaged. Using the parameterising software, a travel start delay time (t6-t5) can be set that regulates the drive at a speed of “0” for the specified time and, after this delay, causes it to move at the set speed at time t6.
7. At time t7 the drive has reached the set speed. The requires ramp settings can be parameterised using the FCT parameterising software.



Note

If external forces (e.g. hanging loads) have an effect on the drive, additional measures (e.g. mechanical brakes) are necessary to avoid hazards.

The Safe Stop 1 stop function (SS1), in which the drive is brought to standstill in a controlled manner, is then always preferred.

4.2.3 CMMS-ST STO sample circuit

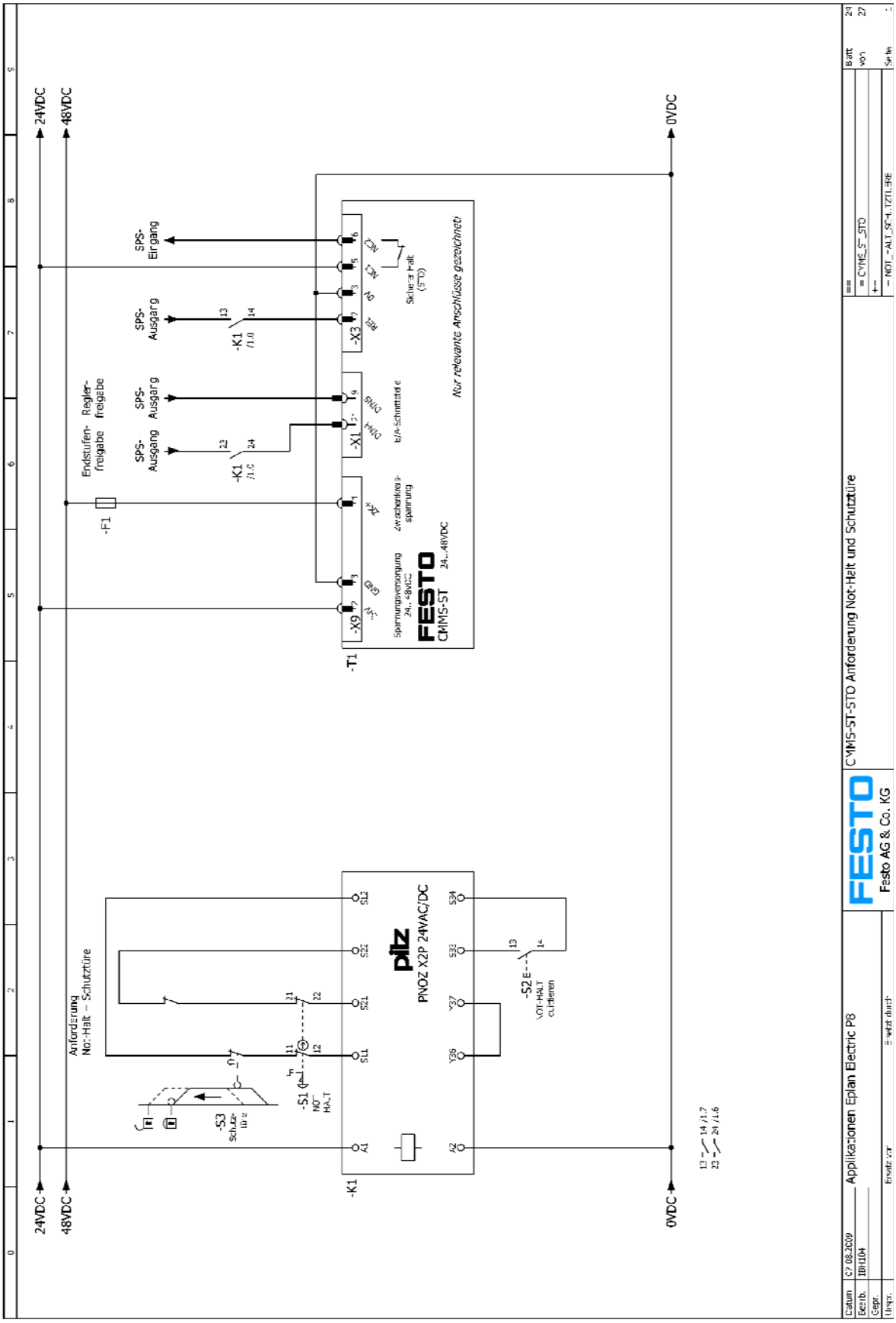


Fig. 4.3 Circuit diagram for STO safety function with CMMS-ST-G2

4.2.4 Explanations of the sample circuit

The circuitry example shows a combination of the CMMS-ST-G2 with a PILZ PNOZ X2P safety switch device. An emergency stop in combination with a protective door is drawn as a switch device. In total, three logic elements can be switched in series. A door position switch can also be used that keeps the protective door closed until the drive has stopped or the “Driver supply acknowledgment” signal indicates a safe state and the plausibility check is successful.

Technical data, such as max. current, etc. can be found in the data sheet of the safety switch devices.

4.2.5 EMERGENCY STOP request, monitoring of protective doors

After the Emergency Stop is actuated or the protective doors are opened, the two normally open contacts of K1(13, 14 and 23, 24) open immediately. This results in the immediate removal of the end-stage enable and disconnection of the driver supply via [X3] Pin 2. The unintended opening of the protective doors must be prevented in the system.

Approx. 80 ms after opening of the PNOZ contacts for switching off the driver supply, the acknowledgment contact ([X3], Pin 5 and 6) is closed.

At least 30 ms after the potential-free acknowledgment contact closes, an “H” is displayed on the 7-segment display of the controller to indicate a “Safe standstill”.

Due to the drawn circuitry, a two-channel operation with cross-circuiting recognition is possible. This permits recognition of:

- Earth faults in the start and initial circuit
- Short circuits in the initial circuit / start circuit
- Cross circuits in the initial circuit.

Removal of the end-stage enable and switching off the driver supply via [X3] Pin 2 causes the drive to run out.

4.2.6 Testing the safety function

For each on-off cycle of the machine, the PILZ device PNOZ X2P checks whether the relays of the safety equipment open and close properly.

The function of switching off the output stage enable must be checked regularly (e.g. monthly) via the PLC.

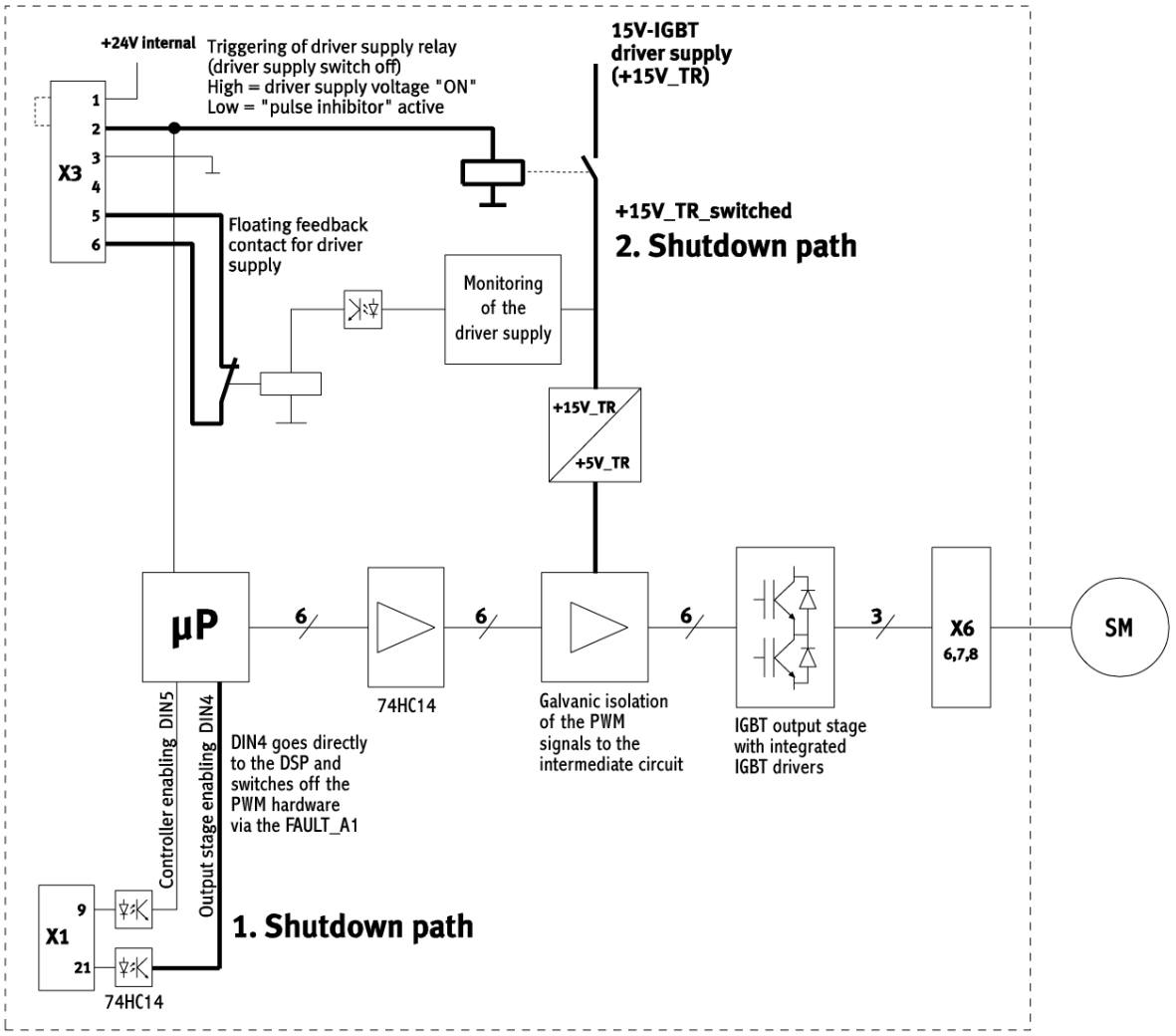


Fig. 4.4 “Safe Torque Off” block diagram as per EN 61508, SIL 2

Caution

If the “Safe torque off” function is not required, then pins 1 and 2 on [X3] must be bridged.

For “STO” as per EN 61508, SIL 2, a second channel is required, i.e. a restart must be reliably prevented via two separate, completely independent paths. These two paths for interrupting the energy supply to the drive with the reliable impulse block are called switch-off paths:

1st Switch-off path:	End stage enable via [X1] (blocking of the PWM signals; the IGBT drivers no longer receive pulse patterns).
2nd switch-off path:	Interruption of the supply for the six end stage IGBTs via[X3] using a relay (the IGBT optocoupler drivers are removed from the power supply via a relay, thus preventing the PWM signals from reaching the IGBTs). A plausibility check between the relay control for the end stage driver supply and the monitoring of the driver supply is performed by the microprocessor. This is used for error detection of the impulse block and also for suppressing error message E 05-2 (“Driver supply undervoltage”) which occurs in normal operation.
Potential-free acknowledgment contact:	The integrated “Safe torque off” circuit also has a potential-free acknowledgment contact ([X3] Pin 5 and 6) for the presence of the driver supply. This is an N/C contact. It must be connected to the higher-order controller, for example. The function of switching off the end stage enable must be checked regularly via the PLC (e.g. monthly; contact open = driver supply available). If an error occurs in the plausibility check, the control system must prevent further operation, for example by switching off the intermediate circuit voltage or breaking off the output stage enable by the PLC.

4.3 SS1, Safe Stop 1

4.3.1 Explanation

In the function “Safe Stop 1” (SS1), the drive is run down in a controlled way and, after that, the power supply to the final output stage is switched off. As a result, the drive cannot generate torque or any force at standstill and so cannot make any dangerous movements.

4.3.2 SS1 timing diagram

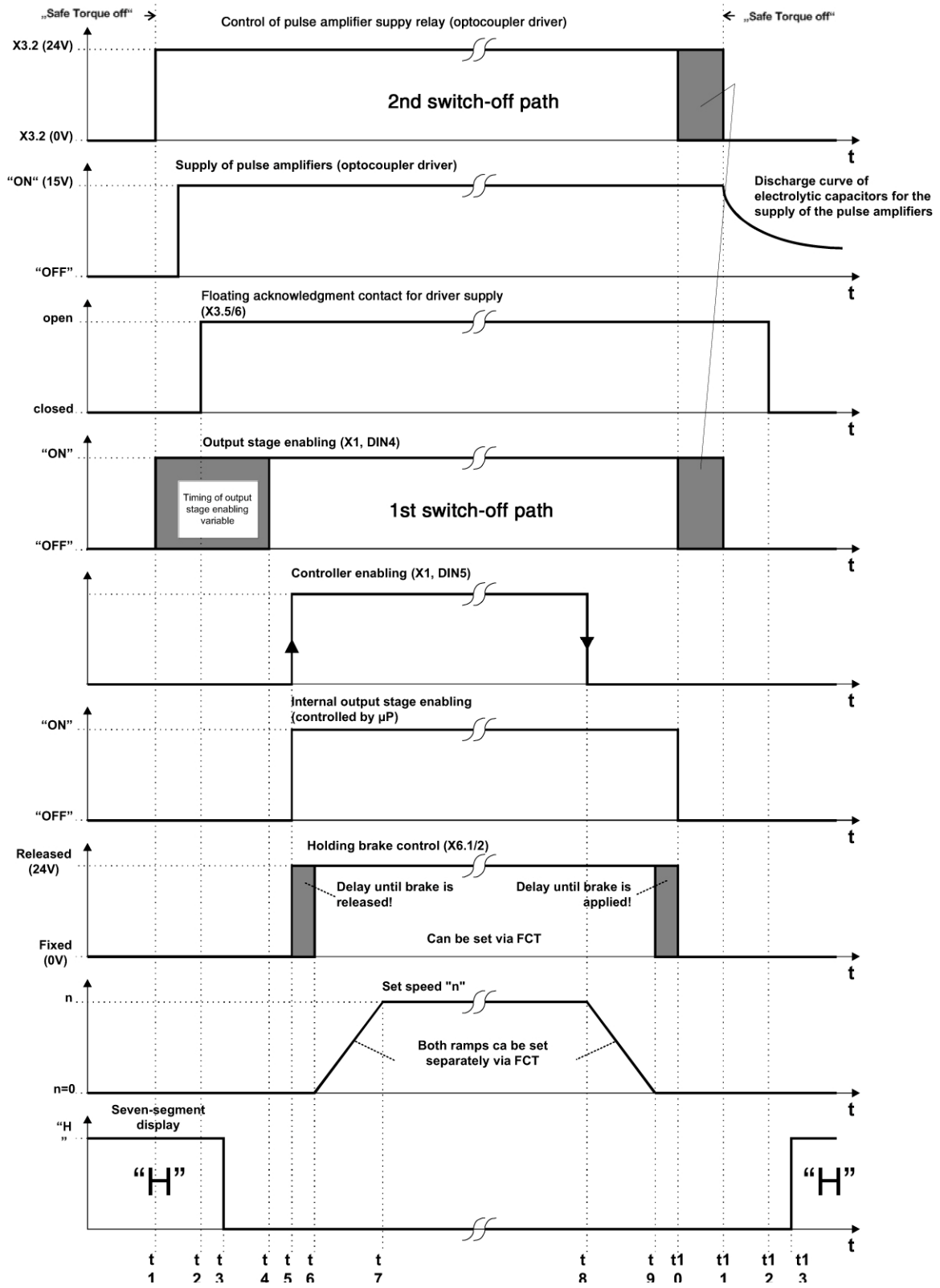


Fig. 4.5 Timing diagram for the SS1 safety function

tv = t(PNOZ XV2p)

The switch-off delay tv takes off as soon as a standstill is recognised by the motor controller.

4.3.3 Description of the timing diagram:

This timing diagram is based on the example of speed regulation using the controller enable DIN 5 at [X1]. For Fieldbus applications, the controller enable is additionally controlled via the respective Fieldbus. Depending on the application, the operating mode is also parameterisable via the parameterising software.

Starting state:
- The 24V supply is switched on and the intermediate circuit is charged.
- The controller is in the ”Safe standstill” status. This state is indicated by a flashing ”H” on the 7-segment display.

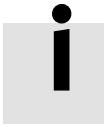
In order to switch the controller end stage active once more, and thus operate the connected motor, the following steps must occur:

1. The relay control for switching the end stage driver power supply (2nd switch-off path) must be supplied with 24V between pin 2 and pin 3 of [X3] at time t1.
2. The driver supply is then charged.
3. The potential-free feedback contact ([X3] Pins 5 and 6) for plausibility checking of the driver supply relay control opens a maximum of 20 ms after t1 (t2-t1) and the driver supply is switched off.
4. Approx. 10 ms after the acknowledgment contact opens, the ”H” on the display goes out at time t3.
5. The time for the end stage enable ([X1], DIN4) is largely freely selectable (t4-t1). The enable may occur at the same time as the relay is controlled, but it must occur approx.10 衽 (t5-t4) before the rising edge of the controller enable ([X1], DIN5), depending on the application.
6. The rising edge of the controller enable at time t5 releases the motor holding brake (if present) and the end stage enable occurs. The brake can only be released when the relay for switching the driver supply is engaged, since this controls a MOSFET in the holding brake circuit. Using the parameterising software, a travel start delay time (t6-t5) can be set that regulates the drive at a speed of ”0” for the specified time and, after this delay, causes it to move at the set speed at time t6. The travel start delay time is set to ensure that the brake has actually released before motion begins. For motors without a holding brake, this time can be set to 0.
7. At time t7 the drive has reached the set speed. The requires ramp settings can be parameterised using the FCT parameterising software.

4.3.4 Activation of “Safe Stop 1”

The following steps show how you can bring a rotating drive into the ”Safe standstill” state:

1. Before ”Safe torque off” is activated (i.e. the driver supply relay ”OFF” and the end stage enable ”OFF”; both switch-off paths block the PWM signals), the drive should be brought to a standstill by removing the controller enable. Depending on the application, the braking ramp (t9-t8) can be parameterized using the parameterizing software (”Emergency stop braking acceleration”).
2. After reaching a speed of 0, the drive is controlled at this setpoint for a parameterisable switch-off delay time (t10-t9). This adjustable time is the delay required to apply the motor holding brake. This time depends on the holding brake used and must be parameterised by the user. For applications without a holding brake, this time can be set to 0.
3. After this time, the internal end stage enable is switched off by the microprocessor (t10).



The holding brake is always applied when the ”braking ramp time + set switch-off delay“ has expired, even when the drive has not come to a stop within this time.

4. From time t10, the "Safe torque off" can now be activated (driver supply relay and end stage enable switched off at the same time). Time (t11-t10) depends on the application and must be defined by the user.
5. When the driver supply relay control signal is removed (t11) the capacitors in this circuit area discharge. Approx 80 ms (t12-t11) after removing the driver supply relay control signal the feedback contact closes ([X3], Pin 5 and 6).

At time t13, an ”H“ is displayed on the 7-segment display of the controller to indicate a ”Safe standstill“. This occurs at least 30 ms after the potential-free feedback contact closes (t13-t12).

4.3.5 Setting the switch-off delay

The switch-off delay of the holding brake must be set in the FCT. The set time is necessary, as the brake does not close immediately due to the mechanical design. If this set time = 0 or <= 10 ms, the vertically hanging load can briefly slip through.

4.3.6 Parameterisation example FCT

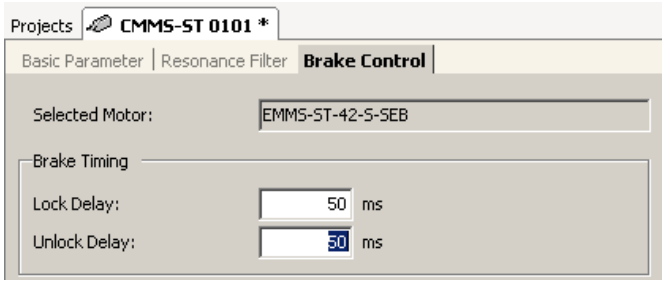


Fig. 4.6 Parameterisation example

4.3.7 CMMS-ST-G2 SS1 sample circuit

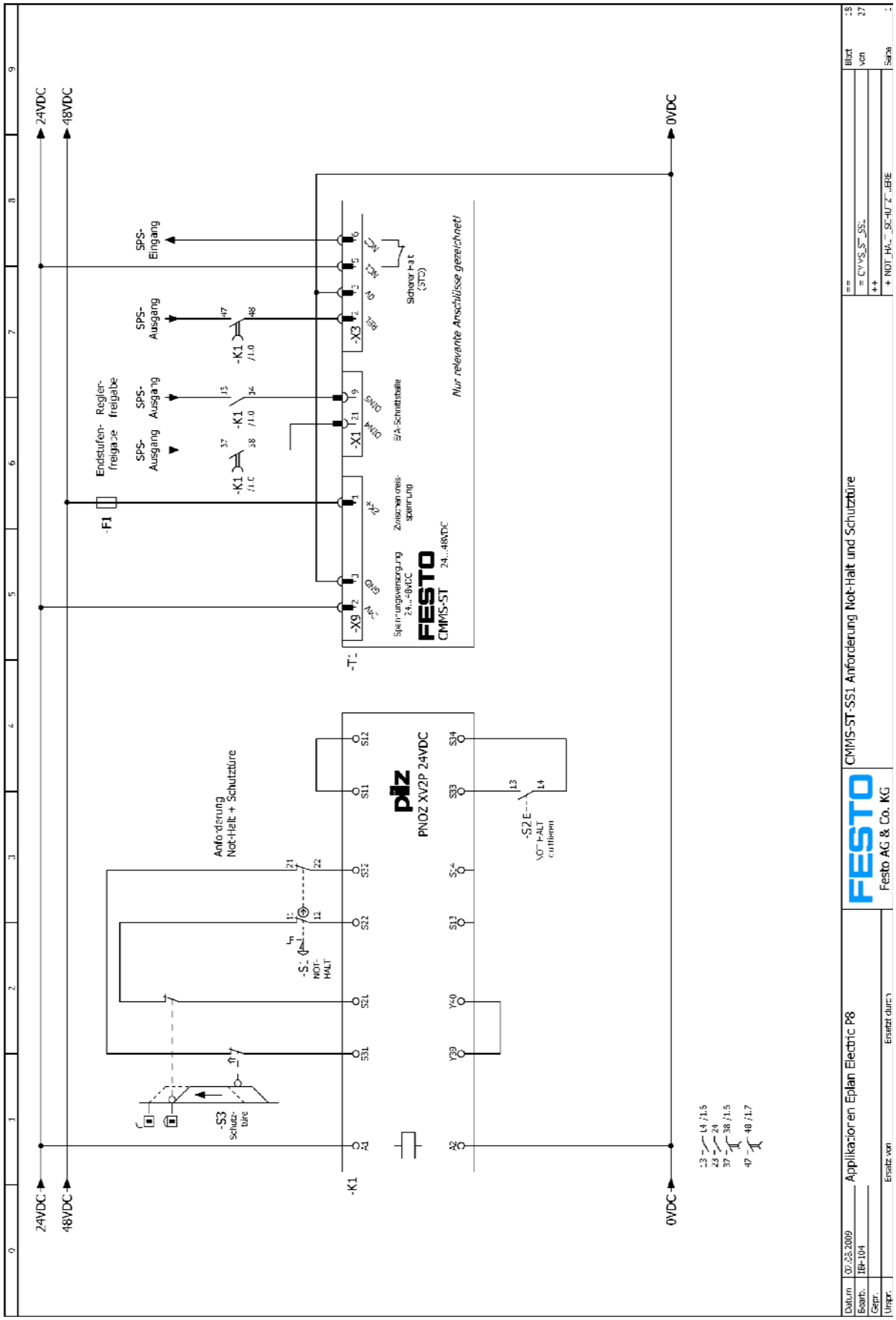


Fig. 4.7 Circuit diagram for SS1 safety function with CMMS-ST-G2

4.3.8 Explanations of the sample circuit

The circuitry example shows a combination of the CMMS-ST-G2 with a PILZ PNOZ XV2P safety switch device. An emergency stop in combination with a protective door is drawn as a switch device. In total, three logic elements can be switched in series. A door position switch can also be used that keeps the protective door closed until the drive has stopped or the “Driver supply acknowledgment” signal indicates a safe state and the plausibility check is successful.

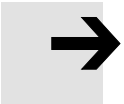
Technical data, such as max. current, etc. can be found in the data sheet of the safety switch devices.

4.3.9 EMERGENCY STOP request, monitoring of protective doors

After the Emergency Stop is actuated or the protective doors are opened, the normally open contact K1 (13, 14) opens immediately. This results in the immediate removal of the controller release. This introduces the ramp function of the controller. The controller brakes with the set Quick Stop delay. After reaching a speed of 0, the drive is controlled at this setpoint value for a parameterisable switch-off delay time (ty). This adjustable time is the delay required to apply the motor holding brake. This time depends on the holding brake used and must be parameterised by the user. For applications without a holding brake, this time can be set to 0.

After this time, the internal end stage enable is switched off by the microprocessor.

After the delay time of the PNOZ has expired, the two delay contacts of K1 (37, 38 and 47, 48) open. Then the driver supply relay and end stage enable are switched off at the same time.



Note

The ramp function of the motor controller's Quick Stop delay is not monitored.

The unintended opening of the protective doors must be prevented in the system.

When the PILZ PNOZ XV2P is used, a two-channel operation with cross-circuit recognition is possible. This permits recognition of:

- Earth faults in the start and initial circuit
- Short circuits in the initial circuit / start circuit
- Cross circuits in the initial circuit.

Warning

The standard motor holding brake or an external motor holding brake controlled by the drive controller is not suitable for protecting people.

- Vertical axes must be additionally secured against falling or sliding down when the motor is switched off with, for example,
  - mechanical locking of the vertical axis,
  - external braking, safety catch or clamping devices or
  - sufficient weight compensation of the axis.

Note

If EMERGENCY STOP is requested, the external brake is immediately switched on, if needed.

Note

The holding brake of the EMMS-ST-...-S**B**/-SE**B** is not suitable for braking the motor and does not have a safety function.

Note

The time delay of the PNOZ relay must be adjusted for the application (see 4.3.13). If this time delay is set too low, the drive performs an STO function when the time has passed and the brake will be worn.

4.3.10 Restoration of normal operation

Before switching it on again, make sure that all hazards have been eliminated and the system can be safely placed in operation again. If there are areas inside that can be entered, a manual acknowledgement must be made via the optional S2 button.

4.3.11 Testing the safety function

For each on-off cycle of the machine, the PILZ device PNOZ XV2P checks whether the relays of the safety equipment open and close properly. The function of switching off the output stage enable and controller enable must be checked regularly (e.g. monthly) via the PLC. In addition, the “Acknowledgment of driver supply” signal must be checked for plausibility.

4.3.12 Determination of the brake time

The brake time can easily be determined through the FCT Trace function. The brake time can vary greatly due to different loads. Determine the values for the maximum brake time.

To do this, input the following settings under the point “Configure measurement data”.

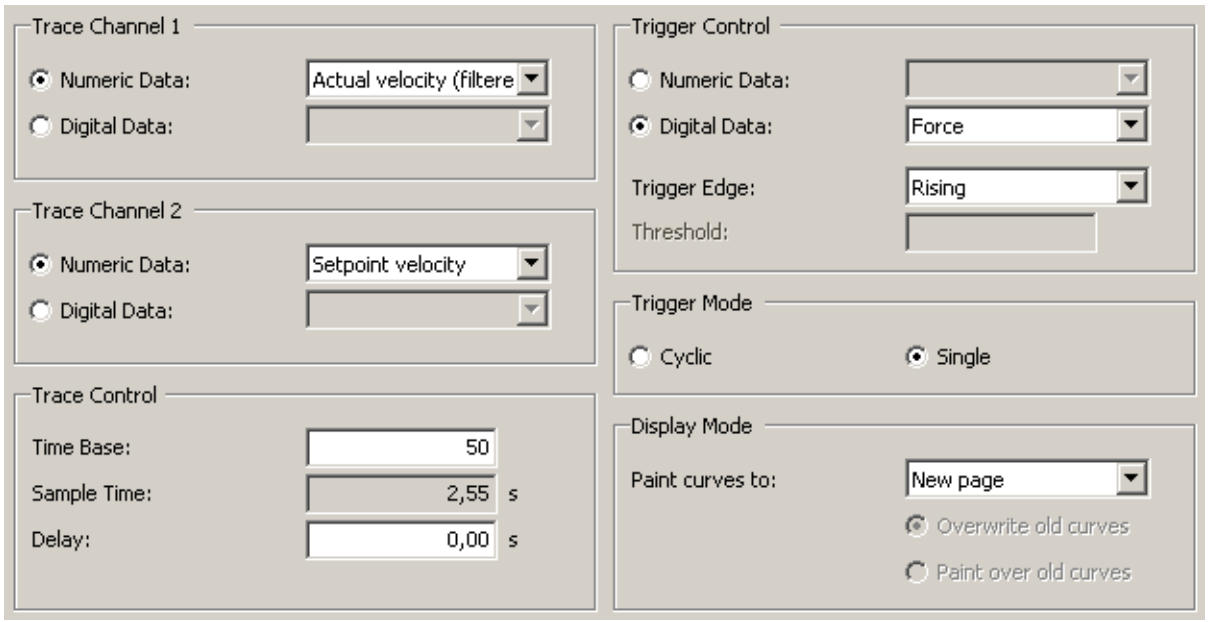
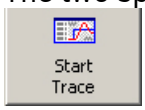


Fig. 4.8 FCT mask for configuration of the measurement data

The two speed values are now immediately recorded for 2.55 s as soon as you actuate the 

button. During this time, you remove the controller enable and so determine the brake time from the measurement curve. This is stored under the point “Measurement data”.

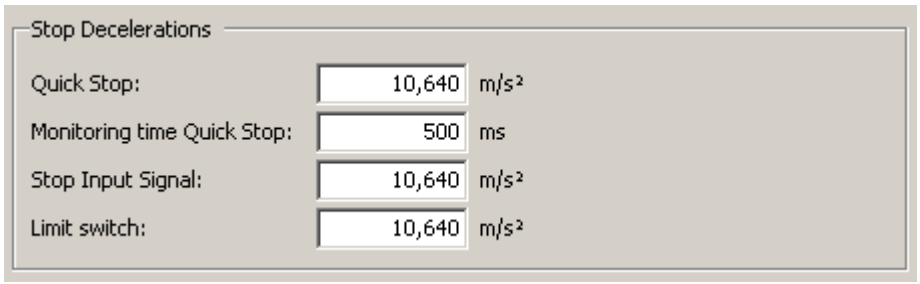
Note

FCT PlugIn version V1.0

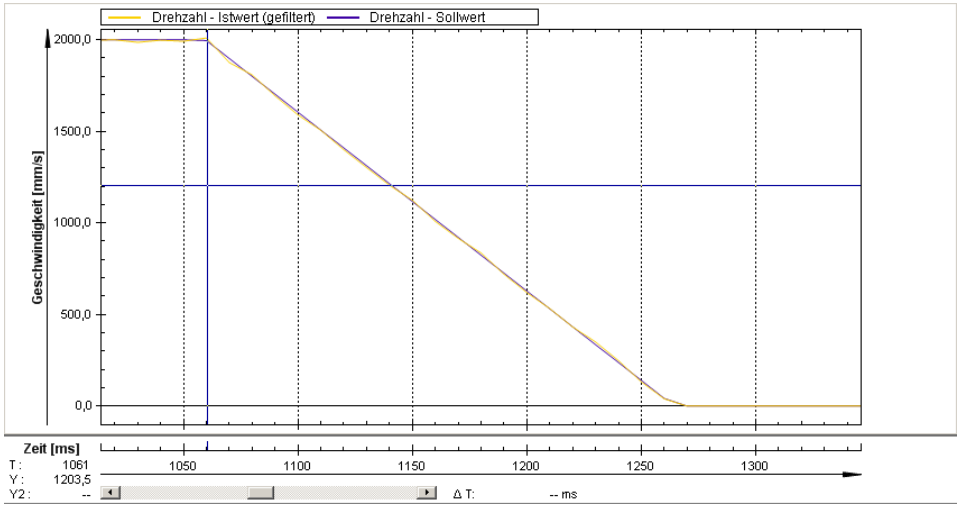
The maximum time until the drive is at speed = 0 after the controller enable is removed is 499.2 ms. If this time is exceeded, the Quick Stop delay must be set to a higher value.

FCT PlugIn version V1.1

The maximum time until the drive is at speed = 0 after the controller enable is removed can be set using the “Maximum switch-off delay” from 2 ... 10000 ms.



A typical measurement curve could look as follows.



Graphically read brake time: 210 ms.

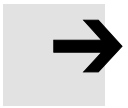
Fig. 4.9 Typical measurement curve for determining the brake time

4.3.13 Setting the delay time

The delay time of the PILZ PNOZ XV2P can be set manually at the device. This delay time must be larger than the determined brake time. Otherwise, the drive would not brake in the defined manner, but run out uncontrollably.

5. Mechanical installation

5.1 Important information



Note

- Use the CMMS-ST stepping motor controller as an integrated device for control cabinet assembly only.
- The mounting position is vertical with the power supply lines [X9] leading upwards
- Mount with the clip to the control cabinet plate
- Mounting clearance:
  For sufficient ventilation, 100 mm of clearance to other assemblies is required above and below the device.
- Pay attention to the fastening interval of 69 mm!

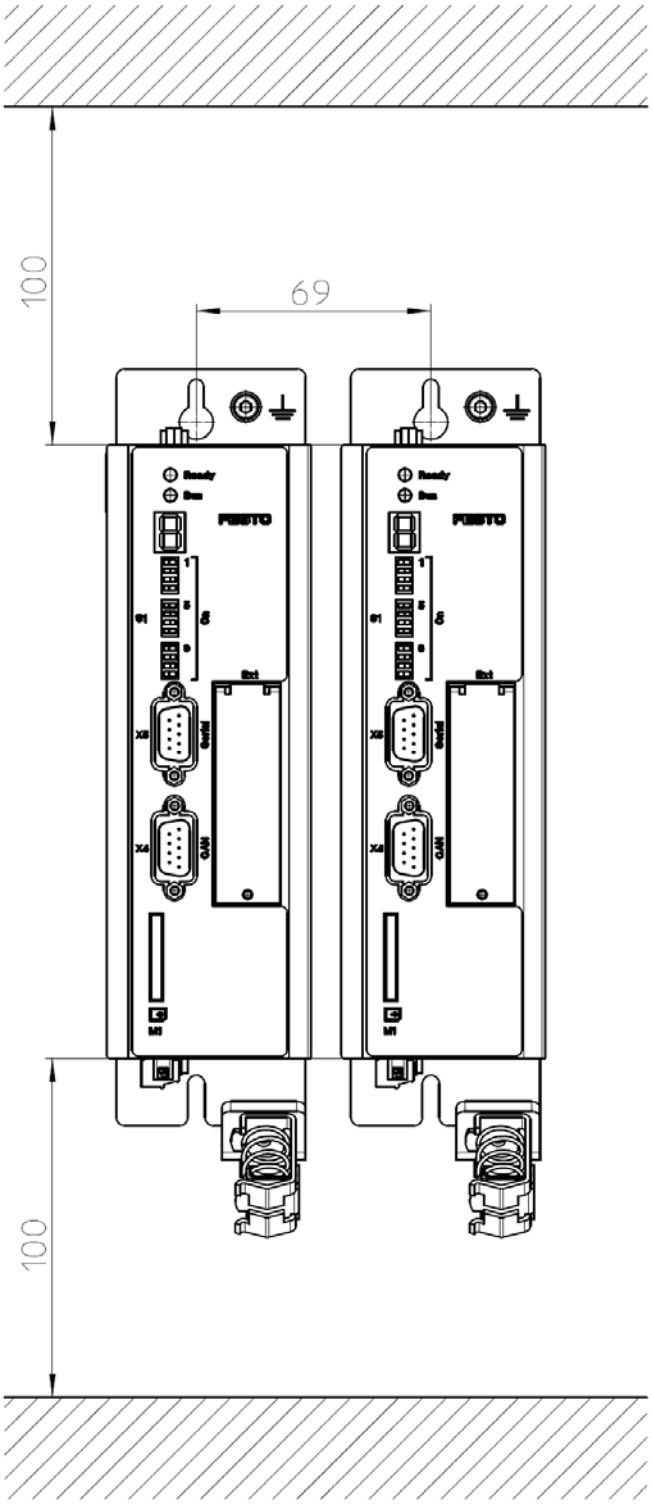


Fig. 5.1 CMMS-ST stepping motor controller: Installation clearance

5.2 Assembly

There are clips at the top and bottom of the CMMS-ST stepping motor controller. They are used to attach the stepping motor controller vertically to a control cabinet mounting plate. The clips are part of the radiator profile, ensuring an optimal heat transfer to the control cabinet plate.

- Use size M4 screws to attach the CMMS-ST stepping motor controller.

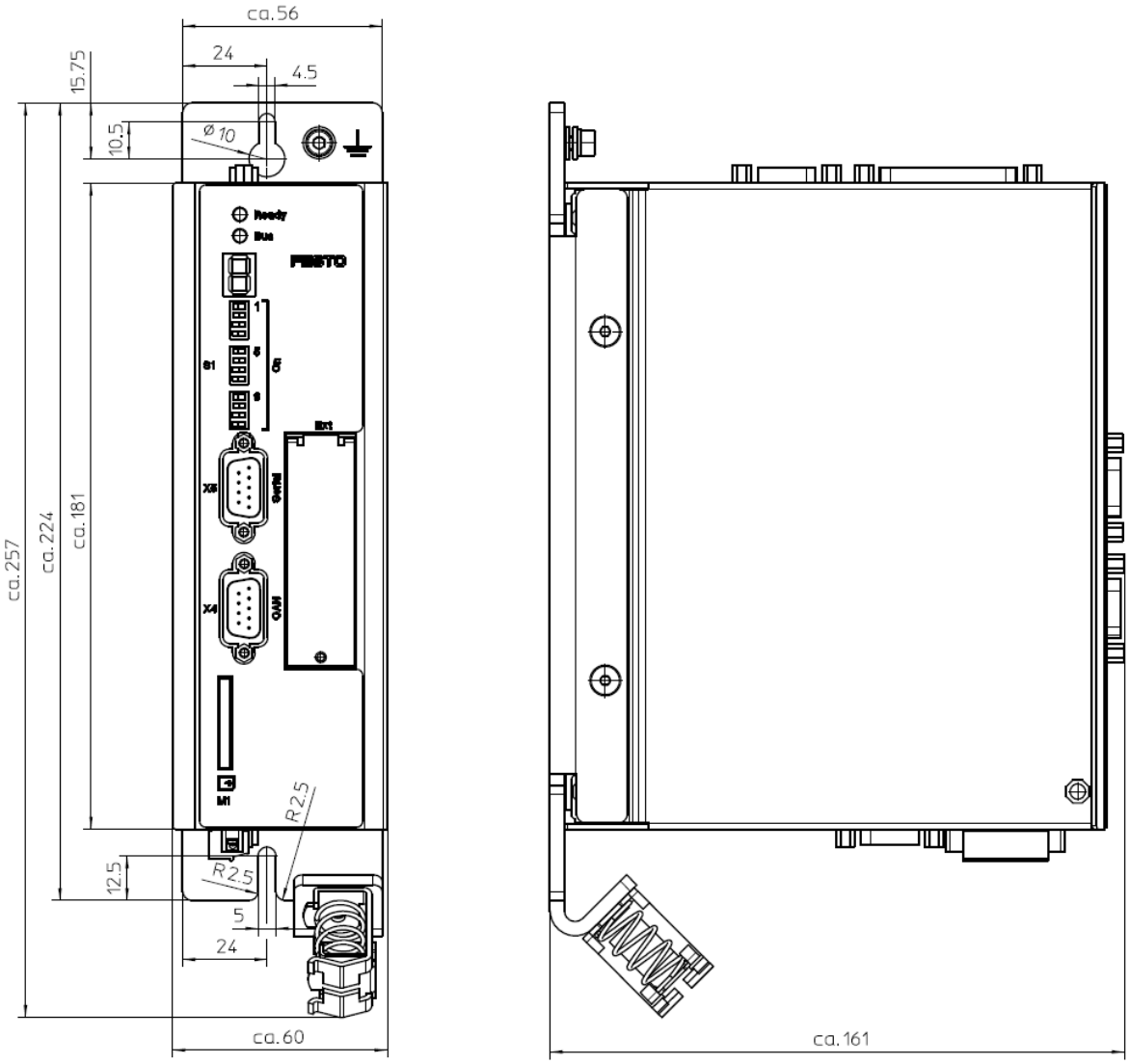


Fig. 5.2 CMMS-ST stepping motor controller: Assembly

6. Electrical installation

6.1 Device view

1 Status display
2 [S1]: Field bus settings and boot loader
3 Technology module (optional)
4 [M1]: SD memory card
5 [X4]: CAN bus
6 [X5]: RS232/485

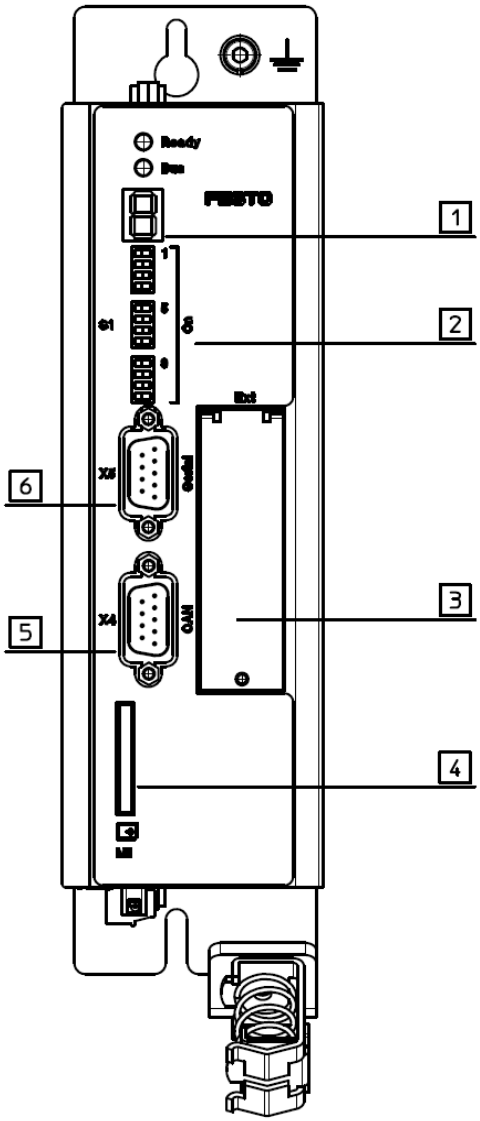


Fig. 6.1 CMMS-ST view

1 Earthing bolt
2 [X9] Power supply
3 [X10] Increment generator interface
4 [X1] I/O interface

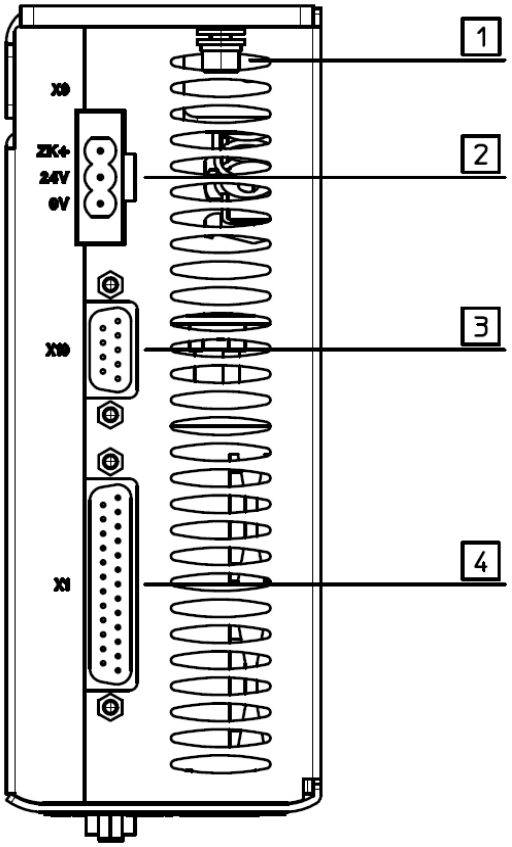


Fig. 6.2 CMMS-ST top view

1 [X3] Safe standstill
2 [X2] Increment generator input
3 [X6] Motor connection
4 Screened connection

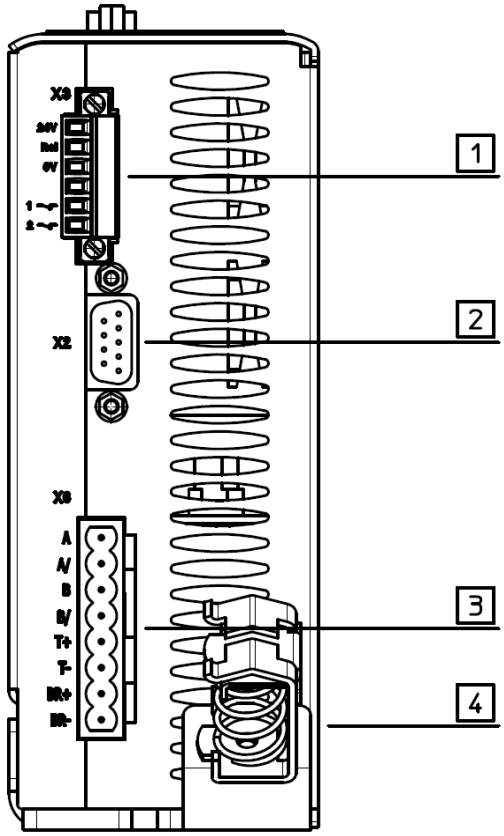


Fig. 6.3 CMMS-ST bottom view

6.2 Interfaces

In order to operate the CMMS-ST stepping motor controller, a 24 V power source is initially needed to supply the electronics systems. It is connected to terminals +24 V and 0 V.

The supply voltage for the power output stage is connected to contacts ZK+ and 0 V.

The motor is connected with the four terminals A ... B/.

The connection of the optional shaft encoder via the d-sub plug to [X2] is illustrated in the diagram Fig. 6.4.

The CMMS-ST stepping motor controller must first be fully wired. Only then can the operating voltages be activated for the intermediate circuit and the power supply. If the polarity of the operating voltage connections is reversed, or if the operating voltage is too high or the operating voltage and motor connections are incorrectly connected, the CMMS-ST stepping motor controller will be damaged.

6.3 CMMS-ST complete system

A complete CMMS-ST stepping motor controller system is shown in Fig. 6.4. The following components are required to operate the stepping motor controller:

Components
- Power pack for the control voltage
- Power pack for the power supply
- Stepper motor controller CMMS-ST
- Motor with motor cable
- Increment generator cable (for motors with increment generators)

A PC with a serial connection cable is required for parameterising.

1 Main switch
2 Fuse
3 Power pack for control voltage
4 Power pack for power supply
5 CMMS-ST
6 PC
7 Motor

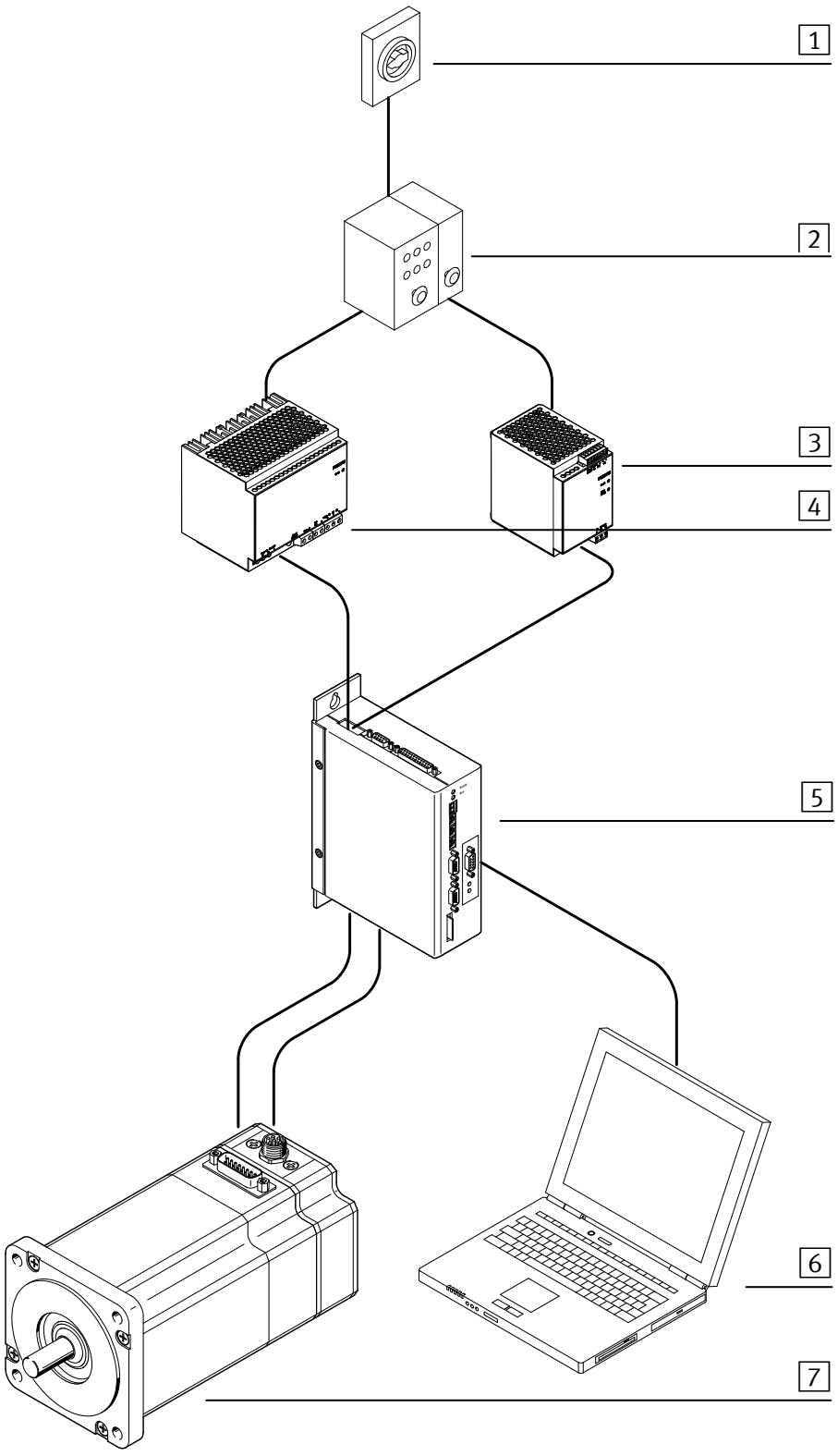


Fig. 6.4 Complete structure of CMMS-ST with motor and PC

6.4 Interfaces

6.4.1 I/O interface [X1]

Mode switching allows assignment of the [X1] interface more than once.
As a result, a maximum of four different I/O assignments can be selected.

Mode	DIN9	DIN12	Table
Mode 0 – Positioning	0	0	Table 6.2
Mode 1 – Jog mode	0	1	Table 6.3
Mode 2 – Record linking	1	0	Table 6.4
Mode 3 – Synchronisation	1	1	Table 6.5

Table 6.1 Mode switching

Pin	Name	Value	Mode = 0 - Positioning
1	AGND	0 V	Screen for analogue signals
2	AIN0	±10 V	Setpoint input 0, differential, maximum 30 V input voltage
3	DIN10		Record selection 4 (high active)
4	+VREF	+10 V ±4%	Reference output for setpoint potentiometer
5	Unassigned		
6	GND24		Reference potential for digital inputs and outputs
7	DIN1		Record selection 1 (high active)
8	DIN3		Record selection 3 (high active)
9	DIN5		Controller enable (high active)
10	DIN7		Limit switch 1
11	DIN9		High-speed input
12	DOUT1	24 V 100 mA	Output freely programmable – Default: Motion complete (high active)
13	DOUT3	24 V 100 mA	Output freely programmable – Default: Error (low active)
14	AGND	0 V	Reference potential for the analogue signals
15	DIN13	Ri = 20k	Stop input (low active)
16	DIN11		Record selection 5 (high active)
17	AMON0	0...10 V ±4%	Analogue monitor output 0
18	+ 24 V	24 V 100 mA	24 V supply carried out
19	DIN0		Record selection 0 (high active)
20	DIN2		Record selection 2 (high active)
21	DIN4		End stage enable (high active)
22	DIN6		Limit switch 0
23	DIN8		Start for the positioning procedure

Pin	Name	Value	Mode = 0 - Positioning
24	DOUT0	24 V 100 mA	Ready for operation output (high active)
25	DOUT2	24 V 100 mA	Output freely programmable – Default: Start ack (low active)

Table 6.2 Pin allocation: I/O interface [X1]

Pin	Name	Value	Mode = 1 - Jog mode
1	AGND	0 V	Screen for analogue signals
2	DIN12	24 V	Mode switch “1” = Jog mode
3	DIN10		Jog + (high active)
4	+VREF	+10 V ±4%	Reference output for setpoint potentiometer
5	Unassigned		
6	GND24		Reference potential for digital inputs and outputs
7	DIN1		Record selection 1 (high active)
8	DIN3		Record selection 3 (high active)
9	DIN5		Controller enable (high active)
10	DIN7		Limit switch 1
11	DIN9		Mode switch "0"
12	DOUT1	24 V 100 mA	Output freely programmable - default motion complete (high active)
13	DOUT3	24 V 100 mA	Output freely programmable - default error (low active)
14	AGND	0 V	Reference potential for the analogue signals
15	DIN13		Stop input (low active)
16	DIN11		Jog – (high active)
17	AMON0	0...10 V ±4%	Analogue monitor output 0
18	+ 24 V	24 V 100 mA	24 V supply carried out
19	DIN0		Record selection 0 (high active)
20	DIN2		Record selection 2 (high active)
21	DIN4		End stage enable (high active)
22	DIN6		Limit switch 0
23	DIN8		Teach (high active)
24	DOUT0	24 V 100 mA	Ready for operation output (high active)
25	DOUT2	24 V 100 mA	Teach ack

Table 6.3 Pin allocation: I/O interface [X1]

Pin	Name	Value	Mode = 2 - Record linking
1	AGND	0 V	Screen for analogue signals
2	DIN12		Mode switch “0”
3	DIN10		Next 1
4	+VREF	+10 V ±4%	Reference output for setpoint potentiometer

Pin	Name	Value	Mode = 2 - Record linking
5	Unassigned		
6	GND24		Reference potential for digital inputs and outputs
7	DIN1		Record selection 1 (high active)
8	DIN3		Stop record linking
9	DIN5		Controller enable (high active)
10	DIN7		Limit switch 1
11	DIN9		Mode switch record linking “1”
12	DOUT1	24 V 100 mA	Output freely programmable default motion complete (high active)
13	DOUT3	24 V 100 mA	Output freely programmable - default error (low active)
14	AGND	0 V	Reference potential for the analogue signals
15	DIN13		Stop input (low active)
16	DIN11		Next 2
17	AMON0	0...10 V ±4%	Analogue monitor output 0
18	+ 24 V	24 V 100 mA	24 V supply carried out
19	DIN0		Record selection 0 (high active)
20	DIN2		Record selection 2 (high active)
21	DIN4		End stage enable (high active)
22	DIN6		Limit switch 0
23	DIN8		Start record linking
24	DOUT0	24 V 100 mA	Ready for operation output (high active)
25	DOUT2	24 V 100 mA	Output freely programmable - default start ack (high active)

Table 6.4 Pin allocation: I/O interface [X1] Mode 2

Pin	Name	Value	Mode = 3 - Synchronisation
1	AGND	0 V	Screen for analogue signals
2	DIN12		Slave synchronisation “1”
3	DIN10		
4	+VREF	+10 V ±4%	Reference output for setpoint potentiometer
5	Unassigned		
6	GND24		Reference potential for digital inputs and outputs
7	DIN1		
8	DIN3	24 V	Direction_24 /CCW
9	DIN5		Controller enable (high active)
10	DIN7		Limit switch 1
11	DIN9		Slave synchronisation “1”
12	DOUT1	24 V 100 mA	Output freely programmable - default motion complete (high active)

Pin	Name	Value	Mode = 3 - Synchronisation
13	DOUT3	24 V 100 mA	Output freely programmable - default error (low active)
14	AGND	0 V	Reference potential for the analogue signals
15	DIN13		Stop input (low active)
16	DIN11		
17	AMON0	0...10 V ±4%	Analogue monitor output 0
18	+ 24 V	24 V 100 mA	24 V supply carried out
19	DIN0		
20	DIN2	24 V	Pulse_24 / CW
21	DIN4		End stage enable (high active)
22	DIN6		Limit switch 0
23	DIN8		Start synchronisation
24	DOUT0	24 V 100 mA	Ready for operation output (high active)
25	DOUT2	24 V 100 mA	Setpoint reached output (high active)

Table 6.5 Pin allocation: I/O interface [X1] Mode 3

6.4.2 Increment generator input [X2]

Pin	Name	Value	Specification
1	A+	5 V, Ri = 120 Ohm	Increment generator signal A, positive polarity
2	B+	5 V, Ri = 120 Ohm	Increment generator signal B, positive polarity
3	N+	5 V, Ri = 120 Ohm	Increment generator zero pulse N, positive polarity
4	GND	-	Reference GND for the encoder
5	VCC	+5 V +-5% 100 mA	Auxiliary supply, max. load 100 mA, short-circuit proof.
6	A-	5 V, Ri = 120 Ohm	Increment generator signal A, negative polarity
7	B-	5 V, Ri = 120 Ohm	Increment generator signal B, negative polarity
8	N-	5 V, Ri = 120 Ohm	Increment generator zero pulse N, negative polarity
9	GND	-	Internal screen for the connecting cable

Table 6.6 Pin allocation: Increment generator input [X2]

6.4.3 Plug allocation for Safe standstill [X3]

Pin	Name	Value	Specification
1	24 V	24 V DC	24 V DC supply carried out
2	REL	0 V / 24 V DC	Setting and resetting the relay for interrupting the driver supply
3	0 V	0 V [GND 24V DC *)]	Reference potential for PLC [Reference potential for the 24V DC power supply and for the PLC *)]
4	UNASSIGNED	-	-
5	NC1	Max. 60V AC 30V DC 2 A	Potential-free feedback contact for driver supply, NC contact
6	NC2		

Table 6.7 Pin allocation: Safe standstill [X3]

6.4.4 Field bus CAN [X4]

Pin	Name	Value	Specification
1	-		
2	CANL	5 V, Ri = 60 Ohm	CAN-low signal line
3	GND	-	CAN-GND, electrically connected to GND in the controller
4	-	-	-
5	Screening	-	Connection for the cable screen
6	GND	-	CAN-GND, electrically connected to GND in the controller
7	CANH	5 V, Ri = 60 Ohm	CAN-high signal line
8	-	-	-
9	-	-	-

Table 6.8 Pin allocation: Field bus CAN [X4]

6.4.5 RS232/RS-485 [X5]

Pin	Name	Value	Specification
1	-		
2	RS232_RxD	10 V, Ri › 2 kOhm	Reception line
3	RS232_ TxD	10 V, Ra ‹ 2 kOhm	Transmission line
4	RS485_A	-	-
5	GND	0 V	RS232/485 GND, galvanically connected to GND in the controller
6	-	-	-

Pin	Name	Value	Specification
7	-	-	-
8	+5 V_Fuse	5 V	Via PTC on plug
9	RS485_B	-	-

Table 6.9 Pin allocation: RS232/RS-485 [X5]

6.4.6 Motor connection [X6]

Version on controller	Counterplug	Plugged/optional plug set	Material number
Combicon 8-pin socket	MSTB 2.5/8-ST-5.08 BK	Plug set	547 452

Table 6.10 Plug version: Motor connection [X6]

Pin	Name	Value	Specification
1	String A	-	Connection of the two motor strings. The cable screen is fitted to the controller housing.
2	String A/	-	
3	String B	-	
4	String B/	-	
5	T +	-	Motor temperature sensor, either N/C contact or PTC (in preparation)
6	T -	-	
7	BR+	-	Motor holding brake
8	BR -	-	

Table 6.11 Pin allocation: Motor connection [X6]

6.4.7 Power supply [X9]

Version on controller	Counterplug	Plugged/optional plug set	Material number
Combicon 3-pin socket	MSTB 2.5/3-ST-5.08 BK	Plugged	547 452

Table 6.12 Plug version: Power supply [X9]

Pin	Name	Value	Specification
1	ZK +	12 ... 58 V	Intermediate circuit voltage
2	24 V	+24 V / 1 A	Power supply for the control section
3	GND	0 V	Common reference potential for the intermediate circuit and the control section

Table 6.13 Pin allocation: Power supply [X9]

6.4.8 Increment generator interface / control signals [X10]

The interface is bidirectional. It allows A/B tracking signals to be output in the “master axis” mode, or alternatively processing of A/B, CLK/DIR or CW/CCW control signals in the “slave axis” mode.

Pin	Name	Value	Specification
1	A/CLK/CW	5 V, Ri = 120 Ohm	Increment generator signal A Pulse CLK Clockwise cycles CW Positive polarity as per RS422
2	B/DIR/CCW	5 V, Ri = 120 Ohm	Increment generator signal B Direction DIR Anticlockwise cycles CCW Positive polarity as per RS422
3	N	5 V, Ri = 120 Ohm	Increment generator zero pulse N Positive polarity acc. to RS422
4	GND	-	Reference GND for the encoder
5	VCC	+5 V +-5%, 100 mA	Auxiliary supply, max. load 100 mA, short-circuit proof
6	A-/CLK	5 V, Ri = 120 Ohm	Increment generator signal A Pulse CLK Clockwise cycles CW Negative polarity as per RS422
7	B-/DIR	5 V, Ri = 120 Ohm	Increment generator signal B Direction DIR Anticlockwise cycles CCW Negative polarity as per RS422
8	N-	5 V, Ri = 120 Ohm	Increment generator zero pulse N Negative polarity acc. to RS422
9	GND	-	Screen for the connecting cable

Table 6.14 Pin allocation: Increment generator output / pulse, direction input [X10]

6.4.9 SD card

The optional SD card is intended for downloading firmware or saving parameters. The interface is allocated in accordance with the SD card specifications. Alternatively, an MMC card can be used.

Type on device

1x12-pin SD card slot

6.4.10 Field bus settings and boot loader

DIP switches	Meaning
1 ... 7	Node number
8	Boot loader (If the switch is set to ON, the system searches for new firmware on the SD card)
9	Baud rate
10	
11	Activation of the CAN interface
12	Terminating resistor

Table 6.15 Assignment of the DIP switches

DIP switches	ON / OFF	Meaning
1	ON	DIP switch 1 is the lowest bit. 1011011=91
2	ON	
3	OFF	
4	ON	
5	ON	
6	OFF	
7	ON	

Table 6.16 Sample node number

DIP switches	ON / OFF	Meaning
9	ON	Dip switch 9 is the low-value bit. 00=125 kBaud 01=250 kBaud (example) 10=500 kBaud 11=1000 kBaud
10	OFF	

Table 6.17 Sample baud rate

6.5 Instructions on safe and EMC-compliant installation

6.5.1 Explanations and terms

Electromagnetic compatibility (EMC) or electromagnetic interference (EMI) involves the following requirements:

Interference immunity	Sufficient interference immunity of an electrical system or electrical device against external electrical, magnetic or electromagnetic noise via lines or space.
Interference emission	Sufficiently low interference emission of electrical, magnetic or electromagnetic interference of an electrical system or an electrical device on other devices in the environment via lines and space.

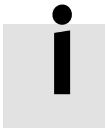
6.5.2 General information on EMC

Interference emission and resistance to interference of a stepping motor controller always depend on the complete design of the drive, which consists of the following components:

Components

- Power supply
- Stepper motor controllers
- Motor
- Electromechanical components
- Design and type of wiring
- Higher-order control system

In order to increase the interference immunity and decrease the interference emission, the CMMS-ST already has integrated motor throttles and mains filters, which means that the CMMS-ST stepping motor controller can be operated without additional screens and filters in most applications.



The CMMS-ST stepping motor controllers were qualified in accordance with product standard EN 61800-3 which applies to electrical drives.

In the majority of cases, no external filter measures are required (see below).

The conformity declaration to EMC directive 89/336/EEC is available from the manufacturer.

6.5.3 EMC areas: second environment

When suitably installed, and with suitable cabling for all connections, the CMMS-ST stepping motor controller conforms to the requirements of the corresponding EN 61800-3 product standard. This standard no longer refers to “limit value classes” but rather to so-

called “environments”. The “first” environment includes electricity grids connected to residential housing. The “second” environment includes grids connected only to industrial plants.

Without filter measures, the following applies to stepping motor controller CMMS-ST:

EMC class	Area	Compliance with EMC requirements
Interference emission	Second environment (industrial)	Motor cable length up to 25 m
Interference immunity	Second environment (industrial)	Regardless of motor cable length

Table 6.18 EMC requirements: Second environment

6.5.4 EMC-compliant wiring

The following must be observed for EMC-compliant installation of the drive system (see also Chapter 6 Electrical installation, Page 101):

1. In order to minimise current leakage and losses in the motor connection cable, the CMMS-ST stepping motor controller should be installed as close as possible to the motor (see also Chapter 6.5.5 Operation with long motor cables, Page 115 below).
2. The motor and angle encoder cables must be screened.
3. The screen of the motor cable is fitted to the housing of the CMMS-ST stepping motor controller (screen connection terminals). The cable screen is also always fitted to the corresponding stepping motor controller to prevent leaked current flowing back to the controller which caused it.
4. Signal lines must be separated as far as possible from the power cables. They should not be routed parallel to one another. If crossovers cannot be avoided, they should be made as close to vertical (i.e. at a 90° angle) as possible.
5. Unscreened signal and control lines should not be used. If they must be used, they should at least be twisted.
6. Even screened lines always have short unscreened parts at either end (unless a screened plug housing is used).

In general:
- Connect the inner screens to the pins of the plug connector provided for the purpose; length max. 40 mm.
- Max. length of unscreened wires: 35 mm.
- Connect total shield flat at the motor to the plug or motor housing; length max. 40 mm.

6.5.5 Operation with long motor cables

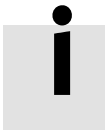
For applications with long motor cables and/or if the wrong motor cables are selected with excessive cable capacity, the filters may be subjected to thermal overload. In order to avoid such problems, we recommend the following procedure for applications in which long motor cables are required:

- From a cable length of over 15 m, only cables with a capacitance between the motor phase and screen of less than 200 pF/m, or, if possible less than 150 pF/m! (Please contact your motor cable vendor if necessary)
- Use of a dU/dt filter on the motor output,
- Filter on the voltage supply connection,
- Mains filter.

6.5.6 ESD protection

Caution

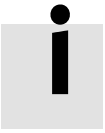
If non-assigned plug connectors are used, there is a danger that damage may occur to the device or to other parts of the system as a result of ESD (electrostatic discharge).



Protective caps are available from specialised retailers to prevent such discharges.

7. Preparations for commissioning

7.1 General connection instructions



As the routing of the connecting cables is critical for EMC, it is essential that you read Chapter 6.5.4 EMC-compliant wiring (Page 115)!

Warning

DANGER!

Failure to follow the instructions in Chapter 2 Safety instructions for electric drives and controllers (Page 12) can result in material damage, injury, electric shock, or in extreme cases, even to fatalities.

7.2 Tools / material

Tools

- Slotted head screwdriver
- Phillips screwdriver
- Serial interface cable
- Increment generator cable
- Motor cable
- Power supply cable
- Control cable

7.3 Connecting the motor

Connecting the motor

1. Insert the motor cable plug in the corresponding socket on the motor and secure it.
2. Insert the PHOENIX plug into the socket [X6] on the device.
3. Insert the motor cable plug in the corresponding socket on the motor and secure it.
4. Insert the D-sub plug in socket [X2] of the device and secure the locking screws.
5. Check all plug connectors once again.

7.4 Connecting the CMMS-ST stepping motor controller to the power supply

Connecting the stepping motor controller

1. Make sure that the power supply is switched off.
2. Insert the PHOENIX plug into the socket [X9] on the device.
3. Connect the 24 V connection to a suitable power pack.
4. Connect the power supply unit.
5. Check all plug connectors once again.

7.5 Connecting a PC

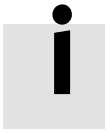
Connecting a PC

1. Insert the D-sub plug of the serial interface cable into the socket for the serial interface of the PC and secure the locking screws.
2. Insert the D-sub plug of the serial interface cable into socket [X5] RS232/COM for the CMMS-ST stepping motor controller and secure the locking screws.
3. Check all plug connectors once again.

7.6 Checking readiness for operation

Checking readiness to operate

1. Make sure that the controller enable switch is switched off.
2. Switch on the power supplies for all devices. The READY LED on the front of the device should now light up.

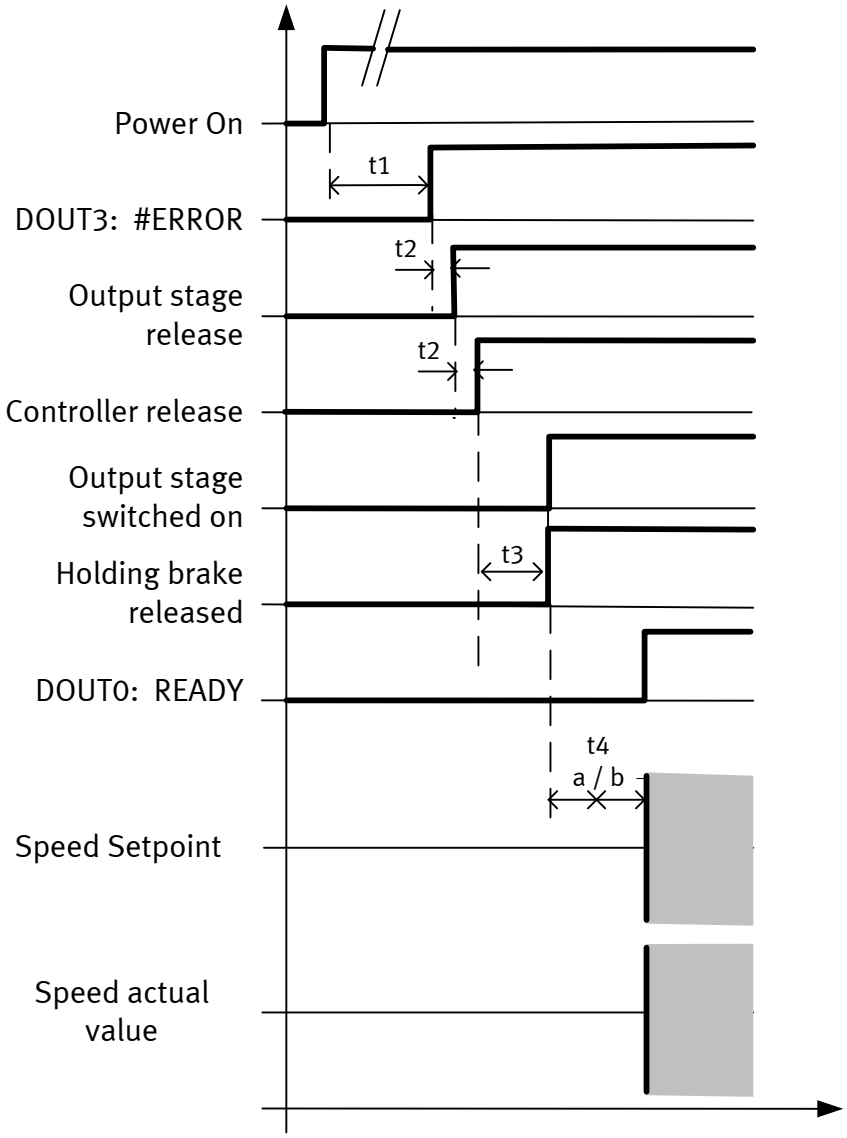


If the READY LED does not light up, there is a fault. If the seven segment display shows a number sequence, this is an error message. You must rectify the cause of the message. If this is the case, see chapter 8.2 Error messages (page 122). If no display lights up on the device, proceed as follows:

No display lights up

1. Switch off the supply voltage.
2. Wait for one minute to allow the intermediate circuit to discharge.
3. Check all connecting cables.
4. Check that the 24 V control voltage is functional.
5. Switch on the supply voltage again.

7.7 Timing diagram switch-on sequence



t1	approx. 500 ms	Execution of boot program and application start
t2	› 1.6 ms	
t3	= 10 ms	Depends on the operating mode and the state of the drive
t4a	= N x 1.6 ms	Can be parameterised (brake parameter run start delay tF)
t4b	= approx. 300 ms	Time for determination of commutator position

Fig. 7.1 Timing diagram switch-on sequence

8. Service functions and error messages

8.1 Protective and service functions

8.1.1 Overview

The CMMS-ST has a comprehensive array of sensors which monitor the controller section, power output stage, motor and external communication to ensure that they function perfectly. All errors which occur are saved in the internal error memory. Most errors cause the controller's controller enable to be switched off. A new enable is not possible until the error memory has been cleared by acknowledging the error, and the error has been rectified or is no longer present.

The following monitoring functions guarantee operational safety:

- Evaluation of the motor temperature (in preparation)
- Evaluation of the power section temperature
- Earth fault detection
- Detection of short-circuits between two motor phases
- Detection of overvoltages in the intermediate circuit
- Detection of faults in the internal voltage supply

If the 24 V supply voltage fails, approximately 20 ms remain to save parameters and shut down the controller in a defined manner.

8.1.2 Overload current and short-circuit monitoring

The overload current and short-circuit monitoring is triggered as soon as the current in the intermediate circuit exceeds twice the maximum current of the controller. It 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 monitor detects overload current, the power output stage shuts down immediately, guaranteeing that the system is short-circuit proof.

8.1.3 Voltage monitoring for the intermediate circuit

Voltage monitoring for the intermediate circuit is triggered as soon as the intermediate circuit voltage leaves the operating voltage range. The power output stage is then deactivated.

8.1.4 Temperature monitoring for the heat sink

The heat sink temperature of the power output stage is measured with a linear temperature sensor. Temperature monitoring is triggered at temperatures below – 40°C and above 85°C. A temperature warning is issued at 80℃.

8.1.5 I²t monitoring

The CMMS-ST stepping motor controller has I²t monitoring to restrict the average power loss in the power output stage and in the motor. As the power loss which occurs in the power electronics and in the motor increases by its square as the current flow increases in a worst case scenario, the square of the current value is usually assumed for the power loss.

8.1.6 Power monitoring for the brake chopper

There is a power monitoring system for the internal braking resistor in the operating software.

8.1.7 Commissioning status

Stepping motor controllers sent to Festo for servicing have other firmware and parameters loaded for testing purposes.

The CMMS-ST must be configured before it is commissioned again at the customer's premises. The configuration software queries the commissioning status and prompts the user to configure the stepping motor controller. At the same time, the device indicates that it is ready for operation but has not yet been configured by displaying “A” on the 7-segment display.

8.2 Operating mode and error messages

8.2.1 Operating mode and error display

A seven-segment display is supported. The display and the meaning of the symbols shown are illustrated in the following table:

Display	Meaning
 	The outer segments “rotate” on the display in this operating mode. The display depends on the current actual position or speed. The central bar is also active when the controller release is active.
	The CMMP-ST stepping motor controller still needs to be parameterised. (seven-segment display = “A”)
	Controlled torque mode. (seven-segment display = “I”)
P xxx	Positioning (“xxx” represents the position number) The digits are sequentially displayed

Display	Meaning
PH x	Homing run. “x” represents the respective phase of the homing run: 0: Search phase 1: Slow moving phase 2: Travel to zero position The digits are sequentially displayed
E xxy	Error message with index “xx” and sub-index “y”
-xxy-	Warning message with index “xx” and sub-index “y”. Warnings are shown at least twice on the seven-segment display.

Table 8.1 Operating mode and error display

8.2.2 Error messages

When a fault occurs, the CMMS-ST displays an error message cyclically in the seven segment display. The error message consists of an E (for error), a main index and sub-index, e.g.: E 01 0.

The meaning and the measures for the error messages are compiled in the table below:

Error message		Meaning of error message	Measures	Error reaction
Main index	Sub-index			
01	0	Stack overflow	Wrong firmware? Reload standard firmware if necessary. Contact Technical Support.	PS off
02	0	Undervoltage in intermediate circuit	Undervoltage monitoring is configured using the FCT. Measure intermediate circuit voltage. Check configuration.	PS off [1)]
03	0	Motor temperature monitoring	Motor too hot? Check parameters (current regulator, current limits) Correct sensor? Cable broken? Sensor defective? If the error remains even when the sensor is bridged: device defective.	PS off
	1	Motor temperature monitoring	Fault in dig. motor temperature sensor	PS off [1)]
04	0	Over-/under-temperature in power electronics	Temperature display plausible? Check installation conditions (cooling: via the housing surface, the integrated heat sink and back wall).	PS off [1)]

Error message		Meaning of error message	Measures	Error reaction
Main index	Sub-index			
05	0	5V supply fault	Disconnect the device from all peripherals and check whether the error is still there after resetting. If yes, then there is an internal defect and repair by the manufacturer is necessary.	PS off
	1	Fault in 24V supply 16V ‹U24V ‹32V = OK, otherwise NOK		
	2	Fault in 12V supply 11V ‹U12V ‹13V = OK, otherwise NOK		
06	0	Overcurrent of the intermediate circuit/power stage	Motor defective? Short-circuit in cable? End stage defective?	PS off
07	0	Overvoltage in intermediate circuit	Check design (application).	PS off
08	2	Encoder supply fault	4V ‹U_encoder ‹6V = OK, otherwise NOK	PS off
11	1	Error during homing	Homing was interrupted, e.g. by withdrawal of controller enable or by a limit switch.	
12	2	CAN communication error	Common error: 1. Error when sending a message (e.g. no bus connected) 2. Timeout when receiving the SYNC messages in interpolated position mode.	PS off [1)]
14	9	Motor identification fault	Error when automatically determining the motor parameters.	
16	2	Initialisation fault	Error initialising the default parameters.	PS off
	3	Unexpected status/programming error	The software went into an unexpected state, e.g. unknown state in the FHPP state machine.	
17	0	Following error limit exceeded	Increase error window. Acceleration parameter too large.	PS off [1)]
18	0	Motor temperature 5℃ below maximum	The motor temperature is less than 5°C below the parameterised maximum temperature	Ignore [1)]
	1	End stage temperature 5℃ below maximum	The end stage temperature is greater than 80°C.	PS off [1)]
19	0	I²t at 80%	Common error: 80% of the maximum I²t utilisation has been reached by the closed-loop controller or by the motor.	Warn [1)]

Error message		Meaning of error message	Measures	Error reaction
Main index	Sub-index			
21	0	Fault in offset current measurement	Error cannot be self-corrected. Send the stepping motor controller to the manufacturer.	PS off
22	0	PROFIBUS: Faulty initialisation	Expansion module defective? Please contact Technical Support.	PS off [1]
	2	Communication fault PROFIBUS	Check set slave address Check bus connection Check cables	PS off [1]
25	1	Hardware error	Motor controller and firmware are not compatible. Update the firmware.	PS off
26	1	Checksum error	Error cannot be self-corrected. Please contact Technical Support.	PS off
29	0	No SD	Tried to access missing SD card.	Warn [1]
	1	SD initialisation error	Error on initialisation communication not possible.	PS off [1]
	2	SD parameter record error	Checksum incorrect File missing Incorrect file format Error when saving the parameter file to the SD card	PS off [1]
31	0	I^2t motor (I^2t at 100%)	I^2t monitoring of the motor has responded; motor/mechanical system blocked or sluggish?	Warn [1]
	1	I^2t controller (I^2t at 100%)	I^2t monitoring of the controller has responded. Check power dimensioning of drive package.	PS off [1]
35	1	Timeout for quick stop	The parameterised time for quick stop was exceeded	PS off
40	0	Fault: SW limit switch reached	Negative software limit switch reached.	Warn [1]
	1	Fault: SW limit switch reached	Positive software limit switch reached.	
	2	Fault: SW limit switch reached	Target position is behind the negative software limit switch.	
	3	Fault: SW limit switch reached	Target position is behind the positive software limit switch.	

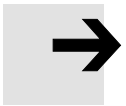
Error message		Meaning of error message	Measures	Error reaction
Main index	Sub-index			
41	8	Fault: record chaining, unknown command	Unknown command found during record chaining.	PS off [1]
	9	Route program jump target error	Jump to a positioning record outside the permitted range.	
42	1	Positioning: Error in pre-calculation	The positioning target cannot be reached due to the positioning options or the parameters. Check the parameterisation of the affected positioning records.	PS off [1]
	4	Homing required	No positioning possible without homing. Homing must be carried out.	Warn [1]
	9	Position data record error	Common error: 1. An attempt is being made to start an unknown or deactivated position record. 2. The set acceleration is too small for the maximum velocity permitted. (Risk of computational overrun in trajectory calculation)	PS off
43	0	Limit switch error	Negative hardware limit switch reached. Check parameters, wiring and limit switches.	Warn [1]
	1	Limit switch error	Positive hardware limit switch reached. Check parameters, wiring and limit switches.	
	9	Limit switch error	Both hardware limit switches active at the same time. Check parameters, wiring and limit switches.	
45	0	Driver supply fault	The driver supply is still active despite "safe standstill".	PS off
	1	Driver supply fault	The driver supply was re-applied even though "safe standstill" was still active.	PS off
	2	Driver supply fault	The driver supply is not re-applied even though the "safe standstill" signal is no longer active.	PS off
	3	Plausibility error DIN 4	Error during plausibility check of output stage enable.	PS off
64	1	DeviceNet communication error	The 24V bus voltage is missing	PS off [1]
	2	DeviceNet communication error	Receive buffer overflow	PS off [1]

Error message		Meaning of error message	Measures	Error reaction
Main index	**Sub-index**			
	3	DeviceNet communication error	Send buffer overflow	PS off [1]
	4	DeviceNet communication error	IO message could not be sent	PS off [1]
	5	DeviceNet communication error	Bus off	PS off [1]
	6	DeviceNet communication error	Overrun in the CAN controller	PS off [1]
65	0	DeviceNet general error	Common error: Communication has been activated even though there is no extension module plugged in. The DeviceNet extension module is attempting to read an unknown KO. Unknown DeviceNet error.	PS off [1]
	1	DeviceNet initialisation error	DeviceNet extension module initialisation error: Node number exists twice	PS off [1]
		DeviceNet communication error	IO connection timeout	
70	2	General arithmetic error	The FHPP factor group cannot be calculated correctly.	PS off
	3	Operating mode error	Prohibited change of operating mode, e.g. torque control for CMMS ST in open-loop-controlled operation or parametrisation mode in FHPP, change in operating mode when output stage is released.	PS off [1]
79	0	RS232 communication error	Overrun when receiving RS232 commands.	PS off [1]
1)	Changeable with FCT			
PS off	Switch off power section			
QStop	Fast stop			
Warn	Warning			
Ignore	Ignore			

Table 8.2 Error messages

Error messages can be acknowledged by:

- the configuration interface,
- the field bus (control word),
- a falling edge at DIN5 (controller enable).



Note

Starting with Firmware 1.3.0.1.7, errors that are parameterised as warnings are automatically acknowledged if the cause is no longer present.

A. Technical data

A.1 General information

Area	Values
Permitted temperature ranges	Storage temperature: -25°C to +70°C
	Operating temperature: 0°C to +40°C +40°C to +50°C with power reduction 4% / K
Permitted installation height	Up to 1000 m above sea level 1000 to 3000 m above sea level with power reduction 10% / 1000 m
Air humidity	Relative humidity up to 90%, non-condensing
Protection class	IP20
Contamination class	1
CE-conformity with low-voltage guideline: EMC law: Current oscillations:	EN 50 178 EN 61 800 - 3 EN 61 000 - 3 - 2
Further certifications	UL / CSA
Specifications on EN ISO 13849-1	
PL (performance level)	d
MTTFd (Mean Time To Failure dangerous) Channel 1 (switching off PWM signals via X1) Channel 2 (switching off driver supply via X3)	 617.06 years 2853.88 years
PFH (Probability of Failure per Hour)	8.32×10^{-8}

Table A.1 Technical data: Ambient conditions and qualifications

Features	Values
Device dimensions (H*W*D)	160x50x160 mm
Weight	2.0 kg

Table A.2 Technical data: Dimensions and weight

Features	Values
Current regulator	20 µs
Speed regulator	200 µs
Position controller	400 µs

Table A.3 Technical data: Cycle times

Area	Values
Maximum motor cable length for interference emissions as per EN 61800-3 (conforms to EN 55011, EN 55022)	
Second environment (Industrial)	l ≤ 25 m
Cable capacitance of one phase against screen or between two lines	C‘ ≤ 200pF/m

Table A.4 Technical data: Cable data

Sensors	Values
Digital sensor	N/C contact: R_{cold} ‹ 1 kΩ R_{hot} › 10 kΩ
Analogue sensor	Silicon temperature probe, e.g. KTY81 ... 84 R_{25} = 1 kΩ or R_{25} = 2 kΩ

Table A.5 Technical data: Motor temperature monitoring (in preparation)

A.2 Operation and display components

The CMMS-ST stepping motor controller has two LEDs on the front and one seven segment display for showing the operating status.

Element	Function
Seven segment display	Displays the operating mode and an error code should an error occur
Ready LED (green)	Ready status
BUS LED (yellow)	CAN bus status display

Table A.6 Display components

A.3 Interfaces

A.3.1 I/O interface [X1]

Digital inputs	Values
Signal level	18 ... 30 V (high active)
Number	14
Reaction time to input	1.6 ms
Reaction time to sample input	‹ 100 µs
Protective function	Against polarity reversal

Table A.7 Technical data: Digital inputs

Digital outputs	Values
Signal level	24 V (from logic supply)
Output current	‹= 100 mA
Number	4
Output reaction time	‹ 2 ms
Protective function	Polarity reversal, short circuit, inductive load

Table A.8 Technical data: Digital outputs

Analogue inputs	Values
Signal level	-10 ... +10 V
Configuration	Differential input
Input reaction time	‹ 250 µs
Protective function	Overvoltage to ±30 V

Table A.9 Technical data: Analogue inputs

Analogue outputs	Values
Signal level	0 ... 10 V
Configuration	Single-ended against AGND
Output reaction time	‹ 250 µs
Protective function	Short circuit against AGND

Table A.10 Technical data: Analogue outputs

Analogue inputs/outputs	Values
High-resolution analogue input: AIN0	±10 V input section, 12 bit, differential, ‹ 250 µs delay time
Analogue outputs: AOUT0 and AOUT1	±10 V output range, 9 bit resolution, f_{limit} › 1 kHz

Table A.11 Technical data: Analogue inputs and outputs [X1]

A.3.2 Increment generator input [X2]

Increment generator input	Values
Signal level of tracking signals A, B, N	5 V differential, RS422
Angle resolution	Max. 12 bit
Number of lines of the increment generator	500
Limit frequency	› 100 kHz
Encoder supply	5 V ±5% 100 mA

Table A.12 Increment generator input [X2]

A.3.3 CAN bus [X4]

Communication interface	Values
Signal level	±2 V
Protection	-3 ... +24 V
Protocol	CANopen CiA DS 301, CiA DSP 402 and FHPP
Baud rate	Max. 1 MBaud
Terminating resistor	120 Ω

Table A.13 Technical data: CAN bus [X4]

A.3.4 RS232/RS-485 [X5]

Communication interface	Values
RS232	According to RS232 specification
RS-485	According to RS-485 specification
Baud rate	9600 ... 115 kBaud
Protection	ESD protected driver

Table A.14 Technical data: RS232 [X5]

A.3.5 Motor connection [X6]

Output data	Values
Output current	8 A_{eff}
Max. output current for 2 s	12 A_{eff}
Max. output frequency	50 kHz

Table A.15 Technical data: Motor connection data [X6]

Features	Values
Voltage range	18 ... 30 V
Output current	0.5 A
Voltage loss	≤ 1 V
Short circuit / overcurrent protection	› 4 A
Temperature protection	T_J › 150°C
Loads	- R › 24 Ω - L approx. 10 H - C ‹ 10 nF
Switching delay	‹ 1 ms

Table A.16 Technical data: Holding brake

A.3.6 Power supply [X9]

Features	Values
Load supply voltage	48 VDC
Alternative DC supply	24 ... 48 VDC
Nominal input current	8 A
Minimum intermediate circuit voltage	12 ... 48 V (configurable)
Control section supply voltage	24 VDC [± 20%]
Control section nominal current	0.2 A
Maximum current (incl. holding brake)	1.5 A
PWM frequency	50 kHz

Table A.17 Technical data: Power data [X9]

Features	Values
Internal braking resistor	17 Ω
Pulse power	500 W
Continuous output	10 W
Response threshold	58 / 30 V

Features	Values
Maximum intermediate circuit voltage	10% above response threshold
Hysteresis	3 V

Table A.18 Technical data: Internal braking resistor [X9]

A.3.7 Increment generator interface [X10]

Increment generator interface	Values
Operating modes	A/B or CLK/DIR input signals A,B,N output signals
Angle resolution / number of lines	32 ... 2048
Tracking signals	According to RS422 standard
Output impedance	120 Ω

Table A.19 Increment generator interface [X10]

B. Glossary

EMC

Electromagnetic compatibility (EMC) or electromagnetic interference (EMI) involves the following requirements:

Interference immunity	Sufficient interference immunity of an electrical system or electrical device against external electrical, magnetic or electromagnetic noise via lines or space.
Interference emission	Sufficiently low interference emission of electrical, magnetic or electromagnetic interference of an electrical system or an electrical device on other devices in the environment via lines and space.

C. INDEX