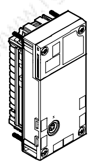
CPX terminal

Description
Communication profile

FHPP for the CMAX axis controller

Activation and diagnostics via CPX node

Typ CPX-CMAX-C1-1



Description
559 757
en 0908NH
[727 411]

Original .... de

Edition .... en 0908NH

Designation .... P.BE-CPX-CMAX-CONTROL-EN

Order-no. 559 757

Internet: http://www.festo.com
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Contents

Intended use

This description contains the communication profile for the axis controller type CPX-CMAX-C1-1. The profile is based on the Festo Handling and Positioning Profile (FHPP).

This provides you with supplementary information about controlling, diagnosing and parameterising the axis controller via the fieldbus.

Additional information can be found in the system description for the used axis controller (see Tab. 0/1):

– Description P.BE-CPX-CMAX-SYS-...:
  Mounting, installation, positioning system diagnostics

Note
Make sure you observe the safety instructions given in the system description.

General basic information on the mode of operation, on mounting, installing and commissioning CPX terminals can be found in the CPX system description, type P.BE-CPX-SYS-... .

General information about the used CPX node can be found in the associated description:

– Description type P.BE-CPX-FB...-.../P.BE-CPX-PNIO-...:
  Description of the respective CPX node.

– Manual type P.BE-CPX-FEC-...:
  Description of the CPX Front End Controller.

Appendix C of this description contains additional information on how to use the CMAX with supported fieldbus nodes.

Safety instructions

When commissioning and programming positioning systems, you must always observe the safety regulations in the descriptions as well as the operating instructions for the other components used.

The user must make sure that nobody is within the sphere of influence of the connected actuators or axis system. Access to the potential danger area must be prevented by suitable measures, such as barriers and warning signs.

Warning
Axes can move with high force and at high speed. Collisions can lead to serious injuries and damage to components.

Make sure that nobody can reach into the sphere of influence of the axes or other connected actuators and that no items are within the positioning range while the system is connected to energy sources.

Warning
Errors in the parameterisation can cause personal injuries and damage to property.

Enable the controller only if the axis system has been correctly installed and parameterised.

Target group

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

Service

Please consult your local Festo Service or write to the following e-mail address if you have any technical problems:

service_international@festo.com

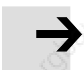
Important user instructions

Danger categories

This description contains instructions on the possible dangers which can occur if the product is not used correctly. These instructions are marked (Warning, Caution, etc.), printed on a shaded background and marked additionally with a pictogram. A distinction is made between the following danger warnings:

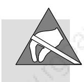
Warning
... means that failure to observe this instruction may result in serious personal injury or material damage.

Caution
... means that failure to observe this instruction may result in personal injury or material damage.



Note
... means that failure to observe this instruction may result in material damage.

The following pictogram marks passages in the text which describe activities with electrostatically sensitive devices:

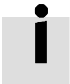


Electrostatically sensitive devices: Inappropriate handling can result in damage to components.

Identification of special information

The following pictograms designate texts that contain special information.

Pictograms



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

Accessories:
Information about necessary or useful accessories for the Festo product.

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

Text designations

- Bullet points indicate activities that may be carried out in any order.

1. Numerals denote activities which must be carried out in the numerical order specified.

– Arrowheads indicate general lists.

Information about the version

This description refers to the following versions:

– Axis controller CPX-CMAX-C1-1 starting from software versionV 1.0

This description contains special information about the control, programming and diagnosis of a CMAX with the used CPX nodes.

User documentation for the CMAX axis controller		
Type	**Title**	**Contents**
Electronics description	"CMAX axis controller, system description" P.BE-CPX-CMAX-SYS-...	Mounting, installation, commissioning and diagnosis of the CMAX axis controller.
Communication profile description	"CMAX communication profile" P.BE-CPX-CMAX-CONTROL-...	Control, programming and diagnosis of a CMAX with the used CPX node.
Online help	Help for Festo Configuration Tool with CMAX plug-in	Configuration and commissioning of the CMAX positioning module with the FCT ➔ www.festo.com ➔ Downloads ➔ Download Area: Software, drivers and firmware ➔ Enter string: **CMAX**
Operating instructions	Operating instructions for the components used.	

Tab. 0/1: Documentation for the positioning system with the CMAX

Glossary

The following product-specific terms and abbreviations are used in this manual:

Term / abbreviation	Meaning
0xA0 ($A0_h$)	Hexadecimal numbers are indicated by a prefixed “0x” or by a subscript “h”.
A	Digital output. From the point of view of the master controller, the CMAX control inputs are module output data. See section 2.2.
AB	Output byte.
Absolute position measuring system	A position measuring system with a fixed (absolute) assignment of measured value (position, angle, etc.) and measured variable, for “digital” or “potentiometer” CMAX.
Adaptation	CMAX function for automatically improving non-optimal control behaviour during operation.
Axis string	Totality of all modules and cables which are connected to the CMAX via the axis interface.
Bus nodes	Provide the connection to specific fieldbuses. Transmit control signals to the connected modules and monitor their functioning (as a CPX module: CPX bus node).
CPX modules	Collective term for the various modules which can be integrated in a CPX terminal.
CPX node	Collective term for all CPX bus nodes or the CPX-FEC.
CPX terminal	Complete system consisting of CPX modules with or without pneumatics.
Control interface	Connection for all modules and cables in the axis string.
Drive	In this description, the term “drive” represents linear drives (DGCI, DGP), standard cylinders or positioning drives (DNC, DNCI, DNCM) or swivel modules (DSMI).
Festo Configuration Tool (FCT)	Software with standardised project and data management for supported device types. The special requirements of a device type are supported with the necessary descriptions and dialogues by means of plug-ins.
Festo Handling and Positioning Profile (FHPP)	Fieldbus data profile for Festo position controllers.

Term / abbreviation	Meaning
Festo Parameter Channel (FPC)	FHPP-specific parameter access.
Functions	Special functions in the different operation modes, such as: – Jog mode – Homing
Homing	By means of homing, the reference position and thereby the origin of the dimension reference system of the axis are defined.
I	Digital input. From the point of view of the master controller, the CMAX status outputs are module input data. See section 2.2.
I/Os	Digital inputs and outputs.
Identification	System function where specific characteristics of the connected axis can be determined, e.g. the break-away forces, frictional behaviour, dynamics (maximum accelerations and speeds), etc., by means of an identification run.
Incremental position measuring system	A position measuring system in which the measured variable refers to a reference point and is determined by counting equally large measurement steps (increments) for the CMAX "encoder".
Jog mode	Manual travel in positive or negative direction. Function for setting positions by approaching the target position, e. g. for teaching records.
Logic 0	Input or output provides 0 V (also LOW, FALSE or logic 0).
Logic 1	Input or output provides 24 V (also HIGH, TRUE or logic 1).
Operating mode	Type of CMAX control, function or setpoint specification.
Parameter	Different settings which are defined for the system operation and have to be saved in the CMAX.
PLC/IPC	Programmable logic controller; for short: controller (also IPC: industrial PC).
PNU	Parameter number. Each parameter has a number and subindex. See Chapter 5.
Position control	Control mode where a defined position is approached under electronic control and is kept.
Pressure/force control	Control mode for which a defined force is built up via pressure control. In the following, the term "force control" will be used.

Term / abbreviation	Meaning
Project zero point (PZ)	Dimension reference point for all positions in positioning tasks. The project zero point forms the basis for all absolute position specifications (e.g. in the position set table or in direct mode). The point of reference for the project zero point is the axis zero point.
Record	Positioning command defined in the position set table, consisting of target position, positioning mode, speed, acceleration, ...
Reference point (REF)	Point of reference for the incremental measuring system. The reference point defines a known position within the drive's travel.
Software end position	Programmable stroke limit (reference point = axis zero point) **Software end position, pos. (upper):** max. limit position in the positive direction (increasing actual values). **Software end position, neg. (lower):** max. limit position in the negative direction (decreasing actual values).

Tab. 0/2: Terms and abbreviations

CPX terminal configuration and FHPP overview

Chapter 1

Contents

1.1 Planning aspects when parametrising the CMAX

1.1.1 Instructions on the available CPX nodes

Tab. 1/1 shows an overview of the available CPX nodes (CPX-FEC or CPX bus nodes) that are suitable for operation with the CMAX (as of August 2009).

CPX node	Required version [1]	Use	For a description see
CPX-CEC	in preparation	On request	–
CPX-FEC	From Revision 18 (R18)	On request	Appendix C.3
CPX-FB6 (Interbus)	From Revision 22 (R22)	On request	–
CPX-FB11 (DeviceNet)	From Revision 20 (R20)	**suitable**	Appendix C.2
CPX-FB13 (PROFIBUS-DP)	From Revision 23 (R23)	**suitable**	Appendix C.1
CPX-FB14 (CANopen)	From Revision 20 (R20)	On request	–
CPX-FB23 (CC-Link)	From Revision 19 (R19)	On request	–
CPX-FB32 (Ethernet/IP)	From Revision 11 (R11)	On request	–
CPX-FB33 (PROFINET, M12)	From Revision 7 (R7)	On request	–
CPX-FB34 (PROFINET, RJ45)	From Revision 7 (R7)	On request	–
CPX-FB38 (EtherCAT)	All	On request	–

[1] Revisions version (Rev...), see name plate. Older revisions are not suitable for use with the CMAX and can lead to unpredictable behaviour.

Tab. 1/1: Instructions/special features/references for CPX nodes

General parametrisation instructions are provided in the description for the used CPX node.

1.1.2 CMAX parameters and CPX node parameters

The CMAX has a number of specific parameters. These internal CMAX parameters cannot be stored as module parameters in the CPX node, but are exclusively saved in the CMAX.

It is therefore not possible to access to the CMAX parameters in the usual way via the I/O diagnostic interface or via any corresponding bus-specific channels, but only via special functions.

Note
For CPX terminals with the CMAX, when exchanging the CPX terminal or the CMAX, it is **always** necessary to carry out parametrisation and commissioning again, since the parameters and data determined during commissioning are only saved in the CMAX.

The internal CMAX parameters can be changed with the following functions:

- Festo Configuration Tool with CMAX plug-in
- Cyclical fieldbus communication with the control and status data of the FHPP (parametrising mode). See sections 2.2.6 and 6.2.
- Acyclical fieldbus communication (e.g. PROFIBUS DPV1). See section 6.3 as well as the respective supplementary description in Appendix C.

1.2 Data format

Multi-byte values are usually interpreted by CMAX in the byte sequence "INTEL (LSB-MSB)".

INTEL (LSB-MSB) - little endian

Example	$21.268.514_d = 01\ 44\ 88\ 22_h$			
Byte address	0	1	2	3
Bit no.	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Bin	0 0 1 0 0 0 1 0	0 1 0 0 0 1 0 0	0 1 0 0 0 1 0 0	0 0 0 0 0 0 0 1
Hex	22h	88h	44h	01h

If your control system uses another byte sequence, you must take this into consideration accordingly, e. g. in your application programs.

CPX parameter "Analogue process value representation"

A few CPX nodes (e. g. CPX-F B13, FB33, FB34 and FB35) support the global system parameter "Analogue process value representation" (system table function number 4402, bit 7):

– Value "0": INTEL (LSB-MSB) – default

– Value "1": MOTOROLA (MSB-LSB)

MOTOROLA (MSB-LSB) - big endian

Example	$21.268.514_d = 01\ 44\ 88\ 22_h$			
Byte address	0	1	2	3
Bit no.	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Bin	0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0	0 1 0 0 0 1 0 0	0 0 1 0 0 0 1 0
Hex	01h	44h	88h	22h

The CMAX evaluates the global system parameter and converts the byte sequence accordingly. After changing the parameter, wait for about 2 seconds until the CMAX conversion has been reliably executed.

The CMAX swaps the values, both in the cyclical (I/O data) as well as acyclical data (parameters).

1.3 CPX parametrisation

1.3.1 Fail-safe or idle mode parametrising example

Depending on your application and the CPX node used, check if corresponding fail-safe or idle mode parametrising is necessary.

Fail-safe parametrising or idle mode parametrising allows defined I/O states to be established in the event of a fault or if the bus fails.

Additional information can be found in the respective Appendix C.3, C.2 or C.1.

1.3.2 Start-up behaviour of the CPX terminal

The desired parametrisation of the CPX terminal should be carried out in the start-up phase or after fieldbus interruptions by the bus controller or the scanner/bus master, providing this is supported by the fieldbus protocol used.

Note
When exchanging a CMAX, parametrisation is not automatically established via the CPX node.
In this case, it is imperative that the CMAX be correctly parametrised, as during the initial start-up. See section 1.1.2.

Follow the instructions for exchanging components in the CMAX system description.

1.4 Commissioning instructions via the CPX node (fieldbus)

Fundamentally, the CMAX can be completely commissioned in a controlled manner via the CPX node.

This requires extensive programming of the master system, however, and suitable measures for monitoring the drive while the commissioning functions are being executed.

Recommendation:
Carry out commissioning with the FCT.

Tab. 1/2 shows an o verview of the necessary functions with references to more detailed information.

Function	Description	Topic	see
Entire commissioning sequence	For special applications, commissioning via the CPX node is possible.	Instructions for commissioning and servicing	Appendix A
During the entire commissioning process	Control and monitoring of CMAX	Control and status bytes	Chapter 2
		Diagnosis	Chapter 4
Parametrisation	Reading the detected actual configuration, writing the target configuration, parametrisation of the application data, etc.	Parametrising mode (FPC)	Section 6.2
		Acyclic parameter jobs	Section 6.3
Commissioning operations	Execution of commissioning operations, movement test, identification, teaching functions	Commissioning mode	Section 2.2.5
		Commissioning operations	Section 3.2

Tab. 1/2: Information on how to commission via the CPX node

Also follow the instructions in the CMAX system description.

I/O data and sequence control

Chapter 2

Contents

2.1 Operating modes

The operating modes differ with regard to their content and the meaning of the cyclic I/O data and with regard to the functions which can be accessed in the CMAX.

2.1.1 Record select mode

The CMAX has over 64 records which contain all the necessary information for a positioning task.

The record number that the CMAX is to process at the next start is transferred in the PLC's output data. The input data contains the record number that was processed last.

The CMAX does not support any user program. Records cannot be processed automatically with programmable logic. The CMAX can therefore not handle any reasonable jobs as a stand-alone device.

However, it is also possible to link various records and execute them one after the other with the help of a start command. It is also possible to define a record switch before the target position is reached.

In this way, positioning profiles can be created without the inactive times (which arise from the transfer in the fieldbus and the PLC's cycle time) having an effect.

Detailed information on record select mode can be found in section 3.3. An overview of the I/O data can be found in section 2.2.3.

2.1.2 Direct operating mode

In direct operating mode, positioning tasks are formulated directly in the PLC's output data (or the CPX node).

The typical application dynamically calculates the nominal target values for each job or just for some jobs. This makes it possible to adjust the system to different workpiece sizes, for example, without having to re-parametrise the record list. The setpoint values are managed completely in the PLC and sent to the CMAX.

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Detailed information on direct operating mode can be found in section 3.4. An overview of the I/O data can be found in section 2.2.4.

2.1.3 Commissioning

Commissioning operating mode is for putting the CMAX into operation, carrying out identification runs, etc. The following functions are permitted:

– Parametrisation of all axis data (with the FCT or via acyclical access)

– Jogging, teaching, referencing

– Identification, movement test, other commissioning functions

Positioning tasks (record selection, direct operation) are not permitted. This operating mode is mainly for establishing a clear separation between the commissioning functions and positioning operations to minimise the risk of operational errors.

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Information about the commissioning functions can be found in section 3.1, and an overview of the I/O data can be found in section 2.2.5.

2.1.4 Parametrisation

In parametrising mode, parameters can be transferred in the cyclical I/O data of the FHPP, which are actually meant to control the CMAX.

Here, the first control byte CCON is transferred for controlling the enabling and operating mode of the CMAX. The seven other bytes are occupied by the Festo Parameter Channel (FPC).

Parametrising mode can be activated in the states "Drive/controller disabled" or "Drive/controller enabled". The controller is then active, or not, accordingly. Enabling might be used to hold a vertical drive.
It is not possible to move the drive with START.

Information about parametrisation as well as an overview of the I/O data can be found in section 2.2.6.

2.1.5 Overview of the available functions in the operating modes

Tab. 2/1 shows the functions available in the individual operating modes.

Function	**Operating mode**			
	Rec. sel. m.	**Direct m.**	**Commiss.**	**Param.**
Parametrisation in the cyclical I/O data [1)]				x
Acycl. parametrisation [2)] of axis data (cylinder length, ...) [1)]			x	
Acycl. parametrisation [2)] of setpoint values (record list, etc.)	x	x	x	
Jogging position	x	x	x	
Teaching of setpoint values	x			
Teaching of zero points, software end positions			x	
Homing	x	x	x	
Point-to-point positioning	x	x		
Tracking mode positioning		x		
Point-to-point force setpoint value	x	x		
On-the-fly setpoint switching (new job before MC)	x	x		
Identification			x	
Movement test			x	

1) Only permissible for STOP = 0
2) e.g. DPV1

Tab. 2/1: Available functions in the operating modes

i Thedrivefunctionsaredescribedinsection 3.

2.2 Structure of the cyclical I/O data in the operating modes

<table>
<tr><th>Data</th><th>Byte 1</th><th>Byte 2</th><th>Byte 3</th><th>Byte 4</th><th>Byte 5</th><th>Byte 6</th><th>Byte 7</th><th>Byte 8</th></tr>
<tr><td>Output data</td><td colspan="2" rowspan="2">Bytes 1 and 2 (fixed) are retained in every operating mode (except byte 2 for parametrisation). They contain control and status bytes (e.g. CCON, SCON, ...) for enabling the CMAX and setting the operating modes</td><td colspan="6" rowspan="2">Bytes 3 to 8 depend on the selected operating mode (direct mode, record select) and transmit further control and status bytes (e.g. CDIR, SDIR,...), as well as setpoint and actual values:
– Record number or setpoint position in the output data
– Feedback of actual position and record number in the input data
– Additional operating mode- and control mode-dependent setpoint and actual values</td></tr>
<tr><td>Input data</td></tr>
</table>

Procedure

First define the operating mode in the CCON control byte. See sections 2.2.1 and 2.2.2.

This results in the assignment of the other control and status bytes:

- Record select mode, see section 2.2.3.
- Direct operating mode, see section 2.2.4.
- Commissioning mode, see section 2.2.5
- Parametrising mode, see section 2.2.6.

Recommendation: During operation, set the control bit CCON.LOCK. This way, the PLC can ensure that the programmed sequence cannot be disturbed by access with the FCT.
Evaluate the status bit SCON.FCT_MMI, and take the missing control access into consideration in the program sequence of the PLC.

2.2.1 CCON/SCON structure

CCON

With control byte 1 (CCON), all the states are controlled which must be available in all operating modes.

Assignment of the CCON control byte (byte 1)

CCON	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode selection		Software access blockage	–	Reset fault	Release brake	Stop	Enable drive

SCON

Control byte 1 (SCON) signals the CMAX status in all operating modes.

Assignment of the SCON control byte (byte 1)

SCON	**B7 OPM2**	**B6 OPM1**	**B5 FCT_MMI**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 OPEN**	**B0 ENABLED**
	Acknowledgement of operating mode		Device control software	Load voltage applied	Fault	Warning	Operation enabled	Drive enabled

The operating mode is defined with CCON.OPM1 and OPM2 and is acknowledged in SCON.OPM1 and OPM2.

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How the control bits work together can be found under the sequence control description in section 3.

Control byte 1 (CCON)		
Bit	**EN**	**Description**
B0 **ENABLE**	**Enable** Drive	= 0: Disable drive (controller) = 1: Enable drive (controller)
B1 **STOP**	**Stop**	= 0: Stop active (execute stop ramp + cancel positioning task). The drive stops with a stop ramp. The job is aborted and the standstill monitoring is deactivated. = 1: Enable drive. Not permissible in parametrising mode. A warning is signaled in parametrising mode if logic 1 is set.
B2 **BRAKE**	Open **Brake**	= 0: Activate brake (0 V at brake output) = 1: Release brake (24 V at brake output) Note: The allocation can be inverted by parametrisation (PNU 522:02). If the enable and brake are activated, the CMAX executes force control with a force setpoint of 0.
B3 **RESET**	**Reset** Fault	With a **rising edge**, any registered fault signal is cleared and, if successful, the fault status is exited.
B4 –	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B5 **LOCK**	**Lock** Software access	Access to the service interface (via FCT): = 1: FCT may only observe. Not possible to take over the device control (FCT). = 0: The FCT can take over the device control (in order to modify parameters or to control inputs).
B6 **OPM1** **B7** **OPM2**	Select **Op**erating **M**ode	Bit 7 6 Operation mode 0 0 Record select mode, see section 2.2.3 0 1 Direct operating mode, see section 2.2.4 1 0 Commissioning, see section 2.2.5 1 1 Parametrising, see section 2.2.6

Status byte 1 (SCON)

Bit	EN	Description
B0 **ENABLED**	Drive **Enabled**	= 0: Drive/controller disabled, controller not active = 1: Drive/controller enabled
B1 **OPEN**	**Op**eration **En**abled	= 0: Stop active = 1: Operation enabled, positioning possible
B2 **WARN**	**Warn**ing	= 0: Warning not registered = 1: Warning registered
B3 **FAULT**	**Fault**	= 0: No fault = 1: There is a fault or fault reaction is active.
B4 **24VL**	**24 V L**oad Voltage is applied	= 0: No load voltage = 1: Load voltage applied
B5 **FCT_MMI**	Drive Control by Software (**FCT/MMI**)	= 0: Device control free (e.g. PLC/fieldbus) = 1: Device control by software (FCT)
B6 **OPM1**	Display **Op**erating **M**ode	Bit 7 6 Operation mode acknowledgment 0 0 Record select mode 0 1 Direct operating mode 1 0 Commissioning 1 1 Parametrising
B7 **OPM2**		

2.2.2 Defining the operating mode with CCON

Operating mode	CCON/SCON		Description
	.OPM2	.OPM1	
Record select operating mode (record select mode)	0	0	The PLC selects a record from a record list saved in the CMAX. A record contains all the parameters which are specified for a positioning task. The record number is transferred to the cyclic I/O data as the setpoint or actual value.
Direct operating mode (direct mode)	0	1	The positioning task is transferred directly in the cyclic I/O data (FHPP standard). The most important setpoint values (position, speed, force) are transferred here. Supplementary parameters (e. g. acceleration) are defined via the parametrisation.
Commissioning mode	1	0	Commissioning operations (e.g. identification) can be executed and parameters can be read or written. Positioning tasks are not possible.
Parametrising mode	1	1	A parameter is transferred in the I/O data according to the FPC protocol. Positioning tasks are not possible.

Tab. 2/2: Overview of CMAX operating modes

Switching the operating mode

The operating mode is switched by means of the control bytes CCON.OPM1 and CCON.OPM2 and are acknowledged in the status bytes SCON.OPM1 and SCON.OPM2. See Tab. 2/2.

Switching the operating mode to “Commissioning” or “Parametrising” is only allowed for the status “Controller disabled” (CCON.ENABLE = 0) or “Controller enabled” (CCON.STOP = 0). Switching between record select mode and direct operating mode is additionally permitted for the status “Ready”, if MC (SPOS.MC = 1).

The operating mode can also be switched if there is a “Fault” status.

2.2.3 I/O data in the record select operating mode

I/O data: Record select mode								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	CPOS	Record no.	Reserved	Reserved			
Input data	SCON	SPOS	Record no.	RSB	Primary actual value (actual position, actual force)			

Assignment of the control and status bytes (record select mode):

Assignment of the control bytes (record select mode)								
CCON Byte 1	**B7** **OPM2**	**B6** **OPM1**	**B5** **LOCK**	**B4** –	**B3** **RESET**	**B2** **BRAKE**	**B1** **STOP**	**B0** **ENABLE**
	Mode selection		Block software access	–	Reset fault	Release brake	Stop	Enable drive
CPOS Byte 2	**B7** –	**B6** **CLEAR**	**B5** **TEACH**	**B4** **JOGN**	**B3** **JOGP**	**B2** **HOM**	**B1** **START**	**B0** **HALT**
	–	–	Teach value	Jog negative	Jog positive	Start homing	Start positioning task	–
Record no. Byte 3	Byte 3: Record number of the starting record (1 to 64)							
res. Bytes 4 to 8	Reserved = 0							

Assignment of the status bytes (record select mode)								
SCON Byte 1	**B7** **OPM2**	**B6** **OPM1**	**B5** **FCT_MMI**	**B4** **24VL**	**B3** **FAULT**	**B2** **WARN**	**B1** **OPEN**	**B0** **ENABLED**
	Operating mode acknowledgement		Software device control	Load voltage applied	Fault	Warning	Oper-ation enabled	Drive enabled
SPOS Byte 2	**B7** **REF**	**B6** **STILL**	**B5** **DEV**	**B4** **MOV**	**B3** **TEACH**	**B2** **MC**	**B1** **ACK**	**B0** **HALT**
	Drive ref-erenced	Standstill warning	Following error	Axis is moving	Acknow-ledge Teach	Motion Complete	Acknow-ledge Start	–
Record no. Byte 3	Acknowledgement of the last started record (1 to 64) In the case of record chaining, the actual record number always contains the currently actually executed record number. This changes, then, when the record is switched without a starting edge.							
RSB Byte 4	**B7** –	**B6** –	**B5** **XLIM**	**B4** **VLIM**	**B3** **RCE**	**B2** **COM1**	**B1** **RCC**	**B0** **RC1**
	–	–	Stroke limit reached	Speed limit reached	Fault switching records	Control mode acknowl-edge-ment	All next records switched to	1. Switched to next record
Primary actual value Bytes 5 to 8	Depending on the parametrisation: Actual position or actual force according to the FHPP setting (PNU 523:04 or 523:08) in the set system of units (section B.1).							

CPOS

Control byte 2 (CPOS) controls the positioning sequences as soon as the drive has been enabled.

Control byte 2 (CPOS) – record select mode

Bit	EN	Description
B0 **HALT**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B1 **START**	**Start** Positioning Task	With a **rising edge** the current setpoint values will be transferred and positioning started.
B2 **HOM**	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is signaled with an absolute measuring system.
B3 **JOGP**	**Jog p**ositive	The drive moves at the specified speed in the direction of increasing actual values, providing the bit is set.
B4 **JOGN**	**Jog n**egative	The drive moves at the specified speed in the direction of decreasing actual values, providing the bit is set. If JOGP and JOGN are set at the same time, the drive moves in the positive direction.
B5 **TEACH**	**Teach** Actual Value	At a **falling edge**, the current actual value is transferred into the setpoint register of the currently addressed record.
B6 **CLEAR**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B7 –	–	Reserved, must be set to 0. A warning is signaled for logic 1.

Status byte 2 (SPOS) – record select mode		
Bit	**EN**	**Description**
B0 **HALT**	Halt	Reserved (= 0).
B1 **ACK**	**Ack**nowledge Start	= 0: Ready to start = 1: Start executed [1]
B2 **MC**	**M**otion **C**omplete	= 0: Positioning task active = 1: Positioning task completed, possibly with error [2]
B3 **TEACH**	Acknowledge **Teach**	= 0: Teaching carried out, actual value is transferred = 1: Ready for teaching
B4 **MOV**	Axis is **mov**ing	Movement monitoring = 0: Drive does not move. (Axis speed signal ‹ limit value) = 1: Drive is moving
B5 **DEV**	Following error	Following error or tolerance monitoring = 0: No following error / within tolerance = 1: Following error active / outside of tolerance
B6 **STILL**	Stand**still** warning	Standstill monitoring. = 0: Standstill warning is not active = 1: Standstill warning is active, drive moved after MC (position control)
B7 **REF**	Axis is **ref**erenced	= 0: Referencing must be carried out = 1: Reference information present, homing not necessary

[1] When programming the handshake between CPOS.START and SPOS.ACK, the registered faults must always be taken into consideration as well, since SPOS.ACK is not set in the event of a fault.
[2] MC is set for the first time after switching on (“Drive disabled” status).

Status byte 4 (RSB) – record select mode		
Bit	**EN**	**Description**
B0 **RC1**	Position set sequencing **#1** completed [1]	If at least one switching condition has been configured: = 0: The first switching condition was not met yet. = 1: The first switch has been executed.
B1 **RCC**	Position set sequencing **C**ompleted [1]	If at least one switching condition has been configured and motion has been completed (MC): = 0: Switching condition not met, record chaining aborted. = 1: Record chain was processed to the end.
B2 **COM1**	**Co**ntrol **M**ode feed back **1**	= 0: Position control active = 1: Force control active
B3 **RCE** [1]	Position set sequencing **E**rror [1]	If at least one switching condition has been configured: = 0: No error switching to next record or no record switching programmed. = 1: A record switch was programmed, but was not executed. Record chaining aborted. A fault is signaled.
B4 **VLIM**	Velocity (**V**-) **Lim**it reached	For force control only: = 0: Speed limit not reached = 1: Speed limit reached. A fault is signaled.
B5 **XLIM**	Stroke (**X**-) **Lim**it reached	For force control only: = 0: Stroke limit not reached = 1: Stroke limit reached. A fault is signaled.
B6 –	–	Reserved
B7 –	–	Reserved
[1] Switching to next record: Position set sequencing ≙ **R**ecord **C**haining		

The RSB (record status byte) is transferred as byte 4 in record select mode. All bits are reset at the start and are updated dynamically.

2.2.4 I/O data in direct operating mode

I/O data: Direct operating mode								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	CPOS	CDIR	Secondary setpoint	Primary setpoint (position, force)			
Input data	SCON	SPOS	SDIR	Secondary actual value	Primary actual value (actual position, force)			

Assignment of the control and status bytes (direct mode):

Assignment of the control bytes (direct mode)								
CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4** –	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Mode selection		Block software access	–	Reset fault	Release brake	Stop	Enable drive
CPOS Byte 2	**B7** –	**B6 CLEAR**	**B5 TEACH**	**B4 JOGN**	**B3 JOGP**	**B2 HOM**	**B1 START**	**B0 HALT**
	–	–	Teach value	Jog negative	Jog positive	Start homing	Start positioning task	–
CDIR Byte 3	**B7** –	**B6 FAST**	**B5 XLIM**	**B4 VLIM**	**B3 CONT**	**B2 COM2**	**B1 COM1**	**B0 ABS**
	–	Exact stop/ fast stop	Deactivate stroke limit	Velocity limit reached	Tracking mode	Control mode 2 (profile)	Control mode 1 (position, force)	Absolute/ relative
Secondary setpoint Byte 4	Setpoint, depending on control mode and FHPP setting (PNU 523) – Speed as percentage of default value (PNU 540) – Force ramp as percentage of default value (PNU 550) – Workpiece mass as percentage of default value (PNU 544 or PNU 551) Value range 0 to 100, no sign given. Impermissible setpoint values are limited. For the "Workpiece mass" secondary setpoint, 100% of the basic value is always used for the speed or force ramp. The setpoint value is transferred to CPOS.START with a positive edge.							
Primary setpoint Bytes 5 to 8	Setpoint value of the position or force in the set system of units (section B.1). The setpoint value is transferred to CPOS.START with a positive edge. During tracking mode, the setpoint position is transferred continuously after the start until tracking mode is ended.							

Assignment of the status bytes (direct mode)

SCON Byte 1	**B7** **OPM2**	**B6** **OPM1**	**B5** **FCT_MMI**	**B4** **24VL**	**B3** **FAULT**	**B2** **WARN**	**B1** **OPEN**	**B0** **ENABLED**
	Operating mode acknowledgement		Software device control	Load voltage applied	Fault	Warning	Operation enabled	Drive enabled
SPOS Byte 2	**B7** **REF**	**B6** **STILL**	**B5** **DEV**	**B4** **MOV**	**B3** **TEACH**	**B2** **MC**	**B1** **ACK**	**B0** **HALT**
	Drive referenced	Standstill warning	Following error	Axis is moving	Acknowledge Teach	Motion Complete	Acknowledge Start	–
SDIR Byte 3	**B7** –	**B6** **FAST** [1]	**B5** **XLIM**	**B4** **VLIM**	**B3** **CONT**	**B2** **COM2**	**B1** **COM1**	**B0** **ABS** [1]
	–	Exact stop / fast stop active	Stroke limit reached	Speed limit reached	Tracking mode	Acknowledgement control mode 2	Acknowledgement control mode 1	Absolute/ relative
Secondary actual value Byte 4	Speed actual value as a percentage of the default value (PNU 540). The secondary speed actual value has a sign, so positive and negative values can be displayed. The entire value range is utilised, i.e. the displayed speed lies in the range from -128 % to +127 %. Higher speeds are limited to -128 % or +127 %.							
Primary actual value Bytes 5 to 8	Actual position or force value in the set system of units (section B.1), depending on the operating status and the FHPP setting (PNU 523).							

[1] The status bit only changes when the job is transferred (starting edge). All other status bits in the SDIR and RSB are updated cyclically.

CPOS

Control byte 2 (CPOS) controls the positioning sequences as soon as the drive has been enabled.

Control byte 2 (CPOS) – direct mode

Bit	EN	Description
B0 **HALT**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B1 **START**	**Start** Positioning Task	With a **rising edge** the current setpoint values will be transferred and positioning started.
B2 **HOM**	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is signaled with an absolute measuring system.
B3 **JOGP**	**Jog p**ositive	The drive moves at the specified speed in the direction of increasing actual values, providing the bit is set.
B4 **JOGN**	**Jog n**egative	The drive moves at the specified speed in the direction of decreasing actual values, providing the bit is set. If JOGP and JOGN are set at the same time, the drive moves in the positive direction.
B5 **TEACH**	**Teach** Actual Value	Reserved (in direct mode) A fault is signaled for logic 1.
B6 **CLEAR**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B7 –	–	Reserved, must be set to 0. A warning is signaled for logic 1.

CDIR

Control byte 3 (CDIR) is a special control byte for the operating mode direct mode.

Control byte 3 (CDIR) – direct mode

Bit	EN	Description
B0 **ABS**	**Abs**olute / Relative	= 0: Setpoint is absolute (relative to the project zero point) = 1: Setpoint value is relative to last setpoint/actual value [1]
B1 **COM1**	**Co**ntrol **M**ode 1	= 0: Position control = 1: Force control
B2 **COM2**	**Co**ntrol **M**ode 2	For position control only (COM1=0): = 0: Free profile: Speed and acceleration are freely specified = 1: Automatic profile: Speed and accelerations are specified by the controller [2] A fault is signaled for logic 1 when force control is active.
B3 **CONT**	**Cont**inous (Tracking) Mode	For position control: Activates continuous tracking mode (continuous setpoint specification): = 0: Do not activate tracking mode = 1: Activate tracking mode
B4 **VLIM**	Speed (**V**) **Lim**it OFF	For force control: = 0: Activate speed limit = 1: Deactivate speed limit
B5 **XLIM**	Stroke (**X**-) **Lim**it OFF	For force control: = 0: Activate stroke monitoring = 1: Deactivate stroke monitoring
B6 **FAST**	**Fast** stop	Control for reaching the target setpoint value: [3] = 0: Exact stop = 1: Fast stop
B7 –	–	Reserved, must be set to 0. A warning is signaled for logic 1.

[1] The setpoint is relative to the last setpoint (if MC) or the actual value (if no MC). Force tasks following positioning tasks refer to force 0.
[2] Speed and accelerations are selected by the controller according to the identification so that the target position is reached as quickly as possible without overshooting.
[3] See section 3.1.4. SPOS.MC is only set when the job is completed according to the quality class. In the event of a fast stop, the standstill monitoring is deactivated.

Status byte 2 (SPOS) – direct mode		
Bit	**EN**	**Description**
B0 **HALT**	Halt	Reserved (= 0).
B1 **ACK**	**Ack**nowledge Start	= 0: Ready to start = 1: Start executed [1]
B2 **MC**	**M**otion **C**omplete	= 0: Positioning task active = 1: Positioning task completed, possibly with error [2]
B3 **TEACH**	Acknowledge **Teach**	Reserved (= 0).
B4 **MOV**	Axis is **mov**ing	Movement monitoring = 0: Drive does not move. (Axis speed signal ‹ limit value) = 1: Drive is moving
B5 **DEV**	Drag (**dev**iation) Warning	Following error or tolerance monitoring = 0: No following error / within tolerance = 1: Following error active / outside of tolerance
B6 **STILL**	Stand**still** warning	Standstill monitoring. = 0: Standstill warning is not active = 1: Standstill warning is active, drive moved (position control)
B7 **REF**	Axis is **ref**erenced	= 0: Referencing must be carried out = 1: Reference information present, homing not necessary

[1] When programming the handshake between CPOS.START and SPOS.ACK, the registered faults must always be taken into consideration as well, since SPOS.ACK might not be set in the event of a fault.
[2] MC is set for the first time after switching on (“Drive disabled” status).

Status byte 3 (SDIR) – direct mode

Bit	EN	Description
B0 **ABS**	**Abs**olute / Relative	= 0: Setpoint value is absolute = 1: Setpoint value is relative to last setpoint value
B1 **COM1**	**Co**ntrol **M**ode feed back **1**	= 0: Position control active = 1: Force control active
B2 **COM2**	**Co**ntrol **M**ode feed back **2**	For position control only (COM1=0): = 0: Free profile = 1: Automatic profile
B3 **CONT**	**Cont**inous tracking mode	Continuous tracking mode acknowledgment (continuous setpoint specification): = 0: Continuous tracking mode inactive = 1: Continuous tracking mode active
B4 **VLIM**	Velocity (**V**-) **Lim**it reached	For force control only: = 0: Speed limit not reached = 1: Speed limit reached
B5 **XLIM**	Stroke (**X**-) **Lim**it reached	For force control only: = 1: Stroke limit not reached = 0: Stroke limit reached, fault is signaled.
B6 **FAST**	**Fast** stop	= 0: Exact stop is active = 1: Fast stop is active, fault is signaled
B7 –	–	Reserved (= 0).

The SDIR status byte is the acknowledgement of positioning mode in direct mode. All bits except for B0 (ABS) and B6 (FAST) are reset at the START and then updated dynamically.

2.2.5 I/O data in commissioning mode

I/O data: Commissioning

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data	CCON	CPOS	Function	Param. 1	Parameter 2 (e.g. current workpiece mass)			
Input data	SCON	SPOS	Function	Progress	Primary actual value (actual position)			

Assignment of the control and status bytes (commissioning mode):

<table>
<tr><th colspan="9">Assignment of the control bytes (commissioning mode)</th></tr>
<tr><td rowspan="2">CCON
Byte 1</td><td>B7
OPM2</td><td>B6
OPM1</td><td>B5
LOCK</td><td>B4
–</td><td>B3
RESET</td><td>B2
BRAKE</td><td>B1
STOP</td><td>B0
ENABLE</td></tr>
<tr><td colspan="2">Mode selection</td><td>Block software access</td><td>–</td><td>Reset fault</td><td>Release brake</td><td>Stop</td><td>Enable drive</td></tr>
<tr><td rowspan="2">CPOS
Byte 2</td><td>B7
–</td><td>B6
CLEAR</td><td>B5
TEACH</td><td>B4
JOGN</td><td>B3
JOGP</td><td>B2
HOM</td><td>B1
START</td><td>B0
HALT</td></tr>
<tr><td>–</td><td>–</td><td>Teach value</td><td>Jog negative</td><td>Jog positive</td><td>Start homing</td><td>Start positioning task</td><td>–</td></tr>
<tr><td>Function
Byte 3</td><td colspan="8">The function number selects the starting commissioning operation in commissioning mode. The value is interpreted as enumeration. The functions are executed with a rising edge at CPOS.START.
<table>
<tr><th>Value</th><th>Function</th><th>Description</th><th>Param. 1</th><th>Param. 2</th></tr>
<tr><td>0</td><td>Reserved</td><td>Not permissible</td><td>–</td><td>–</td></tr>
<tr><td>1</td><td>Identification</td><td>Execute identification run</td><td>= 0</td><td>Workpiece mass</td></tr>
<tr><td>2</td><td>Movement test</td><td>Execute movement test</td><td>= 0</td><td>= 0</td></tr>
<tr><td>3 to 255</td><td>Reserved</td><td>Not permissible</td><td>–</td><td>–</td></tr>
</table>
When reserved functions are executed, the CMAX signals a corresponding error.</td></tr>
<tr><td>Param. 1
Byte 4</td><td colspan="8">When executing a commissioning operation: Reserved = 0
When teaching: Teach target, see section 3.2.7.
A zero (0=) must be transferred in setpoint value bytes which aren’t used.</td></tr>
<tr><td>Param. 2
Bytes 5 to 8</td><td colspan="8">Only for “Identification” commissioning operation: Current workpiece mass in the set system of units (see section B.1).
A zero (0=) must be transferred in setpoint value bytes which aren’t used.</td></tr>
</table>

Assignment of the status bytes (commissioning mode)								
SCON Byte 1	**B7** **OPM2**	**B6** **OPM1**	**B5** **FCT_MMI**	**B4** **24VL**	**B3** **FAULT**	**B2** **WARN**	**B1** **OPEN**	**B0** **ENABLED**
	Operating mode acknowledgement		Software device control	Load voltage applied	Fault	Warning	Operation enabled	Drive enabled
SPOS Byte 2	**B7** **REF**	**B6** **STILL**	**B5** **DEV**	**B4** **MOV**	**B3** **TEACH**	**B2** **MC**	**B1** **ACK**	**B0** **HALT**
	Drive referenced	Standstill warning	Following error	Axis is moving	Acknowledge Teach	Motion Complete	Acknowledge Start	–
Function Byte 3	Acknowledgement of the commissioning operation currently being executed.							
Progress Byte 4	When executing a commissioning operation: The progress display in the status data shows to what degree the function has progressed for long operations. Display in percent (0% to 100%). There could be jumps in the progress display (e. g. from 24% to 60%). At the end of the function, the progress counter is set to 255 (0xFF). When teaching: Teach target, see section 3.2.7.							
Primary actual value Bytes 5 to 8	Depending on the parametrisation: Actual position or actual force according to the FHPP setting (PNU 523:04 or 523:08) in the set system of units (section B.1).							

CPOS

Control byte 2 (CPOS) controls the positioning sequences as soon as the drive has been enabled.

Control byte 2 (CPOS) – commissioning mode

Bit	EN	Description
B0 **HALT**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B1 **START**	**Start** Positioning Task	With a **rising edge** the current setpoint values will be transferred and positioning started.
B2 **HOM**	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is signaled with an absolute measuring system.
B3 **JOGP**	**Jog p**ositive	The drive moves at the specified speed in the direction of increasing actual values, providing the bit is set.
B4 **JOGN**	**Jog n**egative	The drive moves at the specified speed in the direction of decreasing actual values, providing the bit is set. If JOGP and JOGN are set at the same time, the drive moves in the positive direction.
B5 **TEACH**	**Teach** Actual Value	For a **falling edge**, the current actual value is transferred according to the teach function (teach target in parameter 1, see section 3.2.7).
B6 **CLEAR**	–	Reserved, must be set to 0. A warning is signaled for logic 1.
B7 **–**	–	Reserved, must be set to 0. A warning is signaled for logic 1.

Status byte 2 (SPOS) – commisioning mode		
Bit	**EN**	**Description**
B0 **HALT**	Halt	Reserved (= 0).
B1 **ACK**	**Ack**nowledge Start	= 0: Ready to start = 1: Start executed [1]
B2 **MC**	**M**otion **C**omplete	= 0: Positioning task active = 1: Positioning task completed, possibly with error [2]
B3 **TEACH**	Acknowledge **Teach**	= 0: Teaching carried out, actual value is transferred = 1: Ready for teaching
B4 **MOV**	Axis is **mov**ing	Movement monitoring = 0: Drive does not move. (Axis speed signal < limit value) = 1: Drive is moving
B5 **DEV**	Following error	Following error or tolerance monitoring = 0: No following error / within tolerance = 1: Following error active / outside of tolerance
B6 **STILL**	Stand**still** warning	Standstill monitoring. = 0: Standstill warning is not active = 1: Standstill warning is active, drive moved
B7 **REF**	Axis is **ref**erenced	= 0: Referencing must be carried out = 1: Reference information present, homing not necessary

[1] When programming the handshake between CPOS.START and SPOS.ACK, the registered faults must always be taken into consideration as well, since SPOS.ACK might not be set in the event of a fault.
[2] MC is set for the first time after switching on (“Drive disabled” status).

2.2.6 I/O data in parametrising mode

I/O data: Parametrisation

Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	Subindex	Task identifier + parameter number		Parameter value			
Input data	SCON	Subindex	Reply identifier + parameter number		Parameter value			

Assignment of the control and status bytes (parametrisation):

Assignment of the control bytes (parametrisation)

CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Mode selection		Block software access	–	Reset fault	Release brake	Stop	Enable drive
Subindex Byte 2	Subindex of the parameter to be transferred							
Param. identifier Bytes 3+4	Job identifier and parameter number: Bit / Content / Description 0...11 / PNU / Parameter number of the parameter to be transferred 12 to 15 / ReqID / Job identifier, e.g. reading, writing, see section 6.1.1							
Param. value Bytes 5 to 8	Value of the parameter to be transferred (32-bit number)							

Assignment of the status bytes (parametrisation)

SCON Byte 1	**B7** **OPM2**	**B6** **OPM1**	**B5** **FCT_MMI**	**B4** **24VL**	**B3** **FAULT**	**B2** **WARN**	**B1** **OPEN**	**B0** **ENABLED**
	Operating mode acknowledgement		Software device control	Load voltage applied	Fault	Warning	Operation enabled	Drive enabled
Subindex Byte 2	Subindex of the transferred parameter							
Param. identifier Bytes 3+4	Reply identifier and parameter number: Bit / Content / Description 0...11 / PNU / Parameter number of the parameter to be transferred 12 to 15 / ResID / Reply identifier, see section 6.1.1							
Param. value Bytes 5 to 8	Value of the parameter to be transferred (32-bit number)							

2.3 FHPP finite state machine

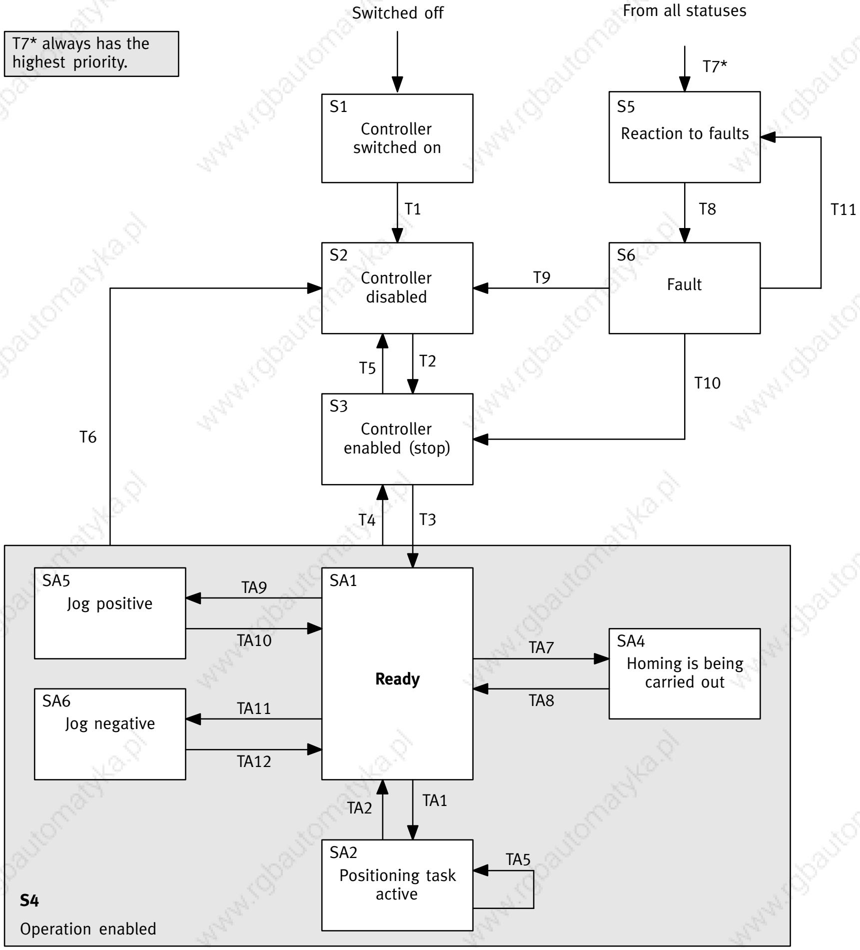


Fig. 2/1: Finite state machine

Notes on the "Operation enabled" state

Transitions T4, T6 and T7* are executed from every sub-state SAx and automatically have a higher priority than any transition TAx.

Reaction to faults

T7 ("Fault recognised") has the highest priority (and is marked with an asterisk "*").

2.3.1 Establish ready status

T	Internal conditions	Actions of the user
T1	Drive is switched on. No error is found.	–
T2	Load voltage applied. The higher-order controller is the PLC/fieldbus master.	“Enable drive” = 1 CCON = xxx0.xxx**1**
T3	–	“Stop” = 1 CCON = xxx0.xx**1**1
T4	–	“Stop” = 0 CCON = xxx0.xx**0**1
T5	–	“Enable drive” = 0 CCON = xxx0.xxx**0**
T6	–	“Enable drive” = 0 CCON = xxx0.xxx**0**
T7*	Fault recognised.	–
T8	Reaction to fault completed, drive stopped (MC = 1).	–
T9	There is no longer a fault (F2).	“Reset fault” = 0 → 1 CCON = xxx0.**P**xxx
T10	There is no longer a fault (F1).	“Reset fault” = 0 → 1 CCON = xxx0.**P**xx1
T11	Fault still exists.	“Reset fault” = 0 → 1 CCON = xxx0.**P**xx1
Key: P = positive edge, N = negative edge, x = any		

Tab. 2/3: Establish transitions to ready status

2.3.2 Positioning

Note: CCON = xxx0.xx11 is also always considered to be a permissible action.

TA	Internal conditions	Actions of the user
TA1	Referencing is running.	Start positioning task = 0→1 CPOS = 00x0.00**P**0
TA2	Motion Complete = 1 The current record is completed. The next record is not to be carried out automatically	CPOS = 00xx.xxx0
TA5a	Record select mode: – A single record is finished. – The next record is processed automatically.	CPOS = 00xx.xxx0 A start is not necessary.
TA5b	Record select mode or direct mode: – A new positioning task has arrived.	CPOS = 00xx.xx**P**0
TA7	Reference run (only with encoder measuring system).	Start homing = 0→1 CPOS = 00x0.0**P**x0
TA8	Referencing finished.	CPOS = 00xx.xxx0
TA9	–	Jog positive = 0 → 1 CPOS = 00x0.**P**xx0
TA10	–	Jog positive = 1→0 CPOS = 00xx.**N**xx0
TA11	–	Jog negative = 0 → 1 CPOS = 00x**P**.xxx0
TA12	–	Jog negative = 1 → 0 CPOS = 00x**N**.xxx0
Key: P = positive edge, N = negative edge, x = any TA3, TA4 and TA6 are reserved for future extensions.		

Tab. 2/4: Positioning transitions

2.3.3 Special features depending on operating mode

Operating mode	Notes on specific features
Record select mode	TA5: A new record can be started at any time With this, it is possible for the PLC to initiate a new record at any time depending on any events. The CMAX automatically handles all setpoint switching problems.
Direct operating mode	TA2: The condition that no new record may be processed no longer applies. TA5: A new positioning task can be started at any time.
Commissioning – Identification	TA2: The condition that no new record may be processed no longer applies. TA5: Restarting during an active commissioning operation is not possible. For this reason, this transition isn't used.
Parametrisation	Parametrising mode is not a positioning mode, but is only meant for transferring parameters. Transition T3 is not permissible. The drive, then, cannot switch to the S4 status.

Tab. 2/5: Special features depending on the operating mode

Drive functions

Chapter 3

Contents

3.1 General functional description

3.1.1 Position control

Single value mode (point-to-point)

Free profile

A positioning task for a free profile is executed with the given speed, acceleration and deceleration.
There might be a limitation imposed on valued determined during identification.

Properties:

- Speed, acceleration, deceleration and mass can be set separately for every task.
- Automatic acceleration limitation to feasible values (if dynamic identification was carried out). Automatic limitation cannot be deactivated.
- On-the-fly switching to a new task is possible.
- Stop behaviour: Braking ramp (if possible), otherwise setpoint position = actual position.

Automatic profile

With the automatic profile, a positioning task is executed with the maximum speed, acceleration and deceleration determined during identification.
Requirement: Dynamic identification has been carried out. Otherwise, the task is executed with the default values of the free profile and a warning message is output.

Properties:

- The mass can be set separately for every task.
- Stop behaviour: Braking ramp (if possible), otherwise setpoint position = actual position.

Continuous mode

In the case of continuous setpoint specification, an external position setpoint is tracked. The setpoint values can be specified by the PLC/via the fieldbus.

The continuous setpoint specification is only possible in direct operating mode and mainly corresponds with the free profile.

Properties:

- Speed, acceleration and deceleration are limited to values specified by the user (no automatic limitation).
- It is possible to set the mass at the start of continuous positioning mode.

General properties

The following generally applies for position control:

- Setpoint values are filtered (low-pass) to "smoothen" jump-like changes.
- Following error monitoring (signal, if following error is greater than the monitoring window).
- Monitoring of software end positions (end position limitation and warning).

3.1.2 Force control

Force control is done by controlling the pressure forces which act on the piston in both cylinder chambers. The force of the cylinder is not controlled directly – a force sensor would be required for this – but is controlled via the force acting on the piston. The imprecision of the force is therefore in the range of the static friction force of the drive. The setpoint values are specified as a force in the used system of units. The force on the piston to be regulated is determined via the force setpoint, the mounting position, the mass and the piston rod diameter. The force controller is parametrised automatically depending on the set project data, so that the controller parameters can remain at their default values in the normal case.

Properties:

- Setpoints and tolerance are specified as forces.
- Path / speed monitoring during force control.
- Stop behaviour: Setpoint position is identical to the actual position.
- Force ramp (modification speed) can be set.
- The force signaled as the actual force does not include gravity as long as the workpiece mass was given correctly in the positioning task.

Force control sequence

If “Force control” is set as the control mode with a rising edge at CPOS.START in RCB1 (record set mode) or in control byte CDIR (direct mode), the CMAX interprets the setpoint specification as a force setpoint. It activates the force control and adjusts the value with the set ramp. The RSB/SDIR signalises the “Force control” status accordingly.

1 Path

2 Force

3 Speed

4 Force control until drive breaks away

5 Feed phase (V_{feed})

6 Force buildup with force ramp

7 MC

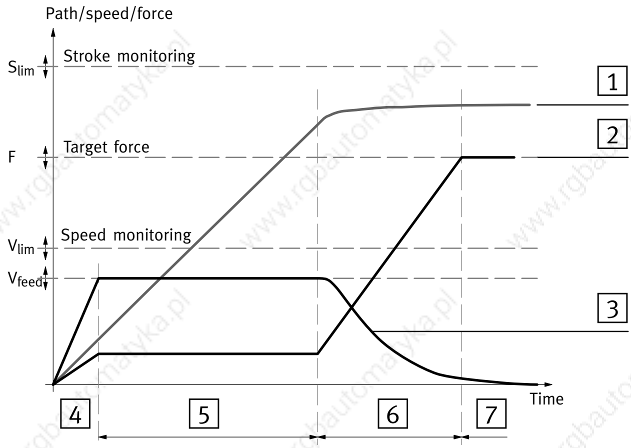


Fig. 3/1: Force control phases

Force control is done in phases according to Fig. 3/1 (for stroke and speed monitoring, see monitoring functions, Fig. 3/2):

1. After starting the force control task until the drive moves (phase 4, “breaking away”).

2. Feed phase/prepositioning at speed setpoint until standstill or target force has been reached (phase 5).
   If the drive does not encounter any counteracting force after the force task has started, it accelerates until it has reached the feed speed V_{feed}, and then switches to positioning mode and moves in the direction of the target force until the counteracting force increases and the controller switches back to force control.

3. At standstill: Force ramp until target force has been reached (phase $\boxed{6}$).
   The target force is approached with the set force ramp.

4. Once the axis has reached the target force, fulfilling the MC conditions, MC is set ($\boxed{7}$).

Notes:

- If there is a "stop" or error F1 (controller active), position control is switched to (setpoint position = actual position, etc.).
  If the limit monitoring responds, regardless of whether stroke or speed, the controller always changes to position control. See also Fig. 3/2, monitoring functions.

- The speed is limited to the value in the "Velocity" parameter.

- Prepositioning can be deactivated by $V_{feed} = 0$. See also Fig. 3/2, monitoring functions.

- If pre-positioning be used together with a large target force, it is better to use record chaining. In the first record, a force is specified which lies a little above the break-away force, so that drive safely switches to pre-positioning. In the second record, the final target value is established, switching will continue after MC. The force upon workpiece impact is then limited and the force ramp required is used in the range between the first and the final target force.

- The force setpoint may have the value 0 ("no force").

- Relative force tasks following positioning tasks refer to force 0.

- Depending on the parametrisation, the actual position or actual force is acknowledged as the primary actual value (PNU 523).

- Continuous setpoint tracking in force mode is not supported and leads to a fault.

- Force control outside the software end positions is not permitted and will lead to a fault.

- With force control, it might be necessary to optimize the control factors more often than with position control.

E. g., it might be necessary to adjust the amplification factor if the drive takes too long to reach the setpoint value. Information on the control factors can be found in section B.7.3.

Additional information about force and standstill control can be found in section B.8.

Monitoring functions for force control

1 Speed limit v_{lim}

2 Stroke limit s_{lim}

3 Target force F

4 Example of limit violation during stroke monitoring

5 Example of limit violation during speed monitoring

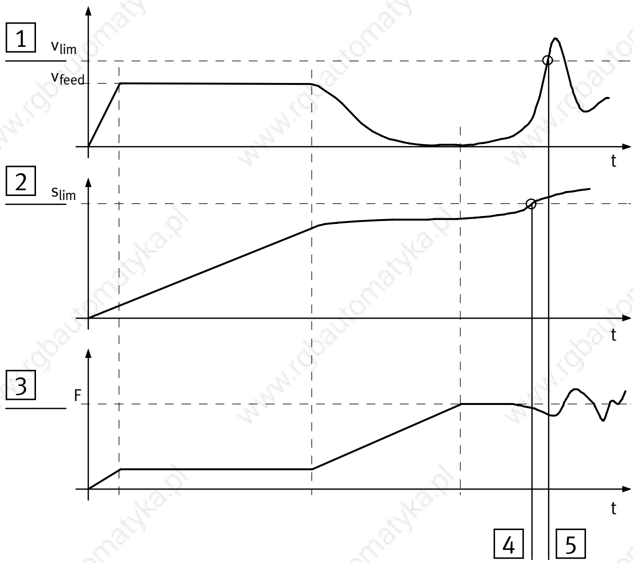


Fig. 3/2: Monitoring function for force control

Stroke monitoring	The stroke is limited for force control with stroke monitoring, e.g. when the workpiece being approached is not present.
Speed monitoring	Speed monitoring limits the speed during force control. This can prevent the drive from hitting a stop at excessive speed.

Notes regarding stroke and speed monitoring:

- When the path is exceeded which is set in the stroke monitoring (PNU 510, relative to the starting position), RSB.XLIM or SDIR.XLIM is set (stroke limit reached).
  If the speed V_{lim} (PNU 511) is exceeded, RSB.VLIM or SDIR.VLIM is set (speed limit reached).
  The drive is decelerated each time with the stop ramp, kept at the current position with position control and SPOS.MC is set as soon as the drive has stopped. A fault is generated and SCON.FAULT is set.

- Stroke and speed monitoring can be activated/deactivated independently of each other for each task (default: activated). The limits are global, however, i.e. apply for all records. (changes possible via fieldbus).

- Stroke and speed monitoring are activated every time a force task is started if they weren't disabled.

- Stroke and speed monitoring are also active after MC, i.e. delayed limit violations are detected.

- V_{lim} must always be greater than V_{feed}.

- V_{feed} can be deactivated by setting it to 0. This suppresses the switch to position control mode for a force task.
  I.e., the axis only moves with force control, and only limit monitoring is active. If limit monitoring is also deactivated, the axis could crash into the end position without braking.

3.1.3 Standstill control

Standstill control starts by ending a positioning task (MC).

There is a switch from position to force control to keep the drive safely at its standstill position. Here, the force currently applied to the piston is measured and is specified as a setpoint for the force control. Due to pressure compensation operations, the force for the setpoint specification is not measured directly after the standstill condition has been reached, but:

– 200 ms afterwards or

– when the change in the actual force exceeds a certain value (› 25% of the frictional hysteresis).

When switching from position to force control, the drive is under standstill control.

If the drive exits the tolerance window for the standstill condition while under standstill control, which can be caused by external forces, the position control is reactivated until the switching condition for the standstill control has been reached again.

Attention: At the end of a positioning task, the drive comes to a standstill due to static friction. For this reason, the standstill force can also vary in the range of the static friction. The force which is displayed at standstill therefore varies from stroke to stroke.

3.1.4 Quality classes

For positioning or force tasks, the respectively specific quality classes are used.

This way, conditions are defined for which a task is signaled as being completed.

Quality class	Description
Exact stop	The task is completed when the drive is within the tolerance for the duration of the monitoring time (in the case of position control, it is nearly stopped - final speed check).
Fast stop	The task is completed as soon as the drive is within the tolerance.

Tab. 3/1: Quality classes

MC (Motion Complete, SPOS.MC) is only output when the record or task is completed according to the quality class. See section 3.1.6.

3.1.5 Handling the clamping unit or brake

On the VPWP there is a digital output available for controlling a clamping unit or brake.

No clamping unit/brake configured

No clamping unit has been configured in the factory settings (PNU 1143:03 = 0). The digital output on the VPWP always delivers 0 V.

Clamping unit/brake configured

If a clamping unit is configured (PNU 1143:03 = 1), the clamping unit is controlled exclusively by the control bit CCON.BRAKE, i.e. the clamping unit is always controlled only by the PLC. The CMAX never switches the VPWP output by itself.

Note
For the CMAX to have a correct control function, it is imperative that the clamping unit or brake be connected with the following logic (see also CMAX system description):
– Pin 2: 0 V = clamping unit/brake closed
– Pin 2: 24 V = clamping unit/brake open.

CCON.BRAKE control logic

In the factory settings, the control logic is low active, i.e. the clamping unit/brake is closed for CCON.BRAKE = 0. The switching output on the VPWP delivers 0 V

With PNU 522:02, the control logic can be inverted. See Tab. 3/2.

CCON.BRAKE control logic	Control	VPWP	Clamping unit
PNU 522:02	**CCON.BRAKE**	**Output**	**Status**
Low active: = 0: Brake active for CCON.BRAKE = 0 (default)	= 0	0 V	closed
	= 1	24 V	open
High active: = 1 brake active for CCON.BRAKE = 1 (CMPX-compatible)	= 0	24 V	open
	= 1	0 V	closed

Tab. 3/2: CCON.BRAKE control logic

→

Note
The CMAX always sets the switching output on the valve to 0 V directly when the task for activating the brake is detected (except if the controller is activated at the same time. See below). The brake then becomes active directly, even if the drive is still moving or a force has built up.

- Make sure that the clamping unit/brake allows this operating state.

Switch-on behaviour:

Since the clamping unit/brake is low-active by default, it is closed at switch-on (as long as CCON.BRAKE = 1 is set).

If the clamping unit/brake is configured to be high-active, this remains closed until the first negative edge at CCON.BRAKE or the first drive enable. This prevents the brake from being released unintentionally, e.g. when all PLC data are set to 0 initially at switch-on.

Setting and releasing the brake

When the controller is disabled, setting and releasing the brake is transferred directly to the clamping unit/brake without any further CMAX reaction.

If the controller is activated while the clamping unit/brake is closed, the CMAX goes over to force control with a force setpoint of 0 after enabling.

If the operation enable (CCON.STOP = 1) is activated and the brake is opened at the same time or later, before the "Operation enabled" response (SCON.OPEN), 50 msec are waited, which the brake/clamping unit requires to open mechanically. A start is only possible after this. See Fig. 3/3.

If the controller has the "Operation enabled" status (SCON.OPEN = 1), the closing of the brake has the same effect as resetting CCON.STOP. The "Operation enabled" status is exited with a stop. When standstill is reached, force control is activated with a force setpoint of 0.

→ **Note**
The controller takes the workpiece mass of the last task into account. If the mass specification is incorrect (e.g. workpiece mass has changed), when the clamping unit/brake is released, there could be compensational movement.

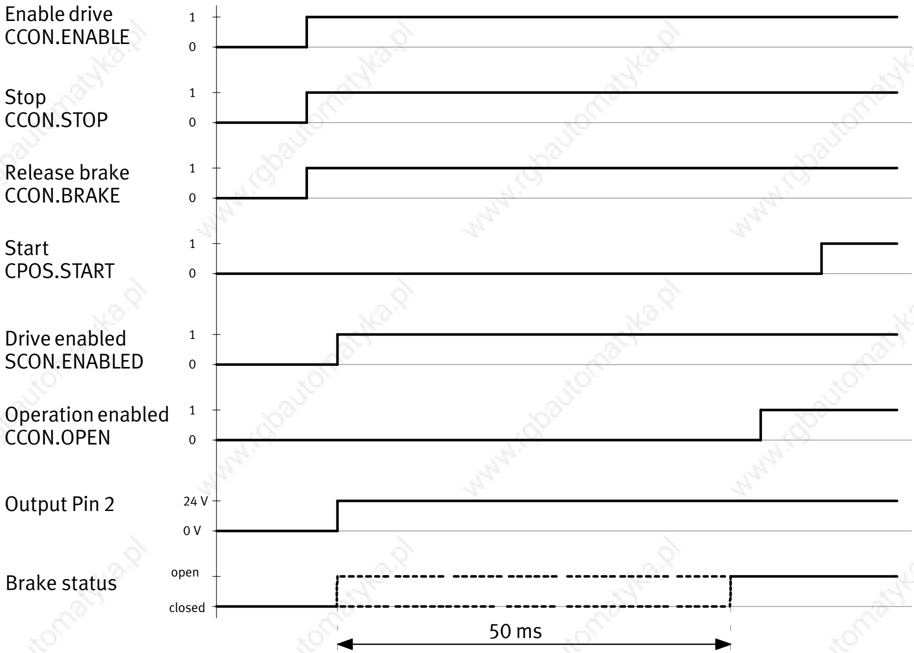


Fig. 3/3: “Open brake” sequence

An overview of different cases for setting and releasing the brake is shown in Tab. 3/3.

An overview of different cases for for activating and deactivating the controller is shown in Tab. 3/4.

Status, action	**Sequence or status for ...**	
	opening the brake	**closing the brake**
Controller is disabled	Brake output (pin 2) = 24 V	Brake output (pin 2) = 0 V
Activate controller simultaneously	1. Brake output (pin 2) = 24 V 2. Position control with Set = Actual 3. SCON.ENABLED = 1	1. Position control with set = actual 2. SCON.ENABLED = 1 3. Brake output (pin 2) = 0 V, simultaneously force control with 0 force
Controller is active	Brake output pin 2 = 24 V, simultaneously switch from force control to position control with stop and set/actual comparison	1. Brake output (pin 2) = 0 V, simultaneously stop with set/actual comparison 2. Force control with 0 force
Disable controller simultaneously	Brake output pin 2 = 24 V, disable controller simultaneously (SCON.ENABLED = 0)	1. Disable controller (SCON.ENABLED = 0) 2. Brake output pin 2 = 0 V

Tab. 3/3: Behaviour when setting and releasing the brake

Status, action	**Sequence or status for ...**	
	Activating the controller	**Disabling the controller**
Brake is closed	1. Position control with Set = Actual 2. SCON.ENABLED = 1 3. Force control with 0 force	Disable controller (SCON.ENABLED = 0)
Brake is open	4. Position control with Set = Actual 5. SCON.ENABLED = 1	Disable controller (SCON.ENABLED = 0)

Tab. 3/4: Behaviour for activating and deactivating the controller

3.1.6 Motion Complete (MC)

Motion Complete (MC) defines whether a positioning task is active. Motion Complete rules:

- **MC = 0** is set at the start of a positioning task, and this **before ACK** = 1 for:
  - Start record or direct mode (position or force control)
  - Jog mode
  - Start homing
  - Identification and movement test.
- **MC = 0** is **not** set for:
  - Stop
  - Disable controller
- **MC = 1** is set:
  - if the MC condition for the started positioning task is met (compare this with the list of positioning tasks when MC = 0 is set).
  - if the drive has been stopped or disabled and speed = 0.
  - MC is set after device has been switched on for the first time (status “Drive (controller) disabled”)

  In the case of force control, the breakaway force can result in the MC condition possibly being met already at the beginning of the task. Here, the criteria for the MC condition can be influenced by the monitoring time, tolerance, and other parameters.

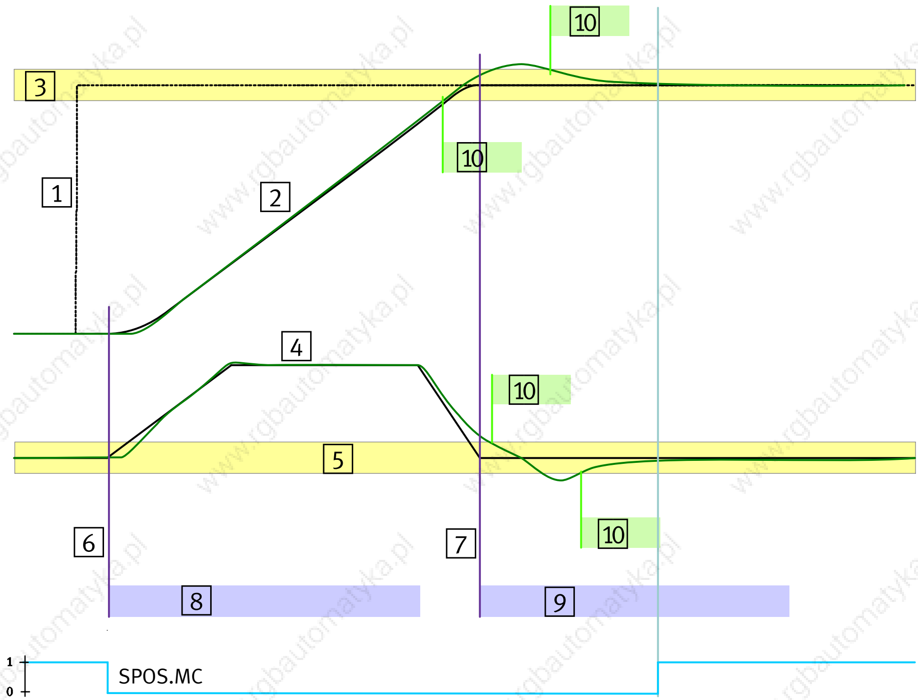
Position control

The Motion Complete (MC) signal indicates whether the last started task has been ended. It is made up of several logical conditions. See Tab. 3/5 and Fig. 3/4.

Condition	Description
Permanent entry in tolerance window for position	The actual position reaches the tolerance window and does not exit it again during the set monitoring time. The monitoring time (PNU 1154) can be configured in expert mode with the FCT (controller data -> position controller). The tolerance window corresponds with the target position +/- the currently set tolerance.
Permanent entry in tolerance window for speed	The actual speed reaches the speed tolerance window and does not exit it again during the set monitoring time. The monitoring time is the same as for the position (PNU 1154). The tolerance window is equivalent to +/- 4 mm/s.
Starting timeout (fault E31)	After starting the setpoint curve, the axis must have moved by at least 11 mm within the timeout time (PNU 1153). Otherwise, the CMAX signals a starting timeout.
Positioning timeout (fault E30)	At the end of the setpoint curve, the position and speed conditions must be met. If one of the two conditions is not met by the end of the timeout time (PNU 1153), the CMAX signals a positioning time-out.

Tab. 3/5: Conditions for Motion Complete

For the quality class “Fast stop”, MC is set as soon as the actual position has reached the tolerance window position. The monitoring time is not waited and the speed condition is not taken into consideration. That means that the axis might still be moving when MC occurs. It is possible that the tolerance could be exited again.
Due to the fast stop, the positioning time is shortened accordingly (= time to MC). This is suitable for positions which do not require high precision.



1	Position target setpoint	6	Start of the setpoint curve
2	Position setpoint value/actual value	7	End of the setpoint curve
3	Positioning tolerance	8	1. timeout (as starting timeout)
4	Speed setpoint value / actual value	9	2. timeout (as positioning timeout)
5	Speed tolerance	10	Monitoring time

Fig. 3/4: Motion Complete (position control)

Information regarding monitoring time in Fig. 3/4:

– Setting with PNU 1154, default = 30 ms.

– Setting with FCT only in expert mode under controller data, position control, monitoring time.

Force control

In the case of force control, the MC conditions correspond to those of position control, and correspondingly refer to the force setpoint and force tolerance.

Special features:

- No MC is output during the speed control phase (see section 3.1.2).
- Timeout: PNU 1163.
- No speed monitoring (i.e. the drive can move).
- No standstill warning.
- No starting timeout (function is covered by pressure monitoring, see fault E50).

3.1.7 Dynamically updated controller status bits MOV, DEV and STILL

The status byte SPOS delivers three dynamically updated controller status bits.

Bit	Description
SPOS.MOV	Axis is moving
SPOS.DEV	Following error / outside of tolerance
SPOS.STILL	Standstill warning

Tab. 3/6: Controller status bits

Movement monitoring (SPOS.MOV)

The bit SPOS.MOV indicates that the drive is moving. For this, CMAX checks whether the speed signal exceeds the internal limit (4 mm/s).

The internal status “Drive in motion” is additionally filtered with the switch-off time to simplify the evaluation in a PLC program.

[1] Target setpoint value

[2] Reference setpoint value

[3] Actual value

[4] Speed

[5] Speed tolerance

[6] Motion Complete (SPOS.MC)

[7] Internal status “Drive in motion”

[8] Axis is moving (SPOS.MOV)

[9] Switch-off time T_{OFF}

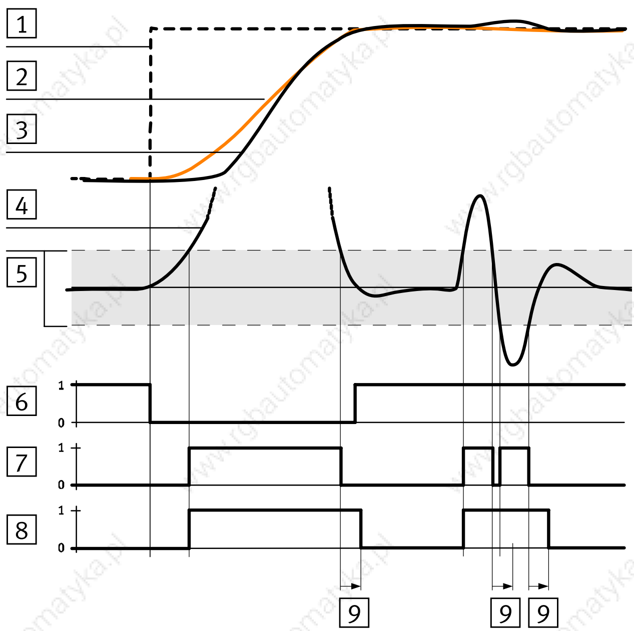


Fig. 3/5: Movement monitoring

Overview of parameters involved		
Parameters involved	**Description**	**PNU**
	Speed tolerance (fixed: ±4 mm/s or 0.16 in/s)	–
	Switch-off time T_{OFF} (fixed: 30 ms)	–

Tab. 3/7: Parameters involved in movement monitoring

Following error or tolerance monitoring (SPOS.DEV)

The bit SPOS.DEV (“deviation” = control fault) indicates that the control fault (i.e. SET/ACTUAL deviation) has exceeded a certain value. The permissible deviation depends on the movement status of the drive.

– During positioning (MC = 0): Following error

– After reaching Motion Complete: Tolerance window

There is no difference between the behaviour of position and force control. Only the parameters and signals used are different. The following figure shows the principle. The designations refer to position control.

1 Target setpoint value
2 Reference setpoint value
3 Actual value
4 Position tolerance
5 Following error tolerance
6 Control faults
7 Motion Complete (SPOS.MC, B2)
8 Deviation (SPOS.DEV, B5)
9 Following error
10 Outside of positioning tolerance

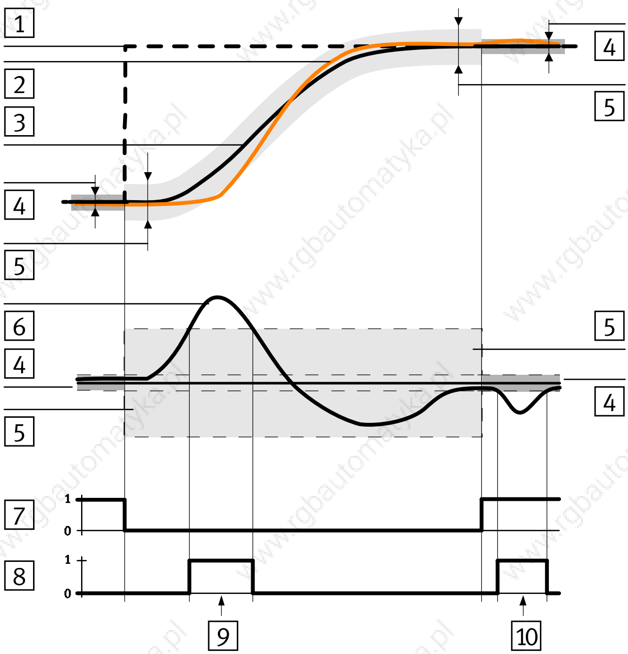


Fig. 3/6: Following error or tolerance monitoring

Regarding Fig. 3/6:

1 to 3: Setpoint value and actual value curves. The setpoint value here refers to the reference setpoint value which is generated by the trajectory planning.

4 to 6: Enlarged illustration of the control fault and the two tolerances. The following error tolerance (11 mm) is much greater than the positioning tolerance (0.1 to 10 mm or 0.004 to 0.394 in).

7: The MC signal determines which tolerance is used.

Overview of parameters involved (see section 5.4.6)

Parameters involved	Description	PNU
Position control	Target setpoint value: Target position	300:02
	Output of the reference setpoint value generator - position	– 1)
	Actual value: Actual position	300:01
	Current deviation: Position deviation	300:03
	Following error tolerance (fixed: 11 mm or 0.43 in)	–
	Positioning tolerance	411:xx or 545
Force control	Target setpoint value: Target force	301:02
	Output of the reference setpoint value generator - force	– 1)
	Actual value: Actual force	301:01
	Force deviation	301:03
	Following error tolerance (fixed: 5 N or 1.12 lbf)	–
	Force tolerance	411:xx or 552

1) No parameter defined, but available in trace

Tab. 3/8: Involved following error or tolerance monitoring parameters

Standstill monitoring (SPOS.STILL)

The standstill warning bit indicates whether the drive has moved again since reaching Motion Complete.

SPOS.STILL	Description
= 0	No movement
= 1	Warning: Drive moved after MC. The bit remains set until the next start.

Tab. 3/9: Standstill monitoring states

Properties:

- Standstill monitoring is activated as soon as SPOS.MC = 1 is set. It is only executed when position control is active. If "Fast stop" is configured, standstill monitoring is deactivated (i.e. a standstill warning is not initiated, even if the drive is still moving after MC).
- Speed condition: The warning is set if the drive moved for longer than a filter time T_F of 30 ms. The filter time prevents the warning from being initiated due to noise, etc.
- Position condition: The warning is set if the drive has moved relative to the MC position by more than half the positioning tolerance, but at least by 0.1 mm or 0.004 in/s (= standstill tolerance). Here, the drive may move outside of the actual positioning tolerance.
- One of the two conditions must be met in order for the warning bit to be set. Here, no warning is entered in the diagnostic memory. The warning bit is reset when the next positioning task is started.
- SPOS.STILL is reset when the controller is disabled.

1 Target position

2 Reference position

3 Actual position

4 Position tolerance

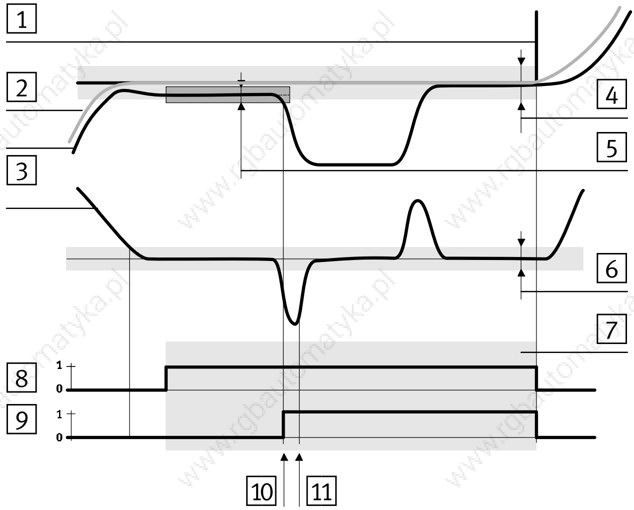
5 Standstill tolerance

6 Speed tolerance

7 Standstill monitoring active

8 Motion Complete (SPOS.MC, B2)

9 Standstill error (SPOS.STILL)



10 Position condition met: Standstill tolerance exited

11 Speed condition met: Drive movedfor30 ms.

Fig. 3/7: Standstill monitoring

Overview of parameters involved (see sections 5.4.4, 5.4.5, 5.4.12)		
Parameters involved	**Description**	**PNU**
	Current setpoint position	300:02
	Actual position	300:01
	Target position window = current tolerance 4	411:xx or 545
	Standstill position window = current tolerance * 0.5 5 But at least 0.1 mm.	0.5 * (411:xx or 545)
	Monitoring time	1132:04
Start (FHPP)	SPOS.MC = positive edge: Motion Complete	
Acknowledgement (FHPP)	SPOS.STILL = 1: The drive has moved outside the standstill tolerance window	

Tab. 3/10: Parameters involved in standstill monitoring

3.1.8 Limitation of setpoint values

In order to position quickly without overshoots when reaching the position or force setpoint value, CMAX limits setpoint values for accelerations, etc. which are too high.

During dynamic identification it is determined what maximum acceleration values allow for overshoot-free positioning. These values can lie under the physically achievable accelerations and decelerations, depending on the mass, starting and target positions, etc. The setpoint values specified by the user for the speed and acceleration are limited to the maximum values determined independently by the CMAX during positioning.

The CMAX generates a data record during a positioning task, which compares the user setpoints with the maximum values determined by the controller. In the FCT, the used values can be displayed under the "Limits" tab in expert mode.

If dynamic identification is not carried out, the maximum permitted values for acceleration must be determined by the user. By using these determined limits as setpoint values, overshoot-free positioning is guaranteed.

Position control

If a setpoint curve is generated based on acceleration setpoints which the drive can't follow, this can lead to overshoots at the target position.

With dynamic identification, the maximum attainable speed as well as the acceleration and deceleration ability of the drive system are ascertained.
The goal is to make overshoot-free positioning behaviour possible during positioning.

Examples can be found in the online help of the FCT CMAX plug-in.

Force control

The target force and force ramp are limited during force control.

Analogue to position control, the start and target values are displayed on the FCT.

The target value is always the target force. The starting value is the last setpoint value. If position control was active, the last setpoint value is always 0 N.

The starting and target positions are also valid, but are not displayed by the FCT.
The respective actual position is used here.

Parameter for limiting values

The parameter for limiting values (PNU 1173) contains a structure with the values required for display. When the CMAX has defined values, it sets the bit in the status word to "New values available".

PNU 1173: Limiting values				
Index	**Status value**	**Unit**	**EI 1)**	**Description**
1	Status word	–	–	Status, record number and additional information: Bit: Description 0 = 1: New values available 1 = 1: Acceleration has been limited 2 = 1: Deceleration has been limited 3 = 1: Speed has been limited 4 = 1: Force setpoint has been limited 5 = 1: Force ramp has been limited 6 to 15 Reserved 16 to 23 For record select mode: Number of the last executed record. 24 = 0: Record select mode = 1: Direct mode 25 = 0: Position setpoint = 1: Force setpoint 26 = 0: Free profile = 1: Automatic profile 27 to 31 Reserved
2	Starting position	Position	1	Starting position (actual position at start)
3	Target position	Position	1	Target position for position control, end position for force control
4	Acceleration setpoint	Accel.	7	That is the acceleration setpoint desired by the user.
5	Maximum acceleration	Accel.	7	The maximum possible acceleration determined by the controller. The maximum acceleration is determined from identification data and depends on the mass, start and target position.
6	Deceleration setpoint value	Accel.	7	That is the deceleration setpoint desired by the user.

1) Units index

PNU 1173: Limiting values				
Index	**Status value**	**Unit**	**EI [1)]**	**Description**
7	Maximum deceleration value	Accel.	7	The maximum possible deceleration determined by the controller. The maximum deceleration value is determined from identification data and depends on the mass, start and target position.
8	Speed setpoint	Speed	6	That is the speed setpoint desired by the user.
9	Maximum speed	Speed	6	The maximum possible speed determined by the controller. This speed is calculated from the acceleration and deceleration.
10	Target force	Force	3	For force control only: Target force.
11	Maximum force value	Force	3	That is the maximum possible force which the drive can produce. This value depends on the mass and direction in which the force is acting (not for horizontal configuration). Without mass compensation (horizontal), the maximum force is 90% of the nominal cylinder force.
12	Force ramp setpoint value	Force ramp	8	The set ramp specified by the user
13	Force ramp maximum value	Force ramp	8	The maximum force ramp determined by the controller.
14	Starting force	Force	3	For force control only: Starting force (last setpoint value)

1) Units index

Tab. 3/11: Limiting values

When is there reliable data in the parameter values?

The bit 0 of the status word must be set. If the bit is not set, the information which follows in the structure does not belong together. It comes from different positioning operations, or the data was not yet completely initialised.

Once the values have been determined, they remain in the CMAX until the FCT reads them out. Resetting the bit 0 in the status word by the FCT allows the CMAX to overwrite the old values again.

Exception

Depending on the positioning type, the individual values are filled at different times. In the event of an error or stop, the information might already be available, but it also might not. The values are initialised during switch-on and after identification. Otherwise, the last entry always remains there.

Record chaining

Also, during record chaining, a maximum of one record can be in the controller at any one time. According to the above-described handshake, it is a question of time when the FCT has read out the data and the CMAX can fill the structure with new data. Without a relatively long waiting time (seconds) between two consecutive records, the FCT cannot display the limit values of both records.

The user has no way of controlling the read-out. If the data from the second record are to be determined, this must be carried out individually or with a correspondingly long pause.

3.2 Commissioning operations

3.2.1 Movement test

The movement test is for detecting defects in the tubing connection.

Note
If the tubing connections of the VPWP get mixed up, the control direction is reversed. When activating the controller, the drive would move at maximum speed into the end position.

Carry out the movement test in the following cases:

- During commissioning after parametrisation. The CMAX expects the movement test to be carried out after parametrisation and indicates this by showing C03 on the display.
- When components are exchanged or the tubing connection has been disconnected and reconnected.

Special cases:

- If the movement test is to be skipped (not recommended), the status of the movement test must be set accordingly.
- The movement test status is automatically reset by the CMAX in the event of faults E01 and E08.
- If a movement test is to be carried out at a later time (e.g. after exchanging hardware), the status of the movement test might have to be reset manually.

Carrying out the movement test

The movement test must be carried out without activating the controller. The valve is only controlled here. The valve control value is then calculated independently of any deviation. Instead, a chamber of the cylinder is deliberately pressurized until the drive moves. Based on the position change, it is decided whether it moved in the right direction.

1. To carry out the movement test, it must be enabled (CCON.ENABLE = 1, CCON.STOP =1). The "Status movement test" parameter (PNU 1174) contains a flag (bit 0) for the executed movement test. If bit 0 has the value 0, the controller remains inactive, even if the CMAX is enabled. The CMAX still signals back the status "enabled".

2. If a clamping unit is configured, this must be released before beginning the movement test.

Note
Especially with a vertical configuration, releasing the clamping unit with the controller deactivated can lead to the drive dropping down directly after starting or even during the course of the movement test.

- Make sure that this does not pose a safety risk.
- Recommendation for vertical operation: Deliberately allow the drive to drop down to a stop or into the end position before starting the movement test.

3. With the positive edge at CPOS.START, the movement test is started when commissioning operation number 2 is registered. The two parameters must have the value 0 here. When another function or positioning is started, the error E14 is signaled.

4. The CMAX then starts an internal sequence where the valve control values are directly specified and a corresponding evaluation is carried out based on the reaction of the drive. Finally, the result is stored in the "Status movement test" parameter. The end of the movement test is signalised with SPOS.MC = 1.

If the tubing connection is correct, the controller is enabled at the end of the movement test.
Here, bit 0 in the movement test status is automatically set to 1 by the CMAX. The CMAX display changes to "000".

If the tubing connection is incorrect of if no clear result was determined, bit 0 remains 0. The controller is not enabled and error message E13 or E15 is output.

PNU 1174: Status movement test	
Bit	**Description**
0	= 0: Movement test must be carried out = 1: Movement test does not have to be carried out
1	= 0: Movement test was not carried out = 1: Movement test was carried out
2	= 0: Result of the movement test is not clear = 1: Result of the movement test is clear
3	= 0: Tubing connection error = 1: Tubing connection OK
4	= 0: Movement test was not skipped = 1: Movement test was skipped
5 ... 31	Not relevant (reserved)

Tab. 3/12: Status movement test

The status of the movement test can be influenced by writing the commissioning operation parameter (PNU 1192:07):

= 1: Movement test is reset and must be carried out again.

= 2: Movement test is set to “does not have to be executed” and is therefore skipped.

The parameter can only be written when the CMAX is in commissioning mode and there is no enable.

Typical causes of error in application

– If bit 0 in the “Movement test” parameter (PNU 1174) has the value 0, the CMAX can only execute a movement test. Every other task (e.g. identification, jogging, etc.) leads to an error.

Information for a correct tubing connection

Valve control value	Ventilation	Exhaust	The drive
-100%	1 --> 4	2 --> 3	... moves in the direction of decreasing actual values
0%	Closed	Closed	... does not move
+100%	1 --> 2	4 --> 5	... moves in the direction of increasing actual values

3.2.2 Homing

For drives with incremental measuring systems, homing must have been carried out before a positioning task can be done. Homing can be carried out in each supported operating mode except for parametrising mode.

The drive references with respect to a stop or, as a special case, the current position. Reaching the stop is detected when the piston comes to a standstill. Here, the possibility that this standstill was caused by a lack of air pressure must be ruled out.

Since the axis zero point for pneumatic axes must fundamentally be placed at the cylinder zero point, the drive (as opposed to electric drives, for example) does not automatically move to this zero point.

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For a description of the homing methods, see section 3.2.4.

General homing information

- The axes lose their reference:
  - when switched off, reset, etc.
  - possibly when there are errors in the sensor interface or axis string
  - when homing is started again.
- If the drive has a position measuring system with an absolute encoder, homing is not possible. An edge at the CPOS.HOME input leads to a fault. No movement is initiated.

3.2.3 Homing sequence and parametrisation

The drive references with respect to a stop (or the current actual position).

Sequence (does not apply to referencing at the actual position):

1. Reset the homing status to “Homing not executed”.
2. Search for the reference point (mechanical stop).
3. Wait for standstill for 500 ms. Afterwards, the pressurized cylinder chamber must have a chamber pressure measuring at least 2/3 of the set operating pressure.
4. Determine the axis zero point/cylinder zero point by setting the corresponding offset to the reference point (current position = 0 + project zero point offset).
5. After reaching the stop, the CMAX sets the status SPOS.REF = 1. The end of homing is signalised afterwards with SPOS.MC.

Overview of parameters involved (see also section 5.4.12)		
Parameters involved	**Description**	**PNU**
	Axis zero point offset	1130
	Homing method (permissible: -18, -17, 35)	1131
	Homing speed	1132
Start (FHPP)	CPOS.HOME = positive edge: Start homing	
Acknowledgement (FHPP)	SPOS.ACK = positive edge: Acknowledge Start SPOS.MC = 1: Movement completed SPOS.REF = 1: Drive referenced	

Tab. 3/13: Parameters involved in homing

The axis zero point offset has a great influence on CMAX controller optimisation. Even small values (a few mm) must be specified as exactly as possible:

– The distance between the used stop (of the reference point) and the cylinder end position (retracted piston rod) is measured as the offset and entered as a negative value.

– When the piston rod is completely retracted (cylinder end position) the value 0 must be entered as the offset.

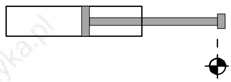
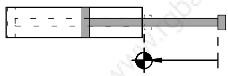
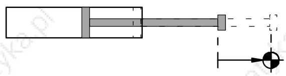
Note
If the offset is imprecisely entered, the drive could end up vibrating strongly depending on the setting of the involved parameters.

- Always carry out identification again after the offset has been corrected.

3.2.4 Homing run methods

The homing methods are oriented towards CANopenDS 402.

Homing methods

Hex	**Dec**	**Description**	
23h	35	**Current position** • The current position is saved as the reference point. There is no movement, not even for checking whether pressure is applied.	
EFh	-17	**Negative stop** • Run at homing speed in negative direction to stop. This position is saved as a reference point.	
EEh	-18	**Positive stop** • Run at reference speed in positive direction to stop. This position is saved as a reference point.	

Tab. 3/14: Overview of homing methods

3.2.5 Identification and adaptation

During identification, mainly those parameters are determined which are influenced by component fluctuations (e.g. valve covers, cylinder friction) or unknown installation factors (e.g. tubing connection, external friction), but the knowledge of which is important for the controller function.

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For a good identification result, all boundary conditions must be correctly set, especially the basic data (mass without workpiece and workpiece mass, supply pressure, etc.), as well as the mechanical drive characteristics (especially the axis zero point offset).
Repeat the identification if one of these parameters changes during operation.

When does identification have to be carried out?

Identification is required during commissioning, when the valid configuration data changes or when certain components are exchanged (see “Exchanging components”, section A.3.2). If the CMAX detects a corresponding change when comparing the set with the actual configuration, a corresponding error message is generated and the controller is not activated.
You must decide for yourself whether the identification data should be reset. E. g., after a fault due to mixed up axis strings, the identification data can continue to be used after changing them back.

- The CMAX signals a warning if identification should be carried out due to a change.
- The CMAX signals a fault if identification must be carried out due to a change.
- The identification status parameter (PNU 1171) contains information about the identification status.

Static identification

With static identification, characteristics are ascertained which have an effect on the behaviour of the system at the beginning and end of the movement as well as on that of the standstill control. This includes static friction of the drive and the valve characteristics in the range of the mid-position (valve hysteresis).

Dynamic identification

With dynamic identification, the maximum attainable speed as well as the acceleration and deceleration ability of the drive system are ascertained.

This identification must be carried out in the case of axes which should move at maximum speed (automatic profile).

If the mass changes considerably during operation, identification should be carried out both with and without the workpiece.

The dynamic part of the identification can be deactivated. This is important for cases where the structure cannot withstand dynamic stress.

No maximum values for the system speed and acceleration are determined without the dynamic identification having been carried out. For tasks with an “automatic profile”, a warning (W17) is output and the task is carried out with a “free profile” and the valid specified values.

The user determines the moving behaviour of the axis with the acceleration values. It might be necessary to manually optimise these values.

Carrying out identification

Only for pneumatic drives with incremental position measuring system (e.g. type DNCI-...):
Homing must be carried out before the identification run.

Identification sequence

During static identification, the axis first moves to the middle of the nominal stroke and carries out smaller movements in both directions.
If the middle of the nominal stroke cannot be approached due to the software end position, the CMAX moves close to the software end position in question at the start of static identification.

For dynamic identification, there should be at least 100 mm of free space available for movement.
The axis moves in the entire traversing range:

- No software end positions parametrised:
  The axis moves in the entire nominal stroke of the drive with a safety distance of about 10% of the nominal stroke to the stops.

- Software end positions parametrised:
  The axis moves in the entire defined effective stroke up to the software end positions.

The identification run consists of several steps:

1. Static identification.

2. Dynamic identification (if configured).

3. If dynamic identification has been carried out: Determination of the maximum values for acceleration and deceleration for a stroke of 90% of the effective stroke in both directions.

Carrying out identification

1. Set commissioning mode.
2. Prepare identification:
   - Set commissioning operation 1.
   - Parameter 1 = 0.
   - Parameter 2 = current workpiece mass in system of units
3. Start with CPOS.START.
4. Wait for SPOS.MC.
5. The CMAX enters the identification result in the identification status (PNU 1171).

PNU 1171: Identification status	
Bit	**Description**
0	= 0: Identification was not yet carried out = 1: Identification was carried out at least once
1	= 0: Static identification results not available. = 1: Static identification carried out successfully.
2	= 0: Dynamic identification results not available. = 1: Dynamic identification carried out successfully.
3 ... 31	Not relevant (reserved)

Tab. 3/15: Identification status

Notes:

- If the mass changes considerably during operation, identification should be carried out both with and without the workpiece.
- If the identification run is interrupted while in progress, static or dynamic identification data determined up to that point remains active.

Resetting identification

The identification data can be reset manually with PNU 1192:03. See section 5.4.16.
The adaptation data is also reset here.

Recommendation:
After exchanging components or changing parameters, the identification data should be reset before carrying out a new identification run.

Adaptation

After successful identification, the adaptation values are automatically determined during operation.

Adaptation is able to independently improve non-optimal control behaviour. The reason for poor control behaviour in small tolerance windows are long-term effects and imprecisely identified values.

Deactivating adaptation

Adaptation can be deactivated via the parametrisation. That usually isn't required in any configuration. Only in extremely rare cases does adaptation lead to worsened positioning behaviour.

Important: Not every deterioration in the positioning behaviour is due to faulty adaptation. Wear or weak construction can also lead to the positioning times gradually being prolonged, for example, or even the number of E30 messages piling up. For this reason, one should only deactivate adaptation if this is justified.

Faulty adaptation could be the reason for the following behaviour:

- After commissioning, the positioning behaviour gradually deteriorates. The positioning times become longer and the machine cycle gets bigger. E30 errors occur more often.
- After identification, the behaviour drastically improves without making any other changes. Afterwards, however, it begins to deteriorate slowly again until identification is carried out again.

In these cases, adaptation could be responsible. If this is your guess, deactivate adaptation and carry out identification again afterwards.

If the positioning behaviour doesn't change again afterwards, adaptation was probably the cause and should remain deactivated.

3.2.6 Jog mode

In the “Operation enabled” state, the drive can be traversed by jogging in the positive/negative directions. This function is usually used for:

- Moving to teaching positions
- Moving the drive out of the way (e.g. after a system fault)
- Manual traversing as a normal operating mode (manually operated feed).

Sequence

1. When one of the signals “Jog positive / Jog negative” (CPOS.JOGP/CPOS.JOGN) is set, the drive starts to move slowly (creeping phase). Due to the slow speed, a position can be defined very accurately.
   If JOGP and JOGN are set at the same time, JOGN has priority.
2. If the signal remains set for longer than the configured creeping period, the speed is increased until the configured maximum speed is reached. This way, large strokes can be traversed quickly.
3. If the signal changes to 0, the drive will be braked with the maximum set deceleration.
4. The drive stops automatically if it reaches a software end position. The software end position is not passed; the travel for stopping is taken into account in accordance with the set ramp. Here, too, Jog mode is only exited again after CPOS.JOGx = 0.

1 Creeping speed (slow travel)

2 Maximum speed

3 Acceleration

4 Deceleration

5 Creeping period

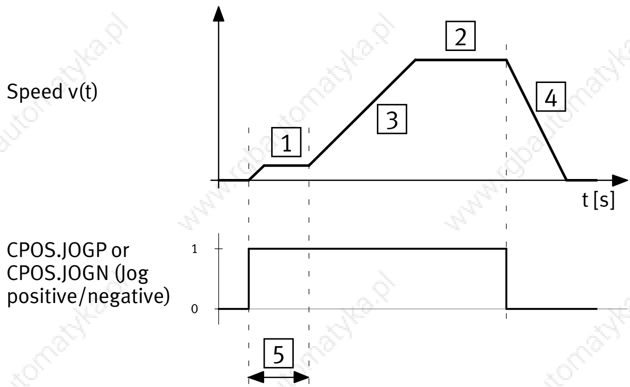


Fig. 3/8: Sequence diagram for jog mode

Special operating states

- Before referencing, jogging is only possible at reference speed.
- If the drive is outside of the software end positions, jogging can be used to move it into the allowed range.
- If the drive is outside of the software end positions and is not in commissioning mode, the drive stops if it is to be moved further out by jogging. No diagnostic message will be output.
- If the software end positions are deactivated, the drive moves to the hardware end positions.
- In commissioning mode, the software end positions can be passed. Here, the drive first stops at the software end positions. Jogging must be restarted at the end position. The drive moves at creeping speed to the hardware end positions by means of an edge(→ teaching the software end positions).
  When the software end positions are passed, warning W35 is signaled.

- If the CMAX determines that the axis came to a standstill before reaching the target position (software end position or hardware end position), e.g. due to a stop or obstacle, the drive is stopped.
- CPOS.JOGN has priority. If JOGP and JOGN are set at the same time, the negative direction is moved in.

Timeout during jogging

The timeout during jogging is not caught, independent of the operating mode. If the axis is clamped and isn't moving at all, error E31 (no movement after start) is generated.

If the CMAX determines that the axis came to a standstill before reaching the target position (software end position or hardware end position), e.g. due to a stop or obstacle, error E30 (target position cannot be reached) is signaled.

Errors E31 and E30 can occur both during the creeping run as well as during the maximum speed phase. This is because CMAX executed two positioning tasks internally.

Since the drive can jog up to the hardware end position in commissioning mode, the timeout here is possible in principle. Jogging up to the hardware end position is for teaching the software end positions or the project zero point. Reaching the stop might very well be desired here.

To avoid a timeout here, the status bit SPOS.MOV should be evaluated. If this is a logic 0 for at least 50 ms, jogging should be terminated.

Overview of parameters involved (see also section 5.4.7)		
Parameters involved	**Description**	**PNU**
	Jog mode, creeping speed	530
	Jog mode, maximum speed	531
	Jog mode, acceleration	532
	Jog mode, deceleration	533
	Jog mode, creeping period in ms	534
	Mass during jog mode	536 / 605 [1]
Start (FHPP)	CPOS.JOGP = positive edge: Jog positive (towards increasing actual values) CPOS.JOGN = negative edge: Jog negative (towards decreasing actual values)	
Acknowledgement (FHPP)	SPOS.MOV = 1: Drive is moving SPOS.MC = 0: (Motion Complete)	
[1] Depending on the parametrisation (PNU521), the default value is used for the workpiece mass. See section 5.3.		

Tab. 3/16: Parameters involved in jog mode

The ratio of the speeds to one another is not limited. PNU 531 can be less than or equal to PNU 530.

3.2.7 Teaching

The following values can be taught:

- Setpoint values in the record list (record selection)
- Project zero point and software end positions (commissioning).

Setpoint value sequence in the record list

Position or force values can be taught. The existing setpoint values are overwritten here. The type is determined by the control mode in record control byte 1 (RCB1).

1. Set record select mode (OPM2 = 0 + OPM1 = 0).
   - The record number (PLC output data, byte 3) must be set on the record which is to be taught. It is transferred to CPOS.TEACH with a positive edge.
   - If a force value is to be taught, the control mode must be set to “force” in record control byte 1 (RCB1).
2. Via jog mode, the drive is put into the desired position by positioning or manually (by moving by hand in “Drive disabled” state).
3. Teaching is done via the bit handshake in the control and status bytes CPOS/SPOS (Fig. 3/9).

1 PLC:
Prepare teaching

2 CMAX:
Ready for teaching

3 PLC:
Teach now

4 CMAX:
Value transferred

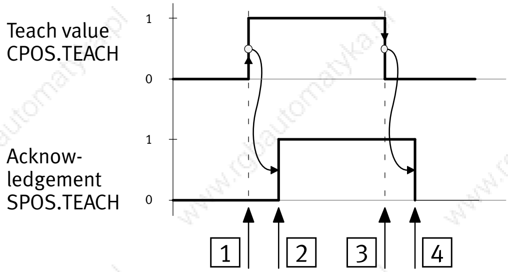


Fig. 3/9: Handshake during teaching

Notes:

– The drive must not stand still for teaching. However, a speed of 1 m/s means that the actual position changes by 1 mm every millisecond. With the usual cycle times of the PLC + fieldbus + CMAX, there will be inaccuracies of several millimetres, even at a speed of only 100 mm/s.

– It is still possible to teach the setpoint value if a record is disabled.

– If the setpoint value of a non-initialised record is taught, a corresponding new record is initialised and assigned default values. Here, the position is fundamentally taught.

– Only absolute setpoint values are taught. During teaching, bit RCB1.ABS = 0 is therefore set in record control byte 1 of the taught record.

Project zero point and software end position sequence

These values can only be taught in commissioning mode. The PLC must notify the CMAX what is being taught in the set parameter 1 (byte 4).

1. Set commissioning mode. (OPM2 = 1 + OPM1 = 0).

2. The last commissioning operation (e.g. identification) must have been ended. Teaching is not permissible while a commissioning operation is active and will lead to a fault.

3. Via jog mode, the drive is put into the desired position by positioning or manually (by moving by hand in "Drive (controller) disabled" state).
   Note: The software end positions may be passed during jogging. Outside of the software end positions, the drive only moves at creeping speed.

4. Enter the teach target in the PLC output data. The function number (byte 3) is ignored.

I/O data: Commissioning, teach function

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data	CCON	CPOS	Function	Param. 1: Teach target	= 0			
Input data	SCON	SPOS	Function	Param. 1: Teach target	Primary actual value			

Teach target (byte 4)

Value	Applies to PNU	What's taught is
3	500:00	Project zero point
4	501:01	Negative software end position
5	501:02	Positive software end position

5. Teaching is done via the bit handshake in the control and status bytes CPOS/SPOS (Fig. 3/9). The teach tar get is acknowledged in byte 4 of the input data (parameter 1) with the positive edge at SPOS.TEACH.

Notes:

– The drive should be stopped during teaching.

– The signaled actual position changes suddenly when teaching the project zero point.

– As long as CPOS.TEACH = 1, the CMAX does not accept any starting edge. Therefore, no function can be started during teaching. Jogging is permissible, however.

– The acknowledgement of the teach target (byte 4 of the input data, parameter 1) is reset when there is a:
rising edge at CPOS.TEACH
rising edge at CPOS.START
change in the operating mode (CCON.OPM1/CCON.OPM2)

– When teaching the software end position, there should be no parameter error E09. That means that the upper software end position must always be greater than the lower one. If that is not the case, error E44 is signaled and the taught value is not accepted.
Recommendation: First teach the upper software end position and then the lower one. If no software end position has been taught yet, the lower software end position can also be taught first. The upper software end position is then automatically set to the upper hardware end position by the CMAX.

Typical errors and warnings during teaching

No.	Type	Cause
W35	Actual position is outside of the software end position	The software end positions were passed during teaching.
E44	Teaching not possible	Teaching cannot be executed. For reasons, see Tab. 3/17.
E46	Start during teaching is not allowed.	Commissioning mode: During CPOS.TEACH = 1, no commissioning operation can be started. Reason: Both the teaching function as well as the commissioning operation use parameter 1.

Causes for E44: Teaching not possible
Teaching is not possible in direct mode (no teach target).
Homing not executed
Commissioning: Unknown teach target specified in parameter 1
Record selection: Impermissible record number (0 or › 64)
Record selection: Impermissible control mode preset in the selected record
Commissioning: Teaching lower software end position ›= upper software end position is not permissible
Commissioning: Teaching upper software end position ‹= lower software end position is not permissible
Commissioning: Teaching is not permissible while a commissioning operation is being executed.

Tab. 3/17: Causes for error E44 during teaching

The cause for E44 during teaching is shown in the diagnostic memory in accordance with Tab. 3/17.

3.3 Record select operating mode (record select mode)

A record can be started in the “Drive enabled” state. This function is usually used for:

- moving to any records in the record list by the PLC
- processing a positioning profile by linking records
- known target positions that seldom change (recipe change).

Controller functions

Tab. 3/18 shows the suppor ted controller functions during record selection.

Controller function	is supported
Point-to-point (PTP) positioning	Yes
PTP force control	Yes
Continuous positioning	No
Continuous force control	No
On-the-fly setpoint switching	Yes

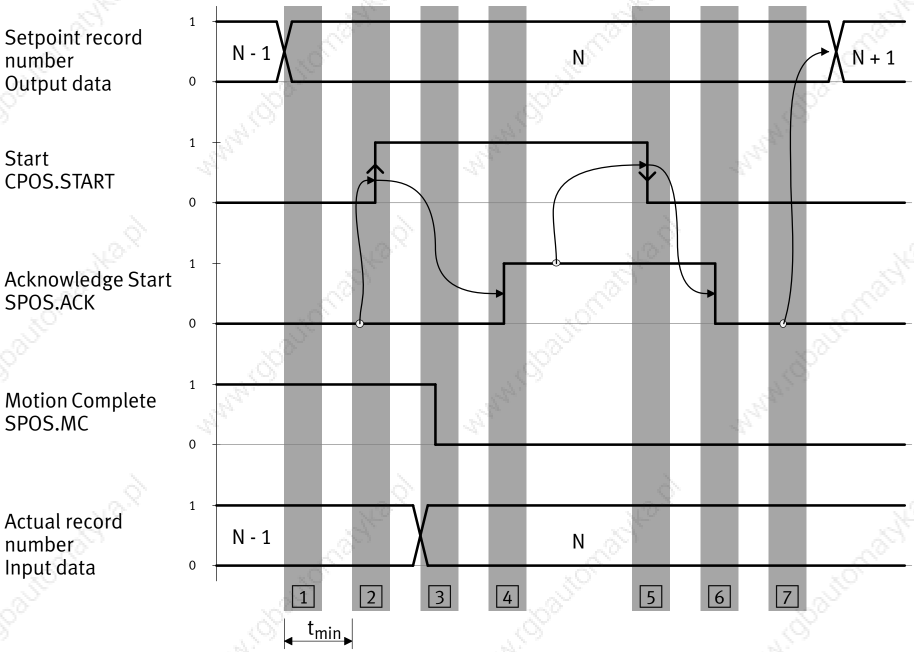
Tab. 3/18: Supported controller functions

Overview of parameters involved (see also section 5.4.5)		
Parameters involved	**Description**	**PNU**
	All parameters of the record data, see sections 3.3.2, Tab. 3/20	401 ... 412 [1]
	Default values, depending on PNU 403 [1]	600 ... 608
Start (FHPP)	CPOS.START = positive edge: Start Jogging and referencing have priority.	
Acknowledgement (FHPP)	SPOS.MC = 0: Motion Complete SPOS.ACK = positive edge: Acknowledge Start SPOS.MOV = 1: Drive is moving	

[1] Depending on parametrisation (PNU403), instead of record data in PNU 406 to 412, the default values are used from PNU 600 to 608. See section 5.3.

Tab. 3/19: Record Select parameters involved

3.3.1 Start of a record



t_{min}: at least 1 bus cycle waiting time. Recommendation: 1 PLC cycle.
Not required if consistent data transmission is used.

Fig. 3/10: Record start sequence

1 Set the required record number in the PLC's output data. Until the start, the CMAX continues to reply with the number of the record last processed.

SCON.FAULT must be 0 during the entire sequence.

2 If SPOS.ACK (Acknowledge Start) = 0, the PLC can initiate execution of the record with a rising edge at CPOS.START.

3 The CMAX accepts the record number and starts positioning, i.e. the setpoint curve.
In the PLC input data, the actual record number is set to the current record and SPOS.MC is reset.

4 The CMAX signalises with the rising edge at SPOS.ACK that the PLC output data have been accepted and that the positioning task is now active.

5 The PLC recognises the acknowledgement SPOS.ACK = 1 in its input data and resets CPOS.START in its output data.

6 CMAX acknowledges the resetting of CPOS.START by resetting SPOS.ACK.

7 After the PLC has registered SPOS.ACK = 0, it may write the new setpoint values in its output data. The CMAX ignores this until the next start.
Once the record or record chain has been ended, SPOS.MC is set.

Notes

- As soon as the PLC detects the rising edge at SPOS.ACK, it can assume that MC is valid. From the PLC's point of view, the falling edge at MC can occur at the same time as the rising edge at ACK. 3 and 4 then cannot be distinguished.
- In the event of faults, the task might not be acknowledged with SPOS.ACK (depending on the fault). For this reason, the SCON.FAULT bit must always be evaluated in addition.

Typical causes of error in applications:

- Referencing has not been carried out.
- Selection of an invalid record number or a record that has not been initialised.
- The target value lies outside the software end positions.

– Errors in the record parameters, e.g. an impermissible switching condition (see section 3.3.3).

– Subsequent record with active record switching not initialised.

– If the next record is configured with an automatic profile, only the condition MC (or none) are permissible. Otherwise, a warning (W37) is signaled and the free profile is used.

– The CMAX does not react to the rising edge at CPOS.START:
  It must be checked whether SPOS.ACK was really reset. After the PLC sets CPOS.START = 0 (Fig. 3/10 $\boxed{6}$), it must wait for SPOS.ACK = 0 (Fig. 3/10 $\boxed{7}$). Otherwise, it may be that the time for START = 0 is too short to be recognised by the CMAX.

Notes regarding force control

If “Force control” is set as the control mode with a rising edge at CPOS.START in RCB1, the CMAX interprets the setpoint specification as a force setpoint. It activates the force control and adjusts the value with the parametrised ramp. The speed is limited to the value in the “Velocity” parameter.

When the setpoint value has been reached, taking into account the tolerance, the “MC” signal is set. The force is controlled again until a new starting edge resets the controller mode to positioning.
If the stroke or speed limits are exceeded, an error is signaled. If there is a stop or error type F1 (controlled), there is a switch to position control (set = actual, etc.).

Force tasks following positioning tasks with a relative setpoint value refer to force 0.

3.3.2 Record structure

A positioning task in record select mode is described by a record made up of setpoint values. Every setpoint value is addressed by its own PNU. A record consists of the setpoint values with the same subindex.

PNU [1]	Name	Position control	Force control
401	Record control byte 1 RCB1	Setting for positioning task: absolute/relative, position/force control, ...	
402	Record control byte 2 RCB2	Record control: Settings for conditional record switching and record chaining	
404	Setpoint value	Position setpoint value	Force setpoint value
405	Preselected value	Preselected value according to RCB2	
406	Speed	Speed	
407	Acceleration	Start up acceleration [2]	– [2]
408	Deceleration	Slow down acceleration [2]	– [2]
410	Mass	Workpiece mass	
411	Tolerance	Position tolerance	Force tolerance
412	Force ramp	not used	Force ramp

[1] The default values are used depending on PNU 403 (RPC). See Tab. 3/19.
[2] The acceleration and deceleration parameters are not used for force control.

Tab. 3/20: Record parameters

3.3.3 Conditional record switching / record chaining (PNU 402)

Record select operating mode allows several positioning tasks to be linked. This means that several records are automatically executed one after the other after START. This allows a travel profile to be defined, e.g. switching to another speed after a position is reached.

To do this, a (decimal) condition is set in RCB2 to define that the following record N + 1 is automatically executed after the current record.
A numerical value is usually linked with the condition, e.g. the switching position. This value is defined in PNU 405 (preselected value).

Motion Complete (SPOS.MC) is only set after the last executed record.

If the MC condition is reached before the switching condition is met, the record chain is interrupted and SPOS.MC is set. In this case, bit 3 in the record status byte (RSB.RCE) is set and a fault is signaled.

Record switching in record 64 leads to an execution error.

Switching can be suppressed by setting bit B7. In this case, the CMAX executes the addressed record without an error message. Switching is ignored, however, and the next record is not executed.
This function is not meant for normal operation (debugging function with FCT).

Record control byte 2 (PNU 402)	
Bits 0 to 6	Numerical value 0 to 128: Switching condition as a list, see Tab. 3/23
Bit 7	= 0: Record switching (bit 0 to 6) is not disabled (default) = 1: Record switching disabled

Tab. 3/21: Settings for conditional record switching and record chaining

Mode of action of the Start, Ack, MC and RCx signals

Signal	Bit	Description
START	CPOS.START	Start of the first record of the record chaining
MC	SPOS.MC	End of the record chain
RC1	RSB.RC1	First record chain executed: After the first switch, bit 0 in the record status byte (RSB) is set.
RCC	RSB.RCC	Record chain complete: At the end of positioning (MC=1), RCC is set to show that all parametrised switches were executed.
RCE	RSB.RCE	Record chain error: A record switch has been parametrised which could not be executed.

Tab. 3/22: Record parameters

Special case: Switching between force and position

If there is a record switch with switching from force control to position control without changing direction, the drive first stops. This is necessary so that the forces which were built up before can be relieved.
Only afterwards is the new target position approached.

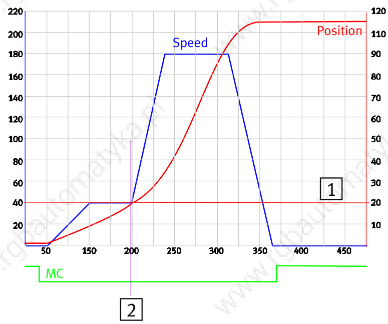
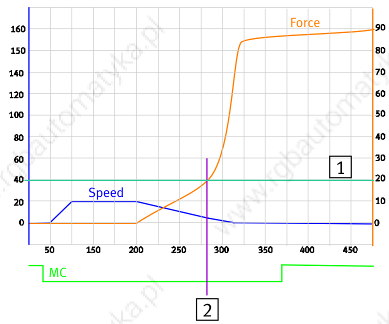
Restriction: Switching to a record with automatic profile

i

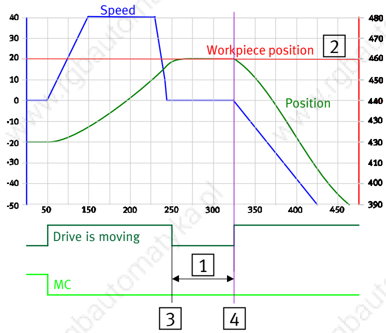
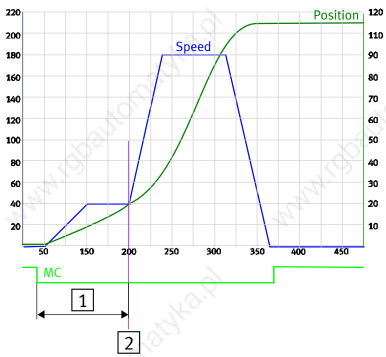
A record switch to a record with an automatic profile is only possible with the switch condition “MC”.

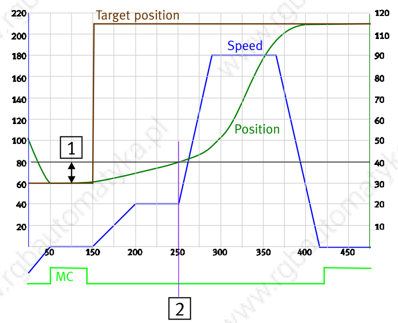
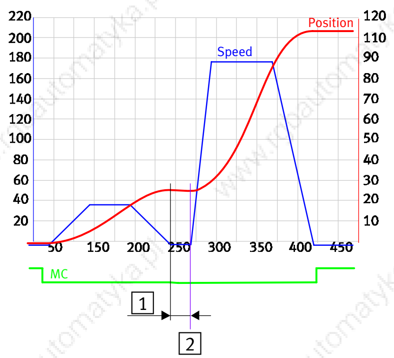
If such a switch is set, a warning (W37) is signaled during execution and the free profile is used.

Defined switching conditions in the CMAX

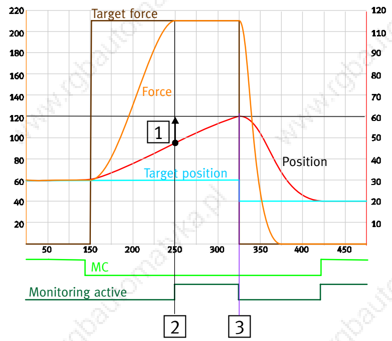
Value	Condition	Description
0	–	No switch.
1	–	Reserved
2	Position	The preselected value is interpreted as the position value [1]. The switch happens as soon as the current actual position exceeds the preselected value in the direction of travel [2]. As there is no need to stop, the drive reaches its target position quicker. 
3	Force	The preselected value is interpreted as the force value [1]. There is a switch when the current actual force has exceeded the preselected value [2] . The first command doesn't necessarily have to be a force command. Example: Slow positioning to the end point. When the force threshold has been reached, force control is switched to. 
		Notes: – The meaning of "exceed" is derived from the starting and target values of the force (analogously to positioning). – When switching from a positioning task: Besides the expected counteracting force, the force for accelerating the mass and the friction of the system also determine the current force value, and with this, the switching position. Therefore, only a small degree of switching position reproducibility is to be expected in this case. Only when the axis is positioned against a spring force, for example, and the force which occurs here is more than twice the frictional forces, including the acceleration force, does the switch result in more-or-less reproducible behaviour.

Defined switching conditions in the CMAX

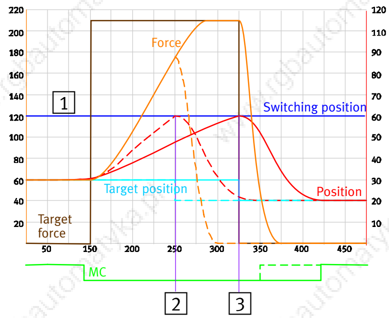
Value	Condition	Description
4	Standstill	The preselected value is interpreted as the time T1 $\boxed{1}$. Switch: The drive moves slowly up to the unknown workpiece position $\boxed{2}$ (to the end point) and stops there $\boxed{3}$. When a standstill is reached, the time T1 begins. As soon as this has elapsed, the next record is executed $\boxed{4}$. If the drive didn't move up to 100 ms after the start of the record (e.g. because it's already at the end point), standstill is also registered and the time T1 is started.  Notes: – To avoid a timeout, the configured timeout time is prolonged by the time T1 in this record. – If a standstill is detected, after the time elapses, switching continues, even if the axis is moving again (no monitoring time). – The axis can not only be stopped with an obstacle (wanted or unwanted), but also with a lack of pressure. – When switching from a force task: Since the force ramp also determines the switching point of the force at a standstill, only low reproducibility with regard to the position and force value can be expected.
5	Time	The preselected value is interpreted as the time T1 $\boxed{1}$. The time T1 is started at the beginning of positioning. The next record is switched to once the time has elapsed $\boxed{2}$. MC can already be reached here. 

<table>
<tr><th colspan="4">Defined switching conditions in the CMAX</th></tr>
<tr><th>Value</th><th>Condition</th><th colspan="2">Description</th></tr>
<tr><td>6 ... 10</td><td>–</td><td colspan="2">Reserved</td></tr>
<tr><td>11</td><td>Stroke</td><td>The preselected value is interpreted as the stroke 1 (position difference, with sign). The stroke refers to the last target position, not the actual position reached during the last positioning.
The switch 2 occurs after reaching the specified stroke.
If the current record has already been started by means of chaining, the preselected value refers to the switching position.
If the record is started without MC, the preselected value refers to the starting position.</td><td>
</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">MC</td><td>The preselected value includes a waiting time T1 1 in milliseconds.
The waiting time starts after reaching the target setpoint value, i.e. when the MC condition is met.
Switching occurs after this waiting time 2 elapses.
Therefore, the axis is at a standstill for a moment during positioning, but not necessarily during force control.</td><td>
</td></tr>
<tr><td colspan="2">Note:
– Motion Complete is also **not** set to 1 for this switching condition while the record is being processed, but only when the CMAX has carried out the last chained record.</td></tr>
</table>

Defined switching conditions in the CMAX

Value	Condition	Description	
13	Stroke after force	Switching is only permissible in a force record. The preselected value is interpreted as the stroke [1] (position difference, with sign). After reaching the MC condition for the force task [2], monitoring of the actual position is started. The switch [3] occurs as soon as the stroke [1] set in the preselected value has been passed. The stroke specified in the preselected value refers to the actual position at the time the MC condition was reached for the force task [2].	
		Notes: – The position could be difficult to reproduce and the absolute position is usually no known or evident because the position at the time the MC condition was met is not output. – The direction of the stroke must agree with the specified direction in which the force acts. Otherwise, a diagnostic message (W27/E27) is output. – If the stroke or speed monitoring is violated, the current positioning record is ended and record switching does not occur. – The timeout time (force) begins to elapse when the MC condition is met for the force task. If the stroke is not reached within the timeout time, the current positioning record is ended, no record switching occurs, SPOS.MC is set to 1 and a diagnostic message (W28/E28) is output. – If the timeout time for force control is deactivated (set to 0), the drive waits indefinitely for the switching position to be reached.	

Defined switching conditions in the CMAX

Value	Condition	Description
14	Position at force	Switching is only permissible in a force record. The preselected value is interpreted as the position value $\boxed{1}$. Switching occurs as soon as the current actual position reaches the preselected value, independently of whether the MC condition for the force task has already been met (case $\boxed{3}$, signals with solid lines) or not (case $\boxed{2}$, signals with dashed lines). Attention: SPOS.MC (Motion Complete) is not set to 1 during record processing, but only when the CMAX has carried out the last chained record.  Notes: – The direction of the switching position with respect to the starting position must agree with the specified direction of the acting force. Otherwise, a diagnostic message (W27/E27) is output. – If the stroke or speed monitoring is violated, the current positioning record is ended and record switching does not occur. – The timeout time (force) begins to elapse again when the MC condition is met for the force task. If the switching position is not reached within the timeout time, the current positioning record is ended, no record switching occurs, SPOS.MC is set to 1 and a diagnostic message (W28/E28) is output. – If the timeout time for force control is deactivated (set to 0), the drive waits indefinitely for the switching position to be reached.
15 ... 128	–	Reserved

Tab. 3/23: Switching conditions

3.4 Direct operating mode (direct mode)

In the “Operation enabled” state (direct mode), a positioning task is formulated directly in the I/O data, which is transmitted by the CPX node (e.g. via the fieldbus). The setpoint values are reserved in the PLC here.

Typical applications

The function is used in the following situations:

- Moving to any position within the effective stroke.
- The target positions are unknown during designing or change frequently (e.g. several different workpiece positions).
- A traversing profile consisting of chaining records is not necessary.
- The drive is to continuously follow a setpoint value.
- The position setpoints should be reserved in the PLC for another reason.

Typical causes of error in applications

- No referencing carried out.
- Target position or target force cannot be reached or are outside of the software end positions.
- Timeout (target position or target force are not reached).

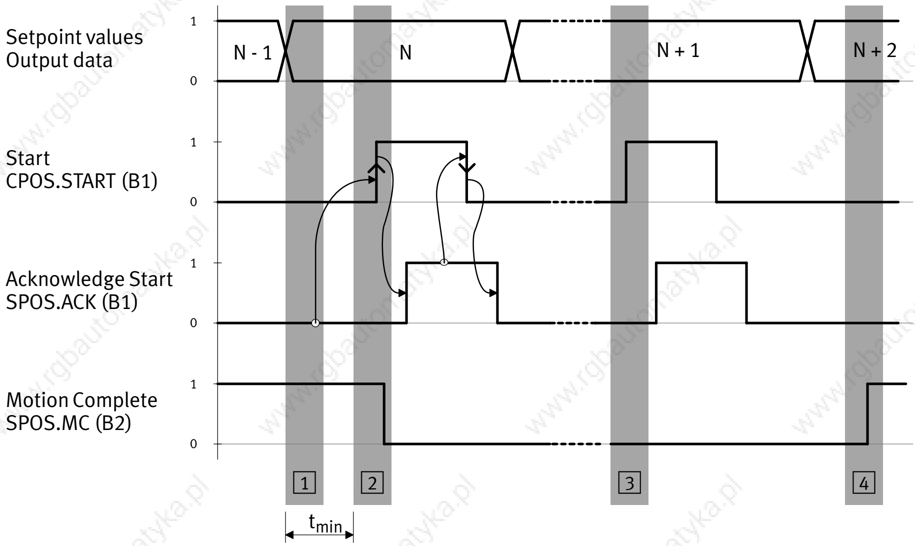
Overview of parameters involved (see also sections 5.4.8 and 5.4.9)		
Parameters involved	**Description**	**PNU** [1]
Position control	Basic speed value [2]	540
	Direct mode acceleration	541
	Direct mode deceleration	542
	Workpiece mass	544
	Tolerance	545
Force control	Basic value for force ramp [2]	550
	Workpiece mass	551
	Force tolerance	552
	Damping time in ms	553
	Speed limit for force control	554
Start (FHPP)	CPOS.START = positive edge: Start CDIR.ABS = absolute/relative setpoint value CDIR.COM1/CDIR.COM2 = control mode (see section 2.2.1) CDIR.CONT = continuous tracking Jogging and referencing have priority.	
Acknowledgement (FHPP)	SPOS.MC = 0: Motion Complete SPOS.ACK = positive edge: Acknowledge Start SPOS.MOV = 1: Drive is moving	

[1] Depending on parametrisation (PNU403), instead of basic values in PNU 540 to 554, the default values are used from PNU 600 to 608. See section 5.3.

[2] The PLC transfers a percent value in the control bytes, which is multiplied by the basic value in order to get the final setpoint value.

Tab. 3/24: Parameters involved, direct mode

3.4.1 Start of a positioning task



t_{min}: at least 1 bus cycle waiting time. Recommendation: 1 PLC cycle.
Not required if consistent data transmission is used.

Fig. 3/11: Start the positioning task

The sequence of remaining control and status bits behave according to record select operating mode. See sections 3.3.1, Fig. 3/10.

1 The desired setpoint value (position, force) and the positioning condition (absolute/relative, speed or force ramp, etc.) are set in the output data of the PLC.

SCON.FAULT must be 0 during the entire sequence.

2 With the rising edge at CPOS.START, the CMAX accepts the setpoint values, starts the positioning task, sets SPOS.MC = 0 and acknowledges the starting edge with SPOS.ACK.

3 After resetting CPOS.START and the acknowledgement SPOS.ACK = 0, a new setpoint value can be started at any time.
There is no need to wait for MC.

The CMAX internally calculates tne necessary steps to execute the new positioning task. If a change of direction is required, for example, the drive is first braked until speed = 0 is reached. Only then is the new setpoint position transferred to the controller. No fault message is generated.

4 Once the last setpoint position is reached, MC SPOS.MC = 1 is set.

Notes:

- As soon as the PLC detects the rising edge at SPOS.ACK, it can assume that MC is valid. From the PLC's point of view, the falling edge at MC can occur at the same time as the rising edge at ACK.
- In the event of faults, the task might not be acknowledged with SPOS.ACK. For this reason, the SCON.FAULT bit must always be evaluated in addition.

Setpoint value limitation

The setpoint values are limited according to Tab. 3/25.

Setpoint value limitation			
Value	**Description**	**Limit values (rel/abs, if necessary)**	**Error or warning**
Secondary setpoint, position	Speed as a percentage of the basic value (PNU 540 or PN U 600).	0 % ... 100% 0.01 m/s to 10 m/s	No
	Workpiece mass as a percentage of the basic value of the workpiece mass (PNU 551 or PNU 605)	0 % ... 100% 0 kg to 2000 kg [1)]	No
Primary setpoint, position	Position.	-10,000 mm to +10,000 mm [2)]	Yes
Secondary setpoint, force	Force ramp as a percentage of the basic value of the force ramp (PNU 550 or PNU 608)	0% ... 100% 10 N/s to 10.000 N/s	No
	Workpiece mass as a percentage of the basic value of the workpiece mass (PNU 551 or PNU 605)	0% ... 100% 0 kg to 2000 kg [1)]	No
Primary setpoint, force	Force	- 100.000 N to +100.000 N [2)]	Yes

1) The sum of the tool and workpiece masses must not exceed 2000 kg.
2) The setpoint values are limited to the software or hardware end positions or the set force limit.

Tab. 3/25: Setpoint value limitation in direct mode

3.4.2 Continuous setpoint specification (tracking mode)

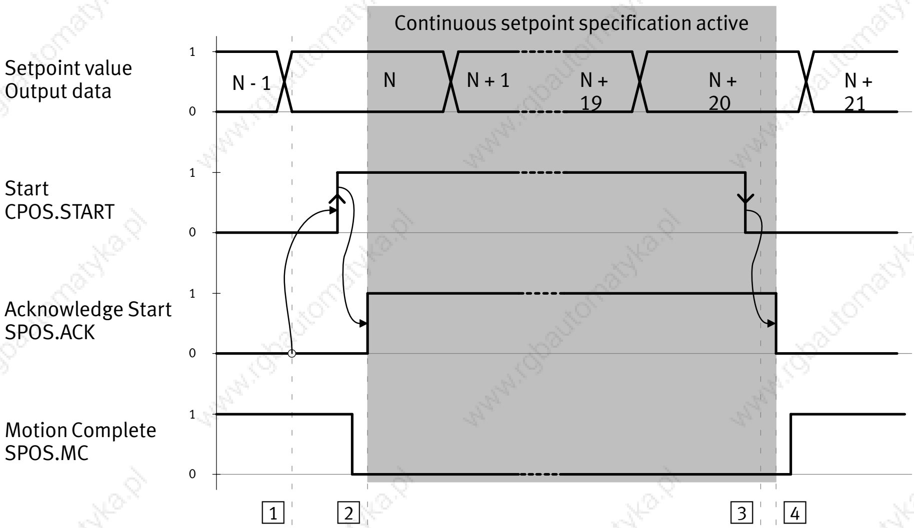


Fig. 3/12: Start the positioning task

1 Set the desired setpoint value (position, force) and the speed setpoint in the output data of the PLC.

2 If SPOS.ACK = logic 0 1, the PLC can start the continuous setpoint value mode with the rising edge at CPOS.START 2. The CMAX accepts the currently registered setpoint value and the speed setpoint and starts the positioning task.

3 As long as CPOS.START = 1, the setpoint value can be changed at any time. The CMAX makes the axis position follow the setpoint value and takes the set accelerations and speeds into account.

4 The setpoint tracking is ended 4 with a falling edge at CPOS.START 3.
The drive is stopped with a stop ramp.

Faults and diagnostics

Chapter 4

Contents

4.1 Overview of diagnostics options

The CMAX supports a number of different options for diagnostics and error handling in the CPX terminal.
An overview is shown in Tab. 4/1.

Access/ Function	Diagnostics option	Brief description	Detailed description
Local Display on the device	LED display, display / 7-segment display	The LEDs and the display directly indicate operating and fault statuses. Fast "on -the-spot" diagnosis.	CMAX system description
	CPX-MMI	The CPX-MMI can be used to display the CPX module diagnosis [1].	Description of the CPX-MMI
Local with PC (e.g. during startup)	FCT with CMAX plug-in	Plain-text display of all diagnostic information during startup and servicing. Full access to the diagnostic functionality of the CMAX.	Help for the CMAX FCT PlugIn
	CPX-FMT	The CPX-FMT can be used to display the CPX module diagnosis [1].	Help for the CPX-FMT
PLC via I/O data	Module output and input data	Diagnostic information is constantly transferred in the SCON status byte (e.g. actual values, WARN and FAULT bits etc.). Direct access to the status (e.g. current position) and diagnostic status via the CPX node.	Section 2.2
	CPX status bits, I/O diagnostic interface	The CPX module diagnosis [1] is reported to the CPX node Optimum integration into the CPX module concept.	Section 4.5
PLC via communications profile	FHPP diagnostics	Diagnostic parameters	Section 4.3
		Diagnostic memory	Section 4.3.2

[1] The CPX diagnostics only show the fault groups of the CMAX.

Tab. 4/1: Diagnostics options

4.2 Faults and warnings

The CMAX permanently monitors the operating status and issues corresponding diagnostic messages in the event of deviations from the nominal status.

The diagnostic messages are categorised as faults (errors) or warnings, depending on the cause or effect, and can be evaluated in detail and then processed.

Faults

Events and statuses that jeopardize or prevent correct operation of the CMAX are reported as faults. A list of the fault messages is provided in section 4.2.5.

Response to a fault

Depending on the type of fault, the CMAX will respond to this in the respective way.

- The red error LED lights up, see CMAX system description.
- The error number E... is indicated on the display, see CMAX system description.
- SCON.FAULT = 1.
- The CMAX has the "Fault" status.
  Depending on the type of the fault,
  - the axis with the stop ramp is stopped (level F1) or
  - the controller is disabled (level F2), drive moves
  using residual energy until it comes to a standstill.

The CMAX display always indicates the fault that occurred first. If additional faults occur, they are not indicated even if they are more serious.

Acknowledging faults

Indicated faults need to be acknowledged with CCON.RESET. It may be necessary to eliminate the cause of the fault first.

1. Positive edge on CCON.RESET.
2. Wait 3 s (depending on the fault, the CMAX requires at the most 3 seconds, e.g. to initialize the axis).
3. Check whether the fault has been eliminated:
   - if SCON.FAULT = 0: ok
   - if SCON.FAULT = 1:
     Check fault number, eliminate cause, if necessary, see section 4.2.5.

The CMAX always tries to acknowledge all currently pending faults. If several faults are active at the same time, the behaviour depends on the most serious fault.

If there are several faults pending and one fault can be deleted after a reset, but not any others, one of the remaining faults is indicated after the reset.

Warnings

Events and statuses that may impair operation are reported as warnings. You will find a list of the warning messages in section 4.2.5.

Response to a warning

In the event of warnings, the CMAX does not have the "Fault" status, but remains "Ready".
Warnings are indicated with SCON.WARN = 1. The sequence control and the axis are not affected.

Acknowledging warnings

Depending on the warning, SCON.WARN = 0

- as soon as the cause has been eliminated.
- with positive edge on CCON.START or CCON.RESET (provided the cause was eliminated).

4.2.1 Error numbers on the CPX terminal

All CMAX faults are also reported as CPX error messages 10x (100 ... 109). These can be ev aluated via the CPX node, e. g. via the I/O diagnostic interface.

Function number	**Module diagnostic data**
2008+m*4+1	Module error number (CPX error)

4.2.2 Fault groups: Classification according to the cause

The CMAX faults and warnings are arranged in groups. The first digit indicates the group and the second digit indicates the cause.

When reading the fault via the function number of the CPX node, only the CPX error number is displayed. The last digit corresponds to the CMAX fault group (first digit of the CMAX fault number).

Fault groups of the CMAX and CPX error numbers			
Group	**Description**	**CPX error**	**CPX error text (MMI, configuration software)**
0	Configuration error	100	[Configurationerror]
1	Execution error	101	[Executionerror]
2	Record error	102	[Record error]
3	Control error	103	[Control error]
4	System error A	104	[System error A]
5	System error B	105	[System error B]
6	Error in valve	106	[Error in valve]
7	Controller error	107	[Controller error]
8	Measuring system error	108	[Encoder error]

4.2.3 Fault level: Classification according to the response to the fault

The fault level is a classification according to the CMAX response to an identified diagnostic event.

Fault level			Effects on		SCON [1]				SPOS [1]	
			Sequence control	**Axis**	**Fault**	**Warn**	**Open**	**Enabled**	**MC**	**Ref**
–	(0)	No fault			–	–	–	–	–	–
W	(2)	Warning	No change	No change	–	1	–	–	–	–
F1	(5)	Fault 1	Transition to the fault status	Stop with stop ramp	1	–	0	–	1	–
F2	(6)	Fault 2	Transition to the fault status	Controller disabled	1	–	0	0	1	– [2]
FS	(15)	System error [3]	System fully stopped, switching on/off required		x	x	x	x	x	x

1) Status bits status: – = no effect; 0 = logic 0, 1 = logic 1; x = no updating
2) Should communication with the measuring system/sensor interface fail, the reference may be lost (SPOS.REF = 0).
3) System error FS : Serious error in firmware (No firmware, ...): It may no longer be possible to update the I/O data.

Tab. 4/2: Fault levels

4.2.4 Reset types: Behaviour in the event of fault acknowledgement

Depending on the type of the fault, acknowledgement leads to various actions in the CMAX, in order to delete the active fault message and possibly quit the fault status.

Type	Description	Example
R	**Acknowledging (reset)** The reset command deletes the message. The fault is then terminated. It will only be reported once more if the command is repeated without the cause of the message having been eliminated.	E33: Target position outside of the software or hardware end positions
F	**Acknowledge if cause eliminated (fix cause and reset)** The CMAX deletes the message provided the cause has been eliminated. If the cause has not yet been eliminated, the message is not deleted and the fault status is not quit.	E51: Load voltage of the controller outside of the tolerance range (undervoltage)
N	**Restart (new initialisation)** The CMAX restarts the axis after acknowledgement. In the course of this, the controller is re-calculated. If necessary, the components (sensor interface and valve) are re-commissioned. All fault messages are deleted prior to restarting. If no fault occurs during restart, the fault status is quit after the restart. Otherwise CCON.Fault is not reset. The maximum time for a restart is 3 s.	E60: Faulty communication with the valve or no valve present
Poff	**Power off** Reset no longer possible, CMAX needs to be switched off.	E72: system software error

Tab. 4/3: Acknowledging fault messages – reset types

Acknowledging warnings

In the event of warnings, the CMAX does not have the “Fault” status, but remains “Ready”.

Warnings are deleted in the event of CCON.RESET or CPOS.START (provided the cause was eliminated).

4.2.5 Error number and warning numbers

Fault group 0 – configuration error
CPX error group 100 (CPX-MMI:[Configurationerror])

No.	Message	Cause/description	Error handling	Type[1)]
01	The nominal configuration deviates from actual configuration [2)]	A component on the axis string does not correspond to the nominal configuration: – Measuring system or sensor interface (type, length). – Cylinder (type, length, diameter). – Valve (size).	• Check component and replace if necessary or • Adopt actual configuration (download).	Level: F2 Reset: N Info: –
		The measuring system and the valve were exchanged and no longer correspond to the nominal configuration or the serial numbers have changed.	• Check configuration of the axis. Check for possible interchange of two axis strings.	
02	Unknown valve type	Connected valve is not supported.	• Exchange valve or • Update firmware.	Level: F2 Reset: N Info: –
03	Unknown cylinder type	Connected cylinder or the sensor interface is not supported.	• Exchange cylinder or sensor interface or • Update firmware.	Level: F2 Reset: N Info: –
04	Unknown measuring system type or unknown sensor interface	Connected measuring system or the sensor interface is not supported.	• Exchange measuring system or sensor interface or • Update firmware.	Level: F2 Reset: N Info: –

1) Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

2) The movement test is reset to avoid tubing errors. The CMAX has C03 status. The movement test should then be run once more.

Fault group 0 – configuration error
CPX error group 100 (CPX-MMI:[Configurationerror]) continued

No.	Message	Cause/description	Error handling	Type[1]
05	Project not loaded completely or block download active	The controller cannot be enabled because the nominal configuration is not yet complete. (Configuration status C00, C01 or C02).	• Complete the nominal configuration, e.g. project download.	Level: F2 Reset: R Info: –
		The controller cannot be enabled because block download is still active.	• Terminate block download. Check PLC program (parametrisation) and correct if necessary.	
08	Cylinder, valve or sensor interface was exchanged [2]	The serial number of a component on the axis string has changed: – Drive (measuring system). – Valve.	1. Adopt serial number of the component. 2. Run movement test (recommendation). 3. Carry out identification (recommendation).	Level: W Reset: F Info: x
09	Faulty parameter in the project	Software end positions inconsistent, see section B.2.4.	• Read diagnostics memory, determine parameter via additional information. • Check and correct software end positions.	Level: F2 Reset: N Info: x
		Invalid values concerning axis parameters or hardware configuration.	• Check parameters and correct.	

[1] Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
[2] The movement test is reset to avoid tubing errors. The CMAX has C03 status. The movement test should then be run once more.

Fault group 1 – execution error
CPX error group 101 (CPX-MMI:[Executionerror])

No.	Message	Cause/description	Error handling	Type1)
10	Homing not carried out	Drive with incremental measuring system is not referenced.	• Carry out homing.	Level: F1 Reset: R Info: x
11	No homing provided	Homing task in the case of absolute measuring system.	• Do not carry out homing.	Level: F1 Reset: R Info: x
13	Wrong direction of movement during movement test	Cylinder and valve are incorrectly tubed.	• Check tubing connection, exchange on cylinder or valve, if necessary.	Level: F2 Reset: R Info: x
14	Movement test not carried out.	Positioning task without valid movement test.	• Run movement test (recommended) or skip.	Level: F2 Reset: R Info: x
15	Result of movement test not clear	Drive jammed.	• Check low friction of drive and guide, check pressure build-up with trace, if necessary.	Level: F1 Reset: R Info: x
		Obstacles on travel path.	• Check travel path and software end positions.	
		Working pressure not sufficient to move the mass.	• Set sufficient working pressure and check configuration of the mass.	
		Cylinder not correctly projected.	• Check size and correct if necessary.	
		Valve defective.	• Check pressure build-up with trace, exchange valve if necessary.	
		Faulty tubing connection.	• Check tubing connection.	
		Valves installed between valve and cylinder (emergency stop) are closed.	• Open valves.	

1) Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 1 – execution error
CPX error group 101 (CPX-MMI:[Executionerror])

continued

No.	Message	Cause/description	Error handling	Type[1]
16	Dynamic identification failed	Incorrect mass parametrised or transferred in parameter 2. [2]	• Check mass and data.	Level: F1 Reset: R Info: x
		Too much mechanical play in the system.	• Check system structure.	
		Constructional design not stable enough.	• Check system structure.	
		Tubes used are too long.	• Move valve closer to the drive.	
		Compressed air not sufficiently stable.	• Check compressed air supply.	
17	Identification was not yet executed	The static identification was not executed during record start, direct operating or homing.	• Execute static identification	Level: W Reset: F Info: x
18	Clamping unit is still activated, operation enable not possible	Operation enable was given (CCON.STOP = 1) although the clamping unit had not yet been released.	• Remove operation enable. • Release clamping unit.	Level: W Reset: F Info: x

[1] Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
[2] Parameter 2: Byte 4 ... 8 in commissioning mode.

Fault group 1 – execution error
CPX error group 101 (CPX-MMI:[Executionerror]) continued

No.	Message	Cause/description	Error handling	Type[1]
19	Impermissible mode change	Change between record select operating mode and direct operating mode during active positioning task (SPOS.MC=0).	• Reversing only after completed positioning task (SPOS.MC = 1)	Level: F1 Reset: R Info: x
		Change between record select operating mode or direct operating mode and commissioning or parametrisation during active operation enable (CCON.STOP = 1).	• Shifting only in stop status. Set CCON.STOP = 0 and wait for SCON.OPEN = 0 and SPOS.MC = 1	

[1] Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 2 – record error
CPX error group 102 (CPX-MMI:[Recorderror])

No.	Message	Cause/description	Error handling	Type[1)]
21	Impermissible record number	When starting an invalid record number was pending (0 or › 64).	• Check record numbers and correct (first transfer record number, then starting edge).	Level: F1 Reset: R Info: x
22	Record is not configured	Retrieved record was not configured and contains no valid positioning data.	• Check record and parametrise.	Level: F1 Reset: R Info: x
23	Record is blocked	The retrieved record is not enabled for execution.	• Check and enable record.	Level: F1 Reset: R Info: x
24	Record sequencing is not permissible	The demanded sequencing condition is invalid.	• Check and correct the sequencing condition.	Level: F1 Reset: R Info: x
		Sequencing parametrised in record 64.	• Remove sequencing condition in record 64, correct record list if necessary	
		The selected sequencing condition is not permissible when using a DSMI. The DSMI does not support force control.	• Correct sequencing condition	
		The selected sequencing condition is only permissible in a record with force control.	• Check and correct record.	

1) Level: fault level, see section 4.2.3
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 2 – execution error
CPX error group 102 (CPX-MMI:[Recorderror])

continued

No.	Message	Cause/description	Error handling	Type[1]
27	Sequencing condition cannot be reached during the positioning task.	Sequencing position is not between the starting position (last setpoint value or actual value at the time of sequencing) and the new setpoint position, or both positions are identical.	• Check sequencing conditions and correct if necessary. Check program sequence in the PLC. After a stop or error, the previous position must be approached once more.	Level: F1 (W) Reset: R Info: x
		Sequencing force is not between the starting force (last setpoint value or actual value at the time of sequencing) and the new setpoint force.		
28	Sequencing condition was not reached	Sequencing was not executed. MC was reached before the sequencing condition was fulfilled.	• Check sequencing condition, parametrise as warning, if necessary.	Level: F1 (W) Reset: R Info: x

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 3 – control error
CPX error group 103 (CPX-MMI:[Controlerror])

No.	Message	Cause/description	Error handling	Type[1]
30	Timeout: Target value not reached [2]	Obstacle in the travel range (only position controller).	• Remove obstacle or correct target position.	Level: F1 Reset: R Info: x
		Compressed air not sufficient.	• Check supply pressure, check hosing connection, configure error 50 as an error.	
		Very strong friction or irregular friction (only position controller).	• Increase control amplification.	
		Mechanical play (only position controller)	• Check installation: mass, stability, guides, check play, repeat identification.	
		System not optimally configured.	• Valve, mass, mounting position, supply pressure, increase timeout time, increase tolerance.	
		Modified system behaviour (only position controller).	• Repeat identification.	

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

[2] The drive did not reach the target tolerance on time. (MC monitoring). Record chaining is cancelled. Can, for instance, occur during positioning or jogging on a stop within the effective stroke.

Fault group 3 – control error
CPX error group 103 (CPX-MMI:[Controlerror]) continued

No.	Message	Cause/description	Error handling	Type[1]
31	No movement after start [2]	Pressure could not be built up.	• Check supply pressure.	Level: F1 Reset: R Info: x
		Drive jammed or sluggish.	• Check guide and mechanical structure.	
		Working pressure not sufficient to move the mass.	• Set sufficient working pressure and check configuration of the mass.	
		Valve defective.	• Check pressure build-up with trace, exchange valve if necessary.	
		Faulty tubing connection.	• Check tubing connection.	
		Valves installed between valve and cylinder (emergency stop) are closed.	• Open valves.	
32	Target force outside of the force limits	Target force outside of the set force limits.	• Correct target force or force limit.	Level: F1 (W) Reset: R Info: x
		The target force is larger than the maximum force that can be reached (the maximum attainable target force determined by the CMAX may deviate from the theoretical value calculated by the FCT).	• Correct target force, increase supply pressure, reduce moving mass in vertical structure, use larger drive.	

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

[2] e.g. setoff timeout, i.e. the drive did not perform the minimal stroke of 11 mm within the timeout time, or during identification.

Fault group 3 – control error
CPX error group 103 (CPX-MMI:[Controlerror]) continued

No.	Message	Cause/description	Error handling	Type[1)]
33	Target position outside of the software or hardware end positions	Target position is outside of the set software end positions.	• Check and correct target position, software end positions and project zero point.	Level: F1 (W) Reset: R Info: x
		Target position is outside of the reachable hardware end positions.	• Check and correct target position and project zero point.	
34	Setpoint value in tracking mode outside of the limit values	Nominal position is outside of the set software end positions.	• Check and correct nominal position, software end positions and project zero point.	Level: W (F1) Reset: R Info: x
		Nominal position is outside of the reachable hardware end positions.	• Check and correct nominal position and project zero point.	
35	Pass software end position [2)]	The drive was pushed out of the valid range by an external force.	• Prevent external force, if possible.	Level: W (F1) Reset: R Info: x
		Not optimally adjusted control leads to significant overswinging.	• Optimize control, check parametrisation, perform identification again.	

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
2) The actual position has exceeded a software end position during active closed loop position control.

Fault group 3 – control error
CPX error group 103 (CPX-MMI:[Controlerror]) continued

No.	Message	Cause/description	Error handling	Type[1]
36	Software end position reached with force control [2]	No workpiece.	• Check workpiece, check workpiece position. • Use record sequencing for return travel or stop.	Level: F1 Reset: R Info: x
		Software end positions can be reached in the desired sequence.	• Correct software end positions.	
37	Switch to Unassigned Profile	An attempt was made to sequence from an active set into a set with Auto Profile.	• Change subsequent set to Unassigned Profile, parametrise accelerations and velocity, if necessary	Level: W Reset: R Info: x
		A positioning task is started with Auto profile, although no dynamic identification was performed yet.	• Perform dynamic identification or use Unassigned Profile.	
38	Impermissible stroke with force control	Configured stroke limit is exceeded with force control.	• Check workpiece, check stroke limit	Level: F1 Reset: R Info: x

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
[2] The actual position has exceeded a software end position during active force control.

Fault group 3 – control error
CPX error group 103 (CPX-MMI:[Controlerror]) continued

No.	Message	Cause/description	Error handling	Type[1)]
39	Speed too high with force control	Configured permissible speed limit was exceeded with force control.	• Check workpiece, check speed limit.	Level: F1 Reset: R Info: x
		Nominal speed of the force record is set too large compared to the limit speed.	• Harmonise nominal speed and speed limit.	
		In the event of record sequencing to force control, the actual speed of the drive is too high at the time of switching.	• Reduce the speed of the previous set; correct speed limit and switch off, if necessary.	

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 4 – system error A
CPX error group 104 (CPX-MMI: [SystemerrorA])

No.	Message	Cause/description	Error handling	Type[1]
40	Impermissible control mode with force control	Force control set for DSMI.	• DSMI cannot execute force control commands.	Level: F1 Reset: R Info: x
		Impermissible control mode set in the RCB1 or CDIR	• Correct RCB1 or CDIR.	
41	Positioning mode “Relative” not permissible in tracking mode	Relative bit (CDIR.ABS=1= set in tracking mode	• Continuous setpoint specification may only occur absolutely	Level: F1 Reset: R Info: –
42	Reserved control bits set	Reserved and not used bit set in the CCON, CPOS or CDIR.	• Check and correct CCON, CPOS and CDIR.	Level: W Reset: F Info: x
43	No peripherals present or axis string communication interrupted	Neither a valve nor a measuring system were found during initialization.	• Check installation.	Level: F2 Reset: N Info: –
		Communication with the valve and the measuring system faulty.	• Check cables and components.	
		Communication faulty, e.g. due to impermissible or damaged components on the axis string.	• Check installation and exchange components if necessary	

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 4 – system error A
CPX error group 104 (CPX-MMI: [SystemerrorA]) continued

No.	Message	Cause/description	Error handling	Type[1]
44	Teaching not possible [2]	Teaching (falling edge on CPOS.TEACH) is triggered unintentionally through disconnection or switching off the control.	• Only activate CPOS.TEACH = 1 (prepare teaching) directly before the teaching process. Always end teaching immediately.	Level: F1 Reset: R Info: x
		Teaching not possible during direct operating.	• Change operating mode.	
		Teaching not possible during active commissioning operation.	• First end commissioning operation.	
		In BA commissioning the teaching target in parameter 1 is invalid.	• Correct parameter 1.	
		Without reference teaching is not possible.	• Perform homing prior to teaching.	
		Lower software end position (SWEL) is larger/the same as the upper software end position when teaching the SWEL to BA commissioning. It is not adopted.	• Teach upper SWEL first. • Correct the teach position.	
	Continued...	Upper software end position (SWEP) is smaller/the same as the lower software end position when teaching the SWEP to BA commissioning. It is not adopted.	• Teach lower SWEP first. • Correct the teach position.	

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
2) For exact cause, see diagnostic memory.

Fault group 4 – system error A
CPX error group 104 (CPX-MMI: [SystemerrorA]) continued

No.	Message	Cause/description	Error handling	Type[1]
44	Teaching not possible [2] (continued)	Specified record number impermissible when teaching to BA set selection	• Correct record number.	Level: F1 Reset: R Info: x
		Parametrised control mode of the selected record during teaching to BA record selection not permissible	• Correct control mode, correct record number.	
45	Faulty commissioning operation or parameter	Invalid function number when starting a commissioning operation in commissioning mode. [3]	• Correct the function number.	Level: F1 Reset: R Info: x
		At least one parameter of the started commissioning operation had an invalid value. [3]	• Check and correct parameter 1 and parameter 2.	
		Movement test was started when a movement test has already been successfully performed.	• First reset movement test.	
46	Start during active teach command not permitted	Commissioning mode: Starting a commissioning function during teaching is not permissible.	• Do not perform Start during teaching, first end teaching.	Level: F1 Reset: R Info: x
47	Starting the tracking mode requires MC	Starting the tracking mode during an active positioning task is impermissible.	• End active positioning task and wait for Motion Compete (SPOS.MC=1).	Level: F1 Reset: R Info: x

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
[2] For exact cause, see diagnostic memory.
[3] See I/O data in the description “CMAX communication profile”

Fault group 5 – system error B
CPX error group 105 (CPX-MMI: [SystemerrorB])

No.	Message	Cause/description	Error handling	Type[1]
50	Supply pressure is too low [2]	Pressure in both cylinder chambers is < 1.5 bar.	• Check the compressed air supply. • Wait until cylinder chambers (poss. via leakage) are sufficiently filled. • Configure as a warning.	Level: F2 (W) Reset: F Info: x
51	Load voltage of the controller outside of the tolerance range (undervoltage)	Load voltage < 20 V with enabled controller or overload on axis string.	• Check the valve load supply (V_{VAL}).	Level: F2 Reset: F Info: x
52	Operating voltage of the controller outside of the tolerance range (undervoltage)	Operatingvoltage< 18 V or overload on the axis string.	• Operating voltage supply for the electronics/sensors Check ($U_{EL/SEN}$)	Level: F2 Reset: F Info: x
53	Load voltage overload on the controller	Short circuit in the cables of the axis string (between controller and valve or valve and sensor interface).	• Check the cables and modules in the axis string (e.g. for a cable breakage), replace if necessary.	Level: F2 Reset: F Info: x
		Overload on valve outputs.	• Check and, if necessary, correct the circuitry of the outputs.	
		Defect in the valve.	• Check the cables and valves step by step and exchange, if necessary.	
		Defect in the CMAX controller.	• Check CMAX, exchange if necessary.	

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3
2) Enable command, but no supply pressure.

Fault group 5 – system error B
CPX error group 105 (CPX-MMI: [SystemerrorB]) continued

No.	Message	Cause/description	Error handling	Type[3)]
54	Operating voltage overload on the controller	Short circuit in the cables of the axis string (between controller and valve or valve and sensor interface).	• Check the cables and modules in the axis string (e.g. for a cable breakage), replace if necessary.	Level: F2 Reset: F Info: x
		Defect in the CMAX controller	• Check CMAX, exchange if necessary.	
		Defect in the valve	• Check the cables and valves step by step and exchange, if necessary.	
		Defect in the sensor (measuring system) or sensor interface	• Check the cables and sensor or sensor interface step by step and exchange, if necessary.	
55	Load voltage drop: The power pack rating is not sufficient	The load voltage dropped several times when sequencing to the valve. The power pack rating is probably not sufficient	• Check total load of the power pack and use a more powerful power pack. Also take into account the loads at the valve output (clamping unit etc.).	Level: F2 Reset: F Info: x
56	Supply pressure is insufficient to safely move or hold the load	Insufficient supply pressure was detected during homing.	• Check supply pressure and increase if necessary. • Check parametrisation of the supply pressure.	Level: F1 Reset: R Info: x
57	Timeout diagnostic interface: FCT device control was deactivated	Connection between PC and CPX node interrupted.	• Check the cables.	Level: W Reset: R Info: x
		Communication breakdown due to FCT.	• Restore connection.	

[1)] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 6 – error in valve
CPX error group 106 (CPX-MMI: [Error in valve])

No.	Message	Cause/description	Error handling	Type[1)]
60	Faulty communication with the valve or no valve present	When switching on, only the position measuring system/sensor interface was found. The valve was not detected.	• Check cables to the valve. • Replace the valve.	Level: F2 Reset: N Info: x
		Communication between CMAX and valve was interrupted	• Check the cables of the axis string, the valve and the sensor step by step and exchange, if necessary.	
61	Valve hardware faulty	The valve reports a hardware error.	• Replace the valve.	Level: F2 Reset: N Info: x
		Fault in initialization of the valve.	• Exchange valve, check firmware update of the CMAX.	
62	Valve over-temperature	The valve reports overtemperature. (Ambient temperature too high).	• Provide sufficient cooling.	Level: F2 Reset: F Info: x
63	Valve is jammed	The valve piston does not move as expected.	• Replace the valve. • Also check the air quality (5 µ-filter and dry air).	Level: F2 Reset: F Info: x
64	Load voltage of the valve outside of the tolerance range (undervoltage)	The valve reports insufficient load voltage. Either the cable between the CMAX and the valve is faulty or the valve.	• Check the cables at the axis string. • Check the valve, exchange if necessary.	Level: F2 Reset: F Info: x

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 6 – error in valve
CPX error group 106 (CPX-MMI: [Error in valve])

continued

No.	Message	Cause/description	Error handling	Type[1]
65	Operating voltage of the valve outside of the tolerance range (undervoltage)	The valve reports insufficient operating voltage. Either the cable between the CMAX and the valve is faulty or the valve.	• Check the cables at the axis string. • Check the valve, exchange if necessary.	Level: F2 Reset: F Info: x
66	Overload at digital valve output	The valve reports an overload on the digital output.	• Check and correct the circuitry.	Level: F2 Reset: F Info: x
67	Overload at 24V supply output of valve	The valve reports an overload on the voltage output.	• Check and correct the circuitry.	Level: F2 Reset: F Info: x
68	Preliminary warning valve over-temperature	The valve reports a high operating temperature. (Ambient temperature too high).	• Provide sufficient cooling.	Level: W Reset: F Info: x

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 7 – controller error
CPX error group 107 (CPX-MMI:[Controllererror])

No.	Message	Cause/description	Error handling	Type[1]
72	system software error	Internal software error (firmware).	• If possible, read diagnostic memory and save and archive the project. • Switch controller off/on and check whether error occurs again. • Contact Support.	Level: FS Reset: Poff Info: x
73	Controller hardware faulty	No communication possible with CMAX. Error is only shown on the display.	• Exchange CMAX.	Level: FS Reset: Poff Info: x
74	No firmware	No firmware. No communication possible via fieldbus.	• Firmware download with FCT.	Level: FS Reset: Poff Info: x
75	User data damaged	Inconsistent user data.	• Perform data reset and re-commission the axis.	Level: F2 Reset: N Info: x
76	Watchdog error: Possible loss of data Data reset required	Internal watchdog error.	• Perform data reset and re-commission the axis. • Contact Support.	Level: F2 Reset: F Info: x

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 8 – measuring system error
CPX error group 108 (CPX-MMI:[Encodererror])

No.	Message	Cause/description	Error handling	Type[1]
80	Faulty communication with the measuring system/ sensor interface or no measuring system/sensor interface present	Position measuring system / sensor interface was not detected when switching on.	• Exchange position measuring system / sensor interface, check the cables.	Level: F2 Reset: N Info: x
		Communication between the CMAX and the position measuring system faulty.	• Check the cables of the axis string, the valve and the measuring system/sensor interface step by step and exchange, if necessary.	
81	Hardware of the measuring system or sensor interface faulty	Hardware of the measuring system or sensor interface faulty.	• Replace the measuring system/sensor interface.	Level: F2 Reset: N Info: x
		Fault in initialization of the measuring system / sensor interface.	• Exchange measuring system/sensor interface, check firmware update of the CMAX.	
82	Invalid measured values or measuring system error	DGCI: no magnet available.	• Check magnet with the measuring system, exchange proximity sensor if necessary.	Level: F2 Reset: F Info: x
		DGCI: several magnets present.	• Ensure: no other magnets permitted in the immediate vicinity of the measuring system.	
		DGCI: e.g.: multiple signals (e.g. due to vibrations).	• Check structure. • Avoid vibration.	
		DNCI: sensor error.	• Exchange sensor head in the DNCI if necessary.	
		Potentiometer: Operating voltage drop below 12 V.	• Check operating voltage, check cables for short circuit and corrosion.	

[1] Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

Fault group 8 – measuring system error
CPX error group 108 (CPX-MMI:[Encodererror]) continued

No.	Message	Cause/description	Error handling	Type[1)]
84	Reference position of the measuring system lost	Although the controller has set the status to “Referenced”, the measuring system/ sensor interface reported “Not referenced”.	• Reference again.	Level: F2 Reset: N Info: x
85	Operating voltage of the measuring system/sensor interface outside of the tolerance range (undervoltage)	Operating voltage of the measuring system too low.	• Check the power supply. • Check the cables at the axis string.	Level: F2 Reset: F Info: x
87	Defective measuring system cable or measuring system in the electrical end-position (potentiometer)	Faulty measuring system cable.	• Check the power supply. • Check the cables at the axis string. • It may be necessary to switch on/off. • Exchange measuring system or sensor interface if necessary.	Level: F2 Reset: N Info: x
		Measuring system in the electrical end position (only potentiometer)	• Move the measuring system (potentiometer) away from the end position.	
89	Faulty data contents in the position measuring system / sensor interface	The position measuring system / sensor interface contains incorrect or contradictory data.	• Switch the power supply off and then on again. When the error is signaled again: • Replace the measuring system/sensor interface. • Check firmware of the CMAX.	Level: F2 Reset: N Info: x

1) Level: fault level, see section 4.2.3; (can alternatively be parametrised as a warning or error)
Reset: behaviour upon reset, see section 4.2.4
Info: – = no info; x = additional info, see FCT or section 4.3.3

4.3 Diagnostic parameters

4.3.1 Latest diagnostic status

The CMAX offers various parameters for the current diagnostic messages.

PNU	Brief description
220	Active fault messages bit-encoded
221	Active warning messages, bit-encoded
224	Currently indicated fault ’Exx’ on the display
225	Currently active fault level
226	Current warning to be indicated in the FCT
227	Error status, bit-encoded for FCT

Tab. 4/4: Diagnostic parameters

Parameter	Description
Bit-encoded messages PNU 220 PNU 221	Each parameter is a bitfield consisting of three uint32 values and thus contains 3x 32 bits = 96 bit memory capacity. Each of these bits in this array represents an error number. If it is set, the corresponding fault message is active. Example: PNU 220:01 = 0x00000001 Bit 0 set E01 active PNU 220:02 = 0x00000040 Bit 38 (32+ 6) set E39 active PNU 220:03 = 0x00030000 Bit 80 (32 + 32 + 16) set E81 active Bit 81 (32 + 32 + 17) set E82 active This representation is optimized for evaluation by a PLC, since this bit encoding can be used directly to activate an MMI. PNU 220: contains current faults PNU 221: contains current warnings
Message on the display PNU 224 PNU 226	The PNU 224 contains the fault number currently being shown on the display. This makes synchronisation between the display in the FCT and the CMAX possible. It is always the fault that occurred first that is displayed. The PNU 226 contains the warning number the FCT is supposed to display. The warning is not shown on the CMAX display.

Parameter	Description
Active fault level PNU 225	In this way the FCT can display the current status of the CMAX in accordance with the fault level (section 4.2.3). The most serious current fault is always responsible for the current fault level.
Bit-encoded fault status PNU 227	The bit-encoded error status allows the FCT to indicate the exact status of an active fault message. The coding is identical to the coding of the PNU 203 support information. For the description, see section 4.3.3.

Tab. 4/5: Parameters of the diagnostic memory

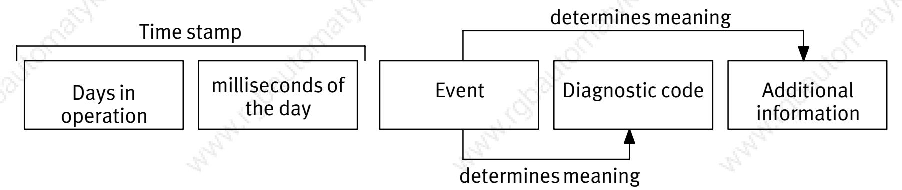
4.3.2 Diagnostic memory

The diagnostic memory contains the diagnostic messages of the last 100 events that occurred. The memory is backed up in the event of a power failure. If the buffer is full, the oldest element will be overwritten. When reading, the newest entry is read first (LIFO principle).

Number (subindex)	Diagnostic memory entry
1	Newest (last) diagnostic message.
2	Last but one diagnostic message.
...	...
100	Oldest diagnostic message.

Tab. 4/6: Structure of the diagnostic memory

Structure of an entry in the diagnostic memory



PNU 222	PNU 202	PNU 200	PNU 201	PNU 203
int32	int32	int32	int32	int32, (bit-encoded)
Number of days in operation	Number of milli-seconds of the day	Diagnostic event	Diagnostic number	Additional in-formation for FCT

Tab. 4/7: Structure of diagnostic memory entry

Parameter	Description
Time stamp PNU 202 PNU 222	Time of the diagnostic event since the delivery status, reset device data or firmware download in milliseconds. – PNU 222 contains the number of days – PNU 202 contains the number of milliseconds of the day The time stamp is not a real-time clock: The time is read from the device data (PNU 140) when the message occurs. The CMAX counts the period of operation. When switching off, the current time (refer to PNU 140:02) is saved, and retrieved when switching on.
Diagnostic event PNU 200	Type of diagnostic message. Not only fault messages are entered into the diagnostic memory, but also switch-on operations, resets or configuration events. The interpretation of the diagnostic code and the additional information depends on the type of these events.
Diagnostic number PNU 201	The diagnostic number contains a detail on the diagnostic event. In the event of faults and warnings this is the exact fault number, in the event of configuration event it is the function performed etc.
Additional information PNU 203	Detailed information on the fault. The evaluation is complex and therefore suitable for a PLC program to a limited extent only. For description see section 4.3.3.

Tab. 4/8: Parameters of the diagnostic memory

Diagnostic events

The diagnostic event determines the meaning of the diagnostic code and the additional information.

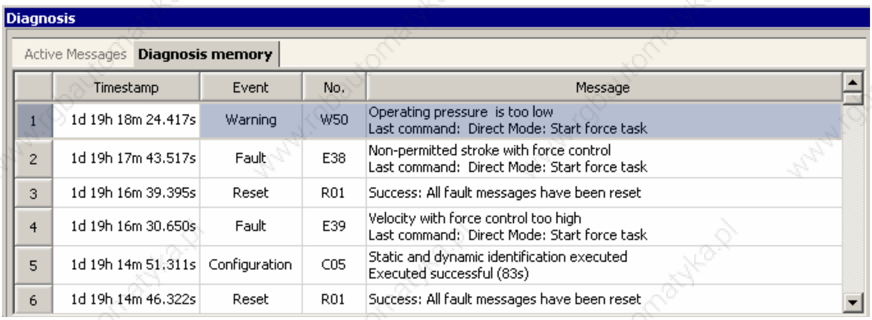
Diagnostic events (PNU 200)

Value [1]	Qty.	Description	Diagnostic code (PNU 201)	Additional information (PNU 203)
0	–	Blank entry	–	–
1	E...	Fault	Fault number (→ 4.2.5)	Additional information incoming fault
3	R...	Reset	Reset number (→ 4.3.4)	Additional reset information
5	W...	Warning	Fault number (→ 4.2.5)	Additional information incoming fault
7	P...	Switch on	Switch-on information (→ 4.3.4)	Additional switch-on information
8	C...	Configuration	Configuration information (→ 4.3.4)	Additional configuration information

[1] Other values are reserved

Tab. 4/9: Values of the diagnostic events with assignment to diagnostic code and additional information

Depending on the event, the FCT can provide detailed information on the respective entry with the help of the additional information.



	Timestamp	Event	No.	Message
1	1d 19h 18m 24.417s	Warning	W50	Operating pressure is too low Last command: Direct Mode: Start force task
2	1d 19h 17m 43.517s	Fault	E38	Non-permitted stroke with force control Last command: Direct Mode: Start force task
3	1d 19h 16m 39.395s	Reset	R01	Success: All fault messages have been reset
4	1d 19h 16m 30.650s	Fault	E39	Velocity with force control too high Last command: Direct Mode: Start force task
5	1d 19h 14m 51.311s	Configuration	C05	Static and dynamic identification executed Executed successful (83s)
6	1d 19h 14m 46.322s	Reset	R01	Success: All fault messages have been reset

Fig. 4/1: Example of display of the diagnostic memory in FCT

Examples of diagnostic messages			
Time stamp	**Event**	**No.**	**Description**
2817d 17h 21.123s	Reset	R01	Reset successfully executed. All the fault messages were deleted. There is no longer a fault.
2817d 16h 18.123s	Fault	E50	Supply pressure too low (< 1.5 bar) Last command: Execute record, record number 64
2817d 03h 18.123s	Switch on	P01	Project data available and load (duration of the initialization: 1289 ms). Number of switch-on operation since last diagnostic entry: 219
117d 03h 18.123s	Configu-ration	C05	Static and dyn. identification executed. Duration: 178 s. Identification was successful.

Tab. 4/10: More examples of diagnostic events

PNU 204: Administration of the diagnostic memory				
Index	**Description**	**Default**	**Min**	**Max**
1, 2	reserved (see section 4.4, PNU 228)	–	–	–
3	– Write 1: diagnostic memory is deleted. – Reading always delivers the value 0 Deleting is usually not required (ring buffer, when the memory is full, the new entry overwrites the oldest).	0	0	1
4	Number of valid entries. Writing is not permitted.	0	0	100
5	Number of unread entries. Is set to 0 when index 4 is read. With every new entry into the diagnostic memory, the value is increased by 1.	0	0	255

Tab. 4/11: Administration of the diagnostic memory

4.3.3 Fault status (PNU 227) and additional information (PNU 203)

This additional information is designed mainly for diagnostics performed by FCT. It supplements the error number by helpful information such as the record number. With active messages, it also indicates whether the error can be acknowledged and whether the cause is still active. The coding is the same for the parameters:

- PNU 203: Additional information with errors/warnings in the diagnostic memory. Index 1 ... 100 corresponding to the entry number.
- PNU 227: Coding of the current status of a fault. Index 1 ... 87 corresponding to the fault number.

Since several faults may be pending simultaneously, the information of the PNU 227 needs to be available for every error number separately. Therefore, when querying, the error number must be specified as the index.

Assignment of the additional information for future faults.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
internal diagnostic code										A	S	Reset				Level				Info				Details							

The coding is the same for PNU 203 and 227, but it only contains the information that is useful and available for the respective parameter.

Range	Name	Description
Bit 31..22 (203/--)	Internal diag- nostic code	Internal diagnostic information (only for service staff).
Bit 21 (--/227)	A	**Required action** = 0: Acknowledge: The cause of the message is currently not active or is presently not being checked. The message can be acknowledged. = 1: Eliminate: The cause of the message is still active. The cause must be eliminated before the message can be acknowledged. Note: In the event of errors with reset type FS (bit 19 ..16) switching on/off is always required independently of the status of the bit 21.
Bit 20 (--/227)	S	**Status of the error message** = 0: The message is currently not active. = 1: The message is active
Bit 19..16 (203/227)	Reset refer to 4.2.4	**Describes what happens in the event of a reset command.** = 0: No reaction = 1: R = Delete fault message(s) = 2: F = Delete fault message, provided the cause has been eliminated. = 3: N = Re-initialize the axis = 4: Poff = switch off CMAX
Bit 15-12 (203/227)	Level refer to 4.2.3	**Describes the reaction to the fault/warning** = 0: none = 1: Information (ignore message) = 2: W = warning = 5: F1 = fault 1 = 6: F2 = fault 2 = 15: FS = system software fault
Bit 11..08 (203/--)	Info	**Describes what the error details refer to** see Tab. 4/13.
Bit 7..0 (203/--)	Details	**Additional details on the cause of the fault** see Tab. 4/13.

Tab. 4/12: Assignment of the additional information for future faults.

Information and details on the faults (PNU 202)			
Info (bit 11 ... 08)		**Details (bit 07... 00)**	
Value	**Description**	**Value**	**Description**
0	No information	–	–
1	Cause of fault E08 (valve, drive or measuring system was exchanged)	1	Not specified.
		2	Valve was exchanged.
		3	Sensor was exchanged.
		4	Valve and sensor were exchanged.
2	Cause of fault E09 (faulty parameter in the project)	1	Not specified.
		2	A required parameter is not configured (supply pressure, basic mass without workpiece, control parameter).
		3	The measuring system type does not match the cylinder type.
		4	The cylinder length does not match the cylinder type.
		5	The measuring system length does not match the cylinder type.
		6	The sensor length must be the same as the cylinder length with this cylinder type.
		7	Offset axis zero point is not permissible for this cylinder (must be 0).
		8	The offset axis zero point is faulty. Permitted range: -Cylinder length <= offset ANP <=0
		9	The cylinder diameter does not match the cylinder type.
		10	The measuring system type does not match the cylinder type.
		11	Two different valves were configured.
		12	The lower software end position is smaller than the lower hardware end position.
		13	The upper software end position is larger than the upper hardware end position.
		14	The lower software end position is larger than or the same as the upper software end position.

Information and details on the faults (PNU 202)			
Info (bit 11 ... 08)		**Details (bit 07... 00)**	
Value	**Description**	**Value**	**Description**
3	Cause of fault E44 (teaching not possible)	1	Not specified.
		2	In direct operating it is not possible to teach (no teach target).
		3	Homing not carried out.
		4	Commissioning: Unknown teach target specified in parameter 1.
		5	Record selection: Impermissible record number (0 or › 64)
		6	Record selection: Impermissible control mode preset in the selected record
		7	Commissioning: Teaching lower software end position ›= upper software end position not permissible
		8	Commissioning: Teaching upper software end position ‹= lower software end position not permissible
		9	Commissioning: Teaching is not permissible while a commissioning operation is being carried out.
4	Record number	nn	In the event of a general fault in operating mode Record select, the number of the record started last is entered. Value range nn: 0 to 255
5	Commissioning operation	nn	In the event of a general fault in commissioning mode, the commissioning operation started last is entered. Value range nn: 0 to 255

Information and details on the faults (PNU 202)			
Info (bit 11 ... 08)		**Details (bit 07... 00)**	
Value	**Description**	**Value**	**Description**
6	Drive function with which the fault occurred	1	Switch on.
		2	Enable drive.
		3	Disable drive.
		4	Enable drive.
		5	Disable operation (stop).
		10	Start direct operating.
		11	Start direct operating positioning task.
		12	Start direct operating force task.
		13	Start direct operating positioning task continuously.
		14	Start direct operating force task continuously.
		20	Start homing.
		21	Start homing mode 35 (current actual position).
		22	Start homing mode -17 (positive against block).
		23	Start homing mode -18 (negative against block).
		30	Jog mode in negative direction (JogN).
		31	Jog mode in positive direction (JogP).
		32	Teaching
		33	Teach setpoint value in record list.
		34	Teach lower software end position.
		35	Teach upper software end position.
		36	Teach offset project zero point.

Tab. 4/13: Information and details for future faults

4.3.4 Diagnostic code and additional information with reset, switching on and configuration

The diagnostic memory contains other diagnostic events along with faults and warnings. Here the contents of what the diagnostic number and additional information means is described.

Diagnostic event 3: Reset

A reset command was executed with FCT or with the PLC.

Diagnostic number	
No.	**Description**
1	Successful: All the fault messages were deleted.
2	Not successful: Not all messages could be deleted.
3	New start of the axis performed.

Additional information	
Info	**Description**
Byte 1	Number of resets so far
Byte 2	reserved
Byte 3 + 4	In case value › 0: Reset duration in milliseconds after restart of the axis

Diagnostic event 7: Switch on

The CMAX was switched on.

Diagnostic number	
No.	**Description**
1	Normal start: Project data fully loaded.
2	Start in configuration mode C00: no project available.
3	Start in configuration mode C01: Project incomplete.
4	Start in configuration mode C02: Project incomplete.
5	Start in configuration mode C03: Movement test must be carried out.

Additional information	
Info	**Description**
Byte 1	Number of switch-on processes so far
Byte 2	reserved
Byte 3 + 4	Duty cycle in milliseconds

Diagnostic event 8: Configuration

A configuration/commissioning operation was executed.

Diagnostic number	
No.	**Description**
1	Firmware was updated.
2	Data reset: All user and controller data was deleted.
3	Movement test carried out.
4	Static identification executed.
5	Static and dynamic identification executed.
6	Identification reset, identification data were deleted.

Additional information	
Info	**Description**
Byte 1	= 1: Successfully carried out = 2: Execution cancelled
Byte 2	reserved
Byte 3 + 4	Duration of the function in 0.1 seconds

4.4 Configuration of diagnostic messages and faults

PNU 228 permits the configuration of diagnostic events.

PNU 228: Configuration of diagnostic events		
Index	**Description**	**Default**
1	Diagnostic events filter	0x0000000F
2	Fault messages filter	0x0000007F
3	Configuration of fault messages	0x000000C0

Tab. 4/14: Configuration of the diagnostic messages

Diagnostic events filter

These settings allow you to determine which diagnostic events should be recorded. PNU 228:01 allows you to exclude specific less important events from the diagnostic memory records.

PNU 228:01: Diagnostic events filter Which events other than faults do you want recording?		
Bit	**Description**	**Specification**
0	Record warnings	1
1	Record configuration events (data reset, identification etc.)	1
2	Record reset commands	1
3	Record switch-on processes	1
4 ... 31	reserved (=: 0 !)	0

Tab. 4/15: Configuration of the diagnostic messages – diagnostic events filter

Fault messages filter

The fault messages filter allows you to exclude certain faults and warnings from the diagnostic memory records. This makes sense for faults that are part of the normal operating cycle because they are inherent to the process (load voltage errors) or because they occur frequently for other reasons.

Warning: Even if these faults are not entered in the diagnostic memory, the respective fault is reported in the corresponding fault situation and has to be acknowledged.

PNU 228:02 – **fault messages filter**
Do you want this fault / warning to be entered in the diagnostic memory?

Bit	Description	Specification
0	W08: Identification was not executed	1
1	W35: Actual position outside of the software end positions	1
2	W42: not used control bits set	1
3	E50: Supply pressure is too low	1
4	E51: Load voltage outside of tolerance range	1
5	W57: Timeout at the diagnostic interface	1
6	W68: Valve warning overtemperature	1
7 ... 31	reserved (=: 0 !)	0

Tab. 4/16: Configuration of the diagnostic messages – fault messages filter

Configuration of fault messages

Some of the faults can also be reported as warnings. This concerns in particular function monitoring, such as maintaining the software end position. Often the right correct reaction depends on the application in these cases.

With faults where both reactions are possible you can define the behaviour of the CMAX.

Not all faults can be configured individually, only selected ones for which configuration in the CMAX makes sense.

PNU 228:03 – **configuration of fault messages**
Which faults do you want treated as a warning?

Bit	Description	Specification [1)]
0	E27: Sequencing condition cannot be reached during the positioning task. In case of warning: Record is executed as if no record sequencing were parametrised. Subsequent record is not executed, error E28 is not reported.	0
1	E28: Sequencing condition was not reached. In case of warning: The CMAX stops in the record whose sequencing condition was not reached.	0
2, 3	reserved (=: 0 !)	0
4	E32: Target force outside of the force limits. In case of warning: If exceeded, the target force is limited to the limit value by the CMAX.	0
5	E33: Target position outside of the software or hardware end positions. In case of warning: If the target position is larger than the software end position, the software end position or the hardware end position (with deactivated software end positions) is approached.	0
6	E34: Setpoint value of tracking mode outside of the limit values. In case of warning: The setpoint value (position or force) is only adopted up to the limit values. The axis stops at the software end position or force limit. Positioning is not cancelled. If the setpoint value is smaller than the limit value, the CMAX will track the axis.	1
7	E35: Pass software end position. In case of warning: The axis does not stop and continues to execute the positioning task (does not apply to force control).	1
8	E50: Supply pressure is too low In case of warning: The CMAX behaves as if there were sufficient pressure. Positionings lead to error E30 or E31.	0
9 ... 31	reserved (= 0 !)	0

[1)] 0 = The message is treated as a fault; 1 = The message is treated as a warning

Tab. 4/17: Configuration of the diagnostic messages – configuration of fault messages

4.5 Diagnostics via standard functions of the CPX terminal

Faults in the CMAX or the connected modules are reported to the CPX node as CPX error messages. The following sections contain the special features of the representation for the CPX-specific diagnostic options.

- I/O data module (control and status bytes, see section 2.2),
- Status bits (see section 4.5.1),
- I/O diagnostics interface (see section 4.5.2).

4.5.1 Status bits of the CPX terminal

Tab. 4/18 shows error messages of the CMA X in the status bits of the CPX terminal.

Bit	Diagnostic information with 1-signal	Description	Error cause CMAX
0	Error in valve	Module type in which an error has occurred	–
1	Error at output		–
2	Error at input		–
3	Error on analogue module/ technology module		Bit 3 is set for all errors of the CMAX.
4	Undervoltage	Type of error	–
5	Short circuit/overload		–
6	Wire break		–
7	Other error		–

Tab. 4/18: Overview of status bits

4.5.2 I/O diagnostic interface and diagnostic memory

A range of different diagnostic information is accessible via the I/O diagnostic interface and the diagnostic memory of the CPX terminal.

Diagnostic memory data (CPX-MMI and I/O diagnostic interface)

The representation of diagnostic messages of the CMAX in the diagnostic memory of the CPX terminal occurs as shown in Tab. 4/19.

Diagnostic memory data (10 bytes per entry, max. 40 entries)				**Function no.** [1]
Byte	**Designation**	**Description**	**Value**	**3488 + n**
1 2 3 4 5	Days [day] Hours [h] Minutes [m] Seconds [s] Milliseconds [ms]	Time information for the reported error, measured from the point when the power supply was switched on (CPX standard).	0 ... 255 0 ... 23 0 ... 59 0 ... 59 0 ... 999 (128...227)	n = 10 * d + 0
6	Module code	Module code of the CMAX: 176	0 ... 255	n = 10 * d + 5
7	Module position [Pos]	Module code of the CPX module that reported the error.	0 ... 47	n = 10 * d + 6
8	Channel number	<u>Bit 7 6 5 ... 0 Description</u> 1 0 0 ... 0 Error in I-channel 1	128 (0 ... 255)	n = 10 * d + 7
9	Error number [FN]	CPX error number (see section 4.2.2)	90 ... 99 (0 ... 255)	n = 10 * d + 8
10	Following channels	Always 0 for the CMAX	0 (0 ... 63)	n = 10 * d + 9

[1] d (diagnostic event) [NB] = 0 ... 39 ; most current diagnostic event = 0

Tab. 4/19: Diagnostic memory data of the CMAX

Instructions on diagnostics with the I/O diagnostic interface can be found in the CPX system manual.

Example of diagnostic memory entry for error E50

Diagnostic memory data			Value		
Byte	**Designation**	**Description**	**Dec**	**Hex**	**Bin**
1 2 3 4 5	Days [day] Hours [h] Minutes [m] Seconds [s] Milliseconds [ms]	Error was reported 22.66 ms after switching on the power supply (bit 7 in byte 5 is set if this is the first entry since Power ON).	0_d 0_d 0_d 22_d 194_d	00_h 00_h 00_h 16_h $C2_h$	00000000_b 00000000_b 00000000_b 00010110_b 11000010_b
6	Module code	Module code of the CMAX: 176	176_d	$B0_h$	10110000_b
7	Module position [Pos]	In this case, the CMAX is CPX module No. 2.	2_d	02_h	00000010_b
8	Channel number	Bit 7 6 5 ... 0 Description 1 0 0 ... 0 Error in I channel	128_d	81_h	10000001_b
9	Error number [FN]	CPX error number: 105	105_d	69_h	01101001_b
10	Following channels	Always 0 for the CMAX	0_d	00_h	00000000_b

Tab. 4/20: Example of diagnostic memory entry

Diagnostic data of the module (I/O diagnostic interface)

The specific representation of module diagnostic data (error messages) of the CMAX occurs as shown in Tab. 4/21 and Tab. 4/22.

Module diagnostic data: Type of error and location where error arose	
Function no.	2008 + m * 4 + 0; m = module number (0 ... 47)
Description	Describes where the relevant error occurred.
Bit	Bit 0 ... 7 Type of error and location where error arose
Values	Bit 7 6 5 ... 0 : Description 1 0 000000 : Error in I-channel 0 (axis 1)

Tab. 4/21: Type of error and location where error arose

Module diagnostic data: Module error number	
Function no.	2008 + m * 4 + 1; m = module number (0 ... 47)
Description	Error number
Bit	Bit 0 ... 7 : error number
Values	100 ... 108: CPX error number, (see example Tab. 4/20)
Note	For CMAX error messages, see section 4.2.2.

Tab. 4/22: Module error number

4.5.3 Split up: Parametrising via the I/O diagnostic interface

In principle, parameters can also be changed via the CPX bus nodes or CPX-FEC-specific functions, such as acyclic services etc.
The CMAX parameters are accessed via the I/O diagnostic interface, see Tab. 4/23.

Information on the parametrisation can be found in the description of the CMAX communication profile.

Function number 1)	Parameter entry
4828 + m*64 + 0 ... 5	reserved (standard module parameters, are not used by the CMAX).
4828 + m*64 + 6	Reserved for special module settings of the CMAX.
4828 + m*64 + 7	
4828 + m*64 + 8 ... 11	Task control
4828 + m*64 + 12 ... 61	50 byte data (depending on the task).
4828 + m*64 + 62, 63	reserved

1) m = module number

Tab. 4/23: I/O diagnostic interface

Additional information

Module code

Function no: 16 + m*16 + 0:
Module code CPX-CMAX-C1-1 = 176

Revision code

Function no: 16 + m*16 + 13
Shows the module version: 0 ... 255 according to the name plate of the module.

After a firmware update the name plate and the version no longer match.

Serial number

Function no:	784 + m*4 + 0
	784 + m*4 + 1
	784 + m*4 + 2
	784 + m*4 + 3

Specifies the serial number of the module (8 digits).

Structure: YMNNNNNN
Y=Year, M=Month,
NNNNNN = continuous number (BCD-encoded)

Example:	37 12 34 56
37:	Date = July 2003 (Year: 0 ... F = 2000 ... 2015; month: 0 ... C)
123456:	continuous number

Parameter

Chapter 5

Contents

5.1 General parameter structure of the CMAX

The CMAX contains a parameter set with the following structure.

Group		Indices	Description
Device data		100 ... 199	Device identification and device-specific settings, version numbers, identifier words, etc.
Axis data	Diagnostic data	200 ... 299	Memory for diagnostic events: fault numbers, fault time, current messages.
	Process data	300 ... 399	Current setpoint values and actual values, status data
	Record list	400 ... 499	For record select operating mode. A record contains all the setpoint value parameters required for a positioning procedure.
	Project data	500 ... 529	Basic project settings: Project zero point, setpoint value limits for position, force, speed, ...
	Setpoint value for Direct operating	530 ... 599	Data for jogging and direct setpoint specification for position, force, ...
	Default values	600 ... 699	Global default values
	Drive configuration	1100 ... 1149	All axis-specific parameters for pneumatic drives: Cylinder lengths and diameter, valve type, ...
	Controller data	1150 ... 1189	Amplification factors, identification, adaptation.
	Commissioning data	1190 ... 1199	Actual configuration, system of measurement, data reset ...

Tab. 5/1: Parameter structure

Parameter classes	Attribute / use
Var	Simple variable. Contains only one value. The subindex does not have a function.
Array	Contains multiple simple variables that all have the same significance, the same limits, the same unit, etc. Example: Record list setpoint position (PNU 404). The elements in the array are addressed using the subindex.
Struct (Record)	Compilation of several single variables with different limit values etc.

Tab. 5/2: Parameter classes for the CMAX

Data types	Attribute / use
bitarray	4-byte value whose individual bits have separate meanings.
char	8-bit ASCII characters.
int32	4-byte integer value with sign.

Tab. 5/3: Data types for the CMAX

5.2 Access protection

5.2.1 Password protection

The password protection prevents unauthorised controlling or modifying of parameters, e.g. via a freely accessible MMI in a producing plant. The password only prevents write access – reading is always possible.

There are three ways to modify parameters:

– via the diagnostic interface – with a PC or MMI (in preparation),

– via fieldbus through the operating PLC (I/O data in parametrising mode),

– via fieldbus through a configuration master.

You can assign a password for the diagnostic interface in the CMAX. Modifications are always possible via fieldbus. When starting up the device for the first time, it will not yet have a password created.

Areas that are protected are the modification of parameters and the controlling of inputs, start, stop, teaching and firmware download. Permissible is the display of parameters, project upload, the display of actual values, setpoint values, diagnostic data.

The following parameters can be modified despite password protection:

PNU	Parameter	Description of the reason
116	Project identifier	reserved for the FCT (synchronisation status).
130	Password	Must be writable.
133	System password	reserved for the FCT (reset CMAX in the event of "Forgot password").
204:05	Number of new entries	Diagnostic memory display (status value, no parameter).
1173:01	Limit value status	Required for the display of the limit values (status value, no parameter).

Tab. 5/4: Parameters that can be written without password

Creating a password

PNU 130 contains the password as a string. The parameter PNU 1192:04 controls the acceptance and delivers the current status. To define a password for the CMAX:

1. Write the password in PNU 130, e.g. PNU 130 ="My_password".

2. Accept the password into the device data by setting PNU 1192:04 = 1.

The password is implemented as a string in CMAX and consists of 8 bytes (ASCII code: 32 to 127). This permits upper and lower case letters, numerals and special characters such as dash '-', smaller '‹ ', at '@' etc.

PNU 1192:04 Accept password	
Access	**Values**
Write	= 0: Delete password
	= 1: Accept password
Read	= 0: No password set
	= 1: Password set and access free
	= 2: Password set and access blocked

Tab. 5/5: Password access control

The password must be entered when connecting with the FCT for the first time. It then remains active until the project is closed in the FCT.

To change it, first enter and delete the old password. Then the new password can be entered and accepted.

The password cannot be read or reset. If you forget the password, the CMAX can be completely reset. This not only deletes the axis data but also the device data. This reset can only be performed by FCT, not via the PLC.

Information on the password protection can be found in the CMAX FCT-PlugIn Help and in the PNU in section 5.4.2 and PNU 1192 in section 5.4.16.

5.2.2 Access via PLC and FCT

Simultaneous operation of the drive through PLC and FCT can be locked. This is done with the bits CCON.LOCK (FCT access blocked) and SCON.FCT_MMI (device control FCT).

Preventing FCT operation: CCON.LOCK

By setting the CCON.LOCK control bit (bit 5) the PLC prevents the FCT from taking over device control. So if the LOCK is set, FCT cannot write parameters or control the drive.

The PLC should be programmed not to issue this release until the user carries out the relevant action. This generally exits automatic operation. This means that the PLC programmer can ensure that the PLC always knows when it has control over the drive.

The lock is active if the CCON.LOCK has a 1 signal. It is not mandatory to set it. If such a lock is not required, CCON.LOCK can always be set to 0.

A subset of the parameters can also be written by the FCT if the device control is not active. This concerns the parameters that can be modified during "optimisation".

- Record list (accelerations and workpiece mass),
- Controller amplifications,
- Several diagnostic parameters for the FCT.

Control sovereignty acknowledgment for FCT: SCON.FCT_MMI

SCON.FCT_MMI indicates that the drive is controlled by the FCT and that no control over the drive is possible via the I/O data. The PLC can react by switching to stop or manual operation.

5.2.3 Status-dependent and operating mode dependent lock

This lock is designed to protect against maloperations during the operating phase. It is not permissible to modify parameters during operation that affect the controller.

To do this, you must change to commissioning mode (or parametrisation, when using the cyclical I/O data). This data is documented as commissioning data. Each parameter also states which operating status is needed.

To write a commissioning parameter

– commissioning mode or parametrising mode must be active,

– the controller must be locked (CCON.ENABLE = 0)

5.2.4 Enable and stop with parametrisation

The parametrisation in the cyclical I/O data requires that the CCON.STOP signal is not set, since operation enable is not possible.
Commissioning parameters require that the controller is locked when writing.

Transferring parameters has the following effects on the CCON.ENABLE and CCON.STOP signals

Operating mode	**Read: CCON**		**Write: CCON**	
	.ENABLE	**.STOP**	**.ENABLE**	**.STOP**
Record selection	x	x	x	x
Direct mode	x	x	x	x
Commissioning	x	x	0	x
Parametrisation	x	0	0 / x [1)]	x / 0 [1)]

1) With commissioning parameters CCON.ENABLE = 0 must be set

Tab. 5/6: Effect of the parameter transfer to CCON

5.3 Default values

Default values can be used to globally specify positioning parameters (speed, acceleration, tolerance, ...) for record select mode and direct operating. They replace the individual record select or direct operating parameters.

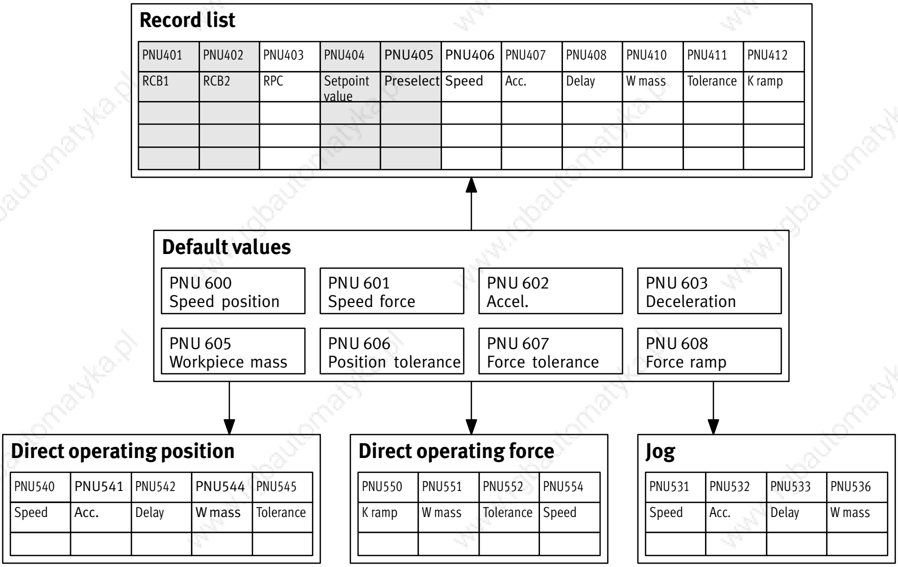


Fig. 5/2: Effect of the default values

If in an application each record is to be moved with the same acceleration e. g., you do not need to enter the same v alue into the position list each time. Instead, the record list refers to the default value.

In order to use values other than the default values in an individual record, you only need to specify the values for the record parameter in this one record.

Advantages:

- Simplifies parametrisation.

  The record and direct operating parameters are by default defined so that the respective default values are used instead of the parameters. If the default values are used for the parameters speed, acceleration, deceleration, workpiece mass and tolerance, this amounts to 5 x 64 = 320 parameters for 64 records that do not need to be entered.

- Increased data transmission performance.

  Since less data is transmitted, the time required for parametrisation is reduced. This affects serial connections such as with the FCT, but also fieldbus connections.

When is a default value used?

For each parameter a flag defines whether the default value is used. If you want the value from the record or the special parameter to be used, the flag needs to be set to 1. Otherwise the default value will be used. The following parameters contain flags for default values:

Positioning type	PNU	Index	Description
Record select mode	403	nn (record no.)	Record Parameter Control (RPC)
Jog	521	01	Direct Mode Parameter Control (DMPC)
Direct mode for position	521	02	Direct Mode Parameter Control (DMPC)
Direct mode for force	521	03	Direct Mode Parameter Control (DMPC)

Tab. 5/7: Control of the default values

Parameter Control		
Bit	**PNU 403: RPC**	**PNU 521: DMPC**
31	= 0: Record is blocked = 1: Record is active	is not evaluated
30	= 0: Record is not initialised or deleted = 1: Record is initialised by user	is not evaluated
0 ... 29	Bitfield, controls acceptance of the default values, see Tab. 5/9. = 0: Using the default values = 1: Using the parameter from record select or direct mode	

Tab. 5/8: Flag for the parameter control

Parameters used depending on the bit status						
Bit	**Parameter**	**Bit = 0**	**Bit = 1**			
			Record select mode	**Jog**	**Position**	**Force**
0	Speed, position	600	406	531	540	–
1	Force speed	601	406	–	–	554
2	Acceleration	602	407	532	541	–
3	Deceleration	603	408	533	542	–
4	– (reserved)	–	–	–	–	–
5	Workpiece mass	605	410	536	544	551
6	Position tolerance	606	411	–	545	–
7	Force tolerance	607	411	–	–	552
8	Force ramp	608	412	–	–	550
9 ... 29	– (reserved)	–	–	–	–	–

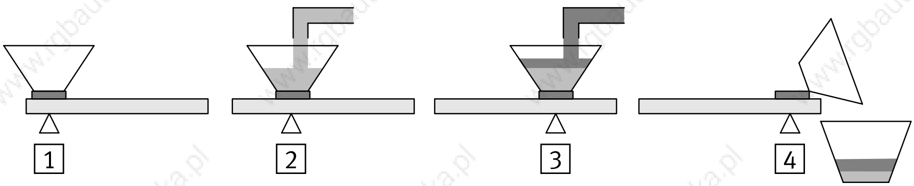
Tab. 5/9: Parameters used

How is evaluation performed?

Evaluation is performed upon start. When using the free profile, the CMAX checks for each target parameter whether it should use the global setting or the individual parameter. Individual parameter values shall be used if the respective bit is set to 1 in the RPV (Record Parameter Control) or the MCPC (Direct Mode Parameter Control).

Example

Let’s assume 2 types of bulk goods are to be brought to a collection point and emptied there.



1 Position 1: 20 mm (“Wait”)

2 Position 2: 75 mm (“Load 1”)

3 Position 3: 145.50 mm (“Load 2”)

4 Position 4: 205.20 mm (“Empty”)

Fig. 5/3: Example of different masses

Step	Task
1	Waiting in a waiting position to start collecting the bulk goods. Upon start the empty slide uses the default values to travel from the starting position 1 to the first loading position 2.
2	With increased mass (12 kg) the slide travels to the second loading position 3. Acceleration and speed may correspond to the default values.
3	The full container (25 kg) is moved to the unloading position 4. Here the slide needs to travel based on reduced speed and acceleration values due to the full container.
4	From the unloading position 4 the slide can return to the initial position 1 at full speed.

Tab. 5/10: Example of default values: Steps

To perform this task, the following default values are defined first. Force control is not required, the values are not taken into account.

Parameter	PNU	Value	Comment
Speed	600	1000 (= 1 m/s)	Do not use the maximum possible values from the identification data.
Acceleration	602	1000 (= 1 m/s^2)	
Braking ramp	603	1000 (= 1 m/s^2)	
Workpiece mass	605	0 (= 0 kg)	No workpiece mass in normal status
Tolerance	606	50 (= 0.5 mm)	Tolerance = 0.5 mm

Tab. 5/11: Example of default values: Specify default values

Record list: All blank fields in the record list do not need to be parametrised explicitly. The record control bytes 1+2 can be used as preset.

Record No.	**RCB1**	**RCB2**	**RPC** (Low word)	**Setpoint value**	**Preselect**	**Speed**	**Accel.**	**Delay**	**WP mass**	**Tolerance**	**Force ramp**
						Bit 0 0001 h	Bit 2 0004 h	Bit 3 0008 h	Bit 5 0020h	Bit 6 0040h	Bit 8 0100h
1			C000 0000$_h$	7500							
2			C000 0020$_h$	14550					120		
3			C000 002D$_h$	20520		400	200	200	250		
4			C000 0000$_h$	2000							

Tab. 5/12: Example of default values: Record list

With this record list and the default values the drive in fact performs the following movement.

Step	Start	Target	Speed	Acc.	Delay	WP mass	Tolerance
1	20.0 mm	75.0 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	0.0 kg	0.5 mm
2	75.0 mm	145.5 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	12.0 kg	0.5 mm
3	145.5 mm	205.2 mm	0.4 m/s	0.2 m/s^2	0.2 m/s^2	25.0 kg	0.5 mm
4	205.2 mm	20.0 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	0.0 kg	0.5 mm

Tab. 5/13: Example of default values: Movements performed

5.4 Description of the parameters

5.4.1 Overview of parameters

The following overview (Tab. 5/14) shows the FHPP's parameters. The parameters are described in sections 5.4.2 to 5.4.16.

PNU [1)]			Name (DE)	Properties[1)]							
PNU	**IND**	**Max**		**Class**	**Type**	**Unit**	**RW**	**SH**	**IB**	**NB**	**UL**
Device data, see section 5.4.2											
100	1	1	Hardware version of manufacturer	Var	int32	0	R				
101	1	1	Firmware version of manufacturer	Var	int32	0	R				
102	1	1	FHPP version	Var	int32	0	R				
103	X	30	Build version	Array	char	0	R				
104	X	3	Software versions	Var	int32	0	R				
105	1	1	Boot loader version	Var	int32	0	R				
114	1	1	Controller serial number	Var	bitarray	0	R				
116	X	33	FCT project identifier	Array	char	0	RW				UL
120	X	30	Manufacturer's device name	Array	char	0	R				
121	X	30	User's device name	Array	char	0	RW				UL
122	X	30	Manufacturer name	Array	char	0	R				
123	X	30	HTTP address of manufacturer	Array	char	0	R				
124	X	30	Festo order number	Array	char	0	R				
130	X	30	Password	Array	char	0	W				UL
133	X	2	Secret system password	Var	int32	0	RW				
140	1	2	System time: Qty. operating days	Struct	int32	0	R				
140	2	2	System time: millisec. of the day	Struct	int32	0	R				
180	X	30	Name of X-axis	Array	char	0	RW				UL
181	X	30	Name of Y-axis	Array	char	0	RW				UL
[1)] see Tab. 5/15											

PNU [1)]			Name (DE)	Properties[1)]							
PNU	IND	Max		Class	Type	Unit	RW	SH	IB	NB	UL
Diagnostics, see section 5.4.3).											
200	X	100	Diagnostic event	Array	int32	0	R				
201	X	100	Diagnostic number	Array	int32	0	R				
202	X	100	Time stamp time of day	Array	int32	0	R				
203	X	100	Additional information	Array	bitarray	0	R				
204	1	5	Reserved	Struct	int32	0	R				
204	2	5	Reserved	Struct	int32	0	R				
204	3	5	Clear memory	Struct	int32	0	RW	SH			UL
204	4	5	Number of entries	Struct	int32	0	R				
204	5	5	Number of unread entries	Struct	int32	0	RW				UL
220	X	3	Current faults	Array	bitarray	0	R				
221	X	3	Current warnings	Array	bitarray	0	R				
222	X	100	Time stamp: operating day	Array	int32	0	R				
224	1	1	Currently displayed fault on display	Var	int32	0	R				
225	1	1	Active fault level	Var	int32	0	R				
226	1	1	Currently displ. warning on the FCT	Var	int32	0	R				
227	X	89	Error status for FCT	Array	bitarray	0	R				
228	1	3	Diagnostic events filter	Struct	bitarray	0	RW	SH			
228	2	3	Diagnostic messages filter	Struct	bitarray	0	RW	SH			
228	3	3	Fault configuration configur-ation	Struct	bitarray	0	RW	SH			
Process data, see section 5.4.4											
300	X	3	Position values	Array	int32	1	R				
301	X	3	Force values	Array	int32	3	R				
302	X	3	Pressure values	Array	int32	4	R				
305	1	4	Count of positioning com-mands	Struct	int32	0	R				
305	2	4	Count of force commands	Struct	int32	0	R				
305	3	4	Cumulated stroke length	Struct	int32	0	R				
305	4	4	Cumulated stroke length fract.	Struct	int32	0	R				
307	1	1	Current speed	Var	int32	6	R				
308	1	1	Extended axis status	Var	bitarray	0	R				
309	1	1	Valve output value	Var	int32	0	R				

1) see Tab. 5/15

PNU 1)			Name (DE)	Properties 1)							
PNU	IND	Max		Class	Type	Unit	RW	SH	IB	NB	UL
Record list, see section 5.4.5											
400	1	3	Setpoint record number	Struct	int32	0	R				
400	2	3	Actual record number	Struct	int32	0	R				
400	3	3	Record status byte	Struct	bitarray	0	R				
401	X	64	Record control byte 1	Array	bitarray	0	RW	SH			UL
402	X	64	Record control byte 2	Array	bitarray	0	RW	SH			UL
403	X	64	Record param. Control	Array	bitarray	0	RW	SH			UL
404	X	64	Record setpoint value	Array	int32	1, 3	RW	SH			UL
405	X	64	Record preselection value	Array	int32	div.	RW	SH			UL
406	X	64	Record velocity	Array	int32	6	RW	SH			UL
407	X	64	Record acceleration	Array	int32	7	RW				UL
408	X	64	Record deceleration	Array	int32	7	RW				UL
410	X	64	Record workpiece mass	Array	int32	5	RW				UL
411	X	64	Record tolerance	Array	int32	1, 3	RW	SH			UL
412	X	64	Record force ramp	Array	int32	8	RW	SH			UL
Project data, see section 5.4.6											
500	1	1	Project zero point	Var	int32	1	RW	SH		NB	UL
501	1	2	Lower software end position	Var	int32	1	RW	SH		NB	UL
501	2	2	Upper software end position	Var	int32	2	RW	SH		NB	UL
507	1	1	Stop ramp	Var	int32	7	RW	SH			UL
510	1	1	Permitted stroke during force control	Var	int32	1	RW	SH			UL
511	1	1	Lower limit setpoint force	Var	int32	3	RW	SH		NB	UL
512	1	1	Upper limit setpoint force	Var	int32	3	RW	SH		NB	UL
514	1	1	Permitted speed during force control	Var	int32	6	RW	SH			UL
521	1	3	Jog mode parameter control	Array	bitarray	0	RW	SH			UL
521	2	3	Direct mode position parameter control	Array	bitarray	0	RW	SH			UL
521	3	3	Direct mode force parameter control	Array	bitarray	0	RW	SH			UL
522	1	2	FHPP: Control/Status bits: CPOS.HALT support	Struct	int32	0	RW	SH	IB		UL
522	2	2	FHPP: Control/Status bits: CCON.BRAKE level	Struct	int32	0	RW	SH	IB		UL
523	X	8	FHPP: Setpoint/actual values	Struct	int32	0	RW	SH			UL

1) see Tab. 5/15

PNU 1)			Name (DE)	Properties1)							
PNU	IND	Max		Class	Type	Unit	RW	SH	IB	NB	UL
Jog mode, see section 5.4.7											
530	1	1	Jog mode slow speed	Var	int32	6	RW	SH			UL
531	1	1	Jog mode fast speed	Var	int32	6	RW	SH			UL
532	1	1	Jog mode acceleration	Var	int32	7	RW	SH			UL
533	1	1	Jog mode deceleration	Var	int32	7	RW	SH			UL
534	1	1	Jog mode time slow speed	Var	int32	9	RW	SH			UL
536	1	1	Jog mode workpiece mass	Var	int32	5	RW	SH			UL
Direct mode position, see section 5.4.8											
540	1	1	Direct m. pos. base veloc.	Var	int32	6	RW	SH			UL
541	1	1	Direct m. pos. acceleration	Var	int32	7	RW	SH			UL
542	1	1	Direct m. pos. deceleration	Var	int32	7	RW	SH			UL
544	1	1	Direct m. pos. workp. mass	Var	int32	5	RW	SH			UL
545	1	1	Direct m. pos. tolerance	Var	int32	1	RW	SH			UL
Direct mode force, see section 5.4.9											
550	1	1	Direct m. force base value force ramp	Var	int32	8	RW	SH			UL
551	1	1	Direct m. force workpiece mass	Var	int32	5	RW	SH			UL
552	1	1	Direct m. force tolerance force	Var	int32	3	RW	SH			UL
554	1	1	Direct m. force velocity limit	Var	int32	6	RW	SH			UL
Default values, see section 5.4.10											
600	1	1	Speed position mode	Var	int32	6	RW	SH			UL
601	1	1	Speed force mode	Var	int32	6	RW	SH			UL
602	1	1	Acceleration	Var	int32	7	RW	SH			UL
603	1	1	Deceleration	Var	int32	7	RW	SH			UL
605	1	1	Workpiece mass	Var	int32	5	RW	SH		NB	UL
606	1	1	Tolerance position mode	Var	int32	1	RW	SH			UL
607	1	1	Tolerance force mode	Var	int32	3	RW	SH			UL
608	1	1	Force ramp	Var	int32	8	RW	SH			UL

1) see Tab. 5/15

PNU 1)			Name (DE)	Properties 1)							
PNU	**IND**	**Max**		**Class**	**Type**	**Unit**	**RW**	**SH**	**IB**	**NB**	**UL**
Axis configuration, see section 5.4.11											
1100	1	1	Cylinder type	Var	int32	0	RW	SH	IB	NB	UL
1101	1	1	Cylinder length	Var	int32	2	RW	SH	IB	NB	UL
1102	1	1	Cylinder diameter	Var	int32	11	RW	SH	IB	NB	UL
1103	1	1	Piston rod diameter	Var	int32	11	RW	SH	IB	NB	UL
1110	1	1	Measuring system type	Var	int32	0	RW	SH	IB	NB	UL
1111	1	1	Measuring system length	Var	int32	2	RW	SH	IB	NB	UL
1112	1	1	Measuring system serial number	Var	bitarray	0	RW	SH			
1120	1	1	Valve type	Var	int32	0	RW	SH	IB	NB	UL
1121	1	1	Valve serial number	Var	bitarray	0	RW	SH			
1125	1	1	Valve type 2	Var	int32	0	RW	SH	IB	NB	UL
1126	1	1	Valve 2 serial number	Var	bitarray	0	RW	SH			
Application settings, see section 5.4.12											
1130	1	1	Offset axis zero point	Var	int32	1	RW	SH	IB	NB	UL
1131	1	1	Homing method	Var	int32	0	RW	SH	IB		UL
1132	1	1	Homing speed	Var	int32	6	RW	SH	IB		UL
1140	1	1	Mounting angle	Var	int32	12	RW	SH	IB	NB	UL
1141	1	1	Supply pressure	Var	int32	4	RW	SH	IB	NB	UL
1142	1	1	Basic mass load without work-piece	Var	int32	5	RW	SH	IB	NB	UL
1143	1	4	Workpiece loaded at power on	Var	int32	0	RW	SH	IB		UL
1143	2	4	Dual axis design	Var	int32	0	RW	SH	IB	NB	UL
1143	3	4	Clamping unit installed	Var	int32	0	RW	SH	IB		UL
1143	4	4	Through piston rod	Var	int32	0	RW	SH	IB	NB	UL
Position controller, see section 5.4.13											
1150	1	1	Pos. contr. gain factor	Var	int32	10	RW			NB	UL
1151	1	1	Pos. contr. cushioning factor	Var	int32	10	RW			NB	UL
1152	1	1	Pos. contr. filter factor	Var	int32	10	RW			NB	UL
1153	1	1	Pos. contr. timeout	Var	int32	9	RW	SH		NB	UL
1154	1	1	Pos. contr. damping time for exact stop	Var	int32	9	RW	SH		NB	UL

1) see Tab. 5/15

PNU 1)			Name (DE)	Properties 1)							
PNU	IND	Max		Class	Type	Unit	RW	SH	IB	NB	UL
Force control, see section 5.4.14											
1160	1	1	Force contr. gain factor	Var	int32	10	RW			NB	UL
1161	1	1	Force contr. dynamic gain	Var	int32	10	RW			NB	UL
1162	1	1	Force contr. filter factor	Var	int32	10	RW			NB	UL
1163	1	1	Force contr. timeout	Var	int32	9	RW	SH		NB	UL
1164	1	1	Force contr. damping time for exact stop	Var	int32	9	RW	SH		NB	UL
Identification, see section 5.4.15											
1170	1	1	Identification settings	Var	int32	0	RW	SH	IB	NB	UL
1171	1	1	Identification status	Var	bitarray	0	R				
1172	X	6	Identified maximum values	Struct	int32	6/7	R				
1173	1	14	Limit values Status	Struct	bitarray	0	RW				
1173	X	14	Limit values	Struct	int32	div.	R				
1174	1	1	Status movement test	Var	bitarray	0	R				
1175	1	1	Disable adaptation	Var	int32	0	RW	SH	IB	NB	UL
1176	X	16	Static identification data	Array	int32	0	R				
System data, see section 5.4.16											
1190	X	43	Actual hardware configuration	Struct	int32	0	R				
1191	X	15	Analysis data	Array	int32	0	R				
1192	1	8	Comm. funct. block download	Struct	int32	0	RW	SH		NB	UL
1192	2	8	Comm. funct. config. status	Struct	int32	0	R				
1192	3	8	Comm. funct. data reset	Struct	int32	0	RW	SH	IB	NB	UL
1192	4	8	Comm. funct. password status	Struct	int32	0	RW				
1192	5	8	Comm. funct. system of meas.	Struct	int32	0	RW	SH	IB	NB	UL
1192	6	8	Comm. funct. system of meas. table	Struct	int32	0	R				
1192	7	8	Comm. funct. movem. test status	Struct	int32	0	RW	SH	IB		
1192	8	8	Comm. funct. valve/sensor status	Struct	int32	0	R				
1193	X	12	System of meas. units	Struct	int32	0	R				
1194	X	12	System of meas. resolution	Struct	int32	0	R				
1195	X	5	Start configuration	Struct	int32	0	R				
1199	X	7	Manufacturing data	Array	int32	0	R				
1) see Tab. 5/15											

Tab. 5/14: Overview of CMAX parameters

The overview contains the following entries

Index	Physical value
PNU	Decimal parameter number
IND	Subindex (Array, Struct) decimal (X = all or several subindexes of the PNU)
Max	Max. index, largest index = array size/struct size
Class	Parameter class (Var, Array, Struct)
Type	Value type (int32, bitarray, char)
Unit	Index of the physical unit (see PNU 1193 and section B.1)
RW	Write permissions: R = read only, W = write only, RW = read and write
SH	Higher-order controller (device control) required to make changes
IB	Commissioning parameters, writing only in commissioning or parametrising mode with disabled controller
NB	Recalculation of the controller is performed after writing
UL	Limit values are taken into account when making changes

Tab. 5/15: Key on CMAX parameter overview

Representation of the parameter entries

1

Cylinder length

2

3

PNU	PNU: 1101	Index: 1		Max. index: 1	Class: Var		Data type: int32	
Values	Unit: Length (index = 2)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	0	1.000.000	0,1 °	0	0	100.000
imperial	0.01 ft	0	0	1.000.000	0,1 °	0	0	100.000

4

The cylinder length is stored in the sensor interface. Standard cylinders are not longer than 2,000 mm, the value range includes reserves for special applications.
When exchanging the drive, no projecting needs to be carried out as long as the specified cylinder length deviates from the recognised cylinder length by no more than 5.00 mm. This also allows optimisation of the effective stroke.

5

- ☒ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
- ☐ This parameter can be written by FCT without higher-order controller.
- ☐ After writing, controller recalculation is carried out.

1 Name of the parameter

2 PNU (parameter number) with index, maximum index of the PNU, class and data type

3 Parameter values:

- For integer parameters (int32) with a physical unit, the unit and the values (default, minimum, maximum) are specified for each system of measurement (example).
- For integer parameters (int32) without a physical unit, only default, minimum and maximum values are specified.
- With bitfields (bitarray), the default value is specified. It is also specified which bit can assume which value 0, 1 or x (any) during writing. With bitfields the CMAX checks the status of the individual bits, not a value range.
- Strings (char) are specified with their default values and the permissible characters during writing.

4 Description of the parameter

5 Information about access restrictions and effects on the controller

Fig. 5/4: Representation of the parameter entries

5.4.2 Device data

Manufacturer hardware version					
PNU	PNU: 100	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0x0100	Minimum: -		Maximum: -	
Coding of the CMAX hardware version. The version number is BCD-encoded, the upper 16 bits are not used. Format: 0x0000HHNN (HH = main version, NN = secondary version)					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Manufacturer firmware version					
PNU	PNU: 101	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0x0100	Minimum: -		Maximum: -	
Coding of the CMAX firmware version. The version number is encoded as BCD. Format: 0xBBBBHHNN (BBBB = build number/output version, HH = main version, NN = secondary version) Example: 0x05050100 corresponds to the version V01.00.0505					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Version FHPP					
PNU	PNU: 102	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0x0110	Minimum: -		Maximum: -	
Coding of the implemented FHPP version. The FHPP version is changed in the event of fundamental adjustments of the FHPP definition. Format: 0x0000HHNN (HH = main version, NN = secondary version)					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Build date

PNU	PNU: 103	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default: -				
	Impermissible characters: -				

Date of creation of the firmware. The date is implemented as a string.
Format “DD.MM.YYYY hh:mm:ss”
Example: 03.07.2008 12:40:44

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Software versions

PNU	PNU: 104	Index: 1 ... 2	Max index: 2	Class: Var	Data type: int32
Values	Without unit				
	Default: 0x0100	Minimum: -	Maximum: -		

Software versions of the PlugIn for firmware operation.

Index	Contains
1	Minimal version
2	Recommended version

Format (BCD): 0000HHNN (HH = main version, NN = secondary version)

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Bootloader version

PNU	PNU: 105	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0x0100	Minimum: -	Maximum: -		

Version of the bootloader installed.
In the event of a firmware update the bootloader is not overwritten. Prior to a firmware download, the system checks whether the firmware to be written is compatible with the bootloader.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Controller serial number

PNU	PNU: 114	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	-			
	Write:	-			

CMAX serial number (CPX module serial number).
It consists of 8 digits. Example: 37 12 34 56
37: Date=July 2003, (year: 0..F=2000...2015; month: 0..C)
23456: Continuous number

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

FCT project identifier

<table>
<tr><td>PNU</td><td>PNU: 116</td><td>Index: 1 ... 33</td><td>Max index: 33</td><td>Class: Array</td><td>Data type: char</td></tr>
<tr><td>Values</td><td>Default:</td><td colspan="4">“0”</td></tr>
<tr><td></td><td>Impermissible characters:</td><td colspan="4">? @ . , ! : ” § | $ % & / # ‘ ’ + ~ * ’ ; ° ^ ‹ ›</td></tr>
</table>

UUID (Universally Unique Identifier) for identification of the FCT project.
FCT generates an UUID after a project download and writes this into the device as the last parameter. The UUID is saved in the project (not visible). In the CMAX the UUID is reset to 0 as soon as a parameter in the configuration area (PNUs >=400) is changed. Changing process and diagnostic data does not cause a reset.
The next time the FCT connects with the device, it checks the UUID after the name. If this is identical to the UUID in the project, synchronisation between the device and the project does not need to be carried out.
Permissible values per character: = 0x20 ... 0xFF
Reasonable values per character: = “0” ... “9” and “A” ... “F”
Reset value = “0”

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Manufacturer device name					
PNU	PNU: 120	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	CPX-CMAX-C1-1			
	Impermissible characters:	-			
CMAX designation (type). Unused characters are filled with zero (=00h='0').					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

User device name					
PNU	PNU: 121	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	CMAX0001			
	Impermissible characters:	? @ . , ! : " § | $ % & / # ' ' + ~ * ' ; ° ^ ‹ ›			
CMAX designation defined by the user. The name serves the identification by FCT and is checked by the FCT when the connection to the device is established. Example: "CMAX1_Slot3". Unused characters are filled with zero (=00h='0'). The CMAX also contains an axis name (PNU 180 ff) along with the device name.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Drive manufacturer					
PNU	PNU: 122	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	Festo AG & Co. KG			
	Impermissible characters:	-			
Controller manufacturer's name Unused characters are filled with zero (=00h='0').					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

HTTP drive catalog address

PNU	PNU: 123	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	www.festo.com			
	Impermissible characters:	-			
Internet address of the manufacturer. Unused characters are filled with zero (=00h='0').					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Festo order number

PNU	PNU: 124	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	"548932"			
	Impermissible characters:	-			
Festo order number. This number can be used to order an identical device. Unused characters are filled with zero (=00h='0').					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Password

PNU	PNU: 130	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	"" (Blank character string)			
	Impermissible characters:	? @ . , ! : " § | $ % & / # ' ' + ~ * ' ; ° ^ ‹ ›			
Password for operating the CMAX via the PC interface. On delivery the device does not have a password created. See section 5.2.1.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

System password					
PNU	PNU: 133	Index: 1 ... 2	Max index: 2	Class: Array	Data type: int32
Internal password for the FCT.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

System time: count operating days .					
PNU	PNU: 140	Index: 1	Max index: 2	Class: Struct	Data type: int32
Values	Days				
	Default: -		Minimum: -		Maximum: -
Number of operating days since new state, device data reset or a firmware download.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

System time: milliseconds of the day .					
PNU	PNU: 140	Index: 2	Max index: 2	Class: Struct	Data type: int32
Values	ms				
	Default: -		Minimum: -		Maximum: -
Number of milliseconds of the current operating day (PNU 140:01). When switching on, the last value before switching off is loaded.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

The PNU 140 does not contain data of a real-time clock. The number of operating days is counted by the CMAX, saved when switching off and re-loaded when switching on. 1 operating day consists of:
24 * 60 * 60 * 1000 ms = 86.400.000 ms

Name of axis X

PNU	PNU: 180	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	Axis X			
	Impermissible characters:	? @ . , ! : ” § | $ % & / # ‘ ’ + ~ * ’ ; ° ^ ‹ ›			
Name of the axis / the drive on the axis interface X.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Name of axis Y

PNU	PNU: 181	Index: 1 ... 30	Max index: 30	Class: Array	Data type: char
Values	Default:	Axis Y			
	Impermissible characters:	? @ . , ! : ” § | $ % & / # ‘ ’ + ~ * ’ ; ° ^ ‹ ›			
Reserved for future extensions.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

5.4.3 Diagnostic memory

The diagnostic memory and the diagnostic parameters are described in detail in the sections 4.3 and 4.4.

Diagnostic event

PNU	PNU: 200	Index: 1 ... 100	Max index: 100	Class: Array	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	

Type of diagnostic message, see section 4.3.2.
Not only fault messages are entered into the diagnostic memory of the CMAX, but also switch-on operations, resets or configuration events. The interpretation of the diagnostic code and the additional information depends on the type of these events.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Diagnostic number

PNU	PNU: 201	Index: 1 ... 100	Max index: 100	Class: Array	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	

The diagnostic number contains a detail on the diagnostic event. In the event of faults and warnings this is the exact fault number, in the event of configuration event it is the function performed etc.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Time stamp: time of the day

PNU	PNU: 202	Index: 1 ... 100	Max index: 100	Class: Array	Data type: int32
Values	ms				
	Default: 0	Minimum: -		Maximum: -	

Time of the current operating day in milliseconds at the time when the fault occurs.
This time stamp is not a real-time clock. The time is read from the device data PNU 140 when the fault occurs.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Additional information

PNU	PNU: 203	Index: 1 ... 100	Max index: 100	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

The parameter contains detailed information about the fault. This information mainly serves convenient diagnostics using the FCT. The evaluation is complex and therefore not suitable for a PLC program. For description see section 4.3.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Reserved

PNU	PNU: 204	Index: 1	Max index: 5	Class: Struct	Data type: int32
Values	Without unit				
	Default: 1	Minimum: -		Maximum: -	

Reserved. Is not used by the CMAX.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Reserved					
PNU	PNU: 204	Index: 2	Max index: 5	Class: Struct	Data type: int32
Values	Without unit				
	Default: 2	Minimum: -	Maximum: -		
Reserved. Is not used by the CMAX.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Clear memory					
PNU	PNU: 204	Index: 3	Max index: 5	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0	Maximum: 1		
Write 1: The entire diagnostic memory is deleted. Reading always delivers the value 0. Deleting is usually not required, since the memory is organised as a ring buffer. If the memory is full, the new entry overwrites the oldest.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Number of entries					
PNU	PNU: 204	Index: 4	Max index: 5	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -	Maximum: -		
Number of assigned entries in the diagnostic memory.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Number of unread entries					
PNU	PNU: 204	Index: 5	Max index: 5	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	
Number of new entries since switching on. FCT deletes the value after reading the diagnostic messages. Every new entry increments the value.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Current faults					
PNU	PNU: 220	Index: 1 ... 3	Max index: 3	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			
Current faults Each parameter is a bitfield consisting of three uint32 values and thus contains 3x 32 bits = 96 bit memory capacity. Each bit in this array represents a fault number. If it is set, the corresponding fault message is active. Example: PNU 220:01 = 0x00000001 Bit 0 set E01 active PNU 220:02 = 0x00000040 Bit 38 (32 + 6) set E39 active PNU 220:03 = 0x00030000 Bit 80 (32 + 32 + 16) set E81 active Bit 81 (32 + 32 + 17) set E82 active This representation is designed for evaluation by a PLC. Bit coding can be used directly to approach an MMI. Fault texts, see section 4.2.5.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Current warnings					
PNU	PNU: 221	Index: 1 ... 3	Max index: 3	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			
Current warnings, refer to current fault messages (PNU 220). The distinction allows the PLC to respond to faults and warnings specifically.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Time stamp: day of operation .					
PNU	PNU: 222	Index: 1 ... 100	Max index: 100	Class: Array	Data type: int32
Values	Days				
	Default: 0		Minimum: -		Maximum: -
Time of the current operating day in milliseconds at the time when the fault occurs. This time stamp is not a real-time clock. The time is read from the device data PNU 140 when the fault occurs.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Current error code on display					
PNU	PNU: 224	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0		Minimum: -		Maximum: -
Fault number currently shown on the display. This makes synchronisation between the display in the FCT and the CMAX possible. It is always the fault that occurred first that is displayed.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Current fault level					
PNU	PNU: 225	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0		Minimum: -		Maximum: -
In this way the FCT can display the current status of the CMAX in accordance with section 4.2.3. The most serious current fault is always responsible for the current fault level.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Current warning to be displayed in FCT

PNU	PNU: 226	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	

The PNU 226 contains the warning number the FCT is supposed to display. Warnings are not displayed on the CMAX display.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Fault status for FCT

PNU	PNU: 227	Index: 1 ... 89	Max index: 89	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

The bit-encoded error status allows to indicate the exact status of a fault message. The coding is identical to the coding of the additional information in PNU 203. For the description, see section 4.3.3.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Filter diagnostic events

PNU	PNU: 228	Index: 1	Max index: 3	Class: Struct	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 0000 0000 xxxx			

This setting can be used to define the scope of the records. By default the CMAX records very large quantities of information. Not all are equally important. Certain information can selectively be excluded from the records, see section 4.4. In this way only the most important events are included in the diagnostic memory. For allocation, see 4.4.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Filter diagnostic message

PNU	PNU: 228	Index: 2	Max index: 3	Class: Struct	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 0000 00xx xxxx			

This filter allows you to exclude certain faults and warnings from the diagnostic memory records. This makes sense for faults that are part of the normal operating cycle because they are inherent to the process (load voltage errors) or because they occur frequently for other reasons. For allocation, see 4.4.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Fault behaviour configuration

PNU	PNU: 228	Index: 3	Max index: 3	Class: Struct	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 000x xxxx xxxx			

Some of the faults can also be reported as warnings. This concerns in particular function monitoring, such as maintaining the software end position. Often the right correct reaction depends on the application in these cases. For allocation, see 4.4.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

5.4.4 Process data

Position values

PNU	PNU: 300	Index: 1 ... 3	Max index: 3	Class: Array	Data type: int32		
Values	Unit: Position (index = 1)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	-	-1.000.000	1.000.000	0,1 °	-	-100.000	100.000
Imperial	0.001 in	-	-393.701	393.701	0,1 °	-	-100.000	100.000

Index	Value
1	Current actual position of the controller
2	Current setpoint position of the controller
3	Current controller deviation

When force control is active, the current setpoint position is tracked to the actual position.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Force values

PNU	PNU: 301	Index: 1 ... 3	Max index: 3	Class: Array	Data type: int32			
Values	Unit: Force (index = 3)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimen-sion	Default	Minimum	Maximum
SI	1 N	-	-1.000.000	1.000.000	1 Nm	-	-1.000.000	1.000.000
Imperial	1 lbf	-	-224.809	224.809	1 lbf ft	-	-737.561	737.561

Index	Value
1	Current actual force of the controller
2	Current setpoint force of the controller
3	Current controller deviation

When position control is active, the current setpoint force = 0.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Pressure values

PNU	PNU: 302		Index: 1 ... 3		Max index: 3	Class: Array		Data type: int32
Values	Unit: Pressure (index = 4)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,1 bar	-	-120	120	0,1 bar	-	-120	120
Imperial	1 psi	-	-174	174	1 psi	-	-174	174

Index	Value
1	Pressure valve chamber 1
2	Pressure valve chamber 2
3	Calculated supply pressure

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Count of positioning commands

PNU	PNU: 305	Index: 1	Max index: 4	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 2.147.483.647	

Total of start commands of the position controller that were executed.
Jogging, homing or identifications are not counted.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Count of force commands

PNU	PNU: 305	Index: 2	Max index: 4	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 2.147.483.647	

Total of start commands of the force control that were executed.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Cumulated stroke length

PNU	PNU: 305	Index: 3	Max index: 4	Class: Struct	Data type: int32
Values	Unit: Always in metres, irrespective of the system of measurement				
	Default: 0	Minimum: 0	Maximum: 2.147.483.647		

Total of movement changes of the drive since new state, the last data reset or a firmware download.
Records all the movements performed by the drive, irrespective of control mode or enable.
Warning: Specified in metres, not in the user system of measurement.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Cumulated stroke length fraction

PNU	PNU: 305	Index: 4	Max index: 4	Class: Struct	Data type: int32
Values	Unit: Always in micrometres, irrespective of the system of measurement				
	Default: 0	Minimum: 0	Maximum: 1.000.000		

Total of movement changes of the drive since the last full meter was reached (PNU 305:3).
Records all the movements performed by the drive, irrespective of control mode or enable.
Warning: Specified in micrometres, not in the user system of measurement.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Current speed

PNU	PNU: 307	Index: 1	Max index: 1	Class: Var	Data type: int32			
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	-	-10.000.000	10.000.000	1 °/s	-	-10.000.000	10.000.000
Imperial	0.01 ft/s	-	-3.280.840	3.280.840	1 °/s	-	-10.000.000	10.000.000

Calculated actual speed.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Additional axis status

PNU	PNU: 308	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	-			
	Write:	-			

Additional status information of the controller.
These are also valid in parametrising mode if SPOS is not available.

Bit 0	Referenced	SPOS.REF
Bit 1	Motion Complete	SPOS.MC
Bit 2	Drive in motion	SPOS.MOV
Bit 3	Contouring error/tolerance error	SPOS.DEV
Bit 4	In tolerance	-
Bit 5	Standstill warning	SPOS.STILL
Bit 6	Supply pressure in tolerance	-
Bit 12	Position control is active	-
Bit 13	Standstill control is active	-
Bit 14	Force control is active	-

All bits not mentioned are reserved.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Valve output value

PNU	PNU: 309	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 2047	Minimum: 0	Maximum: 4095		

Internal setpoint specifcation for the valve.

Value	Standardised setpoint value	Ventilation	Venting	Drive moving
4095	-100 %	1 --> 4	2 --> 3	... towards smaller actual values
2047	0 %	closed	closed	... not
0	+100 %	1 --> 2	4 --> 5	... towards larger actual values

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

5.4.5 Record list

Requested record number					
PNU	PNU: 400	Index: 1	Max index: 3	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 64
The record number that was accepted with the last starting edge. If no record was started yet, the value will be 0 (no permissible record number).					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Actual record number					
PNU	PNU: 400	Index: 2	Max index: 3	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 64
The number of the record executed last. If no record was executed yet, the value will be 0. This is no permissible record number.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Record status byte					
PNU	PNU: 400	Index: 3	Max index: 3	Class: Struct	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			
Record status byte (RSB): contains a feedback code that is transferred to the input data. In accordance with FHPP, only bits 0 ... 7 are defined. Bits 8 ... 31 are always 0. For a description of the bits, see section 2.2.3.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Record control byte 1

PNU	PNU: 401	Index: 1 ... 64	Max index: 64	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 0000 0xxx 0xxx			

The record control byte 1 (RCB1) controls the most important settings for the positioning task. It corresponds to the CDIR in direct mode, see section 2.2.4).

Bit	Name	Description
0 (ABS)	Absolute/Relative	= 0: Setpoint value is absolute = 1: Setpoint value is relative [1)]
1 (COM1)	Control mode 1	= 0: Position control = 1: Pressure/Force control
2 (COM2)	Control mode 2	Only with position control (COM1=0): = 0: Unassigned profile = 1: Auto-profile
3	–	Reserved, must be 0
4 (VLIM)	Velocity limit value deactivated	For force control: = 0: Velocity limit value active = 1: Velocity limit value deactivated
5 (XLIM)	Stroke limit value deactivated	With force control: = 0: Stroke monitoring active = 1: Stroke monitoring deactivated
6 (FAST)	Fast stop	= 0: Exact stop = 1: Fast stop
7...32	–	Reserved, must be = 0.

[1)] The setpoint value is relative to the last setpoint value (with MC and record sequencing with condition “MC”) or to the actual value (if MC is not present). Force tasks following position tasks refer to force 0.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
- ☐ This parameter can be written by FCT without higher-order controller.
- ☐ After writing, controller recalculation is carried out.

Record control byte 2

PNU	PNU: 402	Index: 1 ... 64	Max index: 64	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 0000 xxxx xxxx			

Record control byte 2 (RCB2) controls conditional record sequencing.
Bits 0 ... Bit 6: = Sequencing condition for automatic record chaining (decimal value)
0: no sequencing; 2: Position; 3: Force; 4: Standstill; 5: Time; 11: Stroke;
12: MC; 13: Stroke after force; 14; position at force
Bit 7: = 1: Disable record sequencing, in case a condition was defined.
(only for debugging purposes, not for normal control purposes).
Values not stated are impermissible (-› fault). For description see section 3.3.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record parameter control

PNU	PNU: 403	Index: 1 ... 64	Max index: 64	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	xx00 0000 0000 0000 000x xxxx xxxx xxxx			

The parameter RPC controls the disabling of the record and adoption of the default values.
Bits 0 ... 12 = 0: used value in the record parameter PNU 406 ff
= 1: Used default values acc. to PNU 600 ... 612
For information on the default values, see section 5.3.
Bits 30 = 0: Record is not initialised or deleted
= 1: Record initialised by user
Not initialised records can contain data, but are not executed.
FCT indicates these records as blank records (no upload/download or deviation during synchronisation)
Bits 31 = 0: Record disabled (inactive)
= 1: Record enabled (active)
Disabled or inactive records are not executed.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record setpoint value

PNU	PNU: 404	Index: 1 ... 64	Max index: 64	Class: Array	Data type: int32
Values	Unit depends on control mode: Position (index = 1) or force (index = 3)				
	Default: 0	Minimum: -1.000.000	Maximum: 1.000.000		

Control mode position (RCB1.COM1 = 0): Position setpoint value in unit position (index 1)
Control mode force (RCB1.COM1 = 1): Force setpoint value in unit force (index 3)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record preselection value

PNU	PNU: 405	Index: 1 ... 64	Max index: 64	Class: Array	Data type: int32
Values	Unit depends on sequencing condition: Position, force, time (index = 1, 3, 9)				
	Default: 0	Minimum: -1.000.000	Maximum: 1.000.000		

Contains the value at which sequencing occurs.
The meaning depends on the condition in RCB2 (PNU 402):

Switch. condition		Phys. unit	Index of the unit
2	Position	Position value	Index = 1
3	Force	Force value	Index = 3
4	Standstill	Time	Index = 9
5	Time	Time	Index = 9
11	Stroke	Position	Index = 1
12	MC	Time	Index = 9
13	Stroke after force	Position	Index = 1
14	Position at force	Position	Index = 1

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record velocity								
PNU	PNU: 406	Index: 1 ... 64	Max index: 64		Class: Array		Data type: int32	
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	0	0	10.000	1 °/s	0	0	10.000
Imperial	0.01 ft/s	0	0	3.281	1 °/s	0	0	10.000

Velocity setpoint value, depends on the control mode and travel profile (PNU 401):
Control mode position, unassigned profile:
Maximum speed at which the drive is to be moved. Depending on the setpoint stroke and the parametrised accelerations, this speed may not be reached.
Control mode position, auto-profile:
Parameter is ignored. The maximum speed is derived from the movement profile determined during identification.
Control mode force:
Maximum speed at which the drive travels. If the actual speed reaches this value, the force control switches to positioning and continues at this speed until it arrives at the workpiece and the speed reduces or the setpoint force is reached. The default value of 0 deactivates switching to position control, see section B.8.6.

Default values:	For position control:	RPC bit 0	Default value from parameter PNU 600
	For force control:	RPC bit 1	Default value from parameter PNU 601

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record acceleration

PNU	PNU: 407		Index: 1 ... 64	Max index: 64		Class: Array	Data type: int32
Values	Unit: Acceleration (index = 7)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	0	0	100.000	1 $°/s^2$	0	0	100.000
Imperial	0.01 ft/s^2	0	0	32.808	1 $°/s^2$	0	0	100.000

Velocity setpoint value for starting up, depending on the control mode and travel profile (PNU 401):
Control mode position, unassigned profile:
Setpoint acceleration of the controller. If dynamic identification was performed, this value is reduced to a value that can be reached by the drive.
Control mode position, auto-profile:
This parameter is ignored. The acceleration is derived from the movement profile determined during identification.
Control mode force:
This parameter is ignored.

Default values:	For position control:	RPC bit 2	Default value from parameter PNU 602
	For force control:	–	

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record deceleration

PNU	PNU: 408	Index: 1 ... 64	Max index: 64	Class: Array	Data type: int32		
Values	Unit: Acceleration (index = 7)						
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.001 m/s^2	0	0	100.000	1 $°/s^2$	0	0	100.000
Imperial	0.01 ft/s^2	0	0	32.808	1 $°/s^2$	0	0	100.000

Velocity setpoint value for braking, depending on the control mode and travel profile (PNU 401):
Control mode position, unassigned profile:
Setpoint deceleration of the controller for axis braking. If dynamic identification was performed, this value is reduced to a value that can be reached by the drive.
Control mode position, auto-profile:
This parameter is ignored. The deceleration is derived from the movement profile determined during identification.
Control mode force:
This parameter is ignored.

Default values:	For position control:	RPC bit 3	Default value from parameter PNU 603
	For force control:	–	

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record workpiece mass

PNU	PNU: 410		Index: 1 ... 64		Max index: 64		Class: Array		Data type: int32
Values	Unit: Mass (index = 5)								
	Linear drive				Semi-rotary drive				
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum	
SI	0.1 kg	0	0	20.000	1 kg cm^2	0	0	2.000	
Imperial	1 lb	0	0	4.409	0.1 lb in^2	0	0	6.834	

Current workpiece mass.
Deviations from the actual mass load worsen the positioning behaviour. From mass changes of approx. 30%, the current mass should be specified. The total moving mass is the sum of workpiece load without workpiece (PNU 1142) and workpiece mass.
For vertical installation, the correct workpiece mass is absolutely essential in order to calculate the zero force of the force control. An error in the data can lead to a movement of the axis if the default is 0 N.

Default values:	For position control:	RPC bit 5	Default value from parameter PNU 605
	For force control:	RPC bit 5	Default value from parameter PNU 605

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record tolerance

PNU	PNU: 411	Index: 1 ... 64	Max index: 64	Class: Array	Data type: int32
Values	Unit depends on control mode: Position, force (index = 1or 3)				
	Default: 0	Minimum: 1	Maximum: 1.000		

Specification of the tolerance to be used with this record.
Control mode position (RCB1.COM1 = 0): Position tolerance in unit position (index 1)
Control mode position (RCB1.COM1 = 1): Force tolerance in unit force (index 3)

Default values:	For position control:	RPC bit 6	Default value from parameter PNU 606
	For force control:	RPC bit 7	Default value from parameter PNU 607

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Record force ramp					
PNU	PNU: 412	Index: 1	Max index: 64	Class: Array	Data type: int32
Values	Unit: Force ramp (index = 8)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N/s	0	10	100.000	
Imperial	1 lbf/s	0	2	22.481	
The force ramp permits setting the increasing speed of the force. The controller generates a $\sin^2$-shaped increase of the setpoint force for optimization of the controller behaviour, see section B.8.7. Default values: For position control: – For force control: RPC bit 8 Default value from parameter PNU 608					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

5.4.6 Project data

General description of the dimensional reference system, see section B.2.

Project zero point								
PNU	PNU: 500		Index: 1	Max index: 1	Class: Var		Data type: int32	
Values	Unit: Position (index = 1)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	-1.000.000	1.000.000	0,1 °	0	-100.000	100.000
Imperial	0.001 in	0	-393.701	393.701	0,1 °	0	-100.000	100.000
Reference point for position values in the application. See section B.2.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.								

Software end position								
PNU	PNU: 501	Index: 1 ... 2		Max index: 2	Class: Var		Data type: int32	
Values	Unit: Position (index = 1)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	0	1.000.000	0,1 °	0	0	100.000
Imperial	0.001 in	0	0	393.701	0,1 °	0	0	100.000

Permissible range for position setpoint values. Starting with a target position outside of the limit setpoint values is not permissible and will lead to a fault or warning. If the software end positions are passed in the running process, the system will issue a warning. The offset to the axis zero point (not to the project zero point!) is specified. Specifying 0 for both software end positions deactivates the software end positions.
Index 1: Lower software end position
Index 2: Upper software end position
The controller checks the software end positions for plausibility and generates a fault, if necessary. Notes on calculating the software end positions and a sample calculation of the maximum values can be found in section B.2.4.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Stop deceleration								
PNU	PNU: 507	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Acceleration (index = 7)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	10.000	10	100.000	1 $°/s^2$	10.000	10	100.000
Imperial	0.01 ft/s^2	3.000	3	32.808	1 $°/s^2$	10.000	10	100.000

Deceleration in the event of stop or fault. The stop ramp is only applied if it is larger than the deceleration of the current task.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Permitted stroke during force control

PNU	PNU: 510	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Position (index = 1)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	5.000	100	1.000.000	0,1 °	100	10	100.000
Imperial	0.001 in	2.000	39	393.701	0,1 °	100	10	100.000

Maximum permitted stroke with active force control.
With active force control, the actual position relative to the start position must not change by more than the amount specified in this parameter. In this way you can ensure that, if force control is activated by mistake (“Workpiece missing” for example), the axis will not perform an uncontrolled movement.
This parameter is only taken into account during force control, if the CMAX has “Operation enabled.” status.
Monitoring can be deactivated by setting the bits RCB1.XLIM or CDIR.XLIM.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Lower limit setpoint force)

PNU	PNU: 511	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Force (index = 3)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N	0	-100.000	0	
Imperial	1 lbf	0	-22.481	0	

Smallest permitted setpoint value for a force control. A smaller setpoint value leads to a fault or warning.
If both the smallest and the largest (PNU 512) permissible force setpoint value are set to zero, the setpoint limits are ignored when executing a force task.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Upper limit setpoint force

PNU	PNU: 512	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Force (index = 3)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N	0	0	100.000	
Imperial	1 lbf	0	0	22.481	

Largest permitted setpoint value for a force control. A larger setpoint value leads to a fault or warning.
If both the smallest (PNU 511) and the largest (PNU 512) permissible force setpoint value are set to zero, the setpoint limits are ignored when executing a force task.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Permitted speed during force control

PNU	PNU: 514	Index: 1	Max index: 1	Class: Var	Data type: int32		
Values	Unit: Speed (index = 6)						
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	200	10	500	1 °/s	200	10	500
Imperial	0.01 ft/s	65	3	164	1 °/s	200	10	500

Max. permitted speed after start of a force command. This parameter is used for monitoring, not to limit the speed. If the actual speed exceeds the set value, a fault is indicated, the axis stops and the force command is cancelled.
The speed limit value must be significantly larger than the speed limit of parameters 406 / 554, otherwise monitoring will lead to an error when reaching the speed limit. The speed limit value should preferably be used as a security when the speed limiting (406/554) was deactivated.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Jog mode parameter control

PNU	PNU: 521	Index: 1	Max index: 3	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 1101			
	Write:	0000 0000 0000 0000 0000 000x xxxx xxxx			

This parameter determines the use of the default values for jogging.
A set bit means that the jog parameters (PNU 53x) are used instead of the default values (PNU 6xx), see section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode position parameter control

PNU	PNU: 521	Index: 2	Max index: 3	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 000x xxxx xxxx			

This parameter determines the use of the default values for a positioning task in direct operating mode.
A set bit means that the parameters for direct mode position (PNU 54x) are used instead of the default values (PNU 6xx), see section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode force parameter control

PNU	PNU: 521	Index: 3	Max index: 3	Class: Array	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	0000 0000 0000 0000 0000 000x xxxx xxxx			

This parameter determines the use of the default values for a positioning task in direct operating mode.
A set bit means that the parameters for direct mode force (PNU 55x) are used instead of the default values (PNU 6xx), see section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

FHPP: Control/Status bits: CPOS.HALT support
(FHPP: Control/Status bits: CPOS.HALT support)

PNU	PNU: 522	Index: 1	Max index: 2	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 1

Configuration of the intermediate stop (CPOS.HALT, reserved for future extensions).

Value	Function
0	Intermediate stop status is not supported.
1	Reserved

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

FHPP: Control/Status bits: CCON.BRAKE level
(FHPP: Control/Status bits: CCON.BRAKE level)

PNU	PNU: 522	Index: 2	Max index: 2	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 1

Effect of clamping unit/brake.

Value	Function
0	Brake opens (switching output on valve at 24V) with CCON.BRAKE = 1
1	Brake opens (switching output on valve at 24V) with CCON.BRAKE = 0

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

FHPP: Setpoint and actual values .

PNU	PNU: 523	Index: 1	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0	Maximum: 1	

The setpoint and actual values in the cyclical I/O data can be defined for the various controller modes. See also section 2.2.

Controller mode	Index	Setpoint/Actual value	Value	Transmitted is
Position	1	Secondary setpoint	= 0:	Speed in percent of PNU 540
			= 1:	Workpiece mass in percent of PNU 544
	2	Primary setpoint	= 0:	Setpoint position in user units
			= 1:	reserved
	3	Secondary actual value	= 0:	Display of the actual speed in percent
			= 1:	reserved
	4	Primary actual value[1)]	= 0:	Display of the actual position in user units
			= 1:	Display of the actual force in the user units
Force	5	Secondary setpoint	= 0:	Force ramp in percent of PNU 550
			= 1:	Workpiece mass in percent of PNU 551
	6	Primary setpoint	= 0:	Setpoint force in user units
			= 1:	reserved
	7	Secondary actual value	= 0:	Display of the actual speed in percent
			= 1:	reserved
	8	Primary actual value[1)]	= 0:	Display of the actual position in user units
			= 1:	Display of the actual force in the user units

Default value for each index is the value 0.

[1)] The setting for the primary actual value is valid in the record select operating mode, direct operating mode and commissioning mode. All the other setpoint and actual values are only applicable in direct mode.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
- ☐ This parameter can be written by FCT without higher-order controller.
- ☐ After writing, controller recalculation is carried out.

5.4.7 Setpoint values for jog mode

Jog mode slow speed

PNU	PNU: 530	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	50	10	500	1 °/s	50	10	500
Imperial	0.01 ft/s	15	3	164	1 °/s	50	10	500
Slow speed for jogging.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Jog mode fast speed

PNU	PNU: 531	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	200	10	10.000	1 °/s	200	10	10.000
Imperial	0.01 ft/s	65	3	3.281	1 °/s	200	10	10.000
Maximum speed after expiration of the jogging slow speed period. Depending on PNU 521:01, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Jog mode acceleration								
PNU	PNU: 532	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Acceleration (index = 7)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	100	10	100.000	1 $°/s^2$	100	10	100.000
Imperial	0.01 ft/s^2	30	3	32.808	1 $°/s^2$	100	10	100.000
Jogging acceleration. Depending on PNU 521:01, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Jog mode deceleration								
PNU	PNU: 533	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Acceleration (index = 7)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	500	10	100.000	1 $°/s^2$	500	10	100.000
Imperial	0.01 ft/s^2	150	3	32.808	1 $°/s^2$	500	10	100.000
Jogging deceleration. Depending on PNU 521:01, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Jog mode time slow speed

PNU	PNU: 534	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Time (index = 9)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	1 ms	3.000	0	1.000.000	1 ms	3.000	0	1.000.000
Imperial	1 ms	3.000	0	1.000.000	1 ms	3.000	0	1.000.000

Duration of the slow speed phase.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Jog mode workpiece mass

PNU	PNU: 536	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Mass (index = 5)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.1 kg	0	0	20.000	1 kg cm^2	0	0	2.000
Imperial	1 lb	0	0	4.409	0.1 lb in^2	0	0	6.834

Workpiece mass during jogging.
Depending on PNU 521:01, the corresponding default value is used instead, if necessary.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

5.4.8 Direct operating mode: Positioning

Direct mode position base velocity

PNU	PNU: 540		Index: 1		Max index: 1		Class: Var		Data type: int32
Values	Unit: Speed (index = 6)								
	Linear drive				Semi-rotary drive				
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum	
SI	0,001 m/s	2.000	10	10.000	1 °/s	1.000	10	10.000	
Imperial	0.01 ft/s	650	3	3.281	1 °/s	1.000	10	10.000	

Base velocity in position control direct mode.
The master transmits a percent value in the output data which is multiplied by the base value to reach to the final setpoint speed.
Depending on PNU 521:02, the corresponding default value is used instead, if necessary.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode position acceleration

PNU	PNU: 541		Index: 1		Max index: 1		Class: Var		Data type: int32
Values	Unit: Acceleration (index = 7)								
	Linear drive				Semi-rotary drive				
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum	
SI	0,001 m/s^2	2.000	10	100.000	1 $°/s^2$	1.000	10	100.000	
Imperial	0.01 ft/s^2	650	3	32.808	1 $°/s^2$	1.000	10	100.000	

Acceleration in position control direct mode.
Depending on PNU 521:02, the corresponding default value is used instead, if necessary.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode position deceleration								
PNU	PNU: 542	Index: 1	Max index: 1	Class: Var	Data type: int32			
Values	Unit: Acceleration (index = 7)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	2.000	10	100.000	1 $°/s^2$	1.000	10	100.000
Imperial	0.01 ft/s^2	650	3	32.808	1 $°/s^2$	1.000	10	100.000
Deceleration in position control direct mode. Depending on PNU 521:02, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Direct mode position workpiece mass								
PNU	PNU: 544	Index: 1	Max index: 1	Class: Var	Data type: int32			
Values	Unit: Mass (index = 5)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.1 kg	0	0	20.000	1 kg cm^2	0	0	2.000
Imperial	1 lb	0	0	4.409	0.1 lb in^2	0	0	6.834
Workpiece mass in position control direct mode. Depending on PNU 521:02, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Direct mode position tolerance								
PNU	PNU: 545		Index: 1	Max index: 1		Class: Var	Data type: int32	
Values	Unit: Position (index = 1)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	100	10	1.000	0,1 °	10	1	100
Imperial	0.001 in	40	4	394	0,1 °	10	1	100
Tolerance in position control direct mode. Depending on PNU 521:02, the corresponding default value is used instead, if necessary.								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

5.4.9 Direct operating mode: Force control

Direct mode force base value force ramp

PNU	PNU: 550	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Force ramp (index = 8)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N/s	1.000	10	100.000	
Imperial	1 lbf/s	200	2	22.481	

Base value for the force ramp in direct mode. The master transmits a percent value, which is multiplied by the base value to reach the final setpoint speed.
Depending on PNU 521:03, the corresponding default value is used instead, if necessary.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode force workpiece mass

PNU	PNU: 551	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Mass (index = 5)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	0.1 kg	0	0	20.000	
Imperial	1 lb	0	0	4.409	

Workpiece mass in force control direct mode.
Depending on PNU 521:03, the corresponding default value is used instead, if necessary.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Direct mode force tolerance force						
PNU	PNU: 552	Index: 1		Max index: 1	Class: Var	Data type: int32
Values	Unit: Force (index = 3)					
	Linear drive				Semi-rotary drive	
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
SI	1 N	10	1	1.000		
Imperial	1 lbf	3	0	225		
Tolerance window in force control direct mode. Depending on PNU 521:03, the corresponding default value is used instead, if necessary.						
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.						

Direct mode force velocity limit						
PNU	PNU: 554	Index: 1		Max index: 1	Class: Var	Data type: int32
Values	Unit: Speed (index = 6)					
	Linear drive				Semi-rotary drive	
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
SI	0,001 m/s	100	0	500		
Imperial	0.01 ft/s	30	0	164		
Maximum speed at which the drive travels. If the actual speed reaches this value, the force control switches to positioning and continues at this speed until it arrives at the workpiece and the speed reduces or the setpoint force is reached. The default value of 0 deactivates switching to position control, see section B.8.6. Depending on PNU 521:03, the corresponding default value is used instead, if necessary.						
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.						

5.4.10 Parameters of the default values

Default value speed position mode								
PNU	PNU: 600	Index: 1	Max index: 1	Class: Var	Data type: int32			
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	2.000	10	10.000	1 °/s	1.000	10	10.000
Imperial	0.01 ft/s	650	3	3.281	1 °/s	1.000	10	10.000
This value contains the speed preset by the user. It is used in all records with position control where no individual speeds are specified. RPC-Bit = Bit 0 (= 00000001h)								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Default value speed force mode					
PNU	PNU: 601	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Speed (index = 6)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	0,001 m/s	50	0	500	
Imperial	0.01 ft/s	15	0	164	
This value contains the speed preset by the user. It is used in all records with force control where no individual speeds are specified. RPC-Bit = Bit 1 (= 0000.0002h)					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Default value acceleration

PNU	PNU: 602	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Acceleration (index = 7)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.001 m/s^2	2.000	10	100.000	1 °/s^2	1.000	10	100.000
Imperial	0.01 ft/s^2	650	3	32.808	1 °/s^2	1.000	10	100.000

This value contains the acceleration preset by the user. It is used in all records with position control where no individual acceleration is specified.
RPC-Bit = Bit 2 (=0000.0004h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Default value deceleration)

PNU	PNU: 603	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Acceleration (index = 7)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s^2	2.000	10	100.000	1 °/s^2	1000	10	100.000
Imperial	0.01 ft/s^2	650	3	32.808	1 °/s^2	1000	10	100.000

This value contains the deceleration preset by the user. It is used in all records with position control where no individual deceleration is specified.
RPC-Bit = Bit 3 (= 0000.0008h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Default value workpiece mass

PNU	PNU: 605	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Mass (index = 5)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.1 kg	0	0	20.000	1 kg cm^2	0	0	2.000
Imperial	1 lb	0	0	4.409	0.1 lb in^2	0	0	6.834

This value contains the workpiece mass preset by the user.
RPC-Bit = Bit 5 (= 0000.0020h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Default value tolerance position mode

PNU	PNU: 606	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Position (index = 1)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	100	10	1.000	0,1 °	10	1	100
Imperial	0.001 in	40	4	394	0,1 °	10	1	100

This value contains the tolerance for position control preset by the user. It is used in all records with position control where no individual tolerance is specified.
RPC-Bit = Bit 6 (=0000.0040h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Default value tolerance force mode

PNU	PNU: 607	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Force (index = 3)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N	10	1	1.000	
Imperial	1 lbf	3	0	225	
This value contains the tolerance for force control preset by the user. It is used in all records with force control where no individual tolerance is specified. RPC-Bit = Bit 7 (=0000.0080h)					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Default value force ramp

PNU	PNU: 608	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Force ramp (index = 8)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 N/s	1.000	10	10.000	
Imperial	1 lbf/s	200	2	2.248	
This value contains the force ramp preset by the user. RPC-Bit = Bit 8 (=0000.0100h)					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

5.4.11 Drive configuration

The hardware configuration is important for calculating the controller. The data is recognized automatically as much as possible. Data not recognized must be defined by the user, e.g. based on the name plate.

If one of the following values was determined by the automatic hardware recognition, only the value that was stored in the sensor or valve can be written. Writing any other value leads to a parameter error. If no stored value was found for a parameter, parametrising in the specified area is always possible.

Further information can be found in section B.3.

Cylinder type

PNU	PNU: 1100	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 1		Maximum: 5	

The cylinder type is stored in the sensor interface. The following types are defined in the CMAX:

Value	Type
0	Unknown
1	Rodless linear drive
2	Piston-rod drive
3	DGCI
4	DNCI
5	DSMI
255	Impermissible type (poss. firmware update required)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Cylinder length

PNU	PNU: 1101		Index: 1	Max index: 1	Class: Var		Data type: int32	
Values	Unit: Length (index = 2)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	5.000	1.000.000	0,1 °	0	500	100.000
Imperial	0.01 mm	0	5.000	1.000.000	0,1 °	0	500	100.000

The cylinder length is stored in the sensor interface. Standard cylinders are not longer than 2,000 mm, the value range includes reserves for special applications.
When exchanging the drive, no projecting needs to be carried out as long as the specified cylinder length deviates from the recognized cylinder length by no more than 5.00 mm. This also allows optimization of the effective stroke.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Cylinder diameter

PNU	PNU: 1102		Index: 1	Max index: 1	Class: Var		Data type: int32	
Values	Unit: Diameter (index = 11)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	1.200	20.000	0.01 mm	0	1.200	20.000
Imperial	0.01 mm	0	1.200	20.000	0.01 mm	0	1.200	20.000

The cylinder diameter is stored in the sensor interface.
If the cylinder diameter was recognized by CMAX (e.g. during DGCI), the value cannot be overwritten.
Parallel axes can be parametrised in the FCT by specifying “double axis”, the CMAX then automatically calculates the resulting piston surface.
Other diameters can only be projected via user-specific cylinder types.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Piston rod diameter

PNU	PNU: 1103			Index: 1	Max index: 1		Class: Var	Data type: int32
Values	Unit: Diameter (index = 11)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	0	20.000	0.01 mm	0	0	20.000
Imperial	0.01 mm	0	0	20.000	0.01 mm	0	0	20.000

The piston rod diameter cannot be recognized automatically. However, the Festo standard drives have a fixed allocation of cylinder diameters to piston rod diameters. This allocation is stored in the FCT.
With other drives and special applications, the piston rod diameter can be parametrised as required by using the user-defined type.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Measuring system type (sensor type)

PNU	PNU: 1110	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 1		Maximum: 4	

The sensor type is read from the sensor interface.
If the sensor interface delivers no known type, a fault (E04) is generated. The sensor interface is not commissioned in this case.

ID	Type
0	Unknown
1	Digital position measuring system DGCI
2	Digital position measuring external
3	Potentiometer
4	Encoder
255	Impermissible type, poss. firmware update?

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Measuring system length (sensor length)

PNU	PNU: 1111		Index: 1		Max index: 1		Class: Var	Data type: int32
Values	Unit: Length (index = 2)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	5.000	1.000.000	0,1 °	0	500	100.000
Imperial	0.01 mm	0	5.000	1.000.000	0,1 °	0	500	100.000

With the DGCI and the DNCI the cylinder length and the measuring system length need to tally.
The sensor length is stored in the sensor interface with the DGCI.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Measuring system serial number (sensor serial number)

PNU	PNU: 1112	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

Each sensor interface has a unique serial number.
The serial number can be used to identify exchanged hardware, see appendix A.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Valve type

PNU	PNU: 1120	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 1		Maximum: 5	

The valve type is read from the valve. The type is always recognized. If the valve delivers no known type, a fault (E04) is generated. The valve is not commissioned in this case.

ID	Valve type
0	Not configured
1	VPWP-2
2	VPWP-4
3	VPWP-6
4	VPWP-8
5	VPWP-10

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Valve serial number

PNU	PNU: 1121	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

Each valve has a unique serial number.
The serial number is important for identifying exchanged hardware, see appendix A.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Valve 2 type					
PNU	PNU: 1125	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 1		Maximum: 5	
Reserved (see valve type 1 - parameter for second valve).					
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.					

Valve 2 serial number					
PNU	PNU: 1126	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			
Reserved (see valve serial number 1 - parameter for second valve).					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

5.4.12 Application settings

Offset axis zero point

PNU	PNU: 1130	Index: 1		Max index: 1		Class: Var	Data type: int32
Values	Unit: Position (index = 1)						
	Linear drive				Semi-rotary drive		
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.01 mm	0	-1.000.000	1.000.000	0,1 °	0	-100.000	100.000
Imperial	0.001 in	0	-393.700	393.700	0,1 °	0	-100.000	100.000

Difference between the axis zero point (AZ) and the reference position (REF) or difference between the axis zero point (AZ) and the sensor zero point (SZ).
The axis zero point (AZ) is calculated as:
AZ = REF + offset axis zero point (DNCI)
or AZ = SZ + offset axis zero point (external measuring system: potentiometer)
The axis zero point must be placed on the cylinder zero point for servo-pneumatic drives. With the DGCI the measuring system is calibrated, specification of an offset is not permitted.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Homing method

PNU	PNU: 1131	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: -17		Minimum: -128		Maximum: 127

Defines the method by which the drive performs homing, see section 3.2.2.

hex	dec	Description
23h	35	Adopt current actual position as reference position
EFh	-17	Searching for negative stop
EEh	-18	Searching for positive stop

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Homing speed								
PNU	PNU: 1132		Index: 1	Max index: 1		Class: Var	Data type: int32	
Values	Unit: Speed (index = 6)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,001 m/s	50	10	200	1 °/s	50	10	200
Imperial	0.01 ft/s	15	3	66	1 °/s	50	10	200
Speed at which the drive searches for the stop during homing.								
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.								

Mounting angle								
PNU	PNU: 1140		Index: 1	Max index: 1		Class: Var	Data type: int32	
Values	Unit: Mounting angle (index = 12)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,1 °	0	-900	900	0,1 °	0	-900	900
Imperial	0,1 °	0	-900	900	0,1 °	0	-900	900
Mounting angle for the drive A specification of -90° to -0.1° means that the sensor zero point is at the top and the drive moves downward towards larger positions. With values from 0.1 to 90° the sensor zero point is at the bottom and the drive moves to the top.								
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.								

Supply pressure

PNU	PNU: 1141	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Pressure (index = 4)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,1 bar	60	30	100	0,1 bar	60	30	100
Imperial	1 psi	85	44	145	1 psi	85	44	145

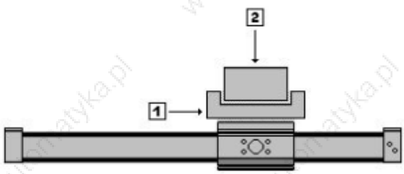
Supply pressure applied to the valve.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Basic massload without workpiece

PNU	PNU: 1142	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Mass (index = 5)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0.1 kg	50	5	20.000	1 kg cm^2	50	1	2.000
imperial	1 lb	10	1	4.409	0.1 lb in^2	200	2	6.834

Basic mass or existing mass for all positioning tasks.



Calculation of the moving mass:
1 Moving mass without workpiece (PNU 1142)
This is the mass of the loading device fixed to the slide. This mass must always be moved by the drive (minimal mass to be moved).
2 Current workpiece mass (PNU 605/410/...)
If the drive also has to move workpieces of different weights, this variable share must be defined as workpiece mass.

The CMAX calculates the sum of both mass data for every positioning process. The respective mass is determined based on the specified variable workpiece mass (PNU 605 is the global default value). However, it is also possible to specifiy the workpiece mass individually in each record (PNU 410), in jog mode (PNU 536) and in direct mode (PNU 544 or 51).

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Workpiece loaded at power-on					
PNU	PNU: 1143	Index: 1	Max index: 4	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	
If a controller is enabled, the last valid workpiece mass is always used. After the first enable after switching on, usually no workpiece is loaded, so CMAX only takes into account the basic mass without a workpiece (PNU 1142). This parameter defines whether the workpiece should also be taken into account when switching on. 0 = Workpiece not loaded when switching on. The workpiece is only loaded during operation. 1 = When switching on, the workpiece is already in the loading device. Note: With every positioning command either the default value (PNU 605) or the value from the individual parameter (PNU 410, 536, 544 or 551)in the controller is used for the workpiece mass. As soon as the first positioning process has occured after switching on, the parameter “Workpiece mass when switching on” will have no effect any more.					
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.					

Dual axis design					
PNU	PNU: 1143	Index: 2	Max index: 4	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	
Parametrising a dual axis. With a parallel axis, two parallel drives/cylinders are mechanically coupled and controlled jointly. The second axis has no measuring system, so only one axis is controlled - the other one is simply also supplied with compressed air through the valve. The double effective piston surface is automatically calculated by the CMAX and does not need to be entered. 0 = Design as single axis 1 = Design as dual axis					
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.					

Clamp unit installed

PNU	PNU: 1143	Index: 3	Max index: 4	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	

Defines whether or not a clamping unit is installed.
The behaviour of the CMAX depends on the clamping unit. Upon start the clamping units needs to be released, for example, otherwise the CMAX will indicate a fault.
0 = not available
1 = available
PNU 522 (FHPP settings) determines what effect the control bit CCON.BRAKE has.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Through piston rod

PNU	PNU: 1143	Index: 4	Max index: 4	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	

Defines whether the piston rod of a piston drive should be double-ended (through) or single-ended. A through piston rod is required for operating a clamping unit. The controller takes into account the resulting effective piston surface.
0 = Single-ended piston rod
1 = Double-ended piston rod

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

5.4.13 Controller data of position controller

Position control gain factor

PNU	PNU: 1150		Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Amplification (index = 10)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000
Position control amplification, see section B.7								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.								

Position control cushioning factor

PNU	PNU: 1151		Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Amplification (index = 10)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000
Position control cushioning, see section B.7								
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☒ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.								

Position control filter factor

PNU	PNU: 1152	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Amplification (index = 10)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000

Position control filter factor, see section B.7

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Position control timeout

PNU	PNU: 1153	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Time (index = 9)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	1 ms	2.000	0	100.000	1 ms	2.000	0	100.000
Imperial	1 ms	2.000	0	100.000	1 ms	2.000	0	100.000

Time within which the actual position must reach the tolerance window after the position setpoint has reached the target value. This means the time starts when the setpoint value generation has elapsed.
If the time is set to 0, no monitoring is carried out.
The time is additionally used for monitoring the start behaviour. If with a positioning task the drive has not moved by at least 11 mm within the parametrised time after the start signal, a fault is generated ("setoff timeout")
Note:
Deactivation of the positioning timeout parameter may cause a record not to be concluded with MC and to remain active permanently, e.g.:
- if the drive comes to a halt before its setpoint position (due to an obstacle),
- if the drive does not reach its setpoint position (depends on specified tolerance).

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Position control damping time for exact stop

PNU	PNU: 1154	Index: 1		Max index: 1	Class: Var		Data type: int32	
Values	Unit: Time (index = 9)							
	Linear drive				Semi-rotary drive			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	1 ms	30	10	1.000	1 ms	30	10	1.000
Imperial	1 ms	30	10	1.000	1 ms	30	10	1.000

This is the duration the actual value must be within the tolerance window without interruption before MC is generated.
If the time is too short, an overswing may lead to MC, but the actual position may leave the tolerance again. If the time is too long, the positioning time is unnecessarily prolonged. With larger drives, we recommend selecting a longer time.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

5.4.14 Force controller data

Force control gain factor								
PNU	PNU: 1160		Index: 1	Max index: 1	Class: Var		Data type: int32	
Values	Unit: Amplification (index = 10)							
	Linear drive				Semi-rotary drive[1]			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000

The gain factor is used to increase the control amplification. It makes the controller respond to deviations more strongly and faster. If this factor is increased too much, the valve starts to hum. This occurs especially with static force setpoints and with standstill control. This humming can be reduced by varying the filter amplification or reducing the amplification.

[1] Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
- ☒ This parameter can be written by FCT without higher-order controller.
- ☒ After writing, controller recalculation is carried out.

Force control dynamic gain								
PNU	PNU: 1161		Index: 1	Max index: 1	Class: Var		Data type: int32	
Values	Unit: Amplification (index = 10)							
	Linear drive				Semi-rotary drive[1]			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000

Dynamic amplification is only effective in the area of the force ramp, in other words when the force setpoint changes. This parameter is suitable for improving the truth to path in the area of the ramp, when amplification cannot be further optimized.

[1] Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
- ☒ This parameter can be written by FCT without higher-order controller.
- ☒ After writing, controller recalculation is carried out.

Force control filter factor

PNU	PNU: 1162	Index: 1		Max index: 1	Class: Var		Data type: int32
Values	Unit: Amplification (index = 10)						
	Linear drive			Semi-rotary drive[1]			
	Dimension	Default	Minimum	Maximum	Dimension	Default	Minimum	Maximum
SI	0,01	100	10	1.000	0,01	100	10	1.000
Imperial	0,01	100	10	1.000	0,01	100	10	1.000

The signal filter factor can be used to influence the signal noise of the pressure sensors. When increasing the factor, the filter becomes faster and consequently the noise lounder. At the same time phase shift decreases.

[1] Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control and should not be modified.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Force control timeout

PNU	PNU: 1163	Index: 1		Max index: 1	Class: Var	Data type: int32
Values	Unit: Time (index = 9)					
	Linear drive				Semi-rotary drive	
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
SI	1 ms	2.000	0	100.000		
Imperial	1 ms	2.000	0	100.000		

Time within which the actual force must reach the tolerance window after the force ramp has reached the target value. This means the time starts when setpoint value generation has elapsed.
If the time is set to 0, no monitoring is carried out.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Force control damping time for exact stop

PNU	PNU: 1164	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Unit: Time (index = 9)				
	Linear drive				Semi-rotary drive
	Dimension	Default	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
SI	1 ms	100	10	1.000	
Imperial	1 ms	100	10	1.000	

This is the duration the actual value must be within the tolerance window without interruption before MC is generated.
If the time is too short, an overswing may lead to MC, but the actual force may leave the tolerance again. If the time is too long, the positioning time is unnecessarily prolonged. With larger drives, we recommend selecting a longer time.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

5.4.15 Identification

Identification settings					
PNU	PNU: 1170	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 1

The parameter allows you to make certain settings that concern identification.
= 0: Identification permits high accelerations
= 1: Only perform the static identification (low accelerations)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Identification status					
PNU	PNU: 1171	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

Current status according to the identification carried out last.
Bit 0 = 0: Identification has not yet been carried out.
= 1: Identification has been carried out at least once.
Bit 1 = 0: Results of the static identification are not available.
= 1: Static identification carried out successfully.
Bit 2 = 0: Results of the dynamic identification are not available.
= 1: Dynamic identification carried out successfully.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Identified maximum values					
PNU	PNU: 1172	Index: 1	Max index: 6	Class: Array	Data type: int32
Values	See description of the respective index.				
	Default: 0		Minimum: -		Maximum: -

Maximum values determined during identification.

Index	Value	Direction of travel	Unit
1	Acceleration	positive	Acceleration (index 7)
2	Deceleration	positive	Deceleration (index 7)
3	Speed	positive	Speed (index 6)
4	Acceleration	nagative	Acceleration (index 7)
5	Deceleration	negative	Acceleration (index 7)
6	Speed	negative	Speed (index 6)

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Limit values

PNU	PNU: 1173	Index: 1	Max index: 14	Class: Array	Data type: int32
Values	See description of the respective index.				
	Default: 0		Minimum: -		Maximum: -

Information on the limits for the positioning stroke carried out last, see section3.1.8.

Index	Value	Unit
1	Status: see below	-
2	Start position (actual value)	Position (index 1)
3	Target position	Position (index 1)
4	Setpoint acceleration	Acceleration (index 7)
5	Maximum acceleration value	Acceleration (index 7)
6	Setpoint deceleration	Acceleration (index 7)
7	Maximum deceleration value	Acceleration (index 7)
8	Setpoint speed	Speed (index 6)
9	Maximum speed value	Speed (index 6)
10	Setpoint force	Force (index 3)
11	Maximum force value	Force (index 3)
12	Force ramp setpoint	Force ramp (index 8)
13	Maximum force ramp value	Force ramp (index 8)
14	Starting force (last setpoint)	Force (index 3)

The status word is used as a handshake between CMAX and FCT. As soon as the bit 0 is set by the controller, the data are no longer overwritten. In this way the FCT can consistently read the data. After reading, FCT writes a 0 into the status word as confirmation, and the controller updates the values. The status word (index 1) may be written by the FCT without higher-order controller. It is also not necessary to enter a password.

Bit	Status information
0	= 1: New values are now available
1	= 1: Acceleration was limited
2	= 1: Deceleration was limited
3	= 1: Speed was limited
4	= 1: Force setpoint value was limited
5	= 1: Force ramp was limited
6 ... 15	Reserved
16 ... 23	In case of Record select mode: Number of the record executed last.
24	= 0: Record select mode / = 1: Direct mode
25	= 0: Positions setpoint/ = 1: Force setpoint value
26	= 0: Unassigned profile / = 1: Auto-profile
27 ... .31	Reserved

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Status movement test					
PNU	PNU: 1174	Index: 1	Max index: 1	Class: Var	Data type: bitarray
Values	Default:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

Current status of the movement test.
Bit 0 = 0: Movement test must be carried out
= 1: Movement test does not have to be carried out
Bit 1 = 0: Movement test was not carried out
= 1: Movement test was carried out
Bit 2 = 0: Result of the movement test is not clear
= 1: Result of movement test is clear
Bit 3 = 0: Tubing error
= 1: Tubing OK
Bit 4 = 0: Movement test was not skipped
= 1: Movement test was skipped
Information about the movement test can be found in section 3.2.1.
As long as the movement test has to be carried out (bit 0 = 0), the controller is not enabled.
SCON.ENABLED = 1 only indicates that movement enable is available for the movement test, the valve is only operated if it is controlled.
With a starting edge for another task other than the movement test the fault E14 “Movement test not executed” is issued.
FCT indicates the status “Movement test” in the “Advanced data” frame. The LED turns green when the parameter value has the status (binary, byte 1) xxx0 1111.
If the hardware was exchanged, the movement test is automatically reset by the CMAX (example: exchange valve and change back again). This is not reversible.
The movement test staus can be reset or skipped with PNU 1192:07.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Disable adaptation					
PNU	PNU: 1175	Index: 1	Max index: 1	Class: Var	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	

This parameter is used to deactivate adaptation. This is practically not required in any configuration, only in extremely rare cases does adaptation worsen the positioning behaviour. In most case adaptation is useful. It improves the absolute reachable precision of the drive.
Important: Worsening of the positioning behaviour is not in all cases caused by a faulty adaptation. Wear or an invalid design can cause e. g. the positioning times to incr ease or even the number of E30 fault messages to grow. Therefore adaptation should only be deactivated in justified cases. Load changes are usually no reason to deactivate adaptation.
A faulty adaptation could be the reason for the following behaviour:
- After commissioning, the positioning behaviour deteriorates with time. Positioning times become longer, the machine cycle becomes longer. Fault E30 occurs frequently.
- After identification the behaviour is significantly better without any other changes having been made. But then is slowly starts be worsen again until you perform the next identification.

In these cases, adaptation could be the reason. If you think this is the case, you should deactivate adaptation and then re-run the identification. If the positioning behaviour does not change afterwards, adaptation was probably the reason and it should remain deactivated.
Values: 0 = Adaptation is performed
1 = Adaptation is disabled

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Static identification data					
PNU	PNU: 1176	Index: 1	Max index: 16	Class: Array	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	

Offsets and hysteresis values (internal parameter) determined during static identification.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

5.4.16 System data

Actual hardware configuration					
PNU	PNU: 1190	Index: 1	Max index: 33	Class: Struct	Data type: int32
Values	see description of the respective index.				
	Default: 0	Minimum: -		Maximum: -	

Hardware configuration found after switching on (actual configuration).
Value 0 means that the parameter could not be recognized automatically.
The actual configuration contains the same parameters as the setpoint configuration (PNU 1100 to 1129). Units and values are identical. For comparison, the PNUs are listed here as well.

Index	Value	Value of setpoint configuration	Unit
1	Cylinder type	PNU 1100	–
2	Cylinder effective length	PNU 1101	Length (index 2)
3	Cylinder diameter	PNU 1102	Diameter (index 11)
4	Piston rod diameter	PNU 1103	Diameter (index 11)
5	Cylinder nominal length	PNU 1101	Length (index 2)
10	Sensor type	PNU 1110	–
11	Sensor length	PNU 1111	Length (index 2)
12	Sensor serial number	PNU 1112	–
13	Sensor resolution	–	1 µm
14	Sampling time	–	1 µsec
15	Sensor additional information	–	–
16	Firmware version	–	–
20	Valve 1 type	PNU 1120	–
21	Valve 1 serial number	PNU 1121	–
22	Valve 1 firmware version	–	–
23	Valve 1 hardware version	–	–
30	Valve 2 type	PNU 1125	–
31	Valve 2 serial number	PNU 1126	–
32	Valve 2 firmware version	–	–
33	Valve 2 hardware version	–	–

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Notes on PNU 1190:

- **Behaviour on delivery or after resetting the axis or device data:** The recognized configuration is not automatically included in the setpoint configuration. Instead the setpoint configuration is filled with 0. The setpoint configuration must be written in a way that is compatible with the actual configuration.
- **Behaviour upon normal start:** If the recognized hardware does not correspond with the setpoint configuration, this will trigger error handling. A decision is made as to whether the change must lead to a warning or a fault. Possibly the controller will not be activated.
- If an identification is performed successfully, the serial numbers are adopted so that the warning "Exchanged hardware" is no longer issued the next time the device is switched on.
- The piston rod diameter is not provided by the sensor interface. The actual configuration always contains the value 0. However, since this is a valid value for rodless drives, the value 0 is not considered as "not recognized" in the case of the piston rod diameter. Therefore no SETPOINT-ACTUAL check is performed after switching on.

Analysis data					
PNU	PNU: 1191	Index: 1	Max index: 15	Class: Array	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	
Internal data for controller qualification.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Commissioning function block download					
PNU	PNU: 1192	Index: 1	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 1	
After writing a parameter, controller initialisation is carried out. During this tests are carried out as to whether certain parameters match, e. g. whether the lo wer software end position is smaller than the upper software end position. If an error is detected, an error message is generated and the CMAX changes to fault status. Activating block download can temporarily deactivate these tests. The controller only checks the data when the block download has finished. Write / Read = 1: Start block download / = 1: Block download active = 0: End block download / = 0: Block download not active The controller is only recalculated after writing the block download = 0 (end block download) While block download is active, start cannot be executed. Activating the block download is ended at the latest when switching off the CMAX. In this case, controller recalculation is carried next time the CMAX is switched on. The controller can be enabled when block download is activated. However, the user must disable the controller if he/she intends to write parameters that require this (2nd option set). If the controller is disabled, it must not be enabled for as long as block download is active. This would otherwise lead to E05 (in the event of enable, the project is not fully loaded or block download active). If during establishment of the connection the FCT detects that block download is active and force mode was active, it assumes that block download remained active unintentionally (as a result of communication breakdown, program crash, computer failure etc.). FCT ends block download and issues a message in the “Output” window. This automatic termination of block download can be suppressed by the PLC by setting CCON.LOCK = 1,					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☒ After writing, controller recalculation is carried out.					

Commissioning operation configuration status

PNU	PNU: 1192	Index: 2	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 4	

When commissioning a certain number of parameters must be transmitted in a certain order. This parameter provides information about the status of parametrising and about the next commissioning step to be performed.

Possible return values	Display
= 0: Waiting for system of measurement	C00
= 1: Waiting for cylinder type	C00
= 2: Waiting for axis data	C00
= 3: Waiting for movement test	C00
= 4: Axis configuration completed	depending on respective operating mode

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Commissioning function data reset					
PNU	PNU: 1192	Index: 3	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 3

This parameter serves to delete axis and identification data.
The axis data must be deleted if a new drive was connected to the CMAX or if the system of measurement is to be changed.
Deleting identification data can make sense if modifications were made in the system that lead to a significantly different positioning behaviour. They need to be deleted if one of the following parameters is to be deleted:
- Cylinder type or cylinder length by more than 5.00 mm
- Cylinder diameter or piston rod diameter
- "Dual axis" setting
- Measuring system type or measuring system length of more than 5.00 mm
- Valve type
- Supply pressure with a change of more than 1 bar
- Mounting position with a change of more than 3°

The parameter can only be written (reading always delivers 0):
= 0: No effect
= 1: reserved
= 2: Delete identification data
= 3: Delete axis data and identification data

When deleting the axis data, the CMAX carries out the following steps:
1. Deactivate controller.
2. Reset axis data to delivery status, delete identification data and adaptation data.
3. Transition to status C00: Waiting for system of measurement

The diagnostic memory is not deleted during axis data reset.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

Commissioning function password status

PNU	PNU: 1192	Index: 4	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 2	

PNU 130 contains a password. The parameter PNU 1192:04 controls the acceptance and delivers the current status.

Write	Read
= 0: Delete password	= 0: No password set
= 1: Accept password	= 1: Password set and access free
	= 2: Password set and access blocked

After acceptance the password needs to be entered each time a connection is established via the diagnostic interface in order to change parameters.
Sequence:
1. Writing PNU 130: = “My_password”
2. Writing PNU 1192:04 = 1 for acceptance
To change it, first enter the old password and then delete it. Then the new password can be entered and accepted.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☒ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Commissioning function system of measurement

PNU	PNU: 1192	Index: 5	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 2	

The system of measurement must be defined prior to parametrising. The metric or imperial system of measurement is selected.
No parameter from PNU 300 onwards can be read or written as long as this index has the value 0 and the table for the system of measurement is not defined.

Write	Read
= 0: Not permissible	= 0: Not configured
= 1: Metric / SI	= 1: Metric / SI
= 2: Imperial / US	= 2: Imperial / US

Switching the system of measurement (1 to 2 or 2 to 1) is not possible. A changeover requires performing an axis data reset first (PNU 1192:03).

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☒ After writing, controller recalculation is carried out.

**Commissioning function
system of measurement table**

PNU	PNU: 1192	Index: 6	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 4

The system of measurement table corresponds to the selected table as per section B.1 (see specified table). The table contains the unit (millimetre or inch) used for every dimension and the scaling. The system of measurement table is derived from the system of units and the cylinder type.
No parameter from PNU 300 onwards can be read or written as long as this index has the value 0 and the table for the system of measurement is not defined.
Read:
= 0: Not configured
= 1: Metric / Linear (Tab. B/3)
= 2: Imperial / Linear (Tab. B/4)
= 3: Metric / Rotative (Tab. B/5)
= 4: Imperial / Rotative (Tab. B/6)
Writing is not permitted.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

**Commissioning function
movement test status**

PNU	PNU: 1192	Index: 7	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0		Minimum: 0		Maximum: 2

Define status of the movement test.
Write:
= 1: Movement test is reset and must be carried out again
= 2: Movement test is set to "does not have to be carried out" and is skipped
Read:
= 0: Movement test does not have to be carried out.
= 1: Movement test must be carried out.
Note: PNU 1174:01 contains the bit-encoded status of the movement test with the details (skipped, executed etc.). This parameter 1192:07 is designed as a possibility for resetting and skipping the movement test and modifies the PNU 1174:01 when writing.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Commissioning function valve and sensor status					
PNU	PNU: 1192	Index: 8	Max index: 8	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: 0		Maximum: 0	
Internal parameter.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

System of measurement units					
PNU	PNU: 1193	Index: 1 ...12	Max index: 12	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	
Determines the physical units, see section B.1.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

System of measurement for resolution					
PNU	PNU: 1194	Index: 1 ... 12	Max index: 12	Class: Struct	Data type: int32
Values	Without unit				
	Default: 0	Minimum: -		Maximum: -	
Determines the scaling/resolution or number of decimal places, see section B.1.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Start configuration					
PNU	PNU: 1195	Index: 1 ... 5	Max index: 5	Class: Struct	Data type: int32
Values	See description of the respective index.				
	Default: 0	Minimum: -		Maximum: -	

These are important configuration data at the time of adopting the serial numbers. The current configuration may only be modified within certain limits after this point in time.

Index	Value	Setpoint configuration	Unit	Tolerance
1	Cylinder length	PNU 1101	Length (index 2)	5.00 mm
2	Sensor length	PNU 1111	Length (index 2)	5.00 mm
3	Sampling time	–	1 µsec	-
4	Mounting position	PNU 1140	Mounting angle (index 12)	3°
5	Supply pressure	PNU 1141	Pressure (index 4)	1 bar

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parametrising mode with disabled controller.
☐ This parameter can be written by FCT without higher-order controller.
☐ After writing, controller recalculation is carried out.

Notes on PNU 1195:

The actual configuration is

- **compatible:** The actual configuration corresponds with the setpoint configuration within the permissible limits. Serial numbers may vary.

- **identical:** The actual configuration corresponds with the identification configuration within the permissible limits. The serial numbers are identical.

If the configuration is not identical, warning W08 (component exchanged) is issued upon the first start. If it is not compatible, error message E01 (configuration error) is issued. The application data is used to check whether certain changes are permissible without resetting the identification data.

Only automatically recognized configuration data can be compared to the setpoint configuration.

Manufacturing data					
PNU	PNU: 1199	Index: 1 ... 7	Max index: 7	Class: Array	Data type: int32
Values	Without unit				
	Default: 0		Minimum: -		Maximum: -
Internal parameter.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parametrising mode with disabled controller. ☐ This parameter can be written by FCT without higher-order controller. ☐ After writing, controller recalculation is carried out.					

Parametrisation

Chapter 6

Contents

6.1 Festo Parameter Channel (FPC)

The FPC is used for transmitting parameters. The PLC sends a request to the CMAX consisting of a parameter number, a subindex, a value and a task identifier. The CMAX responds with the PNU, the subindex, the value and a response identifier. This process takes several bus cycles.

FPC							
	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	Subindex	Parameter identifier		Parameter value			
Response	Subindex	Parameter identifier		Parameter value			

Tab. 6/1: Structure of FPC

Parameter identifier																
Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Request	Request Identifier				Parameter number											
Response	Response identifier				Parameter number											

Tab. 6/2: Structure of parameter identifier

Component	**Abbrevia-tion**	**Description**
Parameter identifier	ParID	16 bit identifier, consisting of ReqID/ResID and parameter number.
Request identifier	ReqID	Request identifier: Reading value, Changing value, ...
Response identifier	ResID	Response identifier Value transmitted, error ...
Parameter number	PNU	Parameter number – for addressing a parameter.
Subindex	IND	Subindex – for addressing an array element.
Parameter value	Value	Parameter value (in the event of an error the error number as a response)

Tab. 6/3: FPC components

6.1.1 Request identifiers, response identifiers and error numbers

Description	**ReqID Request**	**ResID (+) with response**	**ResID (–) in the event of an error**
No request	0	0	0
Read parameter value	6	5	7
Change parameter value	8	5	7

Tab. 6/4: Request identifiers and response identifiers

Rules:

- There are the data types integer, character (char) and bitfield.
- Each parameter value is transmitted as a 32-bit value.
- A string is an array of characters that can only be transmitted individually via the cyclic channel. The value NUL (=0x00) is interpreted as the string end. A PLC must always transmit the zero as the last character.
- Simple variables have no subindex.
  The transmitted subindex can have the values 0 and 1. The value 0 corresponds to “not used”. It is recommendable to set the subindex to 1 as if the parameter were an array with a component. Values that are › 1 are rejected with error 3.

Error	Error description
0	Impermissible PNU.
1	Parameter value cannot be changed.
2	Lower or upper value limit exceeded.
3	Invalid subindex.
11	No higher-order controller. FCT must accept device control in order to write this parameter. This error can only be generated via the service interface.
12	The password entered is wrong.
17	Request cannot be carried out due to operating status. Please check operating mode, stop and enable signals.
101	Request ID is not supported.
102	Parameter cannot be read (password).
103	The system of measurement has not been configured yet. Access to the parameter is not possible.
104	The cylinder type has not been configured yet. Access to the parameter is not possible.
105	The system of measurement has already been configured and cannot be changed without a data reset.
106	Cylinder type cannot be changed since it does not match the system of measurement.
107	The value cannot be changed since there is identification data. Please reset the identification data before writing the value.
108	The parameter value does not match the hardware recognised. (Note: the cylinder type must match the measuring system)
109	Serial numbers cannot be changed before the identification data has been reset.

Tab. 6/5: Error numbers for parameter transmission

6.1.2 Special features of the system of measurement

The following special rules apply to accessing the system of measurement. For detailed information on the system of measurement, see section B.1:

- The system of measurement cannot be switched over at will. To change the system of measurement, the axis data must be reset.
- After defining the system of measurement (metric / imperial), the cylinder type must be transmitted. This defines the movement type translatorily / rotatorily.
- Only when the system of measurement has been defined, can PNUs be accessed that are larger than PNU 300 (exceptions: PNU 1100, 1190).

6.2 Cyclic parametrising in parametrising mode

In parametrising mode the FPC can be used to transmit one parameter at a time in the cyclic I/O data.

The PLC enters the request in the output data and waits until the CMAX has entered a response in the input data. This process takes several bus cycles.

FPC in the cyclic I/O data (see also I/O allocation in section 2.2.6)

	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	Subindex	Parameter identifier		Parameter value			
		Request byte 1 ... 7 of the FPC, see section 6.1, Tab. 6/1						
Input data	SCON	Subindex	Parameter identifier		Parameter value			
		Response byte 1 ... 7 of the FPC, see section 6.1, Tab. 6/1						

Tab. 6/6: FPC in the cyclic I/O data

In the first byte, the control byte CCON is transmitted which controls the operating mode and controller enable. The CMAX responds with the SCON status byte.

Please note that the CCON.STOP bit must not be set since the CMAX cannot switch to “operation enabled” status in parametrising mode.
CCON.STOP = 1 leads to a warning.

6.2.1 Example of parametrising

Programmers can use the following example as an orientation for implementation.

Example		Parameter request (PLC output data)		Parameter response (PLC input data)
Wrote setpoint position Record 3 = 27.89 mm	→	ReqID = 8 (= Write value) PNU = 404 (= Record list setpoint value) IND = 3 (= Record 3) Value = 27.89 * 100 = 2789	→	ResID = 5 (= Value has been transmitted) PNU = 404 (= Record list setpoint value) IND = 3 (= Record 3) Value = 2789

Fig. 6/5: Example of parametrising

Preparing for parametrising

Establish status for switching operating mode

Switching is permitted in the statuses “Controller disabled”, “Controller enabled” or “Fault”.
Example “Controller enabled” status.

Allocation of the control bytes (prepare mode switch)

Bit	B7	B6	B5	B4	B3	B2	B1	B0
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	–	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	x	x	1	x	x	x	**0**	**1**
... Byte 5...8	not relevant. Recommendation: set to 0							

Feedback from the CMAX: Check operational status in status byte. SCON.OPEN must be 0.

Allocation of the status bytes (prepare mode switch)

Bit	B7	B6	B5	B4	B3	B2	B1	B0
SCON Byte 1	**OPM2**	**OPM1**	**FCT_MMI**	**24VL**	**FAULT**	**WARN**	**OPEN**	**ENABLED**
	x	x	0	1	x	x	**0**	**1**
... Byte 5...8	not relevant.							

Switch to parametrising mode

Switching is permitted in the statuses “Controller disabled”, “Controller enabled” or “Fault”.
Example “Controller enabled” status.

Allocation of the control bytes (switch to parametrising mode)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	–	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	1	**1**	1	x	x	x	**0**	**1**
... Byte 5...8	Set to 0							

Feedback from the CMAX: Parametrising mode. SPOS.OPM1 and OPM2 must be 1.

Allocation of the status bytes (switch to parametrising mode)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT_MMI**	**24VL**	**FAULT**	**WARN**	**OPEN**	**ENABLED**
	1	**1**	0	1	x	x	**0**	**1**
... Byte 5...8	Not relevant							

Carry out parametrising

1. Step: Prepare parametrising with “No request”

Allocation of the control bytes (step 1)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	–	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	1	**1**	1	x	x	x	**0**	**1**
Subindex Byte 2	Subindex of the parameter to be transmitted **=0**							
	0	0	0	0	0	0	0	0
Para-meter identifier Byte 3+4	PNU **= 0**							
	0	0	0	0	0	0	0	0
	ReqID **= 0**				PNU = n. r. (0000 0000 0000b)			
	0	**0**	**0**	**0**	**0**	0	0	0
Para-meter value Byte 5...8	Value of the parameter to be transmitted **= 0**							

Waiting for feedback from CMAX: “No request”.

Allocation of the status bytes (step 1)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT_MMI**	**24VL**	**FAULT**	**WARN**	**OPEN**	**ENABLED**
	1	**1**	0	1	**0**	**0**	**0**	**1**
Subindex Byte 2	Subindex of the transmitted parameter: not relevant							
	0	0	0	0	0	0	0	0
Para-meter identifier Byte 3+4	PNU = not relevant							
	0	0	0	0	0	0	0	0
	ResID = **0** (**0000**b)				PNU = not relevant			
	0	**0**	**0**	**0**	**0**	0	0	0
Para-meter value Byte 5...8	Value of the transmitted parameter: not relevant							

2. Step: Transmit parameter

Allocation of the control bytes (step 2)

Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	–	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	1	**1**	1	x	x	x	**0**	**1**
Subindex Byte 2	Subindex of the parameter to be transmitted: **3** (0000 0011b)							
	0	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Para-meter identifier Byte 3+4	PNU = **404** (0001 **1001 0100**b)							
	1	**0**	**0**	**1**	**0**	**1**	**0**	**1**
	ReqID = **8** (1000b)				PNU = **404** (**0001** 1001 0100b)			
	1	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Para-meter value Byte 5...8	Value of the parameter to be transmitted: **2789** (0000 0000 0000 0000 0001 1110 1001 0101$_b$, 32-bit number)							

Check feedback from the CMAX:

1. If ResID = 0: Parameter not yet processed. Wait.
2. If ResID = 7: Error handling (e.g. evaluate error number, check PNU, subindex or value)
3. If ResID = 5: End waiting.

Allocation of the status bytes (step 2)

Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT_MMI**	**24VL**	**FAULT**	**WARN**	**OPEN**	**ENABLED**
	1	**1**	0	1	**0**	**0**	**0**	**1**
Subindex Byte 2	Subindex of the transmitted parameter: **3** (0000 0011b)							
	0	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Para-meter identifier Byte 3+4	PNU = **404** (0001 **1001 0100**b)							
	1	**0**	**0**	**1**	**0**	**1**	**0**	**1**
	ResID = **5** (0101b)				PNU = **404** (**0001** 1001 0100b)			
	0	**1**	**0**	**1**	**0**	**0**	**0**	**1**
Para-meter value Byte 5...8	Value of the transmitted parameter: **2789** (0000 0000 0000 0000 0001 1110 1001 0101$_b$, 32-bit number)							

3. Step: Complete parametrising with “No request”

See step 1.

6.2.2 Sequence chart

Step 1
First send "No request" to ensure that the previous parameter request has been reliably terminated.

Step 2
Set the desired parameter request in the output data (request value, IND, PNU and ReqID).
The CMAX sends "No answer" for as long as it can provide the parameter response.
If the CMAX cannot process the request, this is indicated by ResID = 7. In this case the response value contains the error number.

Step 3
Send "No request" after evaluation of the response.

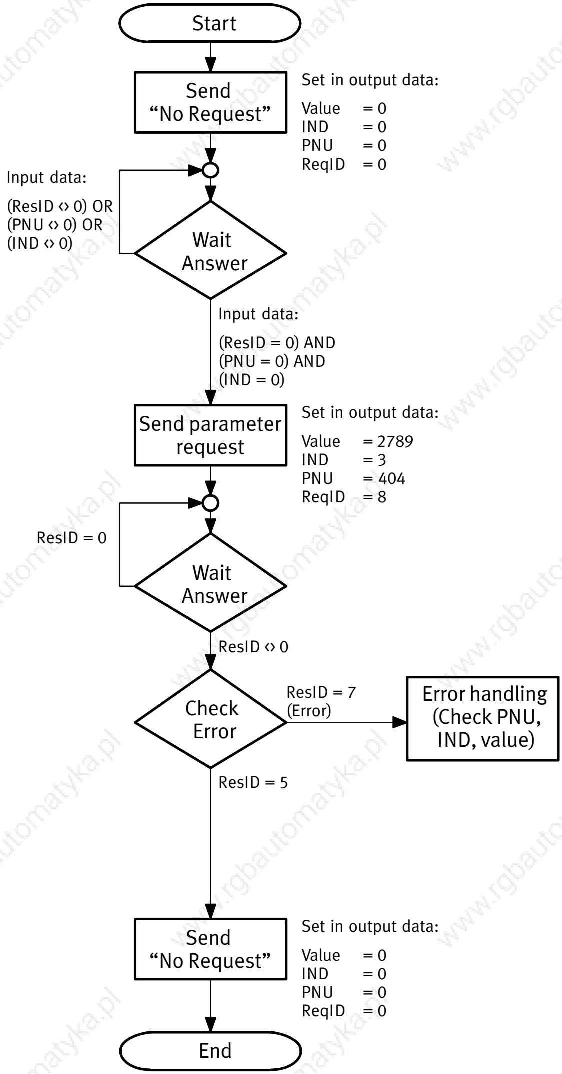


Fig. 6/6: Parametrisation flow chart

6.3 CPX module parameter and acyclic parametrising

6.3.1 CPX function numbers

Per module 64 byte module parameters (function no. 4828 + m*64 + 0...63) can be used in the system table.

CPX module parameter of the CMAX		
Function no.	**Contents**	**Description**
4828 + m * 64 + 0	Module parameter 0	Standard module parameters, are not used by the CMAX (reserved).
4828 + m * 64 + ...	Module parameters ...	
4828 + m * 64 + 5	Module parameter 5	
4828 + m * 64 + 6	Module configuration 1	Special module settings of the CMAX (reserved).
4828 + m * 64 + 7	Module configuration 2	
4828 + m * 64 + 8	Parameter control byte	Function head (request control)
4828 + m * 64 + 9	Parameter status byte	
4828 + m * 64 + 10	Parameter function byte	
4828 + m * 64 + 11	Parameter length byte	
4828 + m * 64 + 12	Data byte 1	50 byte data. The contents depend on the request.
4828 + m * 64 + ...	Data byte ...	
4828 + m * 64 + 61	Data byte 50	
4828 + m * 64 + 62	Byte 62	Not used (reserved).
4828 + m * 64 + 63	Byte 63	

Tab. 6/7: CPX module parameter of the CMAX

6.3.2 Startup parameter

The module parameters 0 ... 5 are not used and not transmitted.

The module configuration (byte 6 + 7) is transmitted from the master to CPX by means of startup parametrising. The parameters are reserved and described in the GSD file.

Both bytes are currently not yet used and reserved for future functions.

The data format of the module is specified via the “Data format analogue value” parameter in CPX, provided it is supported by the CPX node (see section 1.2).

Standard module parameter (byte 0 to 5)

The standard module parameters in byte 0 ... 5 are not used by the CMAX.

Module configuration (byte 6 and 7)

Module configuration 1 and 2			
Byte	**Bit**	**Name**	**Description**
6	0 ... 7	Module configuration 1	=: 0 ! (reserved)
7	0 ... 7	Module configuration 2	=: 0 ! (reserved)

6.3.3 Acyclic parameter request

Acyclic functions in the module parameters

The CPX module parameters byte 8 to byte 61 are used to execute acyclic functions in the CMAX. The area is divided into a function head that serves request control and a data field of 50 bytes.

Byte	Description
8 ... 11	Function head for request control
12 ... 61	Data range (depending on the desired function)

Currently only function 1 = Festo Parameter Channel FPC is available which permits exchanging acyclic parameters between PLC and CMAX.

The PLC transmits up to seven parameters in this data range, while a handshake is required between PLC and CMAX.

The advantage of acyclic parametrising is that the PLC does not need to modify the I/O data during parameter transmission. If the parameter does not require this, the operating mode must not be changed and the axis must not be stopped.

Note
With acyclic parameter transmission, ensure that the setpoint values of a positioning task are fully transmitted to the CMAX when the positioning task is started. If necessary, prevent positioning tasks during the transmission of parameters.

General procedure

The module parameters byte 8 ... 11 contain a function head that controls the handshake between PLC and CMAX.

Design of the function head		
Byte	**Name**	**Description**
PCB Byte 8 (P8.0-P8.7)	Parameter control byte (PCB)	**Request** 0 = Do not execute request 1 = Request request for axis 1
PSB Byte 9 (P9.0-P9.7)	Parameter status byte (PSB)	**Result** 0 = Request being processed 1 = Request processed successfully General errors: -1 = Request (PCB) faulty -2 = Faulty function number (FFB) -3 = system initialisation: Request cannot be executed -4 = A request is already being processed Error concerning function 1 (Festo Parameter Channel) -10 = FPC: Number of parameters (byte 12) is wrong (permissible 1...7)
PFB Byte 10 (P10.0-P10.7)	Parameter function byte (PFB)	**Function number** 0 = No function 1 = Festo Parameter Channel
PLB Byte 11 (P11.0-P11.7)	Parameter length byte (PLB)	reserved for future extensions must be set to 0

Tab. 6/8: Function head

Sequence

1. The PLC compiles the request data according to the function number. The bytes in the data range that are not used must also be transmitted. They should be set to 0.

2. The PLC transmits the data into the module parameters byte 8 ... 61. When doing so it sets the PCB (byte 8) to 1. The status byte should be set to 0.

3. The CMAX processes the request as soon as byte 61 has been transmitted. If the CMAX has finished the processing, it enters the result in the status byte PSB (byte 9).

4. The PLC reads the data 8 ... 61 until it finds a value in the status byte PSB (byte 9) that is not equal to 0.

5. If there is a result, the PLC must check whether the request was processed successfully (PSB = 1) or whether an error was reported (PSB < 0).

Notes

- Bytes 8...61 always have to be written. The request is only processed by the CMAX after byte 61 has been transmitted.

- If a result is retrieved before the request was requested, PSB = 0 (request being processed).

- When writing byte 8...61, make sure that PCB and PFB are correctly allocated.

- The contents of PSB are updated by the CMAX after every write access of the PLC. The CMAX itself does not evaluate the value written by the PLC. The value should be written by the PLC with 0, so that the contents unequal to 0 are reliably from the current request.

- If a request is already being processed, new ones are rejected and not processed (PSB = -4).

6.3.4 Festo Parameter Channel FPC (function 1)

Request control and data bytes			
Byte	**Contents**		**Description**
8	Function head	Para. control byte	PCB = 1 1= Request request for axis X
9		Para. status byte	PSB = 0 Set status to 0 at start
10		Para. function byte	PFB = 1 Function number = parameter channel
11		Para. length byte	PLB = 0 (reserved)
12	Data bytes	Number of parameters	Number of parameters (permissible: 1 ... 7)
13 ... 19		Parameter 1	Byte 1 ... 7 of parameter 1
20 ... 26		Parameter 2	Byte 1 ... 7 of parameter 2
27 ... 33		Parameter 3	Byte 1 ... 7 of parameter 3
34 ... 40		Parameter 4	Byte 1 ... 7 of parameter 4
41 ... 47		Parameter 5	Byte 1 ... 7 of parameter 5
48 ... 54		Parameter 6	Byte 1 ... 7 of parameter 6
55 ... 61		Parameter 7	Byte 1 ... 7 of parameter 7

Tab. 6/9: Allocation of the module parameters for parameter transmission

The individual parameters are FPC requests, as described in section 6.1.

Structure of parameter 1 ... 7							
Transmission of	**byte no. in the parameter**						
	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	Index	Parameter identifier Bit 00...11: PNU Bit 12...15: Request ID		32-bit parameter value			
Response	Index	Parameter identifier Bit 00...11: PNU Bit 12...15: Request ID		32-bit parameter value			

Tab. 6/10: Allocation of parameters 1 ... 7

Notes on commissioning and service

Appendix A

Contents

A.1 Preparations and overview for commissioning

A.1.1 Checking the axis string

Prior to commissioning:

- Check the complete system structure, especially the drive tubing and the electrical installation (see CMAX system description).

A.1.2 Switching on the power supply, switch-on behaviour

Warning
High acceleration forces at the connected actuators! Unexpected motion can cause collisions and severe injuries.

- **Switching on:**
  Always first switch on the power supply and then the compressed air supply.
- **Switching off:**
  Before carrying out mounting, installation and maintenance work switch off the power supply and the compressed air supply, either simultaneously or in the following sequence:
  1. the compressed air supply
  2. the power supply for the electronics/sensors
  3. the load voltage supply for the outputs/valves
  Always make sure that the compressed air supply and power supply are switched off and locked before working in the machine area.

Delivery status (after switching on for the first time or after data reset)

- The connected components (valve and measuring system/ sensor interface) are automatically searched for at the axis interface, the information received are read.
- The recognized components are **not** automatically accepted as the setpoint configuration.
- Without complete parametrising [1] of the axis data, the controller cannot be activated. Actual values are not updated in that case.

Standard startup

- The connected components (valve and measuring system/ sensor interface) are automatically searched for at the axis interface, the information received are read.
- The factual configuration found is compared to the setpoint configuration. Deviations lead to errors, a controller is not activated. This error can only be acknowledged after a parametrisation [1].

Recognisable parameters

The CMAX ascertains all the parameter values stored in the drive, sensor (measuring system) and valve automatically. The FCT PlugIn can read these values from the controller, they must not be entered in the FCT project. The ascertained data cannot be overwritten.

1) "Parametrisation executed": Each parameter from the area of axis data/mechanical system (also homing with DNCI) receives appropriate data.

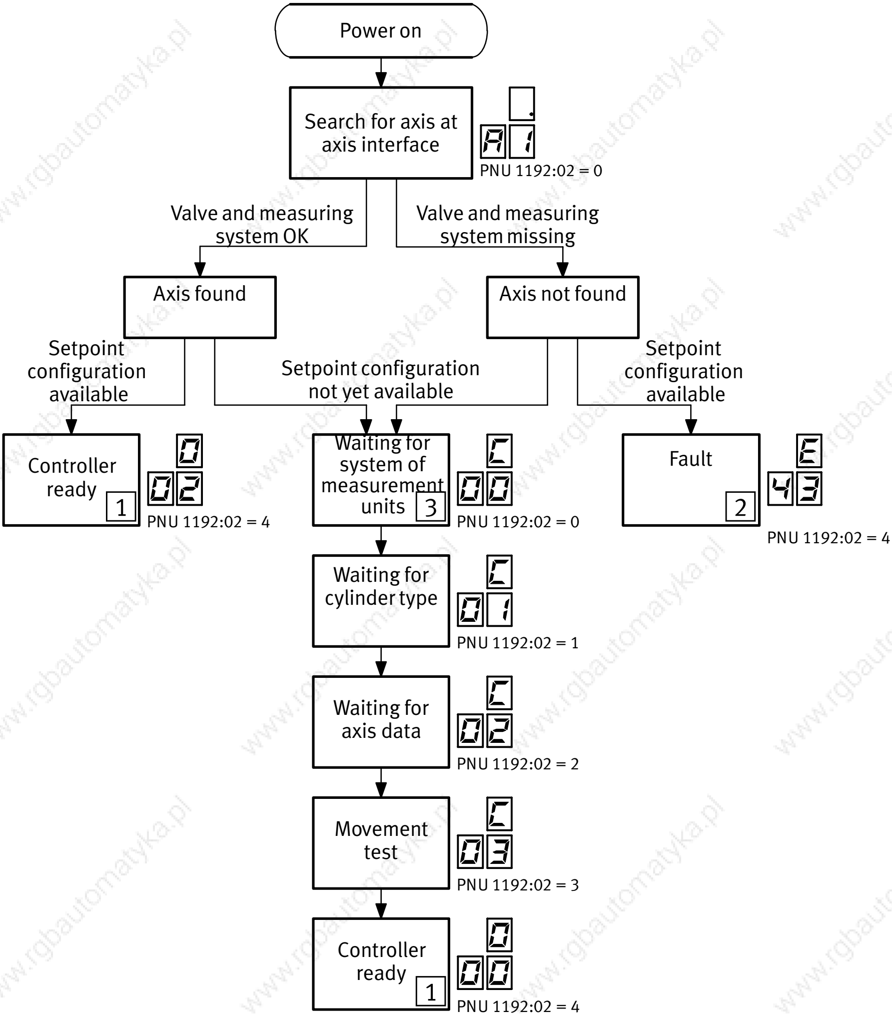
Data reset

An axis data reset (see section A.3.4) resets the axis data of the CMAX to the delivery status. In this status the CMAX contains no setpoint configuration. Parametrisation is required to activate the controller.

The CMAX can be configured with or without connected components ("in the office"). If the valve and the sensor interface have been connected, the CMAX will perform automatic hardware recognition after switching it on. The data found in the course of this are adopted by the FCT.

If commissioning is performed without components, all the data needs to be entered.

In order to indicate the status of parametrisation, the display reads status C00 ... C03 (can also be queried by reading PNU 1102:02) These statuses mark the respective action required next.



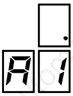
1 Initial start-up executed, CMAX ready for operation

2 Faults see chapter 4

3 Status when switching on for the first time (in delivery status or after data reset) Waiting for initial start-up

Fig. A/1: Switch-on behaviour

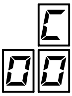
Description of the statuses



PNU 1192:02 = 0

Searching for valve and measuring system.

This process takes max. 3 seconds.



PNU 1192:02 = 0

The CMAX has found no setpoint configuration. The system of measurement units has not yet been defined.

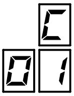
The user must first define the system of measurement units. As long as no system of measurement units has been configured, access to the axis parameters is restricted since the CMAX does not know in what way the parameters need to be scaled. You only have access to diagnostic data and to data required by the FCT to define the system of measurement units (measuring system type etc.).

The system of measurement units is defined with PNU 1192:05.

The following data can be accessed in this status:

PNU:IND	Access	Description
1xx 2xx	Read/write	Device data: define device names, version numbers Diagnostic data: read current fault
1190:01 1190:05 1190:11	Read	From hardware recognition: cylinder type, sensor type, valve type
1192:03	Read/write	carry out data reset
1192:05 1192:06	Read/write Read	System of measurement units System of measurement units table

Tab. A/1: Access to parameters in status C00

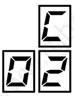


PNU 1192:02 = 1

The system of measurement units has been configured. The CMAX waits for the cylinder type to be defined.

It has now been defined whether the metric or the imperial system of units is used. However, the parameters can still not be scaled, because a distinction between translatory (linear drive) and rotatory (semi-rotary drive) needs to be made. For this, the cylinder type (PNU 1100) must be written. The cylinder type defines the system of measurement units actually used (see PNU 1192:06).

It is possible to trigger another data reset in case the system of measurement units was incorrectly defined.



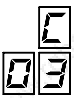
PNU 1192:02 = 2

The system of measurement units and the cylinder type have been successfully parametrised. The CMAX waits for the axis parameter to be written.

The recognized hardware has been scaled. Appropriate default data has been created in the user's system of measurement units. There is access to all the parameters, so now the recognized cylinder length, sensor length etc. can be read.

Now the axis data needs to be transmitted (download). Each parameter from the area of axis data/mechanical system, with DNCI also the homing parameters, must be written at least once irrespectively of the value.

In order to start commissioning again, you can trigger data reset (e.g. in the event of an incorrect system of measurement units).



PNU 1192:02 = 3

Basic parametrising has been completed. The axis can now be used.

A movement text can be performed. In the course of this, the drive is checked for correct tubing connection.
The movement test can be skipped by writing PNU 1192:02 = 2 (not recommended).

Commissioning errors

Fig. A/1 only shows the most impor tant paths, to explain the principle.

If only one component is found, for example (sensor or valve), error E60 or E80 is generated, since it can be assumed that this point to a defect. Apart from that, there are also other possible errors prior to or during commissioning, e.g.

– insufficient operating voltage E52,

– memory error E7x,

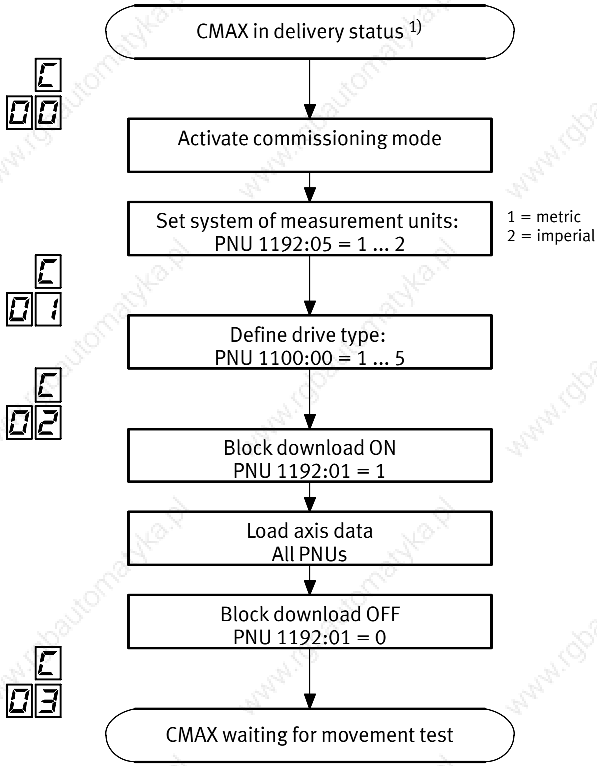
– controller enable before reaching status C03 (causes E05).

More information on the status display can be found in the CMAX system description (Chapter 5).

A.2 Commissioning via the CPX node (fieldbus)

A.2.1 C00: Basic parametrising

This section contains step-by-step instructions for basic parametrisation. Fig. A/2 shows an o verview of the procedure. The description of the statuses C00 to C03 is required to understand the diagram (see section A.1.2, Fig. A/1).



1) A data reset resets the axis data to the delivery status, the device and diagnostic data are retained.

Fig. A/2: Basic parametrising

Commissioning operations (PNU 1192)

The “Commissioning operations” parameter controls important operations of commissioning. Writing the parameter triggers complex actions in the controller which are essential for commissioning.

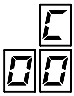
See section 5.4.16.

The function “data reset” (PNU 1192:03) offers the possibility to reset the controller to delivery status at any point in time. Resetting deletes the axis data and the identification data. So you will always need to repeat commissioning and identification after a reset.

A.2.2 Step-for-step instructions for basic parametrising

Step 1:

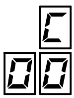
Switch on controller. Status C00 is now active.



1. Check status (read PNU 1192:02 -› setpoint = 0).
2. Recommendation: Write device names (PNU 121). Basically the default value "CMAX1" can be used, but an individual name is recommendable in case you also intend to access the controller with FCT.
3. Check version number of the firmware (read PNU 101). Prior to parametrising you should ensure that the CMAX is really compatible with the following project data.

Step 2:

Select commissioning mode



4. Activate "Commissioning" mode in the CCON, wait for acknowledgement in the SCON. STOP and ENABLE must not be set.

	B7	B6	B5	B4	B3	B2	B1	B0
CCON	**OPM2**	**OPM1**	**LOCK**		**RESET**	**BRAKE**	**STOP**	**ENABLE**
Setpoint	1	0	x	0	x	x	0	0
SCON	**OPM2**	**OPM1**	**FCT_MMI**	**24VL**	**FAULT**	**WARN**	**OPEN**	**ENABLED**
Setpoint	1	0	x	x	0	0	0	0

If the parameters are to transmitted via the cyclical I/O data of the PLC, "Parametrising" mode must be selected.

OPM2	OPM1	Operating mode	Transmit parameters via
1	0	Commissioning	CI/DIAG or module parameters, e.g. DPV1
1	1	Parametrisation	Usage of cyclical I/O data bytes 2..8

Step 3:

Define system of measurement units

C
00

5. Define a system of measurement units (PNU 1192:05).

1192:05 = 1 -›	Metric / SI system (metre, kilogramme, Newton, ...)
1192:05 = 2 -›	Imperial system (inch, pound, pound-force, ...)

Writing the parameter sets the commissioning status C01. This can be checked by reading the PNU 1192:02.

Step 4:

Write cylinder type

C
01

6. Write cylinder type into the setpoint configuration (PNU 1100:01). The cylinder type must correspond with the value from the automatic hardware recognition. The recognized value can be read from the actual configuration (PNU 1190:01).

The cylinder type defines the system of measurement units used. The CMAX now scales the length data from the actual configuration into the user's system of measurement units and copies them to the setpoint configuration. Now all the parameters can be accessed.

Writing the parameter sets the commissioning status C02. This can be checked by reading the PNU 1192:02.

Step 5:

Switch on block download

C
02

7. Switch on block download (write PNU 1192:01 = 1)

During block download the controller is not recalculated. The parameters are only checked for limit values during writing. Dependencies between parameters are not chekked. This function permits loading parameters in any order.

Example of dependent parameters: the software end positions depend on the cylinder length.

Step 5:

Load axis data

C
02

8. Load axis data:

Each parameter from the drive configuration group (also homing with the DNCI) must be appropriately initialised. All written parameters must correspond with the recognized parameters.

The following mechanics data must be written:

Setpoint configuration	Actual configuration	Parameter
PNU 1100	PNU 1190:01	cylinder type
PNU 1101	PNU 1190:02	Cylinder diameter
PNU 1102	PNU 1190:03	Cylinder length
PNU 1103	PNU 1190:04	Piston rod diameter
PNU 1110	PNU 1190:05	Measuring system type
PNU 1111	PNU 1190:06	Measuring system length
PNU 1120	PNU 1190:11	Valve type

With the DNCI / DDPC the following data must also be written:

Axis data	Parameters
PNU 1130	Offset axis zero point
PNU 1131	Homing velocity
PNU 1132	Homing method

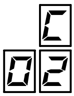
The following parameter should be written:

Application data	Default (SI)	Parameters
PNU 1140	0°	Mounting position
PNU 1141	6 bar	Supply pressure
PNU 1142	5 kg	Moving mass without workpiece (basic load)

All the other parameters contain appropriate default values. This data can, but does not need to be overwritten. The record list is not initialised.

Step 5:

Switch off block download



9. Switch off block download (write PNU 1192:01 = 0)

   When switching off block download, the controller is parametrised for the first time. If all the required parameters were written during axis data writing, status C02 is quit. From this point in time the actual position can be read or any other function of the CMAX can be executed for the first time.

   The CMAX now waits for the movement test to be executed.

A.2.3 Parametrising without hardware

Properties

– The CMAX can be fully parametrised without hardware. Connecting an axis is **not** required for this purpose.

– If no axis is connected, the controller indicates an error after parametrising. The CMAX is still fully diagnostics-capable and parametrisable.

– Without hardware all parametrised data can be read. Connecting an axis is **not** required.

Cylinder length

The actual effective length is stored in the DGCI. It is read when the hardware is connected and also copied to the setpoint data. When commissioning without hardware, the nominal length must be parametrised since the effective length is no known. The CMAX accepts both effective and nominal lengths for nominal/actual comparison.

Example:
With a DBCI-25-500 the effective length of 501.63 mm is read when commissioning with hardware and copied to the setpoint configuration. Without hardware a value of 500.00 mm must be programmed.

When ultimately connecting the hardware, the user can adopt the effective length. This does not occur automatically. If the projected nominal and effective length is not adjusted, the CMAX accepts a variation of 5.00 mm between the projected length and the nominal length stored in the drive without issuing an error or warning.

Serial numbers and sampling time

The serial numbers of the sensor and valve and the sampling time of the sensor (measuring system) are also not known when commissioning offline. This data is automatically adopted after connecting the hardware, if the remaining data complies with the connected components.

A.2.4 C03: Movement test

After parametrising, a movement test should be executed to check the drive's control direction. During this, the system checks that the tubes are correctly connected. After parametrising, the CMAX expects the movement test to be executed and indicates this by issuing C03 on the display.

The movement test must either be executed or skipped (not recommended).

Information on executing the movement test can be found in section 3.2.1.

A.2.5 Homing and identification

After the successful movement test, the following functions need to be executed:

- Homing, see section 3.2.2
  (only with measuring type "encoder").
- Identification, see section 3.2.5

A.3 Operation and service

A.3.1 Nominal/actual comparison

When switching on, the CMAX compares the setpoint and actual configuration. How complex this comparison is depends on whether the serial numbers of the components were adopted.

Serial numbers have not been transferred yet.	The actual configuration only needs to be compatible with the setpoint configuration. Deviations lead to error E01. The actual configuration is compatible if it corresponds with the hardware configuration within a certain tolerance range. In this no serial numbers are compared, only the size, supply pressure and mounting position.
Serial numbers have been transferred.	The actual configuration must be compatible with the setpoint configuration. The components valve and measuring system have clearly been assigned to the project. Deviations lead to fault E01. The serial numbers of the measuring system/sensor interface and valve must correspond with the projected serial numbers. A deviation leads to warning W08, deviations from both to fault E01. The reason for this is the data that depends on the individual valve and drive which is ascertained during identification and adaptation.

The serial numbers are transferred when a movement test, start, or homing is performed **for the first time**.

The serial numbers and corresponding configuration data are transferred **each time** the user performs the identification.

Parameters	Permissible deviations for nominal/actual comparison		
	Prior to transfer of SN [1]	**After transfer of SN** [2]	**After identification**
Cylinder			
Type	no deviation	no deviation	no deviation
Nominal/effective length [3]	5 mm	5 mm	5 mm
Diameter	no deviation	no deviation	no deviation
PR diameter [4]	no deviation	no deviation	no deviation
Measuring system			
Type	no deviation	no deviation	no deviation
Nominal length	5 mm	5 mm	5 mm
Serial number	any changes	any changes [5]	any changes [5]
Valve			
Type	no deviation	no deviation	no deviation
Serial number	any changes	no deviation	no deviation

1) Prior to transfer of the serial numbers any changes to the setpoint configuration are permissible if there is no actual configuration. A complete actual configuration is currently only available when using the DGCI.
2) After transfer of the SN or the identification, these tolerances not only apply to variations between the setpoint values and actual values, but also between old and new setpoint values.
3) Only a cylinder length to which both actual values are compared is projected.
4) Piston rod diameter
5) No deviation permissible with the DGCI.

Tab. A/2: Permissible deviations for nominal/actual comparison

Optimize parameters

Various parameters can still be modified after commissioning in order to optimize the project. The cylinder length can, for example, be modified by up to 5.00 mm in order to be able to move right up to cylinder end position with force control.

Modifications outside of the specified tolerances are not permissible. To prevent an excessive extent of modifications through repeat downloads, a copy of the data is created at the time of serial number transfer and this is used as a basis for comparison (PNU 1195).

After identification, modification of other parameters is restricted.

Parameters	Permissible deviations for nominal/actual comparison		
	Prior to transfer of SN	After transfer of SN	After identification
Application data			
Supply pressure	any changes	any changes	1 bar
Mounting position	any changes	any changes	3 °
Settings			
WP mass at power-on [1)]	any changes	any changes	any changes
Dual axis	any changes	any changes	no deviation
Clamping unit	any changes	any changes	any changes
Through piston rod	any changes	any changes	no deviation
[1)] Workpiece mass(mass moment of inertia when switching on			

Tab. A/3: Permissible deviations for nominal/actual comparison

A.3.2 Exchanging components

Nominal/actual comparison of the hardware configuration

With each new calculation of the controller, a nominal/actual comparison between the current hardware configuration (actual configuration) and the setpoint configuration is performed.

Setpoint configuration

The setpoint configuration consists of the values for the drive configuration parametrised by the user.

Actual configuration

The actual configuration consists of values for the hardware components ascertained during the automatic hardware recognition.

Exchange of a component

The CMAX identifies an exchange as specified in Tab. A/4.

Component	**Component exchanged for component ...**	
	of the same type and size	**of another type or size**
Cylinder/drive	DGCI: Recognition based on serial number of the measuring system	DGCI: Recognition based on length and diameter information in the measuring system
	Other drives: recognition not possible	Other drives: recognition not possible
Valve	Recognition based on serial number	Recognition based on type information
Measuring system	DGCI: Recognition based on serial number	DGCI: Recognition based on length and diameter information
	Other measuring systems: recognition not possible	Other measuring systems: recognition of the design based on sensor interface, no length information.
Sensor interface	Recognition based on serial number	Recognition based on type information

Tab. A/4: Exchange of a component - recognition by the CMAX

Response of the CMAX to exchanging for the same type

- The identification data is not discarded.
- Operation is permissible without new parametrisation/identification.
- A warning is generated. It remains active as long as no formal parametrisation/identification is performed.

Response of the CMAX to exchanging for another type or size

- The identification data is not discarded.
- Operation is not permissible without new parametrisation, the controller cannot be activated.
- An error is generated.

Cylinder length

The cylinder length and the sensor length may be modified by up to 5.00 mm without requiring a new identification. When modifying by $<$ 5.00 mm, the CMAX assumes that it is expected to optimize the effective length of the cylinder.

When commissioning the CMAX offline, the nominal length of the cylinder must be specified. It is accepted even if it deviates by more than 5.00 mm from the effective length.

If the cylinder was exchanged, it must in any case be re-identified, even if the CMAX does not report an error!

Adjust setpoint parameters

The parameters of the mechanical system can only be modified once the identification data have been deleted.

Defined error codes

Message		Effect
E01	More than one component (cylinder **and** valve) were replaced for another.	Identification must be reset and executed anew once the setpoint configuration has been adjusted. Or reset to previous status, as required.
	Cylinder (type, length, diameter) does not correspond to the setpoint configuration.	
	Measuring system (type, length) does not correspond to the setpoint configuration.	
	Valve (type) does not correspond to the setpoint configuration.	
W08	A component (cylinder, sensor **or** valve) was replaced for another.	Identification should be repeated, but operation is still possible.

A.3.3 Reconfigure axis

If a CMAX was connected to a certain axis via the serial number (see section A.3.1), the hardware configuration data can only be modified in a certain range. If the CMAX is operated at a different axis, this connection must be deactivated first.

It is possible for the user to exchange an axis in the plant for an axis of a different size, e.g. to achieve greater force with a larger piston surface. In this case you do not need to delete the entire controller. Only the data that is essential should be deleted.

There are two ways of deleting data:

– Delete all the data of an axis.

– Only delete the identification data and the adaptation data.

With the second variant, the record list, default values, controller amplifications etc. are retained. This can make sense when position values were taught, for example.

The CMAX reports the necessity of deleting data during data transmission with the FPC error code 107:

“There are identification and adaptation data in the CMAX that prevent modifying the current configuration. This data must be reset first.”

As the user, you can then decide whether to delete all the data or only the identification data.

A.3.4 Data reset

There are three ways of resetting data in the CMAX, see Tab. A/5.

Reset	Description
Identification data reset	– This function can be performed with the FCT and by the PLC. – Only the identification data and the adaptation data are reset. All the other data is retained. The data reset is triggered by writing on the commissioning parameter “data reset” PNU 1192:03 = 2.
Axis data reset	– This function can be performed with the FCT and by the PLC. – All user parameters of an axis are reset to the delivery status. – The identification data, the adaptation data and the maintenance data of an axis are reset. – The diagnostic memory is retained and it contains the entry “data reset”. – Device data such as device name, operating time are retained. – A password is not deleted. The data reset is triggered by writing on the commissioning parameter “data reset” PNU 1192:3 = 3.
Device data reset	– This function is only available by CI at the diagnostic interface and can only be triggered by the FCT. A PLC cannot trigger a device data reset via fieldbus. – With this reset the entire CMAX is reset to delivery status. The identification data, adaptation data and maintenance data of both (level 2) axes and the shared device data such as device name, operating time etc. are deleted. – The diagnostic memory of the axes is deleted. – A password specified in the device is deleted. This is the only way to continue using a device if a set password has been lost. After the reset it is no longer possible to communicate with the CMAX. The display shows 3 flashing dashes “---”. The CPX terminal must be switched off and then back on again.

Tab. A/5: Types of data reset

When speaking about a data reset in general, this refers to an axis data reset.

A.3.5 Firmware update

Updating the CMAX firmware can be done with the FCT PlugIn CMAX via the diagnostic interface of the CPX node.

If no valid firmware is loaded on the module at the time of switching on, the error E74 “no firmware” is indicated.

The bootloader is not overwritten in the event of a firmware update, switching off during download does therefore not cause the CMAX be become inoperative. The download can be started again. The firmware files contain compatibility information to ensure that the bootloader and the firmware harmonize.

A.3.6 Switch-on behaviour and power-down

After switching on, not only initialisation is checked but also whether the data backup of the FMAM was performed without errors last time the system was switched off.

In the event of an error, E76 (power-down error) is issued.

If the operating voltage drops below 17.9 V, all retentive data (device and axis parameters, identification and adaptation data) are saved retentively.

– If the supply voltage returns to the valid range within 10 ms, this mains drop has no external effect.

– If the voltage drops lasts longer than 10 ms (do not switch off), fault E52 is issued.

A.4 Programming flow charts

The following section provides flow charts for CMAX control via I/O for typical applications.

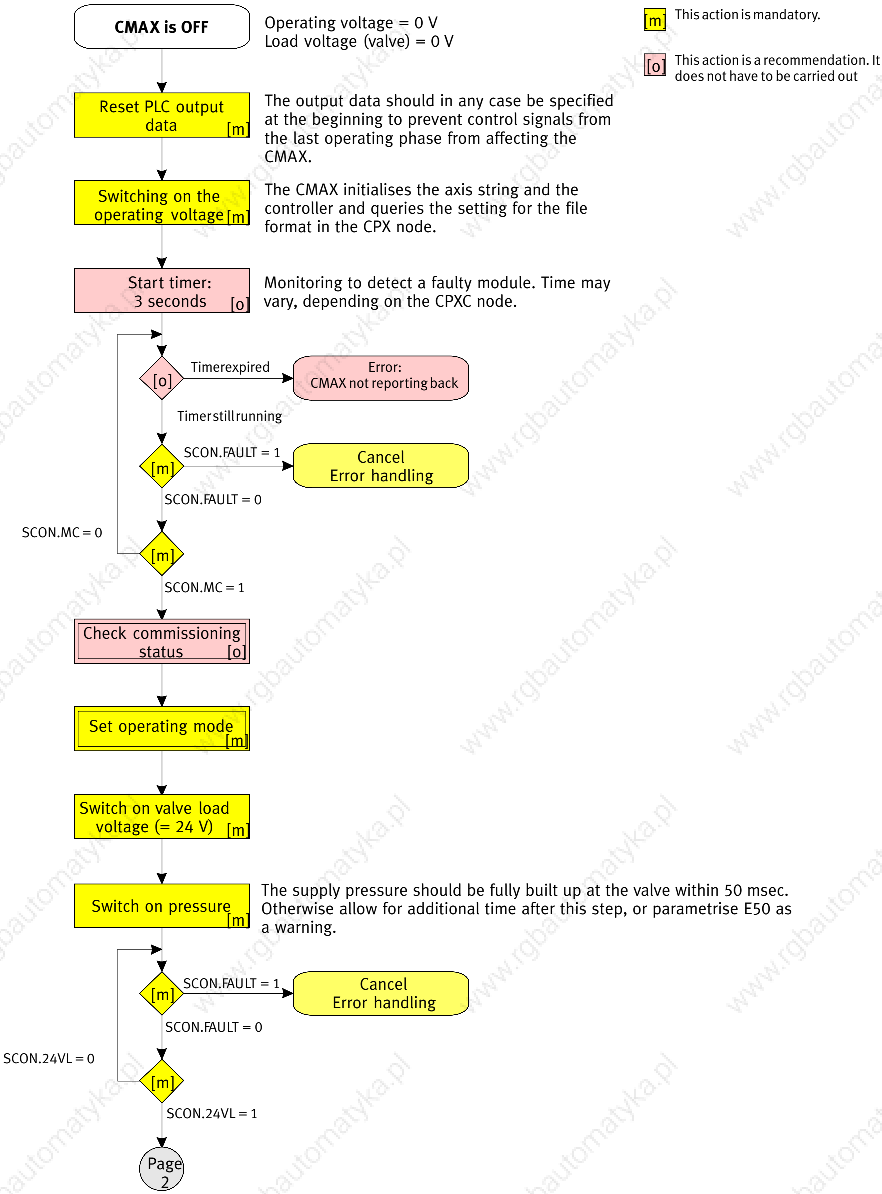
A.4.1 Create ready status

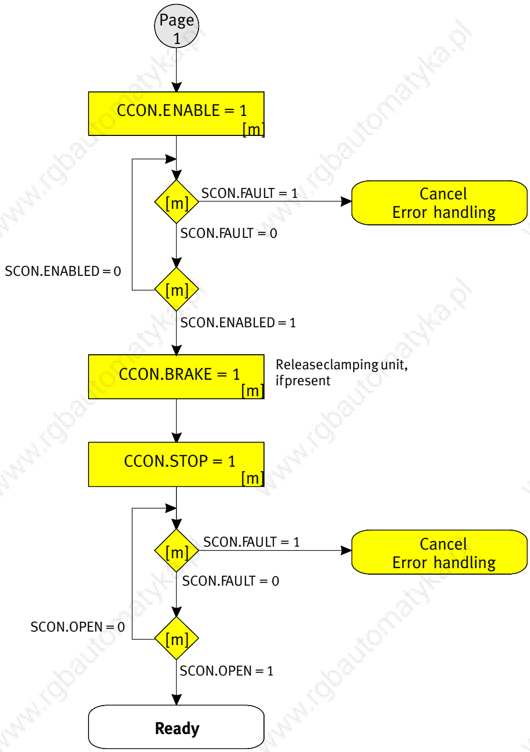
Requirements

- Valve operating voltage and load voltage OFF.
- Fieldbus master is ready for communication, so communication is established as soon as the CPX terminal is switched on. If this is not the case, additional time must be allowed for change of the byte order after establishment of communication.

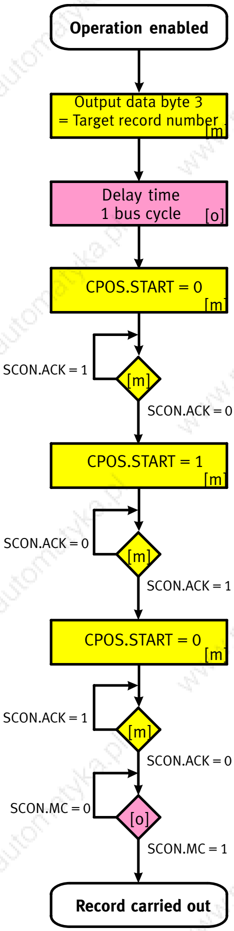
Notes

- All enabling bits (enable, stop, brake) can be set right from the beginning and simultaneously. Correspondingly, feedback can be evaluated simultaneously.
- When exchanging components, the movement test is reset automatically, if applicable. The movement test status should therefore be checked before switching on and the test be re-run automatically or user-guided, if required.
- Setting the operating mode should be done in a separate module of the control at a central position. See also section A.4.4.
- If the CMAX reports a faults, depending on this fault, not all of the expected status signals can be indicated. Evaluation of SCON.ENABLED or SCON.OPEN, for example, should then be aborted.


CMAX is OFF
Operating voltage = 0 V
Load voltage (valve) = 0 V
[m] This action is mandatory.
[o] This action is a recommendation. It does not have to be carried out
Reset PLC output data [m]
The output data should in any case be specified at the beginning to prevent control signals from the last operating phase from affecting the CMAX.
Switching on the operating voltage [m]
The CMAX initialises the axis string and the controller and queries the setting for the file format in the CPX node.
Start timer: 3 seconds [o]
Monitoring to detect a faulty module. Time may vary, depending on the CPXC node.
[o]
Timerexpired
Error: CMAX not reporting back
Timerstillrunning
[m]
SCON.FAULT = 1
Cancel Error handling
SCON.FAULT = 0
SCON.MC = 0
[m]
SCON.MC = 1
Check commissioning status [o]
Set operating mode [m]
Switch on valve load voltage (= 24 V) [m]
Switch on pressure [m]
The supply pressure should be fully built up at the valve within 50 msec. Otherwise allow for additional time after this step, or parametrise E50 as a warning.
[m]
SCON.FAULT = 1
Cancel Error handling
SCON.FAULT = 0
SCON.24VL = 0
[m]
SCON.24VL = 1
Page 2


Page 1
CCON.ENABLE = 1
[m]
[m]
SCON.FAULT = 1
Cancel Error handling
SCON.FAULT = 0
SCON.ENABLED = 0
[m]
SCON.ENABLED = 1
CCON.BRAKE = 1
[m]
Release clamping unit, if present
CCON.STOP = 1
[m]
[m]
SCON.FAULT = 1
Cancel Error handling
SCON.FAULT = 0
SCON.OPEN = 0
[m]
SCON.OPEN = 1
Ready

A.4.2 Start record



SCON.ENABLED = 1
SCON.OPEN = 1

[m] This action is mandatory.

[o] This action is a recommendation. It does not have to be carried out

For all fieldbuses that do not support consistent data transmission, it is necessary to wait one bus cycle after entering the record number during which the record number on the fieldbus is transmitted to the CMAX.
Recommendation: with most control systems the PLC cycle is longer than the bus cycle -> delay time = 1 PLC cycle

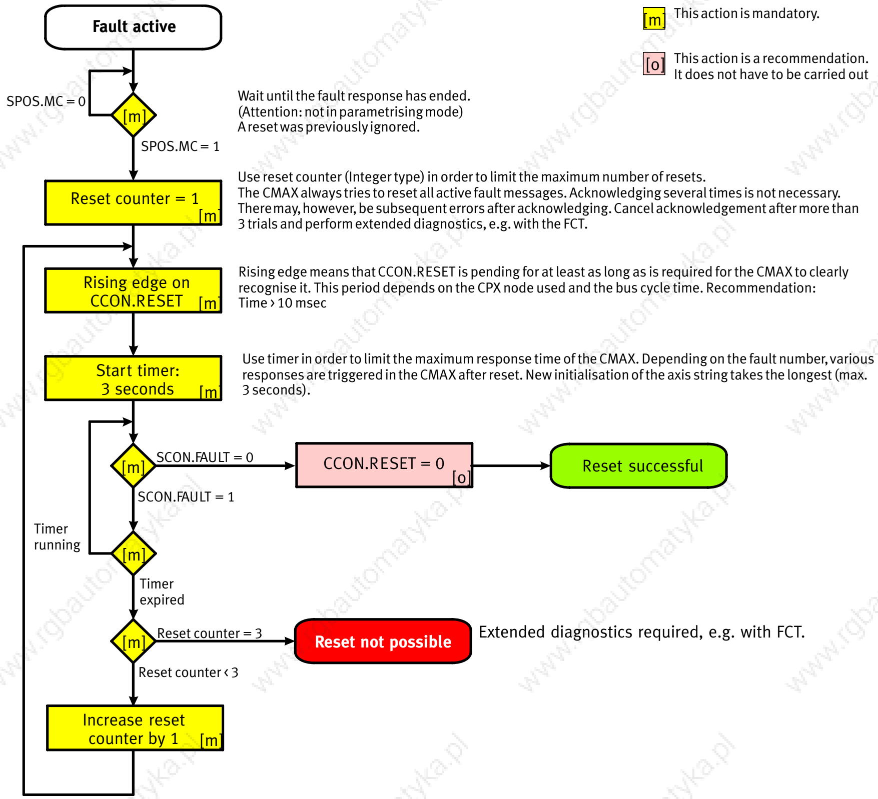
Preparing the starting edge

Starting edge

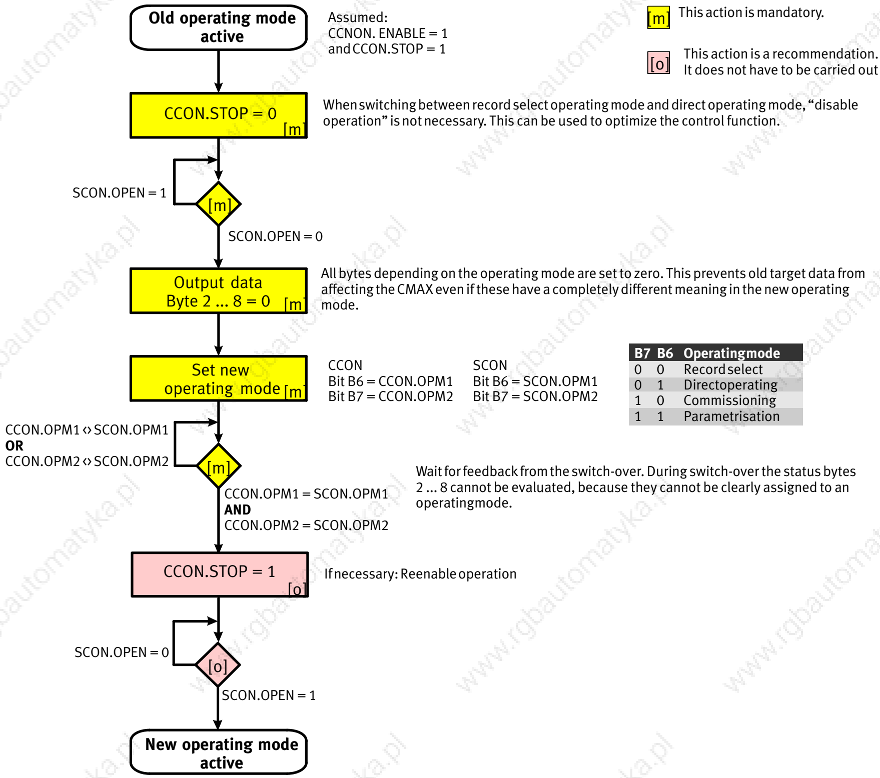
Reset start in order to reduce the delay time next time.

It is only required to wait for MC if reaching the target position is necessary for the further process.

A.4.3 Reset fault



A.4.4 Switch over operating mode



Basic controlling principles

Appendix B

Contents

B.1 CMAX system of measurement units

The CMAX can either be operated in the metric (SI) or in the imperial system of measurement units.

The system of measurement units needs to be defined in delivery status (after switching on for the first time or after data reset, status C00). The configuration of the drive type (in status C01) determines whether a translatory or a rotatory system of units will be used (refer to Appendix A.1.2, Fig. A/1).

After the system of measurement units has been configured, the parameters are set accordingly, e. g. the actual configur - ation is scaled in user units and default values are defined. Only then can the parameters be accessed.

The units thus defined are used for all numerical values, also for the primary setpoints and actual values in the I/E data.

Once the system of measurement units has been defined, it cannot be changed. The CMAX does convert values from one system of units to the other. To change the system of measurement units, the axis data must be reset and commissioning must be restarted in status C00.

The CMAX uses 12 physical variables. For each variable, the physical unit and the scaling is predefined.

For each possible physical unit a type is defined that stands for the unit. Position values (index 1) can, for example, be given in millimetres (type 10), in inches (type 11), or in degrees (type 15), see Tab. B/1.

The scaling describes the number of decimal places, and consequently the precision of the respective integer value. Here the exponent of 10 is given. A specification of -3 for scaling results in a factor of 1/1000 (=10^{-3}).

Hence for each physical variable, a table with 12 entries for the unit and the scaling can be given.

Unit (PNU 1193)

Index	Physical variable	Drive[1]	Type	Unit	Character	Conversion
1	Position (angle)	L	10	Millimetre	mm	= 0.03937 in
		L	11	Inch	in	= 25.4 mm
		D	15	Degree	°	–
		A	–	Foot [2]	ft	= 304.8 mm
2	Length (swivel angle)	L	10	Millimetre [3]	mm	= 0.03937 in
		D	15	Degree	°	–
3	Force (torque)	L	20	Newton	N	= 0.22481 lbf
		L	21	Kilonewton [2]	kN	= 1000 N
		L	22	Pound-force	lbf	= 4.44822 N
		D	25	Newtonmetre	Nm	= 0.73756 lbf ft
		D	26	Pound-force foot	lbf-ft	= 1.35582 Nm
4	Pressure	A	30	Bar	bar	= 100,000 Pa
		A	31	Millibar [2]	mbar	= 100 Pa
		A	32	Pascal [2]	Pa	= 1E-5 bar
		A	33	Pound per square inch	psi	= 0.06895 bar
5	Mass (mass moments of inertia)	L	40	Kilogramme	kg	= 2.20462 lb
		L	41	Pound	lb	= 0.45359 kg
		D	45	Kilogramme square centimetre	kg cm^2	= 23,73036 * 10^{-4} lb-ft^2
		D	46	10^{-2} pound square foot	10^{-2} lb-ft^2	= 0.04214 10 2 kg m^2
		D	47	Pound square inch	lb in^2	= 2.9264 kg m^2
6	Velocity (angular speed)	L	50	Metre per second	m/s	= 3.28084 ft/s
		L	51	Feet per second	ft/s (fps)	= 0.3048 m/s
		D	55	Degree per second	°/s	–
		D	56	1,000 degree per second	1000 °/s	–

1) Drive type: A=All, L=Linear, D=Rotary/Semi-rotary drive
2) Cannot be configured (internally used definition or only for information)
3) In FCT: Display/Entry in mm and additionally display in inches in parentheses

Unit (PNU 1193)						
Index	**Physical variable**	**Drive[1]**	**Type**	**Unit**	**Character**	**Conversion**
7	Acce-leration (Angular acceler-ation)	L	60	Metre per second squared	m/s^2	= 3.28084 ft / s^2
		L	61	Feet per second squared	ft/s^2	= 0.3048 m / s^2
		D	65	Degree per second squared	$°/s^2$	
		D	66	1,000 degrees per second squared	1000 $°/s^2$	
8	Force ramp (torque ramp)	L	70	Newton per second	N/s	= 0.22481 lbf / s
		L	71	Kilo-Newton per second	kN/s	= 1,000 N/s
		L	72	Pound-force per second	lbf/s	= 4,44822 N/s
		D	75	Torque per second	Nm/s	= 0.73756 lbf ft / s
		D	76	Pound-force-foot per second	lbf ft/s	= 1.35582 Nm/s
9	Time	A	80	Millisecond	ms	–
		A	81	Second	s	–
10	Gain	A	100	– (without)	–	–
11	Diameter	A	10	Millimetre [3]	mm	= 0.03937 in
12	Mounting angle	A	15	Degree	°	–

[1] Drive type: A=All, L=Linear, D=Rotary/Semi-rotary drive
[2] Cannot be configured (internally used definition or only for information)
[3] In FCT: Display/Entry in mm and additionally display in inches in parentheses

Tab. B/1: Units and their conversion

The 2 systems of units and the 2 movement types result in four tables with units and resolution for the 12 variables.

Table no.	System of measurement units	Movement (drive)
1 ➔ Tab. B/3	International / SI	Translatory
2 ➔ Tab. B/4	Imperial	Translatory
3 ➔ Tab. B/5	International / SI	Rotatory
4 ➔ Tab. B/6	Imperial	Rotatory

Tab. B/2: Possible system of units tables

The table used in the CMAX is stored in PNU 1192:06. The tables each contain an index for the unit and the scaling:

- PNU 1193: Table of units
- PNU 1194: Table of resolution

The index within the PNU corresponds to the index of the physical variable

Example of acceleration

PNU 1193:07 contains the value 60, i.e. “metre per second squared”. PNU 1194:07 contains the value -3, so the resolution is 0.001 (=10^{-3})
⟶ So a value of 2,550 corresponds to 2.550 m/s^2.

Unit (PNU 1193)					Resolution (PNU 1194)
Index	Physical variable	Value	Unit	Character	
1	Position	10	Millimetre	mm	-2
2	Length	10	Millimetre	mm	-2
3	Force	20	Newton	N	0
4	Pressure	30	Bar	bar	-1
5	Mass	40	Kilogramme	kg	-1
6	Velocity	50	Metre per second	m/s	-3
7	Acceleration	60	Metre per second squared	m/s^2	-3
8	Force ramp	70	Newton per second	N/s	0
9	Time	80	Millisecond	ms	0
10	Gain	100	– (without)	–	-2
11	Diameter	10	Millimetre	mm	-2
12	Mounting angle	15	Degree	°	-1

Tab. B/3: Linear drive – metric/SI (PNU 1192:05 = 1)

Unit (PNU 1193)					Resolution (PNU 1194)
Index	Physical variable	Value	Unit	Character	
1	Position	11	Inch	in	-3
2	Length	10	Millimetre [1]	mm	-2
3	Force	22	Pound-force	lbf	0
4	Pressure	33	Psi	psi	0
5	Mass	41	Pound	lb	0
6	Speed	51	Feet per second	ft/s	-2
7	Acceleration	61	Feet per second squared	ft/s^2	-2
8	Force ramp	72	Pound-force per second	lbf/s	0
9	Time	80	Milliseconds	ms	0
10	Gain	100	– (without)	–	-2
11	Diameter	10	Millimetre [1]	mm	-2
12	Mounting angle	11	Degrees	°	-1
[1] In the FCT additional display in inches					

Tab. B/4: Linear drive – imperial (PNU 1192:05 = 2)

Unit (PNU 1193)					Resolution (PNU 1194)
Index	Physical variable	Value	Unit	Character	
1	Angle	15	Degree	°	-1
2	Swivel angle	15	Degree	°	-1
3	Torque	25	Newtonmetre	Nm	0
4	Pressure	30	Bar	bar	-1
5	Mass moment of inertia	45	Kilogramme square centimetre	kg cm^2	0
6	Angular speed	56	Degree per second	°/s	0
7	Angular acceleration	66	Degree per second squared	°/s^2	0
8	Torque ramp	75	Newton-metre per second	Nm/s	0
9	Time	80	Millisecond	ms	0
10	Gain	100	– (without)	–	-2
11	Diameter	10	Millimetre	mm	-2
12	Mounting angle	15	Degree	°	-1

Tab. B/5: Semi-rotary drive – metric/SI (PNU 1192:05 = 3)

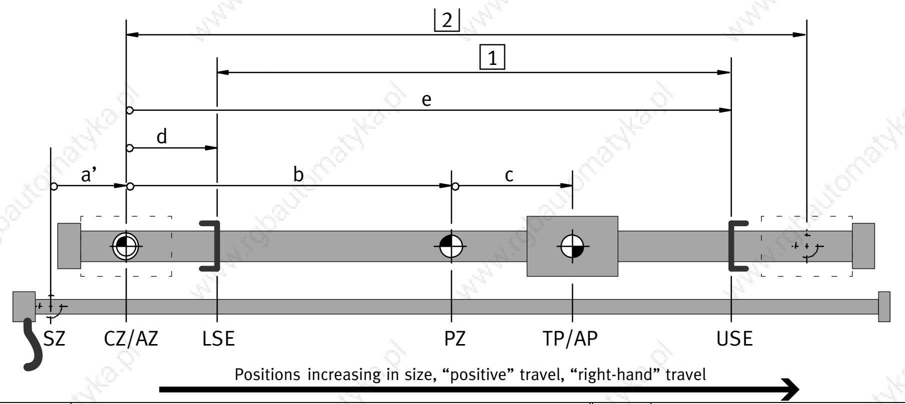
Unit (PNU 1193)					Resolution (PNU 1194)
Index	Physical variable	Value	Unit	Character	
1	Angle	15	Degrees	°	-1
2	Swivel angle	15	Degrees	°	-1
3	Torque	26	Pound-force foot	lbf-ft	0
4	Pressure	33	Pound per square inch	psi	0
5	Moment of inertia	47	Pound-force square inch	lb in^2	-1
6	Angular speed	56	Degrees per second	°/s	0
7	Angular acceleration	66	Degrees per second squared	°/s^2	0
8	Torque ramp	76	Pound-force-foot per second	lbf ft/s	0
9	Time	80	Milliseconds	ms	0
10	Gain	100	– (without)	–	-2
11	Diameter	10	Millimetre [1]	mm	-2
12	Mounting angle	15	Degrees	°	-1
[1] In the FCT additional display in inches					

Tab. B/6: Semi-rotary drive – imperial (PNU 1192:05 = 4)

B.2 Dimension reference system for pneumatic drives

B.2.1 Dimension reference system with absolute measuring system

System of units for linear drives with absolute measuring system



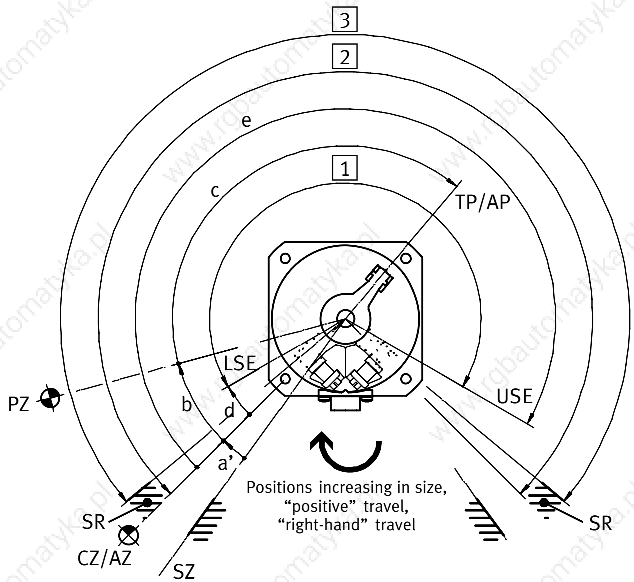
SZ	Sensor/measuring system zero point (sensor zero point)	a’	Offset axis zero point (distance AZ - SZ, so far “mounting offset”)
CZ	Cylinder zero point, stop		
AZ	Axis zero point	b	Offset project zero point
PZ	Project zero point	c	Offset target/actual position
LSE	Lower software end position	d, e	Offset software end positions:
USE	Upper software end position	$\boxed{1}$	Effective stroke
TP, AP	Target/actual position	$\boxed{2}$	Cylinder/axis length

Tab. B/7: Dimension reference system for pneumatic drives with absolute measuring system

The vectors a’ to e are user specifications provided these cannot be recognised (e. g. cylinder and measuring system length with the DGCI).

The axis zero point always has to be on the cylinder zero point! This is necessary because the controller requires the absolute piston position within the cylinder.

System of units for swivel modules

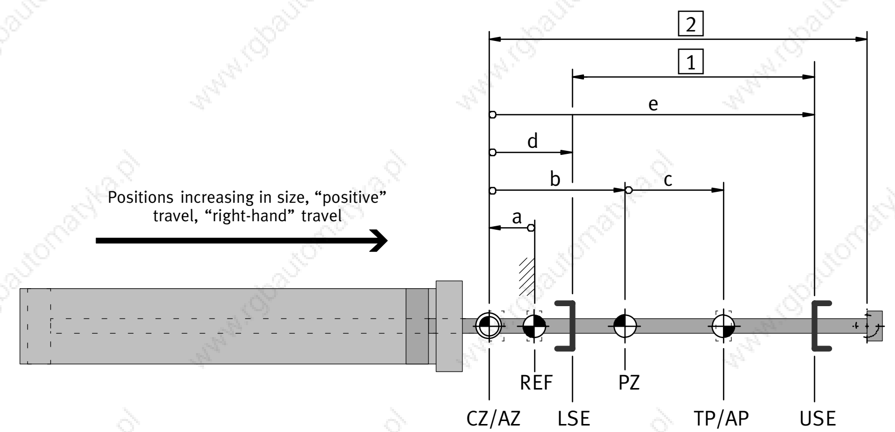


SZ	Sensor / measuring system zero point (sensor zero point)	a’	Offset axis zero point (distance AZ - SZ, “mounting offset”)
CZ	Cylinder zero point, stop		
AZ	Axis zero point	b	Offset project zero point
PZ	Project zero point	c	Offset target/actual position
LSE	Lower software end position	d, e	Offset software end positions:
USE	Upper software end position	1	Effective stroke
TP, AP	Target/actual position	2	Working stroke
SR	Stroke reserve, 5° with the DSMI	3	Nominal stroke

Tab. B/8: Dimension reference system for swivel modules

B.2.2 Dimension reference system with incremental measuring system

System of units with incremental measuring system



CZ	Cylinder zero point	a	Offset axis zero point offset (increm. sensor: to the reference point)
REF	Reference point, stop		
AZ	Axis zero point	b	Offset project zero point
PZ	Project zero point	c	Offset target/actual position
LSE	Lower software end position	d, e	Offset software end positions:
USE	Upper software end position	1	Effective stroke
TP, AP	Target/actual position	2	Cylinder/axis length

Tab. B/9: Dimension reference system for pneumatic drives with incremental measuring system (example of homing negative stop)

The axis zero point always has to be on the cylinder zero point! This is necessary because the controller requires the absolute piston position within the cylinder.
This means that the vector a must always be specified.

B.2.3 Calculating specifications for the measuring reference system

Point of reference	Calculation rule			
Axis zero point	AZ	= SZ + a’		
Project zero point	PZ	= AZ + b	= SZ + a’ + b	
Lower software end position	LSE	= AZ + d	= SZ + a’ + d	
Upper software end position	USE	= AZ + e	= SZ + a’ + e	
Target/actual position	TP, AP	= PZ + c	= AZ + b + c	= SZ + a’ + b + c

Tab. B/10: Calculating rules for the dimension reference system with absolute measuring systems

Note on absolute measuring systems

When calculating for drives with absolute encoding sensor (only pneumatic), the axis zero point refers to the sensor zero point (“mounting offset a’ instead of a) All other derived variables are identical.

Reference point	Calculation rule			
Axis zero point	AZ	= REF + a		
Project zero point	PZ	= AZ + b	= REF + a + b	
Lower software end position	LSE	= AZ + d	= REF + a + d	
Upper software end position	USE	= AZ + e	= REF + a + e	
Target/actual position	TP, AP	= PZ + c	= AZ + b + c	= REF + a + b + c

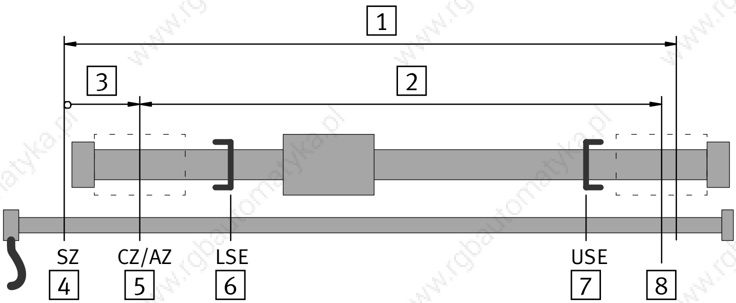
Tab. B/11: Calculation rules for the measuring reference system with incremental measuring systems

Note on incremental measuring systems

The ”offset axis zero point” must always be specified as a negative due to the definition of the axis zero point = cylinder zero point.

B.2.4 Software end positions / Hardware end positions

The software end positions may only be set within certain limits depending on the projected hardware. The parameters as shown in Fig. B/3 will be taken into account.



1	Measuring system length: PNU 1111
2	Cylinder length: PNU 1101
3	Offset to the axis zero point: PNU 1130
4	Measuring system zero point
5	Lower hardware end position = minimum permissible lower software end position
6	Lower software end position: PNU 501:01
7	Upper software end position: PNU 501:02
8	Upper hardware end position = maximum permissible upper software end position

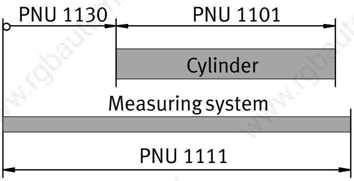
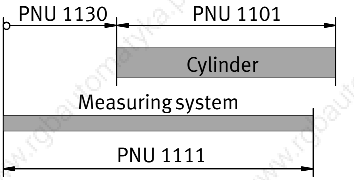
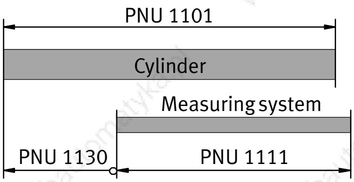
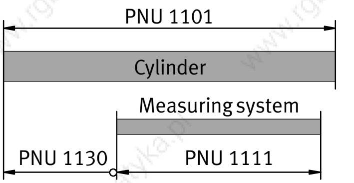
Fig. B/3: Parameters for software end positions

These limits result from the length of the measuring system and the cylinder as well as the mounting offset between the two. The mounting offset is given based on the offset of the measuring system zero point to the axis zero point.

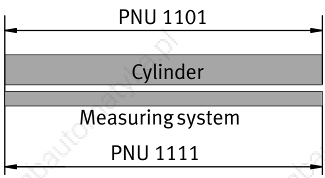
The two limit values are referred to as "hardware end positions". If the user sets both software end positions to 0, in order to deactivate them, all setpoint specifications are limited to the hardware end positions.

If position control is active, the set tolerance is taken into account, so that minor overswings when starting up the software end positions do not lead to an error.

Case distinction for external measuring systems

Layout	Description
	**The sensor projects above the cylinder on both sides** Offset to the axis zero point: PNU 1130 >= 0 PNU 1130 + PNU 1101 <= PNU 1111 → Min. permissible lower software end position = 0 Max. permissible upper software end position = PNU 1101
	**The cylinder projects above the sensor at the end** Offset to the axis zero point: PNU 1130 >= 0 PNU 1130 + PNU 1101 > PNU 1111 → Min. permissible lower software end position = 0 Max. permissible upper software end position = PNU 1111 - PNU1130
	**The cylinder projects above the sensor at the beginning** Offset to the axis zero point: PNU 1130 < 0 | PNU 1130 | + PNU 1111 >= PNU 1101 → Min. permissible lower software end position = | PNU 1130 | Max. permissible upper software end position = PNU1101
	**The cylinder projects above the sensor on both sides** Offset to the axis zero point: PNU 1130 < 0 | PNU 1130 | + PNU 1111 < PNU 1101 → Min. permissible lower software end position = | PNU 1130 | Max. permissible upper software end position = | PNU 1130 | + PNU 1111

Integrated measuring systems

Layout	Description
	**Cylinder and sensor fully cover each other** DGCI: Offset to the axis zero point: PNU 1130 = 0 DNCI: Offset to the axis zero point: PNU 1130 <= 0 PNU 1111 = PNU 1101 → Min. permissible lower software end position = 0 Max. permissible upper software end position = PNU 1101

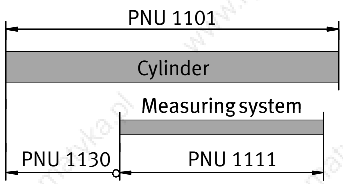
Configuration using FCT

As a specification, the software end positions in FCT are deactivated.

The specification of PNU 501:01 = PNU 501:02 = 0 will deactivate the software end positions. However, the CMAX limits setpoint specifications to the maximum or minimum permissible end positions.

With the DGCI, the axis zero point cannot be edited.

Numerical example

Layout	PNU	Description	Value
	1130	Offset axis zero point	25.5 mm
	1111	Length of the measuring system	280 mm
	1101	Length of drive	350 mm

The CMAX calculates the following limit values for the two end positions:

PNU	Description	Minimum	Maximum
501:01	Lower hardware end position, minimum lower software end position	25.5 mm	< upper software end position
501:02	Upper hardware end position, maximum upper software end position	> lower software end position	280 - 25.5 = 254.5 mm

B.3 Drives and measuring systems

The CMAX supports the following combinations of drive and measuring system types.

Selecting a different combination is not possible in the FCT and will lead to an error in the CMAX.

DGCI linear drive

Parameter	Value
Measuring system type	Prescribed: = Digital position measuring system
Cylinder length	Nominal length/effective length
Measuring system length	Prescribed = cylinder length
Offset axis zero point	Prescribed = 0
Cylinder diameter	Selection: 18, 25, 32, 40, 50, 63, 80, 100, 125 [1)]
Piston rod diameter	0

1) In the CMAX drives with smaller or larger diameters will lead to errors here. A DGCI with a diameter of e.g. 57 mm would be permissible, however.

Standard cylinders DNCI

Parameter	Value
Measuring system type	Prescribed: = encoder
Cylinder length	50 mm ... 10,000 N
Measuring system length	Prescribed: = cylinder length
Offset axis zero point	Selectable within the cylinder length
Cylinder diameter	Selection: 32, 40, 50, 63, 80, 100, 125 [1)]
Piston rod diameter	Smaller than cylinder diameter

1) In the CMAX cylinders with smaller or larger diameters will lead to errors here. A DNCI with a diameter of e.g. 57 mm would be permissible, however.

Swivel module DSMI	
Parameter	**Value**
Measuring system type	Prescribed: = Potentiometer
Cylinder length	= 270° ... 275°
Measuring system length	Prescribed: = 290°
Offset axis zero point	Selectable within 5° ... 15°
Cylinder diameter	Selection: 25, 40 [1)]
Piston rod diameter	0

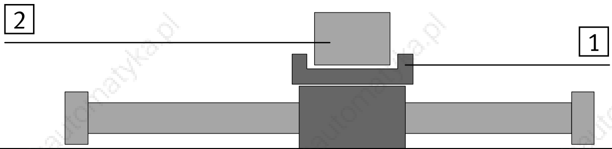
1) In the CMAX drives with other diameters will lead to errors here.

Rodless linear drive / Piston rod drive	
Parameter	**Value**
Measuring system type	Selectable: 1. Potentiometer 2. Digital position measuring system
Cylinder length	50 mm ... 10,000 mm
Measuring system length	50 mm ... 10.000 mm
Offset axis zero point	within the max. positioning range [1)]
Cylinder diameter	12 mm ... 200 mm
Piston rod diameter	Rodless linear drive: 0 Piston rod drive: smaller than cylinder diameter

1) max. positioning range: stroke between the hardware end positions. The hardware end positions describe the range where cylinder and sensor overlap, i.e. where the piston can actually move. However, the max. positioning range must always be larger than 5 mm.

B.4 Taking into account the load

The controller of the CMAX needs the specifications concerning the moving masses to be as precise as possible. This must be taken into account by means of special parameters, see Tab. B/12.

Parametrising the masses	
	
1	**Moving mass without workpiece (PNU 1142)** This is the mass of the loading device fixed to the slide. This mass must always be moved by the drive (minimal mass to be moved).
2	**Workpiece mass (PNU 605)** If the drive also has to move workpieces of different weights, this variable share must be defined as workpiece mass. The CMAX calculates the sum of both mass data for every positioning process. Parameter 605 is also the default value for the record list.
–	**Status when switching on (PNU 1143:01)** If a controller is enabled, the last valid workpiece mass is always used. After the first enable after switching on, usually no workpiece is loaded, so CMAX only takes into account the basic mass without a workpiece (PNU 1142). This parameter defines whether the workpiece should also be taken into account when switching on. 0 = Workpiece not loaded when switching on. The workpiece is only loaded during operation. 1 = When switching on, the workpiece is already in the loading device.

Tab. B/12: Parameter concerning the load

Example: Only workpieces of the same mass are transported. The workpieces are pushed from pos 1 to pos 2, the drive returns empty. For the return stroke, the workpiece mass is specified as = 0 in the record list.

B.5 Basic information on position control

The basis for control of the pneumatic axes is a model control path stored in the CMAX. This model assumes a pneumatic axis which is built up in accordance with specifications, e.g. with regard to:

- the compressed air provided
- the valve-cylinder combination used
- the permitted mass load
- tube sizes and lengths, etc.

The basic parameters of this control path are:

- the axis and application data,
- internal data ascertained by the identification and by adaptation.

Identification

During commissioning, variables such as the maximum achievable speed, acceleration ability, static friction and valve characteristics are ascertained based on a dynamic and static identification travel.

Adaptation

With adaptation, the positioning behaviour is continuously monitored during operation. Internal controller data is adapted here to the actual state of the axis, e.g. in order to compensate for system wear etc. during the service period.

Auto-profile

With auto-profile positioning, setpoint value curves for path, speed and acceleration are generated by the CMAX. These should enable reproducible, fast and overswing-free movement towards the setpoint position.

Unassigned profile

When positioning with unassigned profile, the setpoint value curves are calculated on the basis of the setpoint values programmed by the user for position, speed and acceleration.

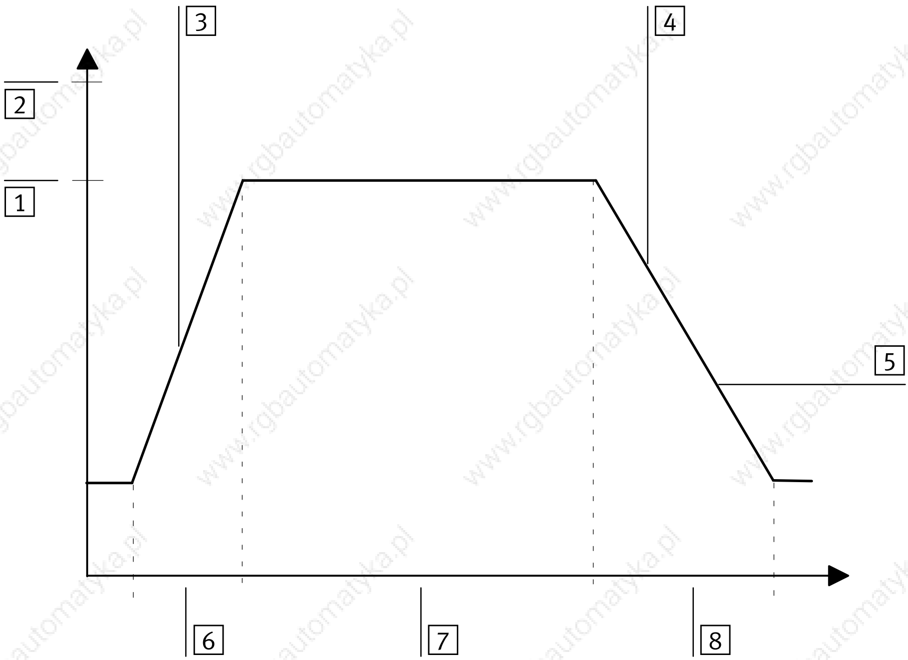
The setpoint positioning time is the sum of the individual times of the following phases (see Fig. B/1):

– Acceleration phase

– Braking phase

– Phase of consistent movement

Note that the programmed speed and acceleration values are automatically limited to implementable values depending on the positioning stroke. The implementable maximum values are ascertained by the CMAX individually for each axis during the identification travel.



1 Programmed speed

2 Identified maximum speed

3 Acceleration ramp

4 Deceleration ramp

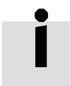
5 Setpoint value curve with unassigned profile

6 Acceleration phase (t1)

7 Consistent movement (t3)

8 Braking phase (t2)

Fig. B/1: Speed setpoint value curve, unassigned profile



With dynamic identification, the maximum speed and the maximum acceleration values of the positioning system concerned are ascertained. These cannot be exceeded when using the free profile either.

Phases of a positioning process	Calculation formulae	Description
Acceleration phase	$t_1 \square \frac{v}{a_1}$	v = programmed speed a_1 = acceleration for acceleration ramp a_2 = acceleration for braking ramp t_1 = approach time t_2 = braking time t_3 = time with constant speed s_1 = approach path s_2 = braking path s_3 = path with constant speed s_{ges} = complete path
	$s_1 \square \frac{a_1}{2} \square t_1^2$	
Braking phase	$t_2 \square \frac{v}{a_2}$	
	$s_2 \square \frac{a_2}{2} \square t_2^2$	
Consistent movement	$s_3 \square s_{ges}\text{-}(s_1 \square s_2)$	
	$t_3 \square \frac{s_3}{v}$	

B.6 Optimisation of the mechanical structure and the pneumatic installation

Check the system structure:

- Check whether using a greater basic load (mass without workpiece) improves the behaviour.
- Check whether the mechanical connections:
  - Drive – moving mass,
  - Drive – measuring system,
  - Drive – machine frame

  are backlash-free.
- Check whether the pneumatic installation fulfils the demands listed in the CMAX system description. Make sure especially that the supply pressure is stable, that the tubing is of the correct length and diameter and that the correct screw connectors are used.

B.6.1 Proceed as follows if the compressed air supply is unstable:

If your compressed air supply does not reliably fulfil the requirements (tolerance of +/- 1 bar in operation), although a compressed air reservoir has been installed (see CMAX system description), the maximum values for acceleration and deceleration ascertained during identification may, under circumstances, not be reached.

This may result e.g. in overswing, if the supply pressure required for deceleration is not available.

In order to avoid such overstressing, you can reduce the dynamics of the system. In order to do this proceed as follows:

1. Ascertain the lowest static supply pressure available for positioning in your compressed air network.
2. Lower the supply pressure statically to this level.
3. Now carry out the dynamic identification travel again.
4. When system identification is concluded, increase the supply pressure again to the value set in the application data.

B.7 Optimisation of the controller

From the basic parameters the CMAX ascertains various controller parameters. These determine the dynamics (speed) as well as transition behaviour (cushioning) of the controller. The aim is to guarantee fast, overswing-free positioning with little contouring error (dynamic deviation).

The controller factors are standardised to 1.0 by the CMAX. If the factors are increased (>1), the parameters will be increased accordingly; if the factors are reduced (<1), the parameters will be reduced accordingly.
The controller data ascertained by the CMAX are usually the optimum values. The (real) pneumatic axes used, however, do not always correspond to the axes used as a basis for the control process (ideal axes). In order that possible deviations can be taken into consideration, you can influence the control parameters by entering factors.

B.7.1 Description of the controller factors for position control

i

Further instructions on optimising the positioning behaviour can be found in section B.7.2.

Amplification gain

With the amplification gain you can influence the sensitivity with which the positioning control circuit reacts to modifications of the “variables” (position, speed, acceleration).

Behaviour of the axis	**Factor**
The drive tends towards instability (tendency to vibrate during positioning, up to continuous vibration around the setpoint position).	Reduce
Bad positioning accuracy or high contouring error as well as long positioning time.	Increase
The positioning process is carried out quickly and accurately.	Optimal

Cushioning factor

Cushioning is a measure for the transition behaviour of the system from the actual to the setpoint status, especially when there are fast modifications to the setpoint value. As a rule the system should guarantee low-vibration behaviour with setpoint specifications and movement into the target position without overswing.

By modifying the factor for cushioning, you can influence the transition behaviour of the system.

Behaviour of the axis	Factor
Bad positioning quality, setpoint position is approached only slowly (underswing).	Reduce
The drive tends towards instability (tendency to vibrate during positioning, up to continuous vibration around the setpoint position, heavy overswing).	Increase
The positioning process is carried out quickly and accurately.	Optimal

Signal filter factor

Speed and acceleration are derived from the positioning signal and filtered to improve the signal quality. If in practice there is bad signal quality, e.g. due to electrical interference, filtering of the signal can be influenced by the signal filter factor.

If filtering is too strong it may destabilise control.

Behaviour of the axis	Factor
The drive tends towards instability (despite low gain and good cushioning).	Reduce
“Noise” or loud valve noises (observe gain; this may be too high).	Increase
The positioning process is carried out quickly and accurately, low valve noises.	Optimal

B.7.2 Optimize positioning behaviour

During identification the positioning behaviour is auto-optimised. If the quality of the positioning behaviour still does not fulfil expectations, proceed as follows:

– Check the parametrising (FCT).

– Check the controller settings.

Note
Incorrect parameters may destroy the drive.

- Be very careful when setting the parameters.

If fluctuations in pressure of over 1 bar occur in front of the proportional directional control valve, install a compressed air reservoir (see CMAX system description). Please observe the general installation instructions!

The following problems may typically occur during positioning:

– The axis stops prematurely on several occasions,

– Swinging around the setpoint position,

– Stability problem, higher-frequency swinging around the setpoint position,

– Overswing,

– Underswing.

However, before you begin to optimize the positioning behaviour of your axis, proceed at first as follows:

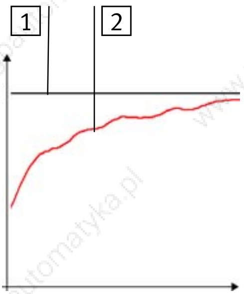
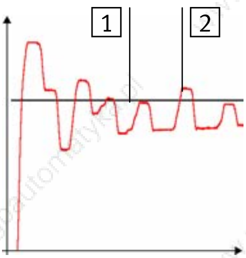
- Make sure that the pneumatic axis is designed in accordance with the regulations (see CMAX system description).
- Make sure that all axis and application data are set correctly.
- Always carry out the identification.
- Then always have several positioning cycles carried out. This is to guarantee that the adaptation is effective.

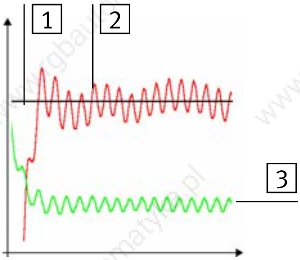
If problems still occur, proceed as follows:

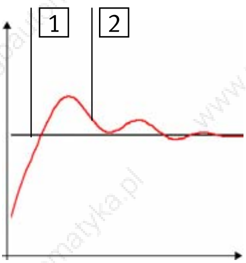
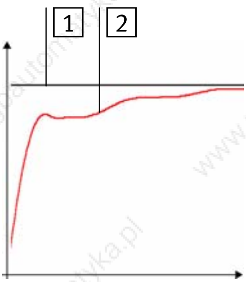
1. Observe the positioning behaviour. Use the FCT plugIn in this case. With the PlugIn you can record and graphically display setpoint and actual values for path, speed and acceleration, for example.

Detailed information on this can be found in the help for the CMAX PlugIn.

2. Compare the positioning behaviour or the graph compiled with PlugIn with the following examples.
3. In order to optimize the positioning behaviour, proceed as described in the table of the corresponding example. Check first from top to bottom the most probable causes and their remedial measures.

Effect	Cause	Remedy
Premature stop several times		
	– Identification not carried out – Adaptation not yet completed – Bad running behaviour of cylinder/guide (stick-slip) – Incorrect mass	• Carry out identification travel • Carry out some positioning cycles (adaptation) • Carry out test or maintenance or replace components • Correct mass
Swinging around the setpoint position with standstill times		
	– Identification travel not carried out – Incorrect mass load configured or programmed – High performance of cylinder (friction has changed) – Amplification gain set too low	• Carry out identification travel • Correct configuration or program • Carry out identification again • Correct the parameter
1 Setpoint position 2 Actual position		

Effect	Cause	Remedy
Stability problem, higher-frequency swinging around the setpoint position		
	– Incorrect mass load configured or programmed – Amplification gain set too high – Cushioning factor set too low – Signal filter factor set too high (smooth acceleration/ speed signal but continuous swinging) – or very noisy acceleration signal with high amplitude – Minimum mass load not reached – Too small tolerance demanded	• Correct the configuration • Correct the parameter • Correct the parameter • Reduce signal filter factor • Increase signal filter factor • Increase basic load • Increase tolerance
1 Setpoint position 2 Actual position 3 Speed		

Effect	Cause	Remedy
Overswing (no or minimum standstill time before MC)		
	– Reduction of the static supply pressure in operation below the permitted tolerance limit – Mass load too high (or configured mass load too low) – Overstressing (setpoint acceleration too high) – Signal filter factor set too high – Amplification gain set too high – Cushioning factor set too low	• Stabilize supply pressure or carry out new identification travel with low supply pressure (see section B.6.1) • Correct mass load • Reduce setpoint values (especially acceleration) or carry out dynamic identification travel (automatic limiting) • Correct the parameter • Correct the parameter • Correct the parameter
Overswing (no or minimum standstill time before MC)		
	– too high mass load entered (in some cases causes overdampened controller) – Overstressing (too high, “fast” setpoint values)	• Reduce mass load • Adapt setpoint values or carry out dynamic identification travel (automatic limiting)
1 Setpoint position 2 Actual position		

B.7.3 Description of the controller factors for force control

Amplification gain

The amplification gain is used to increase or reduce the control amplification.

- It makes the controller respond to deviations more slowly or faster. The time up to reaching the static final value can be optimised.
- The amplification gain is used to influence path accuracy over the entire force record.
- If this factor is increased too much, the valve starts to hum. This occurs especially with a static force setpoint and with standstill control.

Behaviour of the axis	Factor
Force builds up too slowly, the static accuracy is reached only hesitantly.	Increase
Overswing occurs during force build-up. The valve tends to hum.	Reduce
The force value follows the setpoint value with few deviations.	Optimal

Dynamic amplification

Dynamic amplification is only effective in the area of the force ramp, in other words when the force setpoint changes.

- It can be used to influence the path accuracy during the force ramp.
- A modification does not affect the static accuracy.

Behaviour of the axis	Factor
During force build-up the actual value cannot follow the setpoint value.	Increase
During force build-up the actual value runs ahead of the setpoint value.	Reduce
The force build-up is performed fast and accurately.	Optimal

Signal filter factor

Derived signals (e.g. force ramp from the pressure signal) are filtered to improve the signal quality.

– If filtering is too strong or too weak it may destabilise control.

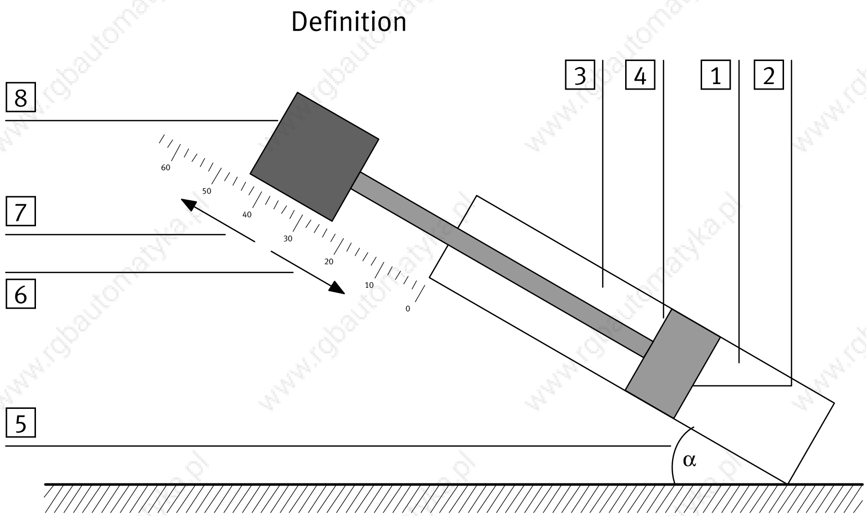
– The signal filter factor can be used to influence the signal noise that, originating from the pressure sensors, affects the force value.

– When increasing the factor, the filter becomes faster and consequently the noise louder. At the same time the phase shift decreases.

– If a valve hums as a result of an increase in the amplification gain, it usually helps to reduce the signal filter factor.

Reduce the signal filter factor to suppress valve humming. This may be necessary, for example, if the demanded control precision can only be achieved by increasing the amplification and if in that context the valve tends to hum.

B.8 Basic principles of force control/standstill control



Cylinder chamber 1:

1 Chamber pressure p_1

2 Piston surface A_1

Cylinder chamber 2:

3 Chamber pressure p_2

4 Piston surface A_2

5 Mounting position (α)

6 Position values become smaller,
Force values become smaller
(Prefix –)

7 Position values become larger,
Force values become larger
(Prefix +)

8 Moving mass

Fig. B/2: Reference values for force control

Force during force control	
$F \square p_1 \square A_1 - p_2 \square A_2 - g \square m \square \sin\alpha$	
P_1	Pressure in cylinder chamber 1: no piston rod, on measuring system zero point (smaller position values, blue connection)
P_2	Pressure in cylinder 3, poss. piston rod, on measuring system end (larger position values, black connection)
A_1, A_2	The two piston surfaces of the cylinder: they are calculated by the CMAX based on the cylinder type and cylinder diameter. The controller knows the piston rod diameters of Festo cylinders. If the cylinder type is not known, the diameter of the piston rod can be entered with the help of the FCT. The piston rod diameter is taken into account during force control.
g	Acceleration due to gravity
m	is the mass to be moved (workpiece mass + tool mass). Like with all other positioning tasks, the workpiece mass is either taken directly from the record or from the settings for direct operating (PNU 53x) or the project data (PNU 1142).
α	is the angle of the mounting position of the axis, it can be taken from the project data.

Tab. B/13: Definition of the force for force control

The controlled force is the force at the piston minus the gravitational force of the moving mass. The force applied to the slide or the piston rod deviates from this due to friction forces.

B.8.1 Influence of the mass on force control

The moving mass consists of the workpiece mass and the tool mass (or basic load). Often the exact basic load is not known.

$m = m_{total} = m_{current\ tool\ mass} + m_{current\ workpiece\ mass}$

As with any other positioning process, the workpiece mass needs to be specified for the identification, too.

$m_{ident.} = m_{tool\ mass\ ident.} + m_{workpiece\ mass\ ident.}$

During static identification the controller identifies the force at which the drive is safely held at a standstill. It also determines the forces that are required to let the drive break away in both directions of movement. The mean value of these break-away forces is stored as the standstill force in the identification data.

If you do not take into account the friction forces, the standstill force F_0 must only just compensate the force due to weight of the moving mass:

$F_0 = p_{01} * A_1 - p_{02} * A_2 = m_{ident.} * g * \sin \alpha$

The total mass m_{ident} specified during identification is also stored in the identification data.

During force control, the identified standstill force F_0 serves as basic value for the force to be controlled. It compensates the gravitational force and other external axial forces. Due to identification (i.e. measurement) of the standstill force F_0 , an error in the specification of $m_{ident.}$ leads to no error in force control.

If the user specifies different workpiece masses per record, the difference m_{delta} to the identification mass is taken into account and additionally compensated. The workpiece mass in the records should therefore be specified precisely, so that the standstill force can be tracked as best as possible.

$$m_{delta} = m_{current\ tool\ mass} + m_{current\ workpiece\ mass} - m_{ident.}$$

$$m_{delta} = m_{current\ tool\ mass} + m_{current\ workpiece\ mass} - (m_{workpiece\ mass\ ident.} + m_{workpiece\ mass\ ident.})$$

$$F_{piston} = F_{setpoint} + F_0 + m_{delta} * g * \sin\alpha$$

In the simplest case, the following applies:

$$m_{current\ tool\ mass} = m_{tool\ mass\ ident.}$$
$$m_{workpiece\ mass\ ident.} = 0\ kg$$

This simplifies calculation for:

$$m_{delta} = m_{current\ workpiece\ mass}$$
$$F_{piston} = F_{setpoint} + F_0 + m_{current\ workpiece\ mass} * g * \sin\alpha$$

What does this mean in terms of force control?

- It is not necessary for the mass m_{ident} specified during identification to be exact, since the force F_0 required for compensation is identified.
- If the drive is not mounted horizontally ($\alpha \neq 0°$), it is important to specify the mass changes precisely. Since the controller calculates a compensation force based on the specified mass, an error in the mass specification will lead to a systematic deviation from the force setpoint value $F_{setpoint}$.

  $$F_{piston} = F_{setpoint} + F_0 + (m_{delta} + m_{error}) * g * \sin\alpha$$

- Error F will then be:

  $$F = m_{error} * g * \sin\alpha$$

B.8.2 Influence of the mass on standstill control

After completion of a positioning task, on-the-fly switch-over from positioning control to force control occurs so as to ensure safe standstill of the drive. The standstill force F_{still}, to which controlling is done, corresponds to the force on the piston after the drive has reached its target position. It is tapped by the cylinder 200 ms after MC, the following applies:

$F_{still} = p_{1\text{-}200ms} * A_1 - p_{2\text{-}200ms} * A_2$
(p_1 and p_2 are the pressure values in the cylinder, 200 ms after MC)

If towards the end of the positioning process the actual force drifts so fast that it threatens to exceed friction hysteresis, then the system switches directly to standstill control without taking into account the delay time of 200 ms.

So in contrast to force control, standstill control is not based on calculated values that are dependent on configured mass values, but on force values measured at the end of the positioning process. Mass changes that are not specified in the positioning records, do therefore not affect the behaviour of the drive in the standstill position.

Warning: When positioning, the drive comes to a standstill within the static friction, so the standstill force can also vary in the area of static friction. So the force the FCT displays during standstill varies from stroke to stroke.

B.8.3 Behaviour of the force control

- A force task is treated like any positioning task.
- As soon as the force task begins, the MC signal goes to 0 level, when the force setpoint value has been reached, the MC signal =1. As long as there is no new positioning task, the axis remains in force control.
- With the force ramp, the user specifies the increase in force per time unit. The unit is [N/s]. The permissible value range is 10 N/s ... 10.000 N/s. The force ramp is appropriately restricted by the FCT.
- The force tolerance has the same function as the positioning tolerance for positioning.
- The sign of the force setpoint value determines the direction of force control:

  + : means force build-up towards increasing position values,

  –: means force build-up towards decreasing position values (measuring system zero point).
- The Stop signal (CCON.STOP = 0) ends a force task as quickly as possible. The system immediately switches back to position control, while in standstill position the setpoint position is set as = actual position.
- The FCT PlugIn supports the correct parametrisation of force control. It calculates the theoretical maximum force values, dependent on the cylinder (type and diameter).

The maximum force applied to the piston is referred to as nominal force F_N , and it is calculated as follows:

$F_N\,[N] = A_N * p_{operation}$

The maximum forces applied to the drive for both directions of movement are calculated as follows: With non-horizontal mounting position ($\alpha \neq 0$ for linear drives, refer to Fig. B/2) they are dependent on direction and mass:

$F_{max+}\,[N] = +\,0.9 * A_N * p_{operation} - m_{current} * g * \sin\alpha$

$F_{max-}\,[N] = -\,0.9 * (A_N - A_{KS}) * p_{operation} - m_{current} * g * \sin\alpha$

This contains the following user data:

$p_{operation}$ = supply pressure
A_N = nominal piston surface
(e.g. DNCI-25-...: $A_N = \pi / 4 * 0.025^2$)
A_{KS} = piston rod surface
$m_{current}$ = $m_{current\ tool\ mass} + m_{current\ workpiece\ mass}$
α = mounting position

The values for F_{max+} and F_{max-} are calculated in the controller. The controller limits the user data to these limit values and reports a fault if necessary.

Parameter	**Unit**	**FCT default**	**Minimum**	**Maximum**
Force tolerance	N	10	1	1.000
Force ramp	N/s	1.000	10	10.000
Speed limit value	mm/s	200	10 [1)]	500
Stroke limit value	mm	50	1 [1)]	10.000

[1)] The speed and stroke limit values can be deactivated for every force record, so entering 0 is not permissible.

- The controller contains appropriate default settings.
- During parameter download, the CMAX only checks the absolute limit values of the parameters. The parameters maximum setpoint force and tolerance are **not** limited dependent on other project data (cylinder diameter etc.).
- In the CMAX the controller limits the setpoint values to reachable maximum values. In this, the piston surface, the moving mass and the mounting position are taken into account. The limited values can be read from the controller and displayed in the same way as the limited acceleration values for position control.
- During force control, either the current position or the current force value in the PLC input data is transmitted. Switching over is done via PNU 523:08.
- If you want Stop to be carried out (CCON.STOP = 0) while the drive is pushing into a stop under force control, the system switches from force control to position control and adopts the current actual position as setpoint position. Since the drive is at a standstill, the tolerance is reached immediately, and transition to standstill control occurs. The force to which the drive controls in this case is specified by the actual force which can range between the last setpoint force and 0 N. If the drive is to be positioned force-neutrally after stop, a force record with 0 N should be executed before setting CCON.STOP = 0.

- A force task can always be started from a position-controlled or force-controlled status. Depending on the initial status, different types of behaviour are possible:
  - The axis is positioned force-controlled or position-controlled (MC=1): A new force task is started immediately.
  - The axis is carrying out a positioning task (MC=0): “On-the-fly change of controller”: the current positioning task is ended with the set stop ramp. As soon as the speed = 0, the force task is started. MC always remains = 0.
  - The axis is carrying out a force task (MC=0), the new force task has the same direction of force: “On-the-fly sequencing”: The new force task is started immediately. MC always remains = 0.
  - The axis is carrying out a force task (MC=0), the new force task has the opposite direction of force: “On-the-fly reversing”: The current force task is ended with a configured ramp, as soon as the force value reaches “0” the new force task is started. MC always remains = 0.

B.8.4 Behaviour of standstill control

After completion of a positioning task, position control is switched to force control to keep the drive at a standstill. Reversing does not occur at the time of reaching the standstill condition, but:

- 200 ms later or
- when the change in the actual force after reaching the standstill condition is more than 25% of the friction hysteresis.

The standstill condition has been reached if

- the tolerance has been reached once and
- the position error is within 70% of the permissible tolerance window and
- the speed is less than 4 mm/s and
- the chamber pressures are smaller than the supply pressure (especially in vertical operation with large masses, chamber pressures that are larger than the supply pressure may briefly occur).

If the drive leaves its tolerance window for standstill position during standstill control or if the speed exceeds 4 mm/s, then the position controller is activated to move the drive back to its target position. If the drive has reached the target position and the standstill conditions, standstill control is re-activated, provided one of the stated conditions for the delay time or force control is fulfilled.

B.8.5 Individual value mode

The individual value mode can be used in record select operating mode and in direct mode.

After the force command has started, the controller starts to build up the force according to the specified target force and force ramp.
If the drive is not faced with any counteracting force, the force initiates a drive movement. This can be the case when the workpiece is movable or yielding, or if there is no workpiece. If the drive exceeds the setpoint speed in this case, the controller automatically switches to position control (see section B.8.6). In this the hardware end position in the direction of force effect is used as the setpoint position and the setpoint speed of the record or the speed parameter in direct mode (PNU 406 or 554) is used as the speed.

If you want to prevent reversing to position control, the setpoint speed must be set to 0.000 m/s.

In order to prevent too much kinetic energy, the maximum permissible valueforthespeedislimitedto0.500 m/s.

Reversing to position control permits a workpiece to start moving. The typical process in an application is:

1. Record 1: Fast approach to a preliminary position near the workpiece (e.g. -10 mm)

2. Record 2: Start force control. The CMAX automatically switches to position control until the workpiece has been reached. This prevents strong acceleration of the drive in the event of “no workpiece”. The drive simply moves right up to the software end position or to the configured stroke limit and stops there.

With the help of record sequencing, it is possible to switch between position control and force control anytime.

If the axis is in the process of performing positioning, it is stopped first. Only then does force control begin.

1 Path

2 Force

3 Velocity

4 Feed phase (V_{vor})

5 Force ramp

6 MC

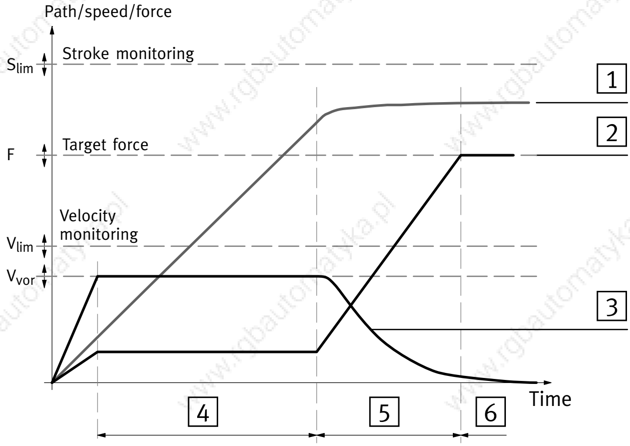


Fig. B/3: Force control process

The following options are permitted:

– Stroke and velocity monitoring can be activated or deactivated independently of each other for each record (default: activated). However, the limit values are global, i.e. apply to all records (changes possible in parametrising mode).

– V_{vor} can be deactivated by setting to 0.000 m/s, i.e. the axis moves force-controlled only. In extreme cases, the axis may move into the end position unbraked. If reversing was deactivated, limit monitoring is still active, provided it was not switched off as well.

– The force setpoint value may have the value 0 N.

Notes:

- Stroke monitoring and velocity monitoring are activated each time a force task is started, provided they have not been disabled by the user.
- Stroke monitoring and speed monitoring is also active after MC, i.e. delayed limit value violations are recognised.
- V_{lim} must always be sufficiently larger than V_{vor} in order to prevent velocity monitoring from being triggered during positioning.
  Recommendation: $V_{lim} = (2 \ldots 3) * V_{vor}$
- If limit monitoring responds, no matter whether stroke or velocity, the controller always changes to position control.
- If the axis reaches the target force once and when doing so fulfils the MC conditions, MC is set.
  MC then remains set until the next task is started, even if the target force is no longer present.

The monitoring functions are explained in detail in section B.8.10.

B.8.6 Position control during a force task

If during a force task the drive exceeds the setpoint speed V_{vor} in the active direction of the force, e.g. because the drive is still at a small distance to the workpiece and the drive starts to move due to the missing counteracting force, then the system switches to position control. This occurs independently of an MC being available or not. In this the hardware end position in the direction of active force direction is used as the setpoint position and the setpoint speed of the record or the speed parameter in direct mode (PNU 406 or 554) is used as the speed V_{vor}. The drive then moves at speed V_{vor} until high braking acceleration occurs (drive stops at a workpiece), a standstill is recognised (speed in force direction is smaller than 0.004 m/s for 20 ms) or the actual force reaches the specified target force after a delay time of at least 10 ms after reversing to position control. Then the force controller is again activated, the force is (further) built up with the set force ramp.

The monitoring functions configured for the force task (stroke, speed, software end positions) are active also during position control.

Position control is activated at the earliest 30 ms after the force task starts (as a result of positive edge at CPOS.START or start due to record sequencing). This time is required for transient effects. Until then the force controller is always active.

Preventing position control

If the user wants to prevent reversing to position control, the setpoint speed must be set to 0.000 m/s. This deactivates the position control during a force task.

B.8.7 Force ramp

When a force task starts, calculation of a ramp-shaped signal is started as the basis of the force control setpoint specification. This signal begins with the actual force at the start of the force task and runs linearly to the pitch of the force ramp up to the desired force setpoint value.

A constantly differentiable force setpoint value is an advantage for optimisation of the controller behaviour, which is why the force ramp is replaced with a $\sin^2$ function which runs through the same force stroke within the same time. Since the $\sin^2$ function starts and ends its course with the pitch 0, this results in a higher maximum pitch than with the force ramp. The maximum pitch of the $\sin^2$ function is at the turning point, and it is larger by Pi/2 there than at the force ramp.

When moving to a stop or a facility that generates the corresponding counteracting force, the setpoint force is possibly reached immediately. In this case, force build-up with the force ramp can therefore not occur.

1 Setpoint force final value
2 Setpoint force ramp
3 Setpoint force, smoothed with $\sin^2$
4 Actual force
5 Start value

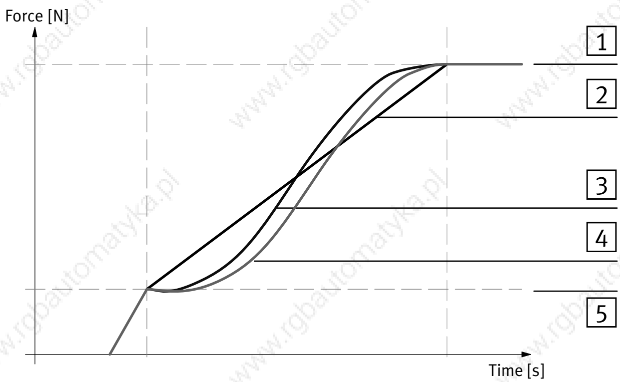


Fig. B/4: Force ramp

B.8.8 Controller amplifications

The possible controller amplifications in the context of force control depend on the design of the pneumatic system. An unnecessarily long tubing connection has a negative effect, the system may then tend to hum. Exchanging the valve may also result in differences in the control behaviour.

The controller amplifications are calculated based on the parameters that describe the pneumatic system. Due to tolerances, the default controller amplifications do not produce the same control quality with all systems. Three parameters are available for optimisation:

– Amplification gain

– Dynamic amplification

– Signal filter factor

The gain factor is used to increase the control amplification. It makes the controller respond to deviations more strongly and faster. If this factor is increased too much, the valve starts to hum. This occurs especially with a static force setpoint and with standstill control. This humming can be reduced by varying the signal filter factor or reducing the amplification.

Dynamic amplification is only effective in the area of the force ramp, in other words as long as the force setpoint value is changing. This parameter is suitable for improving the truth to path in the area of the ramp, when amplification cannot be further optimised.

The signal filter factor can be used to influence the noise of the pressure signals. When increasing the factor, the filter becomes faster and consequently the noise louder. At the same time the phase shift decreases.

B.8.9 Influence of the static identification on force control

Key parameters for force control are determined during static identification. These are:

- Friction hysteresis
- Standstill force F_0

If no static identification is carried out, these parameters will be assigned default values. The control quality is limited in this case, and the following effect may occur:

- The real standstill force deviates from the calculated default value. This may lead to uncontrolled force control behaviour.
  With non-horizontal applications, the default value for the standstill force can be influenced via the mass. The default value is set correctly if, in a force record with 0 N and speed and stroke monitoring switched off, the drive is at a standstill and can be moved in both directions by manually applying approximately the same force.

B.8.10 Monitoring function

With active force control, there are three permanent monitoring functions: Stroke monitoring, speed monitoring and monitoring of the software end positions. In the event of an error, the CMAX responds as follows:

- the message is added to the diagnostic memory as a fault,
- position control is activated and the axis is stopped,
- after the standstill, the CMAX changes to “Fault” or “Ready” status,
- depending on the fault, the bit SDIR.XLIM / SDIR.VLIM or RSB.XLIM / RSB.VLIM is set. These bits are reset with the reset command,
- in the event of stop, disable and fault, all of the monitoring functions are deactivated.

Stroke monitoring

With the starting edge, the CMAX remembers the current actual position as the starting position. With each controller cycle, stroke monitoring checks the path (stroke) covered since the last start.

Stroke = | actual position (current) - actual position (starting edge) |

If the actual position changes by a larger value than the parametrised stroke limit value (PNU 510) while a force command is being executed, error E38 is indicated and the bit SDIR.XLIM (direct mode) or RSB.XLIM (record select mode) is set.

Notes:

- The starting position is always the actual position on the starting edge, so the stroke limit value also comprises the stroke during the speed control of a force task.
- If the task is started by record sequencing, the starting position is the actual position at the time of reversing.
- If the stroke limit value is outside of the software end position, reaching the software end position has priority. The stroke limit value does not deactivate the software end position.
- If CDIR.XLIM or RCB1.XLIM is set, stroke monitoring is deactivated.

Speed monitoring

Velocity monitoring is activated each time a force task is started, provided it has not been disabled by the user. It is also active after MC, i.e. delayed limit value violations are recognised.

The maximum permissible velocity V_{lim} (PNU 514) must always be greater than the setpoint velocity V_{vor} (PNU 406 or 554).v

If, during activated force control, the velocity limit V_{lim} is exceeded, the axis is stopped and error message E39 is issued. SDIR.VLIM or RSB1.VLIM is set.

Monitoring can be deactivated by setting CDIR.VLIM or RCB1.VLIM.

Monitoring of the software end positions

If a software end position is reached during force control, the axis is stopped and a fault is reported. Setting both software end positions = 0 deactivates this monitoring.

MC (Motion Complete)

In compliance with the MC conditions, Motion Complete reports that the setpoint force has been reached.

Under unfavourable conditions during force control, the break-away force may result in the MC condition being fulfilled even at the beginning of the task. Here the criteria for the MC condition can be influenced via the parameters monitoring time, tolerance etc.

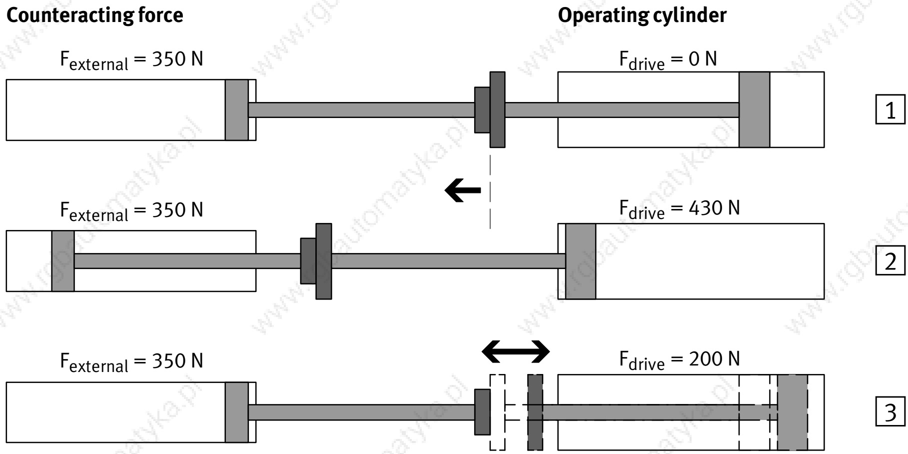
B.9 Notes on application, special operating statuses

B.9.1 Changing an external force

Changes in an external force may cause vibration or even bouncing on a stop.

Example:

- Cylinder1: DNCI-32-250 horizontal 16 kg
- Cylinder2: for counteracting force from 160 mm of approx. 350 N constant



1 1st record: F = 430 N --> Cylinder1 moves cylinder2 until cylinder1 is in the stop.

2 2nd record: F = 200 N --> Cylinder2 moves cylinder1 out of the stop to position 160 mm.

3 --> This causes bouncing with 2 to 3 impacts.

Explanation:
Cylinder1 has kinetic energy during transition from the fault force. The setpoint force counteracts the direction of movement, the inert system needs to be braked and accelerated in the opposite direction. Then the inert mass hits an elastic stop.

Configuration with CPX node

Appendix C

Contents

C.1 CPX-FB13

General information on the CPX-FB13 are found in the description on the P.BE-CPX-FB13-...

C.1.1 General configuration information

Identifier

Module (order code)	Module identifiers	Occupied bytes	Identifier Siemens / EN 50170
CPX-CMAX-C1-1 (T21)	CMAX	8 bytes I, 8 bytes O	192 / $C0_h$, 87_h, 87_h

Device master file (GSD file) and icon files

Sources of supply

Current GSD files and icon files can be found on the Festo Internet pages at:

➔ www.festo.com ➔ Downloads ➔ Download Area: Software, drivers and firmware ➔ Enter string: CMAX or GSD

GSD file

You will require one of the following GSD files for the CPX terminal with the CMAX:

- Cpx_059e.gsd (German version)
- Cpx_059e.gse (English version)

Depending on the configuration program used, install the GSD file and the icon files with the aid of the appropriate menu command or copy the files manually into a particular directory of your peripheral/PC.

C.1.2 Configuration with STEP 7

This description refers to software version V 5.3.

An appropriate device master file (GSD file) must be installed for configuration.

Proceed as follows for configuration (see Fig. C/1):

1. Add a DP master system $\boxed{1}$ and the CPX terminal $\boxed{2}$ to the CPX-FB13, as per the description.

2. Fill the configuration table with the modules of your CPX system.
   Open the module "Festo CPX terminal" (folder\PROFIBUS-DP\Additional FIELD DEVICES\Valves\...) in the hardware catalogue. $\boxed{3}$.
   There are two entries for the CMAX:

Entry	Description
CPX-CMAX-C1-1 [8 Byte I/8 Byte O]	CMAX with 8 byte I / 8 byte O consistent, **without** Failsafe parameters (occupies 5 byte parametrising data) [1)]
CPX-CMAX-C1-1 [8 byte I/8 byte A Failsafe]	CMAX with 8 byte I / 8 byte O consistent, **with** Failsafe parameters (occupies 15 byte parametrising data) [1)]

[1)] The maximum number of parametrisation data for the CPX terminal is limited to 234.

3. Assign each of the starting addresses in the "Properties - DPslave"window $\boxed{4}$.

This concludes the station selection and configuration.

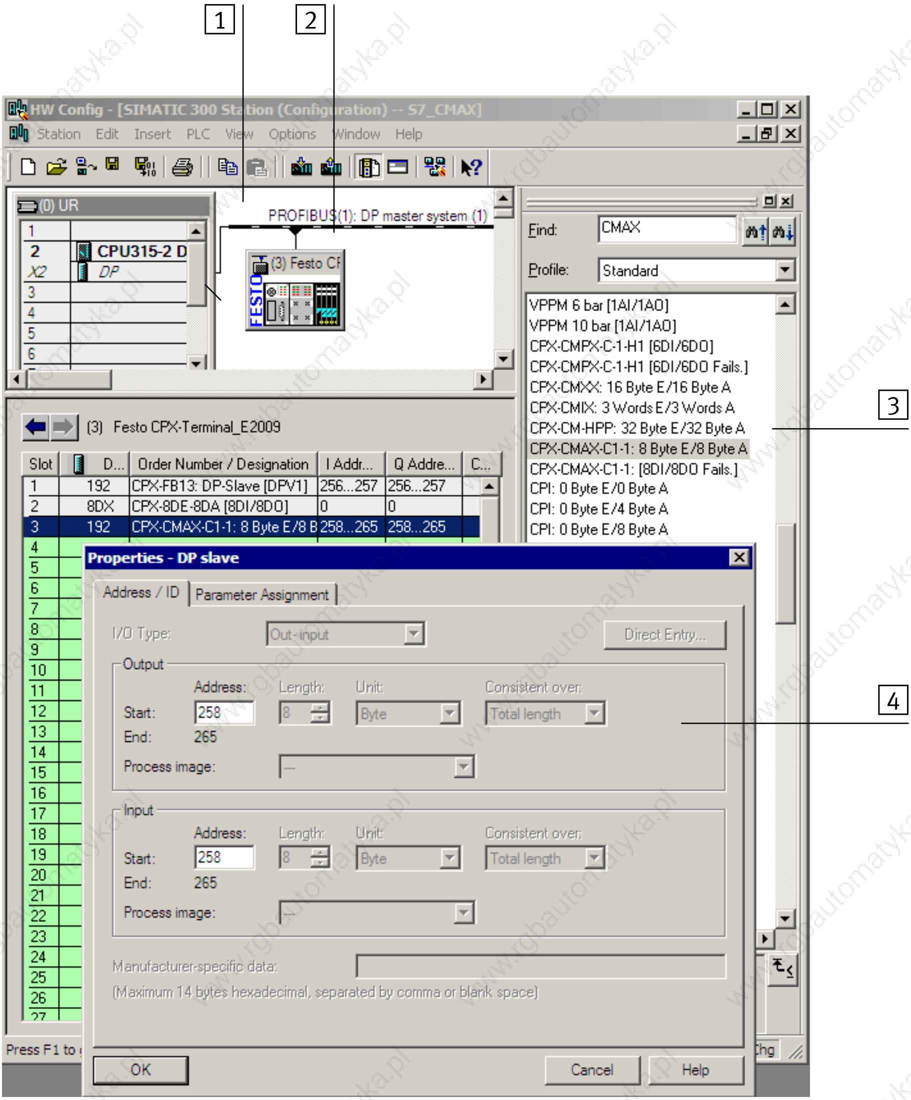


Fig. C/1: Configuration with STEP7 – Hardware catalogue

C.1.3 Start parametrisation

When setting the “System start with default parametrisation (factory settings) and current CPX structure” CPX system parameter, the parameters stored at the master are transferred to the CPX-FB13.

Observe the general instructions in section 1.3.

Start parametrisation

1 Master loads the start parameter set into the node

2 The node distributes parameter set to the modules

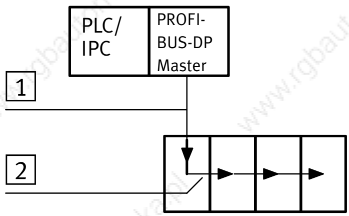


Fig. C/2: Sequence of start parametrisation

When the field bus system is switched on, the CPX terminal is parametrised as “Start parametrising” by parameter set 1 saved in the PROFIBUS master. The field bus node then distributes the parameters module-orientated to the CPX modules 2.

Note
The number of start parameters is limited, depending on the software version of the CPX-FB13. Observe the notes in the description for the CPX-FB13.

Note
After each interruption of the field bus system (e.g. after interruption of the power supply to the field bus node), the start parameter set will be sent again by the PROFIBUS master to the fieldbus node.

Note
CPX terminals with the CMAX **always** require new parametrisation and commissioning after exchanging the CPX terminal or the CMAX, since the parameters and the data ascertained during commissioning are only stored in the CMAX, see section 1.1.2.

The CMAX cannot be parametrised via the start-up parametrisation. This must always be done via the FCT or via the special parametrisation function.

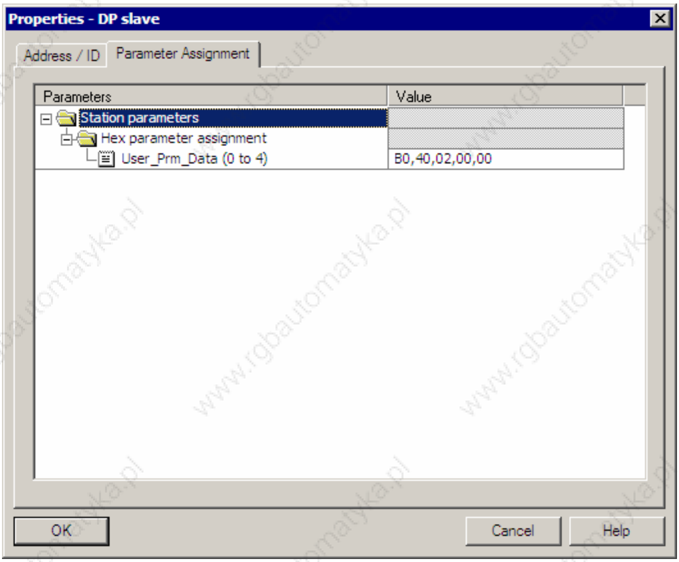


Fig. C/3: No specific parameters

Data format

The CMAX evaluates the setting for the data format of analogue values (32 bit values) of the CMX-FB13, see section 1.2. Please take this into account in your application programs.

Fail Safe parametrising

Check your application to see if Fail Safe parametrisation is required.

Example

In the example as per Tab. C/1, the drive should be stopped and the brake activated (emergency stop).
The brake is high-active and the controller is enabled.

Allocation		**CMAX inputs — Module output data**					
Bit	**Value**	**CCON**	**Value**	**CPOS**	**Value**	**Control bytes 2 ... 8**	**Value**
0	1	**ENABLE = 1**	**1**	HALT = 0	0	- (no function, all = 0)	0
1	2	**STOP = 0**	**0**	START = 0	0		0
2	4	**BRAKE = 1**	**1**	HOM = 0	0		0
3	8	RESET = 0	0	JOGP = 0	0		0
4	16	– (reserved = 0)	0	JOGN = 0	0		0
5	32	LOCK = 0	0	TEACH = 0	0		0
6	64	OPM1 = 0	0	CLEAR = 0	0		0
7	128	OPM2 = 0	0	– (reserved = 0)	0		0
Fault mode mask		**Value for channel 0**	**5**	**Value for channel 1**	**0**	**Value for channels 2 ... 8**	**0**

Tab. C/1: Fail Safe parametrising example

For the values to take effect, the “Fail Safe” setting for the affected channel must be set to “Fault Mode”. The byte values as per Tab. C/1 must be entered into the “F ault Mode Mask” for the corresponding channel.

This results in a parametrisation as per Fig. C/4.

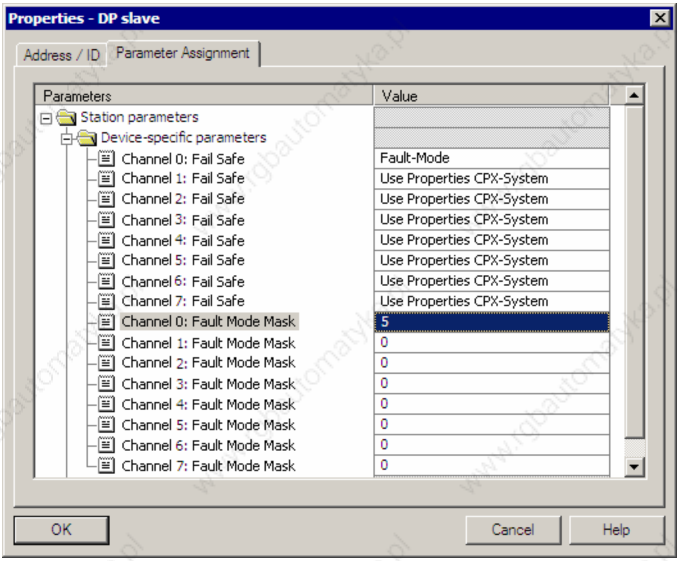


Fig. C/4: Fail Safe parametrising

i In order for the settings to take effect, the global system parameter must be set to “Output fault mode”.

C.1.4 Addressing

Example: Addresses used as from input/output word 7

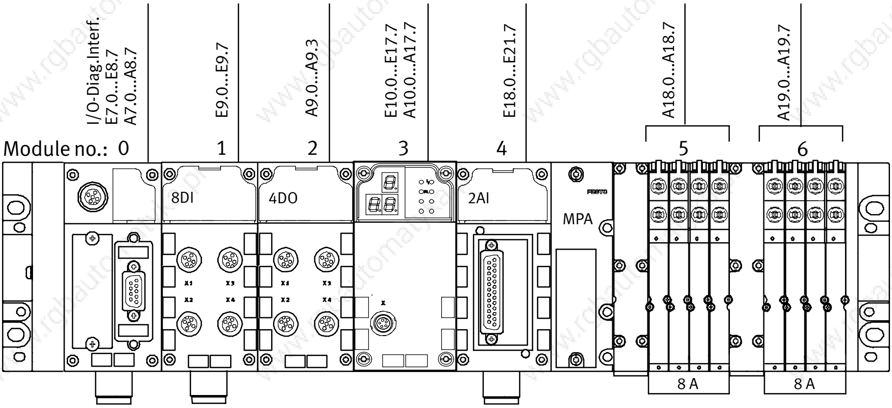


Fig. C/5: CPX-FB13 address assignment example

No.	Module	DP identifier Siemens	Addresses	
			Input address	Output address
0	CPX-FB13 (FB13: DPV1, I/O-Diag.Interface)	192	7 ... 8	7 ... 8
1	8-way digital input module (E: CPX-8DE)	8DE	9	–
2	4-way digital output module (A: CPX-4DA 2x)	8DA	–	9
3	Axis controller CMAX (CPX-CMAX-C1-1), For assignments, see Tab. C/3	192	10 ... 17	10 ... 17
4	Analogue input module (A: CPX4AE-I)	2AE	18 ... 21	–
–	MPA pneumatic interface (passive module)	–	–	–
5	MPA1 pneumatic module (VI: VMPA1-FB-EMS-8)	8DA	–	18
6		8DA	–	19

Tab. C/2: Input and output addresses for the example, see Fig. C/5

Example of address assignment (record selection)

Module output data			Module input data		
AB	**Contents**	**Address**	**EB**	**Contents**	**Address**
AB10	CCON: Bit Name 0 ENABLE 1 STOP 2 BRAKE 3 RESET 4 – (reserved) 5 LOCK 6 OPM1 **= 0** 7 OPM2 **= 0**	 A10.0 A10.1 A10.2 A10.3 A10.4 A10.5 A10.6 A10.7	EB10	SCON: Bit Name 0 ENABLED 1 OPEN 2 WARN 3 FAULT 4 24VL 5 FCT_MMI 6 OPM1 **= 0** 7 OPM2 **= 0**	 E10.0 E10.1 E10.2 E10.3 E10.4 E10.5 E10.6 E10.7
AB11	CPOS: Bit Name 0 – (reserved) 1 START 2 HOME 3 JOGP 4 JOGN 5 TEACH 6 – (reserved) 7 – (reserved)	 A11.0 A11.1 A11.2 A11.3 A11.4 A11.5 A11.6 A11.7	EB11	SPOS: Bit Name 0 – (reserved) 1 ACK 2 MC 3 TEACH 4 MOV 5 DEV 6 STILL 7 REF	 E11.0 E11.1 E11.2 E11.3 E11.4 E11.5 E11.6 E11.7
AB12	Record No.	A12.0 ... 7	EB12	Feedback record no.	E12.0 ... 7
AB13	Reserved	A13.0 ... 7	EB13	RSB: Bit Name 0 RC1 1 RCC 2 COM1 3 RCE 4 VLIM 5 XLIM 6 – (reserved) 7 – (reserved)	 E13.0 E13.1 E13.2 E13.3 E13.4 E13.5 E13.6 E13.7
AB14 AB15 AB16 AB17	Reserved	A14.0 ... 7 A15.0 ... 7 A16.0 ... 7 A17.0 ... 7	EB14 EB15 EB16 EB17	Primary actual value (int32)	E14.0 ... 7 E15.0 ... 7 E16.0 ... 7 E17.0 ... 7

Tab. C/3: Addresses of the CMAX control and status bytes in the example Fig. C/5

If the actual values are supposed to be treated as marker double-words, the byte structure must be taken into account according to the CPX parameter “Data format for analogue values...”, see section 1.2.

C.1.5 Acyclical parametrisation with DPV1, parameter READ/WRITE

When using the FB13, there are two ways of accessing the data.

- A direct task for reading/writing the module parameters is possible, but only for modules 0...9 (data record number (FB52/53) = 5 + 72 + 15*module number)
- Generally valid is an indirect task via the command box, which has the additional advantage of being able to write the data as of a certain offset. In this way the bytes 0...7 from the startup parametrisation do not have to be over-written (slot = 100 + module number; index = 21)

Further information on acyclical parametrisation can be found in the P.BE.CPX-FB13-... description

General access via command box

Slot 3: Indexed addressing of the objects				
Index	**Name**	**Length [byte]**	**Access**	**Record number (Siemens)**
16	Command box	4	r/w	9
17	Read Box	64	r	10
18	Write Box	64	w	11

Command box: Access to CMAX module parameters				
Byte	**1**	**2**	**3**	**4**
Contents	Slot no.	Index module data	Offset data	–
CMAX	100 + module number	21	8	0

Sequence:

1. Ensure that the command box is currently not being used. In case several modules are parametrised via the command box in a PLC program, you must apply an appropriate method to ensure that only one module is accessed at a time. Since the command box is set "permanently", a PLC program should allocate data to the box, transfer the data and then enable it again. A global flag may be sufficient for this purpose.

2. Allocate data to the command box. Mark the box as allocated within the PLC. Then transfer the slot number of the module, the index of the module parameters and the offset of the data to the command box.

3. Compile the task (byte 8 to 61) according to the function number. Bytes that are not used must also be transferred, they should be set to zero.

4. Write the task data into the Write Box. These are then automatically transferred to the module.

5. Read the data from the Read Box. If the status byte PSB does not equal 0, the task is performed. Check for possible errors (PSB ‹0)!

6. If the PSB = 0, another status must be requested -› (5).

7. If another task is to be performed: -› 3.

8. If all the tasks have been performed, the command box must now be enabled.
   The data in the command box should be deleted, i.e. set to 0. This is not mandatory, but prevents the possibility of module data being overwritten due to a faulty access to the Write Box.

Note

– There can be other CPX modules which other modules of the PLC access. These could modify the command box.

– There can be other PROFIBUS masters (class 2 masters) that access the CPX data at the same time as the PLC, modifying the command box without the PLC knowing of this, for example.

The programmer(s) of the overall application must apply appropriate measures to ensure they always access the correct data.

C.2 CPX-FB11 (DeviceNet)

General information on the CPX-FB11 are found in the description on the P.BE-CPX-FB11-...

C.2.1 Configuring DeviceNet station properties (EDS)

When starting up a new DeviceNet station for the first time, you must inform your configuration program about certain properties of the station.

The features of the various slaves are usually administered by the configuration program in a list or library e. g. E DS library (EDS for electronic data sheets).

The following possibilities can be used with the CMAX:

- Install EDS files: **modular EDS**.
  Parametrising of technology modules such as the CMAX is **only** supported via modular EDS.
- Manually enter the slave features (no parameter setting possible).

Observe the notes in the manual for the CPX-FB11.

Source of supply for EDS files

Sources of supply

Current EDS files and picture files (icons) can be found in the Internet under the following address:

➔ www.festo.com ➔ Downloads ➔ Download Area: Software, drivers and firmware ➔ Enter string: Fieldbus GSD/ EDS or CMAX

Installing a modular EDS file

You will require the following files for the CPX terminal:

File type	File name	Language	Description
EDS	cpx_chassis.eds	English	Base file for modular EDS.
EDS	cpx_fb11...eds	English	Provides the communication adapter in the configuration program.
EDS	cpx_...eds	English	There is an EDS file for every module type. It contains the information needed for configuration and parametrisation.
ICO	cpx_...ico	–	Icon file for representing the CPX terminal or mode in the configuration program.

Tab. C/4: Configuration files (modular EDS) for the CPX terminal for DeviceNet

Installing modular EDS files

- Install the files with your configuration program.

You must install at least the Chassis EDS and the EDS files of the required modules.
Recommendation: Install all EDS files.

Icon files

Depending on the configuration program used, you can assign icon files (.ico format) to the CPX terminal or the CPX modules. The CPX terminal or the modules will then be represented accordingly in the configuration program.

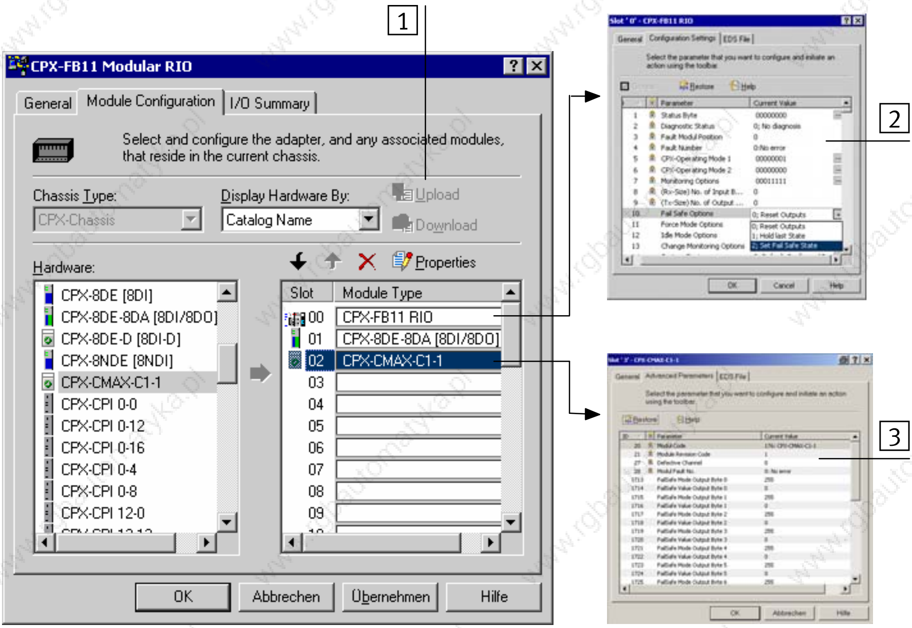
Notes on installing the EDS files and the icon files can be found in the documentation for your configuration program.

C.2.2 Parametrisation (RSNetworx example)

When modular EDS is used, you can set the parameters by module with RSNetWorx.

Note the general instructions on CPX parametrising in section 1.3.
Make sure that parameters cannot be unintentionally overwritten. If necessary, carry out an upload.

The following diagram shows the “Module Configuration” register of the CPX terminal. Double clicking on the module in the configuration table brings you to the window for setting the parameters.



1 Buttons for uploading and downloading the parameters

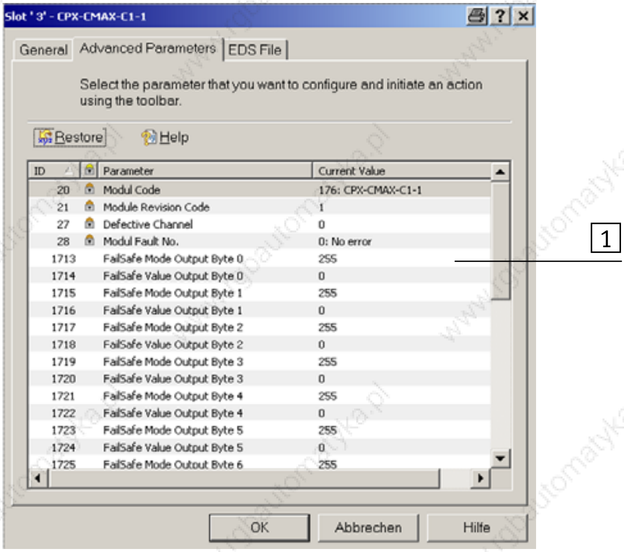
2 System parameters and data

3 Module parameters

Fig. C/6: Parametrisation with modular EDS

Module parameters

- Double-click on the CPX modules in the configuration table. Set the module parameters in the displayed window in the “Advanced Parameters” register. Confirm twice with OK.



1 CMAX parameters

Fig. C/7: Example of parametrising the CMAX with RSNetworx

The settings saved in the project are displayed in offline mode.

Fail Safe and Idle Mode parametrising

Check your application to see if Fail Safe or Idle Mode parametrisation is required.

Example

In the example as per Tab. C/5, the drive should be stopped and the brake activated (emergency stop).
The brake is high-active and the controller is enabled.

Allocation		CMAX inputs – Module output data					
Bit	**Value**	**CCON**	**Value**	**CPOS**	**Value**	**Control bytes 2 ... 8**	**Value**
0	1	**ENABLE = 1**	**1**	HALT = 0	0	- (no function, all = 0)	0
1	2	**STOP = 0**	**0**	START = 0	0		0
2	4	**BRAKE = 1**	**1**	HOM = 0	0		0
3	8	RESET = 0	0	JOGP = 0	0		0
4	16	– (reserved = 0)	0	JOGN = 0	0		0
5	32	LOCK = 0	0	TEACH = 0	0		0
6	64	OPM1 = 0	0	CLEAR = 0	0		0
7	128	OPM2 = 0	0	– (reserved = 0)	0		0
Mask		**Value byte 0**	**5**	**Value byte 1**	**0**	**Value byte 2 ... 8**	**0**

Tab. C/5: Fail Safe or Idle Mode parametrising example

This setting applies to both Fail Safe and Idle Mode.

The global system parameter of the CPX-FB11 must also be set for the settings to take effect:

– “Fail Safe Options”: “Set Fail Safe State”.

– “Idle Mode Options”: “Set Idle Mode State”.

C.2.3 Addressing

Assign the I/O addresses of the slave (RSNetworx example)

1. Double-click **on the scanner** in the network. A dialog box will open.

2. With the registers “Input” and “Output”, you assign the I/O addresses of the CPX terminal to the PLC operands.

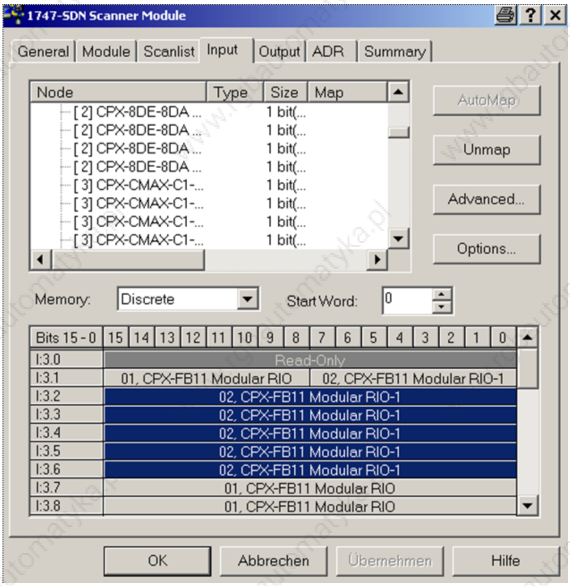


Fig. C/8: Input address assignment

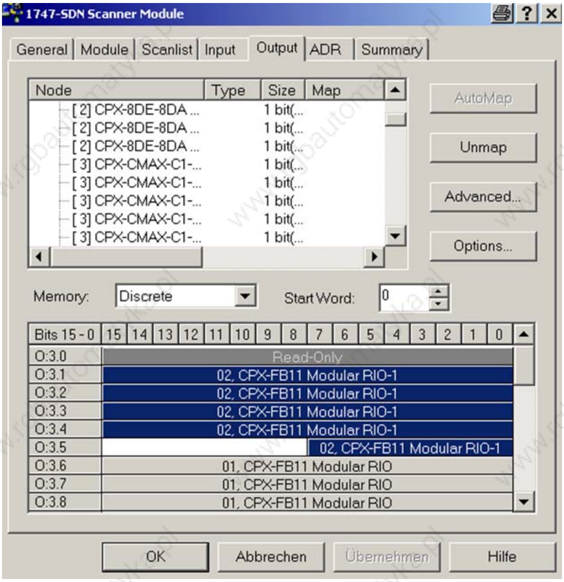
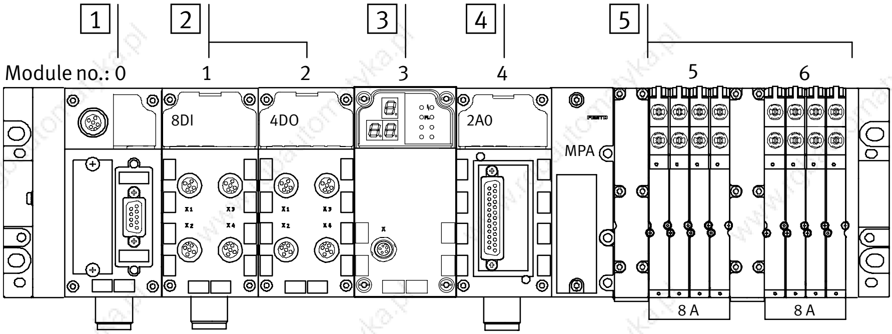


Fig. C/9: Output address assignment

Example: scanner 1747-SDN (SLC 500 series)

Addressing for example of terminal with:

- 2 input bytes for status bits (strobed data)
- 11 input bytes, input address from I:1.1.0
- 9 output bytes, output address from O:1.1.0



1	CPX-FB11 (with status bits)
2	Digital I/O modules
3	Technology module CMAX
4	Analogue I/O modules
5	MPA pneumatics (2 pneumatic modules)

Fig. C/10: CPX example terminal 3 (address example for scanner 1747-SDN, see Tab. C/6)

Module no.	Module	Addressing	
		Input address	Output address
0	Fieldbus node CPX-FB11	I:1.1.0 ... I:1.1.15 (for status bits)	–
1	Digital 8-input module CPX-8DE	I:1.8.0 ... I:1.8.7	–
2	Digital 4-output module CPX-4DA	–	O:1.5.0 ... O:1.5.3
3	Axis controllers CPX-CMAX-C1-1	I:1.4.0 ... I:1.4.15 I:1.5.0 ... I:1.5.15 I:1.6.0 ... I:1.6.15 I:1.7.0 ... I:1.7.15	O:1.1.0 ... O:1.1.15 O:1.2.0 ... O:1.2.15 O:1.3.0 ... O:1.3.15 O:1.4.0 ... O:1.4.15
4	Analogue 2-input module CPX-2AE	O:1.2.0 ... O:1.2.15 O:1.3.0 ... O:1.3.15	–
5	MPA1 pneumatic module	–	O:1.5.8 ... O:1.5.15
6	MPA1 pneumatic module	–	O:1.6.0 ... O:1.6.7

Tab. C/6: Addressing example for scanner 1747-SDN

Module output data			Module input data		
AB	**Contents**	**Address**	**EB**	**Contents**	**Address**
OW:1.4	CCON:		IW:1.1	SCON:	
	Bit Name			Bit Name	
	0 ENABLE	O:1.4.0		0 ENABLED	I:1.1.0
	1 STOP	O:1.4.1		1 OPEN	I:1.1.1
	2 BRAKE	O:1.4.2		2 WARN	I:1.1.2
	3 RESET	O:1.4.3		3 FAULT	I:1.1.3
	4 – (reserved)	O:1.4.4		4 24VL	I:1.1.4
	5 LOCK	O:1.4.5		5 FCT_MMI	I:1.1.5
	6 OPM1 **= 0**	O:1.4.6		6 OPM1 **= 0**	I:1.1.6
	7 OPM2 **= 0**	O:1.4.7		7 OPM2 **= 0**	I:1.1.7
	CPOS:			SPOS:	
	Bit Name			Bit Name	
	0 – (reserved)	O:1.4.8		0 – (reserved)	I:1.1.8
	1 START	O:1.4.9		1 ACK	I:1.1.9
	2 HOME	O:1.4.10		2 MC	I:1.1.10
	3 JOGP	O:1.4.11		3 TEACH	I:1.1.11
	4 JOGN	O:1.4.12		4 MOV	I:1.1.12
	5 TEACH	O:1.4.13		5 DEV	I:1.1.13
	6 – (reserved)	O:1.4.14		6 STILL	I:1.1.14
	7 – (reserved)	O:1.4.15		7 REF	I:1.1.15
OW:1.5	Record No.	O:1.4.0 ... 7	IW:1.2	Feedback record no.	I:1.2.0 ... 7
	Reserved	O:1.5.8 ... 15		RSB:	
				Bit Name	
				0 RC1	I:1.2.8
				1 RCC	I:1.2.9
				2 COM1	I:1.2.10
				3 RCE	I:1.2.11
				4 VLIM	I:1.2.12
				5 XLIM	I:1.2.13
				6 – (reserved)	I:1.2.14
				7 – (reserved)	I:1.2.15
OW:1.6 OW:1.7	Reserved	O:1.6.0 ... 15 O:1.7.0 ... 15	IW:1.3 IW:1.4	Primary actual value (int32)	I:1.3.0 ... 15 I:1.4.0 ... 15

Tab. C/7: Addresses of the CMAX control and status bytes in the example Fig. C/10

i

DeviceNet does not provide for consistent data transmission. Therefore, always take into account the cycle time to ensure consistent setpoint values.

C.2.4 Examples of error display with RSNetWorx

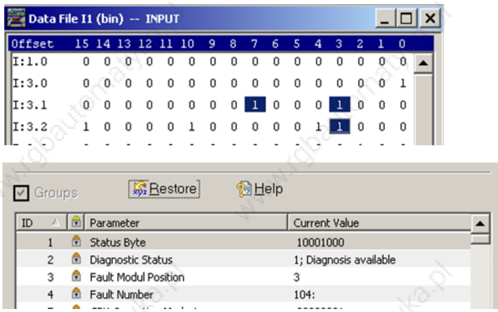


Fig. C/11: Error via strobe byte 104 - E43

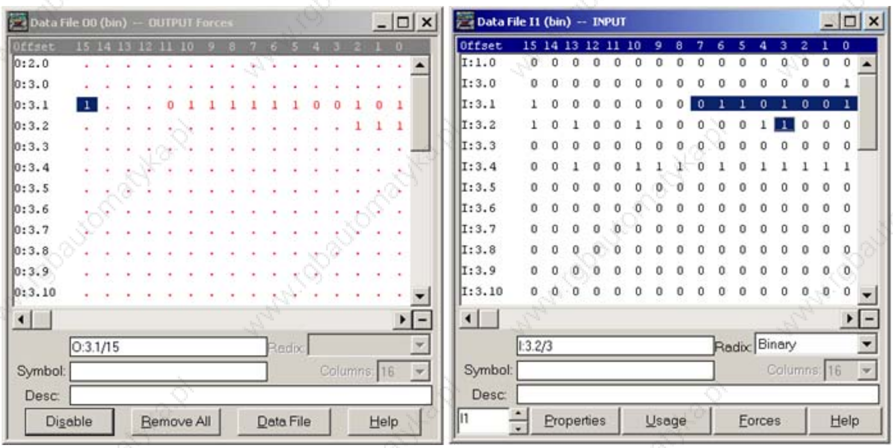


Fig. C/12: Error via remote I/O operating mode (I/O diagnostics interface) 105 - E50

C.3 CPX-FEC

General information on the CPX-FEC can be found in the description of the P.BE-CPX-FEC-....
Detailed information on operating the FST can be found in the FST manual P.BE-FST...

C.3.1 Configuration

Use Festo Software Tools (FST 4.1 or higher) with the Hardware Configurator in order to configure your CPX terminal with CPX-FEC.

To configure the CMAX, this must be in the catalogue of the CPX configurator (CPX terminal / Technology modules / CPX-CMAX...). You may require an FST software update for this (CPX configuration update):

➔ www.festo.com ➔ Downloads ➔ Download Area: Software, drivers and firmware ➔ Enter string: **FST**

Caution
If you have connected a CPX terminal to your PC for configuration: Test projects and programs at first without active actuators or without compressed air.
You will then avoid damage in the test phase.

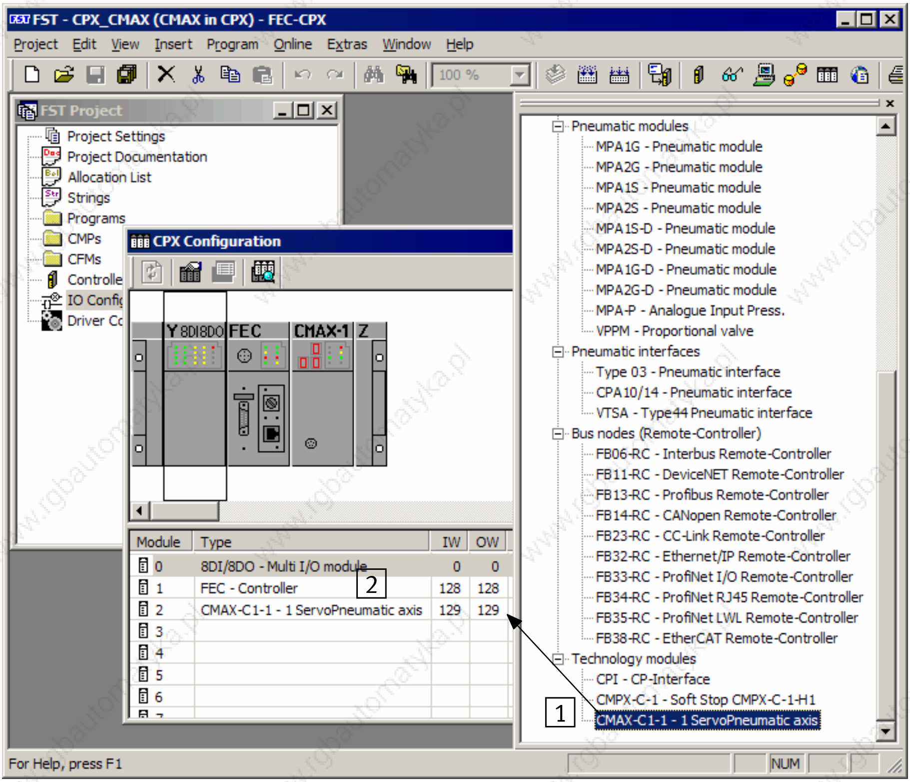
I/O configuration / CPX configuration

You can create the configuration in the following ways:

- Nominal/actual comparison in the editor mode
- Change to the online mode
- Manual configuration with the Hardware Configurator

The first two methods require the CPX terminal to be connected and ready for operation. The hardware configuration with the CMAX is automatically recognised.

With manual configuration, the CMAX can initially be configured without a connection to the CPX terminal.



1 Configuration with drag & drop

2 Configured modules in the configuration table

Fig. C/13: Manual configuration of the CPX terminal in the Hardware Configurator

Input word / Output word addresses

Set the start address of the input word and output word of the CMAX.

Module	**Module identifiers**	**Allocated address space**	**Remarks**
CPX-CMAX	T21 CMAX-1	4 Input words (8 bytes) 4 Output words (8 bytes)	For assignment of the addresses depending on the operating mode, see section 2.2. For an example, see section C.3.4.

Tab. C/8: Technology module CMAX

C.3.2 CMAX parametrisation

The CMAX has no module parameters.

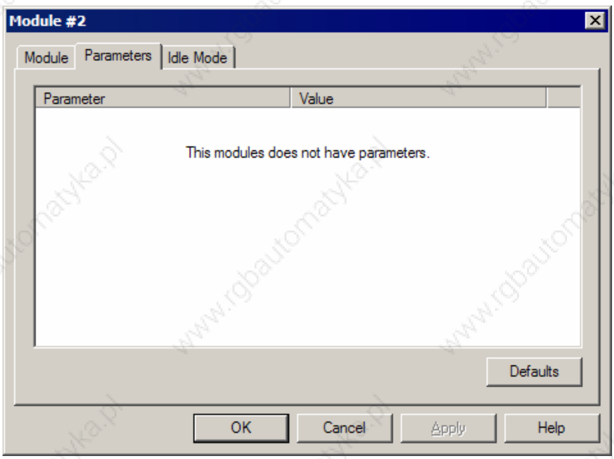


Fig. C/14: No module parameters

Note
CPX terminals with the CMAX **always** require new parametrisation and commissioning after exchanging the CPX terminal or the CMAX, since the parameters and the data ascertained during commissioning are only stored in the CMAX, see section 1.1.2.

Idle mode parametrisation

Check your application to see if parametrisation of the idle mode is required.

Example

In the example as per Tab. C/9, the drive should be stopped and the brake activated. The controller should remain active.

Allocation		**CMAX inputs – Module output data**					
Bit	**Value**	**CCON**	**Value**	**CPOS**	**Value**	**Control bytes 2 ... 8**	**Value**
0	1	**ENABLE = 1**	**1**	HALT = 0	0	- (no function, all = 0)	0
1	2	**STOP = 0**	**0**	START = 0	0		0
2	4	**BRAKE = 0**	**0**	HOM = 0	0		0
3	8	RESET = 0	0	JOGP = 0	0		0
4	16	– (reserved = 0)	0	JOGN = 0	0		0
5	32	LOCK = 0	0	TEACH = 0	0		0
6	64	OPM1 = 0	0	CLEAR = 0	0		0
7	128	OPM2 = 0	0	– (reserved = 0)	0		0
Idle mode		**Value for channel 0**	**1**	**Value for channel 1**	**0**	**Value for channels 2 ... 8**	**0**

Tab. C/9: Example of idle mode parametrisation

This results in a parametrisation as per Fig. C/15.

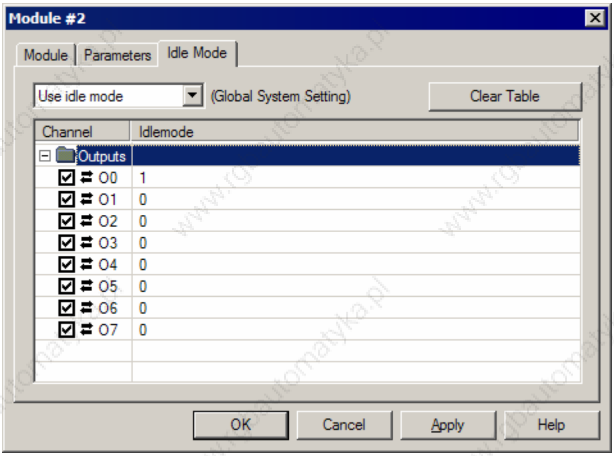


Fig. C/15: Idle mode parametrisation for example Tab. C/9

In order for the settings to take effect, the global system parameter must be set to “Use idle mode”.

C.3.3 Save actual configuration as the nominal configuration

In order to save the changes permanently, after the changes:

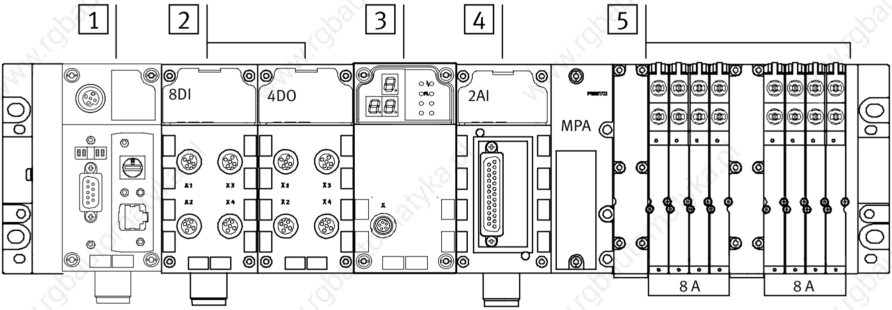
– the actual configuration must be saved as the nominal configuration,

– or the project must be loaded into the CPX-FEC (a program must exist for this).

Note
Make sure that you have supplied taught parameters, or parameters edited via the keyboard or the CPX-MMI, to the CPX configurator.

C.3.4 Address assignment

Address assignment example



1 CPX-FEC

2 Digital I/O modules

3 Technology module CMAX

4 Analogue I/O modules

5 MPA1 pneumatics (2 pneumatic modules)

Fig. C/16: CPX-FEC address assignment example

Loca-tion	Module	Input address	Output address	Remarks
0	CPX-FEC	128	128	The outputs are not used.
1	8-way digital input module (8DI)	0	–	–
2	4-way digital output module (4DO)	–	0	–
3	Servo-pneumatic axis CMAX (T21)	129 ... 132	129 ... 132	For assignments, see Tab. C/11
4	2-way analogue input module (2AI)	64, 65	–	–
–	MPA pneumatic interface	–	–	Passive module.
5	MPA pneumatic module (CPX-type32: 1-8V)	–	32	–
6		–	33	–

Tab. C/10: Configuration of address assignment for example Fig. C/16

Example of I/O assignment record select mode

Module output data			**Module input data**		
AW	**Contents**	**Address**	**EW**	**Contents**	**Address**
AW129	CCON:		EW129	SCON:	
	Bit Name			Bit Name	
	0 ENABLE	A129.0		0 ENABLED	E129.0
	1 STOP	A129.1		1 OPEN	E129.1
	2 BRAKE	A129.2		2 WARN	E129.2
	3 RESET	A129.3		3 FAULT	E129.3
	4 – (reserved)	A129.4		4 24VL	E129.4
	5 LOCK	A129.5		5 LOCK	E129.5
	6 OPM1 **= 0**	A129.6		6 OPM1 **= 0**	E129.6
	7 OPM2 **= 0**	A129.7		7 OPM2 **= 0**	E129.7
	CPOS:			SPOS:	
	Bit Name			Bit Name	
	0 – (reserved)	A129.8		0 – (reserved)	E129.8
	1 START	A129.9		1 ACK	E129.9
	2 HOME	A129.10		2 MC	E129.10
	3 JOGP	A129.11		3 TEACH	E129.11
	4 JOGN	A129.12		4 MOV	E129.12
	5 TEACH	A129.13		5 DEV	E129.13
	6 – (reserved)	A129.14		6 STILL	E129.14
	7 – (reserved)	A129.15		7 REF	E129.15
AW130	Record No.	A130.0...7	EW130	Feedback record no.	E130.0...7
	reserved	A130.8...15		RSB:	
				Bit Name	
				0 RC1	E130.8
				1 RCC	E130.9
				2 COM1	E130.10
				3 RCE	E130.11
				4 VLIM	E130.12
				5 XLIM	E130.13
				6 – (reserved)	E130.14
				7 – (reserved)	E130.15
AW131	reserved	A131.0...15	EW131	Primary actual value (4 bytes, int32)	E131.0...15
AW132		A132.0...15	EW132		E132.0...15

Tab. C/11: Addresses of the control and status bytes in the example Fig. C/16, example of record select mode

Example of I/O assignment direct mode

Module output data			Module input data		
AW	**Contents**	**Address**	**EW**	**Contents**	**Address**
AW129	CCON:		EW129	SCON:	
	Bit Name			Bit Name	
	0 ENABLE	A129.0		0 ENABLED	E129.0
	1 STOP	A129.1		1 OPEN	E129.1
	2 BRAKE	A129.2		2 WARN	E129.2
	3 RESET	A129.3		3 FAULT	E129.3
	4 – (reserved)	A129.4		4 24VL	E129.4
	5 LOCK	A129.5		5 LOCK	E129.5
	6 OPM1 **= 1**	A129.6		6 OPM1 **= 1**	E129.6
	7 OPM2 **= 0**	A129.7		7 OPM2 **= 0**	E129.7
	CPOS:			SPOS:	
	Bit Name			Bit Name	
	0 – (reserved)	A129.8		0 – (reserved)	E129.8
	1 START	A129.9		1 ACK	E129.9
	2 HOME	A129.10		2 MC	E129.10
	3 JOGP	A129.11		3 TEACH	E129.11
	4 JOGN	A129.12		4 MOV	E129.12
	5 TEACH	A129.13		5 DEV	E129.13
	6 – (reserved)	A129.14		6 STILL	E129.14
	7 – (reserved)	A129.15		7 REF	E129.15
AW130	CDIR:		EW130	SDIR:	
	Bit Name			Bit Name	
	0 ABS	A130.0		0 ABS	E130.0
	1 COM1	A130.1		1 COM1	E130.1
	2 COM2	A130.2		2 COM2	E130.2
	3 CONT	A130.3		3 CONT	E130.3
	4 VLIM	A130.4		4 VLIM	E130.4
	5 XLIM	A130.5		5 XLIM	E130.5
	6 FAST	A130.6		6 FAST	E130.6
	7 – (reserved)	A130.7		7 – (reserved)	E130.7
	Secondary setpoint	A130.8...15		Secondary actual value 1	E130.8...15
AW131	Primary setpoint (4 bytes, int32)	A131.0...15	EW131	Primary actual value (4 bytes, int32)	E131.0...15
AW132		A132.0...15	EW132		E132.0...15

Tab. C/12: Addresses of the control and status bytes in the example Fig. C/16, example of direct mode

Example of I/O assignment commissioning

Module output data			**Module input data**		
AW	**Contents**	**Address**	**EW**	**Contents**	**Address**
AW129	CCON:		EW129	SCON:	
	Bit Name			Bit Name	
	0 ENABLE	A129.0		0 ENABLED	E129.0
	1 STOP	A129.1		1 OPEN	E129.1
	2 BRAKE	A129.2		2 WARN	E129.2
	3 RESET	A129.3		3 FAULT	E129.3
	4 – (reserved)	A129.4		4 24VL	E129.4
	5 LOCK	A129.5		5 LOCK	E129.5
	6 OPM1 **= 0**	A129.6		6 OPM1 **= 0**	E129.6
	7 OPM2 **= 1**	A129.7		7 OPM2 **= 1**	E129.7
	CPOS:			SPOS:	
	Bit Name			Bit Name	
	0 – (reserved)	A129.8		0 – (reserved)	E129.8
	1 START	A129.9		1 ACK	E129.9
	2 HOME	A129.10		2 MC	E129.10
	3 JOGP	A129.11		3 TEACH	E129.11
	4 JOGN	A129.12		4 MOV	E129.12
	5 TEACH	A129.13		5 DEV	E129.13
	6 – (reserved)	A129.14		6 STILL	E129.14
	7 – (reserved)	A129.15		7 REF	E129.15
AW130	Function	A130.0...7	EW130	Function feedback	E130.0...7
	Parameter 1	A130.8...15		Progress display	E130.8...15
AW131	Parameter 2 (4 bytes, int32)	A131.0...15	EW131	Actual position (4 bytes, int32)	E131.0...15
AW132		A132.0...15	EW132		E132.0...15

Tab. C/13: Addresses of the control and status bytes commissioning in the example Fig. C/16

Example of I/O assignment parametrisation

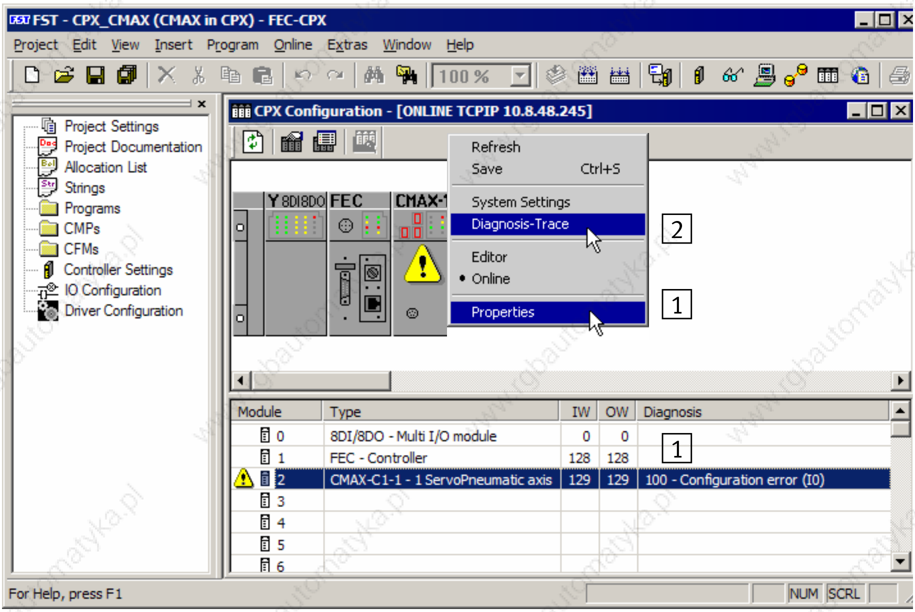
Module output data			**Module input data**		
AW	**Contents**	**Address**	**EW**	**Contents**	**Address**
AW129	CCON:		EW129	SCON:	
	Bit Name			Bit Name	
	0 ENABLE	A129.0		0 ENABLED	E129.0
	1 STOP	A129.1		1 OPEN	E129.1
	2 BRAKE	A129.2		2 WARN	E129.2
	3 RESET	A129.3		3 FAULT	E129.3
	4 – (reserved)	A129.4		4 24VL	E129.4
	5 LOCK	A129.5		5 LOCK	E129.5
	6 OPM1 **= 1**	A129.6		6 OPM1 **= 1**	E129.6
	7 OPM2 **= 1**	A129.7		7 OPM2 **= 1**	E129.7
	Subindex	A129.8...15		Subindex	E129.8...15
AW130	Task identifier + Parameter number	A130.0...15	EW130	Reply identifier + Parameter number	E130.0...15
AW131	Parameter value (4 bytes, int32)	A131.0...15	EW131	Parameter value (4 bytes, int32)	E131.0...15
AW132		A132.0...15	EW132		E132.0...15

Tab. C/14: Addresses of the control and status bytes parametrisation in the example Fig. C/16

C.3.5 Diagnostics

Diagnostics with the Hardware Configurator

With the Hardware Configurator you can carry out complete diagnostics of the CPX terminal. For this the CPX terminal must be connected **online** to your PC: Diagnostic messages of the modules are displayed directly in the Hardware Configurator with an icon on the appropriate module:



1 View current diagnostic message (Properties or module entry)

2 View diagnostic memory (context menu)

Fig. C/17: Warning icon as diagnostic message in the Hardware Configurator

View current diagnostic message

- Diagnostic message in the Hardware Configurator.

- Display the “Diagnostic” tab of the “Module...” dialog, by double-clicking or via the [Properties] context menu.

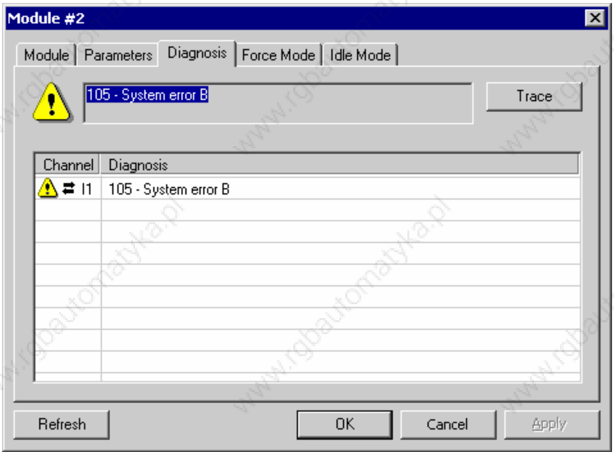


Fig. C/18: Diagnostic message in the properties dialog

Diagnostic memory

- Display the “Diagnostic memory” dialog via the [Diagnostic memory] context menu of the Hardware Configurator.

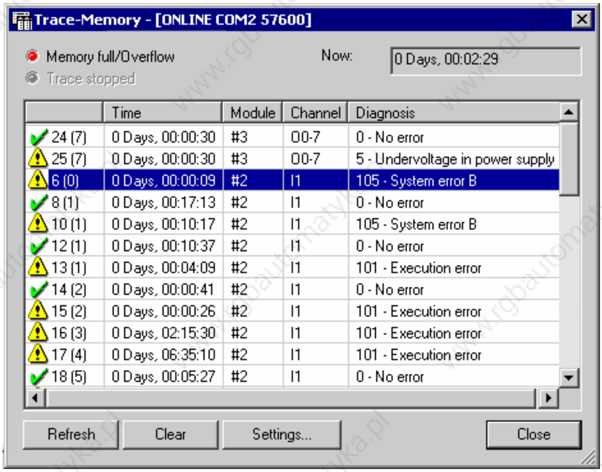


Fig. C/19: Diagnostic memory

Diagnostics with the online control panel

- Select [Online] [Control panel].

Coded diagnostic information is displayed under “Error”: Error type, CPX error number, module number

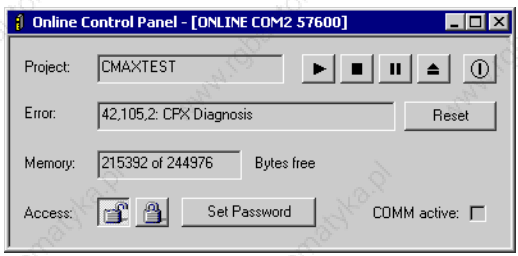


Fig. C/20: FST online control panel

Diagnostics in the user program

You can read out diagnostic information in your user program via function modules (CFM).

Modules	Description
C_STATUS	Query diagnostic status
C_TR_rd	Read entries in diagnostic memory
C_MD_rd	Read module diagnostic data

Tab. C/15: CFM for diagnosing the CPX terminal

Error program

If a fault occurs during running time, an error number will be entered in the error word (FW). Depending on whether an error program has been configured, the following applies:

– Error program = 0 (no error program defined): Programs will be stopped

– Error program › 0: Programs will be stopped and the error program with the entered number will be started

The following example shows a program for error handling. Enter it as “Error program” in the “PLC settings” of the “Runtime behaviour” tab .

```
STEP    1
                                  "Wait for error acknowledgement

IF              I0.7              'Reset FEC Error
THEN    RESET   F                 'Error
        LOAD    V0
         TO     FW                'Fault word
        RESET   P63               'Error acknowledgement
        SET     P0                'General - organisation
```

Fig. C/21: Sample extract from an error program

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