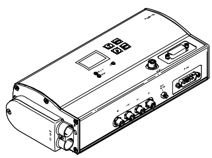
Motor controller
SFC-LACI

Description

Motor controller

Type SFC-LACI-...-CO
(CANopen)



Description
567 381
en 0812NH
[742 423]

Original .... de

Edition .... en 0812NH

Designation .... GDCP-SFC-LACI-CO-EN

Order-no. 567 381

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

Contents

Intended use

The single-axis field controller (Single Field Controller) type SFC-LACI-... is used as a position controller and position servo for the electric drives, types DNCE-...-LAS and DFME-...-LAS.

This manual deals with the basic functions of the SFC-LACI and the CANopen interface of the SFC-LACI-...-CO.
The drives DNCE-...-LAS and DFME-...-LAS and additional components are documented in separate operating instructions.

The SFC-LACI and the connectable modules and cables may only be used as follows:

– As intended
– Only in an industrial environment
– In perfect technical condition
– In original condition without modification (only the conversions or modifications described in the documentation supplied with the product are permitted).

- Follow the safety instructions and use all the components and modules as described in the documentation.
- Observe also the standards specified in the relevant chapters, as well as national and local laws and technical regulations.
- Observe the limit values of all additional components (e.g. sensors, actuators).

Safety instructions

When commissioning and programming positioning systems, the safety regulations in this manual as well as those in the operating instructions for the other components used should be observed unconditionally.

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

Warning
Electric axes move with high force and at high speed. Collisions can lead to serious injury to human beings 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
Faults in the parameterisation can cause injury to human beings 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

Scope of delivery

Included in the scope of delivery for motor controller type SFC-LACI are:

– Single field controller, optionally with control panel

– Configuration package FCT (Festo configuration tool)

– User documentation on CD ROM

The following are available as accessories (see appendix A.2):

– Connecting cables

– Mounting attachments

Important user instructions

Danger categories

This manual 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.

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

Identification of specific information

The following pictograms designate texts that contain special information.

Pictograms

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

Accessories:
Information on necessary or useful accessories

Environment:
Information on the environment-friendly use of the 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.

SFC-LACI motor controller manual

This manual contains basic general information on operating, mounting, installing and commissioning the positioning systems with the motor controller SFC-LACI-...-CO. It also contains information on the functions of the CANopen interface as well as information on commissioning with the Festo Configuration Tool (FCT) software package.

Information on additional components can be found in the operating instructions supplied with the product.

Type	Designation	Contents
Brief overview + descriptions on CD ROM	–	Brief overview: Important initial information and documentation overview. CD: Includes descriptions as listed below.
Description	**Motor controller SFC-LACI** GDCP-SFC-LACI-CO-...	Installation, commissioning and diagnosis of positioning systems with the SFC-LACI with communication via CANopen.
Help system for software	Festo Configuration Tool help (contained in FCT software)	Functional descriptions for the Festo Configuration Tool configuration software.
Further descriptions as per control interface	**Variants** GDCP-SFC-LACI-IO-... GDCP-SFC-LACI-PB-... GDCP-SFC-LACI-DN-...	Installation, commissioning and diagnosis of electric drives with the SFC-LACI with communication via a different control interface.
Operating instructions	**Drives** DFME-...-LAS DNCE-...-LAS	Installing and commissioning the drive.

Information on the version

The hardware version specifies the version status of the mechanical and electronic components of the SFC-LACI. The firmware version specifies the version status of the operating system of the SFC-LACI.

You can find the specifications on the version status as follows:

– Hardware version and firmware version under "Device data" in the Festo Configuration Tool, when there is active linkage to the SFC-LACI

– Firmware version on the control panel under [Diagnostic] [Software information].

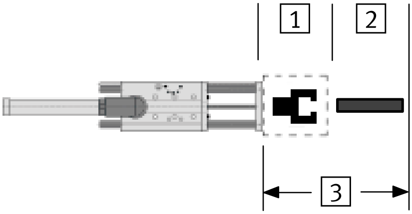
Firmware version from	What is new?	Which FCT plug-in?
V 01.00	Motor controller with CANopen interface Type SFC-LACI-...-CO, supports the following drives: – DNCE-...-LAS – DFME-...-LAS	SFC-LAC V 03.00

Product-specific terms and abbreviations

Term / abbreviation	Meaning
Acknowledge	Confirm, reply message, e.g. "Acknowledge START." "Acknowledge a fault." The user confirms that he has noted the fault. The device then leaves the fault status (if the fault still exists, it will be displayed again).
Applied load (additional load)	The mass of a workpiece. Applies only to a single positioning record, see Fig. 0/1.
AZ (= axis zero point)	Axis zero point. See section 1.1.5.
EMC	Electromagnetic compatibility
FCT (= Festo Configuration Tool)	Software with uniform project and data management for all supported device types. The special requirements of a device type are supported with the necessary descriptions and dialogues by means of plug-ins.
FHPP	"Festo Handling and Positioning Profile:" Uniform fieldbus data profile for positioning controllers from Festo. See 1.2.3.
FHPP standard	FHPP sequence control. See 1.2.3.
FPC	"Festo Parameter Channel" for parameter access. See section 1.2.3.
HALT	With a HALT signal a running positioning movement is interrupted and the drive stops. The positioning record remains active, i.e. with a new START signal the record will be continued. Compare STOP.
HMI	"Human Machine Interface" refers to the control panel on the variant SFC-LAC-...-H2. [HMI = on] means that parameterisation and operation can begin using the control panel or FCT. The control interface is then deactivated.
Homing	See overview of measuring reference system in section 1.1.5.
I/O	Input and/or output
Jog mode	Manual positioning in positive or negative direction
Load voltage, logic voltage	The load voltage supplies the power electronics of the motor controller and thereby the motor. The logic voltage supplies the evaluation and control logic of the motor controller as well as the local digital I/Os (see section 3.2).
Logic 0	0 V present at input or output (positive logic, corresponds to LOW).

Term / abbreviation	Meaning
Logic 1	24 V present at input or output (positive logic, corresponds to HIGH).
MMI	“Man Machine Interface”. Corresponds to HMI.
PLC/IPC	Programmable logic controller/industrial PC
Positioning mode (Profile position mode)	See overview of operating modes in section 1.1.4.
Positioning record	Positioning command defined in the position set table, consisting of target position, speed, acceleration and other values.
PZ (= project zero point)	Project zero point. See section 1.1.5.
REF (= REFerence point)	Reference point. See section 1.1.5.
Reference switch	Proximity sensor used for defining the reference point. The integrated homing switch must not be moved in DNCE-...-LAS and DFME-...-LAS (exception: minimum offset as described in section 6.7).
Software end position	See overview of measuring reference system in section 1.1.5.
STOP	With a STOP signal a running positioning movement is interrupted: The drive stops, the positioning record counts as concluded. See HALT.
Teaching	Accept an actual position in the position set table, or as axis zero point, project zero point, or software end point. The desired position can be approached in jog mode.
Tool mass (tool load)	For example: the mass of a gripper attached to the piston rod (or the front plate) of the drive (including mounting elements). The tool load applies to all positioning records, see Fig. 0/1

Tab. 0/1: Index of terms and abbreviations



1 Tool load

2 Additional load

3 The total of 1 and 2 : See under “Effective load” in the operating instructions for the drive.

Fig. 0/1: Tool load and additional load

CANopen specific terms and abbreviations

Term / abbreviation	Meaning
0x1234 or 1234h	Hexadecimal numbers are marked by a prefixed “0x” or by a suffixed “h.”.
BCD	Binary coded decimal
EDS	Electronic Data Sheet; contains the specific properties of the slave (e.g. number of I/Os, parameters, etc.).
LSB	Least significant byte (lower-value byte)
MSB	Most significant byte (higher-value byte)
Object Directory	The Object Directory contains all device parameters and current processing data which are directly accessible via SDO. The Object Directory possesses 3 ranges: – 1xxxh: identification of the device and communication parameter, – 2xxxh: specific device functions, – 6xxxh: standardized parameters for drives as per DS402. The identification of an entry (“Object”) in the Object Directory is made via a 16-bit index and an 8-bit subindex.

Term / abbreviation	Meaning
PDO	Process data object PDOs are generally transmitted event-orientated, cyclically or on demand. A message can be received and evaluated simultaneously by all slaves. The assignment of application objects on a PDO takes place with “PDO mapping”. In a PDO the values of several objects can also be transmitted and the recipients of the PDOs can use only parts of the data depending on their PDO mapping entries.
SDO	Service data object SDOs are used mainly for transmitting acyclic data, e.g. for initialising during the boot procedure. With SDOs you can access all entries in the Object Directory. The relevant Object Directory entries can be addressed with the index and subindex of the entry. Within an SDO only one object can be accessed. A reply is always sent to an SDO: A pair of CAN telegrams per object are transmitted.
Terminating resistor	Resistor for minimising signal reflections. Terminating resistors must be installed or switched in at the end of bus segment cables.

Tab. 0/2: Index of CANopen terms and abbreviations

System overview

Chapter 1

Contents

1.1 Overview

1.1.1 Components

1 Higher-order controller

2 Software level: Festo Configuration Tool (FCT)

3 Controller level: SFC-LACI

4 Drive level: DFME-...-LAS or DNCE-...-LAS

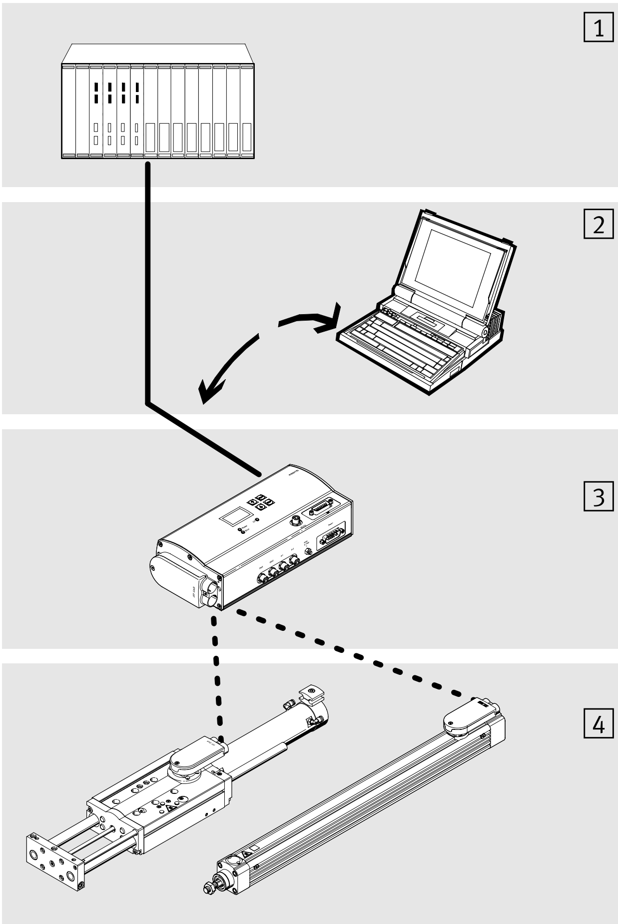


Fig. 1/1: Principle of a positioning system with the SFC-LACI

To construct a positioning system with the SFC-LACI, you need the following components:

SFC-LACI	Motor controller, optionally with control panel
Drive	Electric drive DNCE-...-LAS or DFME-...-LAS, with accessories and mounting attachments
Power supply unit 24 V	For logic voltage supply
Power supply unit 48 V	For load voltage supply
Power supply cable	For supplying the SFC-LACI with logic and load voltage → Section 3.2
Motor cable / Encoder cable	For connecting the drive to the SFC-LACI → Section 3.4
Programming cable	For information transfer between the PC and the SFC-LACI → Section 3.5
Fieldbus cable	For information transfer between the higher-order controller and the SFC-LACI → Section 3.6

1.1.2 Operational principle

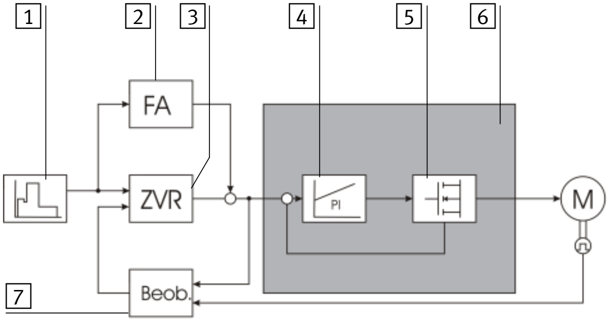


Fig. 1/2: Simplified diagram of control structure

No.	Block	Task
1	Setpoint generator	Generates executable position and velocity curves.
2	Reference variable input	Uses desired position, velocity and acceleration curves to calculate a force curve and from that a current curve, which is then directly input as the current setpoint value. Permits drive with minimum contouring error.
3	State vector feedback	Controls position and speed.
4	PI current regulator	Makes sure that all three strings have the correct current values.
5	Output stage	The three strings are supplied with current via pulse width modulation.
6	Current regulator	Phase current regulation and electrical commutation.
7	Observer	Determines speed and external forces of interference (e.g. friction, gravity).

The SFC-LACI has three types of memory:

FLASH

The FLASH memory stores the default settings and the firmware. The data from the FLASH memory are loaded when the device is switched on the first time or when the EEPROM has been deleted.

RAM

The volatile RAM memory stores the parameters that are currently being used and which can be modified using the control panel or FCT. When the modifications have been saved, they are transferred to the EEPROM.

EEPROM

The non-volatile EEPROM stores the parameters that are loaded when the device is switched on. The parameters in the EEPROM are retained even after the power supply has been switched off.

In order to restore the default settings, you can delete the EEPROM with the CI command 20F1h / PNU 127 (see appendix B.3.2). User-specific settings will then be lost.

1.1.3 Operational reliability

A complex system of sensors and monitoring functions ensures operational reliability:

- Temperature monitoring: Final output stage in the SFC-LACI and linear motor
- Voltage monitoring: detection of faults in the logic power supply and detection of undervoltage in the load voltage supply
- I^2t monitoring / overload protection
- Contouring error monitoring (e.g. in the event of sluggishness or overloading of the drive)
- Software end position detection
- Limit switch detection.

➔

Note
Check within the framework of your EMERGENCY STOP procedures to ascertain the measures that are necessary for switching your machine/system into a safe state in the event of an EMERGENCY STOP.

- If an EMERGENCY STOP circuit is necessary for your application, use additional, separate safety limit switches (e.g. as normally closed limit switches wired in series).
- Use hardware limit switches or, if required, mechanical safety limit switches and fixed stops or shock absorbers as appropriate in order to make sure that the axis always lies within the permitted positioning range.

- Note also the following points:

Remedy	Reaction
Cancelling the ENABLE signal at the controller interface	– Without brake/clamping unit: The controller end stage is switched off. The effective load on the drive will continue to move due to inertia, or it will fall if mounted in a vertical or sloping position. – When using a brake/clamping unit: If the drive moves when ENABLE is cancelled, then it will initially be brought to a standstill (using quick stop deceleration). As soon as the drive is standing still, the configured brake output (Out1 or Out2) is reset: The brake/clamping unit closes. Simultaneously, the switch-off delay time begins to run. The SFC-LACI still controls the position. The controller end stage is switched off after the switch-off delay.
Switching off the load voltage or cancelling the hardware enable	The load voltage is switched off. The effective load on the drive will continue to move due to inertia, or it will fall if mounted in a vertical or sloping position. The controller may report the drop out of the load voltage after a few seconds have initially passed. Accordingly, a brake is only closed after a delay. Refer also to the information on using the hardware enable in section 5.6.9.
Cancelling the STOP signal at the controller interface.	By default, the drive brakes with the “Quick stop deceleration” (can be set via FCT or CI object 6085h). As an alternative, the braking ramp in the respective positioning record can be used, see CI object 605Eh.
Triggering a limit switch	The drive brakes with the limit switch deceleration (can be set via FCT or CI object 6510/15h). The error message “Limit switch actuated” is issued. The drive is held stationary in a controlled position. The brake is opened (if present), Err=0, MC=0, Ready=0 (if no automatic brake is parametrised).

Note

Remaining path check for the STOP signal

If the parametrised stop ramp is not sufficient to stop the drive before reaching the software end point, the deceleration (braking) is raised to the maximum value (as far as possible).

Warning
There is no plausibility check to see whether the deceleration (braking) that is set is actually achievable. The deceleration that can be achieved depends on your application (e.g. power and switching speed of your power supply unit, effective load, mounting position).

If the deceleration cannot be achieved, an error will occur and the controller may be turned off (depending on the fault). The effective load on the drive will continue to move due to inertia, or it will fall if mounted in a vertical or sloping position.

- Perform a test run to see whether the quick stop deceleration that is set is actually achievable.
- When doing this, pay attention to the FCT diagram (“Measured data” page).

If the desired deceleration cannot be achieved:

- Use stronger power units or reduce the dynamics.

1.1.4 Operating modes of the SFC-LACI-CO

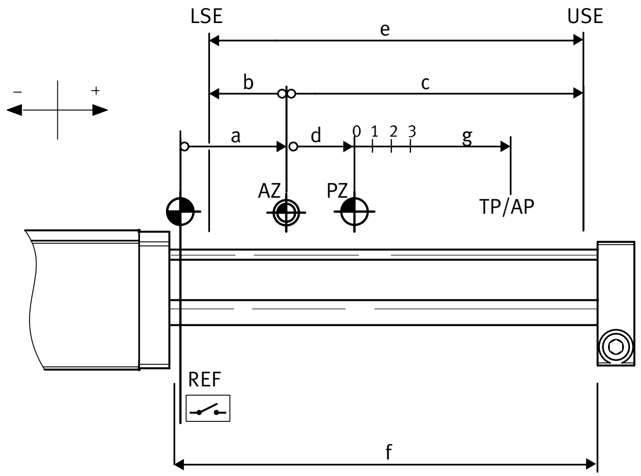
Profile position mode	Positioning mode. Standard operating mode when the SFC-LACI is switched on. The specification of the positioning tasks occurs: – Via record selection: Selection of one, from a maximum of 31 positioning records stored in the SFC-LACI. With profile FHPP automatic record chaining is possible. – Via direct mode: The positioning task is directly transferred with the appropriate setpoint values over the fieldbus.
Profile torque mode	Force control. The drive exerts a certain force.
Interpolated position mode	Continuous setpoint specification as per DS402.
FHPP continuous mode	With FHPP profile: A changeable target position is specified at a millisecond frequency (typically 4...10 ms). Corresponds to the DS402 “Interpolated position mode” (but without SYNC signal).
Homing mode	Performing a homing run
Demo mode	The positioning records stored in the SFC-LACI are executed in sequence.

The FHPP operation modes are described starting from chapter 5.5.

1.1.5 Measuring reference system

Homing	Homing determines the position of the homing reference point REF. When homing is concluded, the axis stands at the axis zero point AZ.
The homing method	The homing method defines how the homing point REF is determined.
Reference point REF	binds the measuring reference system to a proximity sensor or a fixed stop, depending on the homing method.
Axis zero point AZ	is shifted by a defined distance to the reference point REF (offset of the axis zero point). The software end positions and the project zero point are defined in relation to the axis zero point.
Project zero point PZ	is a point within the effective stroke which the user can select, and to which both the actual position and the target positions in the position record table refer. The project zero point is shifted by a defined distance to the axis zero point AZ (offset of the project zero point). The offset of the project zero point cannot be adjusted via the control panel.
Software end positions	limit the permitted positioning range (effective stroke). If the target position of a positioning command lies outside the software end positions, the positioning command will not be processed and an error will be registered.
Effective stroke	The distance between the two software end positions. The maximum stroke which the axis can perform with the parameters currently set.
Offset reference point	The distance of the reference point REF from the retracted end position (tolerance +/- 1 mm). For reasons of technical control, this has to be measured and parameterised. See figures in Tab. 1/2 and Tab. 1/3.

Measuring reference system [1)]



REF	Homing point (reference point)	a	Offset axis zero point
AZ	Axis zero point	b, c	Offset software end positions
PZ	Project zero point	d	Project zero point offset
LSE	Lower software end position	e	Effective stroke
USE	Upper software end position	f	Nominal stroke
TP/AP	Target position / Actual position	g	Offset TP/AP to PZ

[1)] Represented using the example of a drive of the DFME-...-LAS type and on the basis of the homing method: Reference switch negative with index search. Applies to other drives as appropriate.

Tab. 1/1: Measuring reference system

Calculation rules

Point		Calculation rule	
Axis zero point	AZ	= REF + a	
Project zero point	PZ	= AZ + d	= REF + a + d
Lower software end position	LSE	= AZ + b	= REF + a + b
Upper software end position	USE	= AZ + c	= REF + a + c
Target/actual position	TP, AP	= PZ + g	= AZ + d + g = REF + a + d + g

Prefix

All points and offsets have a sign prefix:

Value	Direction
+	Positive values face from the basis point in the direction of the extended end position.
–	Negative values face from the basis point in the direction of the retracted end position.

Units of measurement

Different units of measurement can be set in the FCT, e.g. metric (mm, mm/s, mm/s^2) or imperial (inch, inch/s, inch/s^2).
The CI interface, on the other hand, works with increments. For converting increments: see appendix A.3.

1.1.6 Homing methods to switch with index search

The following can be used for homing to a proximity sensor:

1. The integrated reference switch of the drive (recommended). It is located on the retracted (negative) end position and must not be moved (exception: minimum offset with an “Index pulse warning”, see section 6.7).

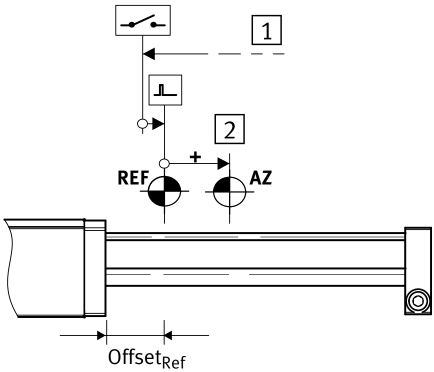
2. A proximity sensor to be externally attached by the user.

i

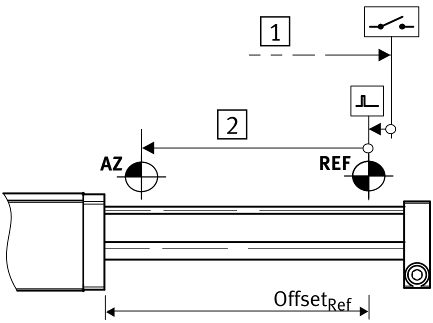
The proximity sensors can be configured as reference switches or as limit switches. This means homing either runs to the reference switch or to the limit switch.
If a proximity switch is configured both as a reference switch and as a limit switch, then its signal during homing is interpreted as a reference signal, and afterwards as a limit switch signal in the referenced state of the drive.

Homing methods to switch with index search

– Switch negative (at the retracted end position)



– Switch positive (at the extended end position)



1 The drive (here: DFME-...-LAS) moves at search speed v_rp to the switch and reverses. After leaving the switching range, the drive moves to the next index signal of the displacement encoder. The reference point REF is there.
2 Then the drive moves at speed v_zp from the reference point REF to the axis zero point AZ.

Tab. 1/2: Homing to switch with index search

Special features of homing

to reference switch

If a reference signal is not found when homing to the reference switch before the drive reaches a fixed stop or a limit switch, then the drive will reverse and search for the switch in the opposite direction. If a reference signal is found there, the drive runs through the switching range of the reference switch. The reference point is subsequently the following index pulse at the end of the switching range.

to limit switch

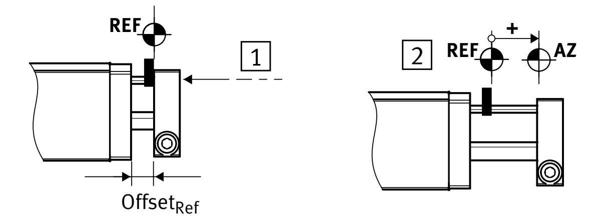
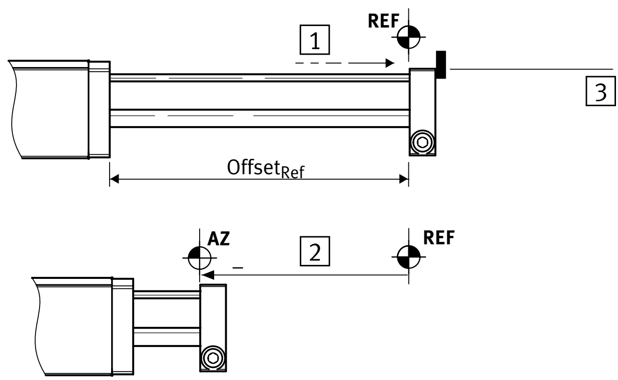
If a reference signal is not found when homing to the limit switch before the drive reaches a fixed stop, then homing is interrupted and a homing error is registered.

Note
Homing error due to incorrect positioning of the limit switches

- Position the limit switches such that the switching range extends over the nearest fixed stop (or end position). There must no range between the limit switch and fixed stop (or end position) in which the limit switch is not actuated (undefined range).
- Note that ferritic elements (e.g. mounting attachments) in the vicinity of magnetic switches can move the switching range.

1.1.7 Homing methods to the stop

Exact homing by reference to a fixed stop can only be carried out against externally fitted stops (without rubber buffer or similar). Therefore you should preferably use the homing methods to switch.

Homing methods to the stop
– Negative fixed stop (retracted end position, near to motor)

– Positive fixed stop (extended end position, remote from motor)

1 The drive (here: DFME-...-LAS) moves at search speed v_rp to the fixed stop (= reference point). 2 The drive moves at speed v_zp from the reference point to the axis zero point AZ. The offset must be ≠ 0! 3 Externally fitted fixed stop

Tab. 1/3: Homing to the stop

1.2 Communication

1.2.1 Data exchange via CANopen

CANopen devices have an object directory which makes all important slave parameters accessible in a standardized manner. A CANopen system is essentially configured by accessing the objects in the object directory of the individual stations. The data exchange in CANopen is in the form of telegrams with which the work data is transmitted. A distinction is made between Service Data Objects (SDO), which are used for transmitting service data from and to the object directory, and between Process Data Objects (PDO), which serve for the fast transfer of current process states. In addition, telegrams are defined for the network management and the fault messages.

1.2.2 Activating the SFC-LACI-CO: FHPP or DS402

The SFC-LACI-CO can either be activated as per FHPP or DS402.

FHPP

Festo has developed an optimised data profile, the "Festo Handling and Positioning Profile (FHPP)", tailored to handling and positioning tasks.

DS402

The CANopen profile DS402 for activation by the master can also be used as an alternative to the Festo profile.
Sequence control: as per sub-profile "Positioning profile" with slight deviations, see Finite state machine DS402 ⟶ Appendix C.1.
Parameterisation: via SDO access as per object descriptions ⟶ Appendix C.2.

DS301

The communications profile is DS301.

This manual explains the application of FHPP in SFC-LACI-CO in detail.

Basic information on DS402 and DS301 can be found at: www.can-cia.org

1.2.3 Festo handling and positioning profile (FHPP)

Festo has developed an optimised data profile, the "Festo Handling and Positioning Profile (FHPP)", tailored to handling and positioning tasks.

FHPP enables uniform sequence control and programming for the various fieldbus systems and controllers from Festo.

Communication over the fieldbus can occur cyclically (PDO) or acyclically (SDO). Mixed operation is typical:

- Commissioning and application parameters are transmitted via SDOs.
- Time-critical process control occurs via **FHPP standard** (PDO1, 8 bytes I/O).
- Parametrising during operation occurs via **FHPP-FPC** (PDO2, additional 8 bytes I/O) or via SDO (conversion is required ⟶ 5.4.4).

FHPP standard

FHPP standard is used for the time-critical sequence control via the first PDO. Here there are two FHPP operating modes:

- **Record selection**: The higher-order controller (PLC) selects positioning records (positioning tasks) stored in the SFC-LACI.
- **Direct mode:** Positioning tasks are formulated directly into the master's cyclical output data. Possible are positioning mode, continuous setpoint specification and force mode.

Detailed information on the FHPP standard can be found starting at chapter 5.5. The FHPP finite state machine can be found in appendix B.1.

FHPP-FPC (Festo Parameter Channel)

As an option, the second PDO can be used for parametrising as per FPC.

Detailed information on the FPC can be found in appendix B.2.

If parameterisation is not to be done for the FHPP profile via FPC, but rather via SDO access, then a conversion is required for the object numbers as per appendix B.2, see section 5.4.4.

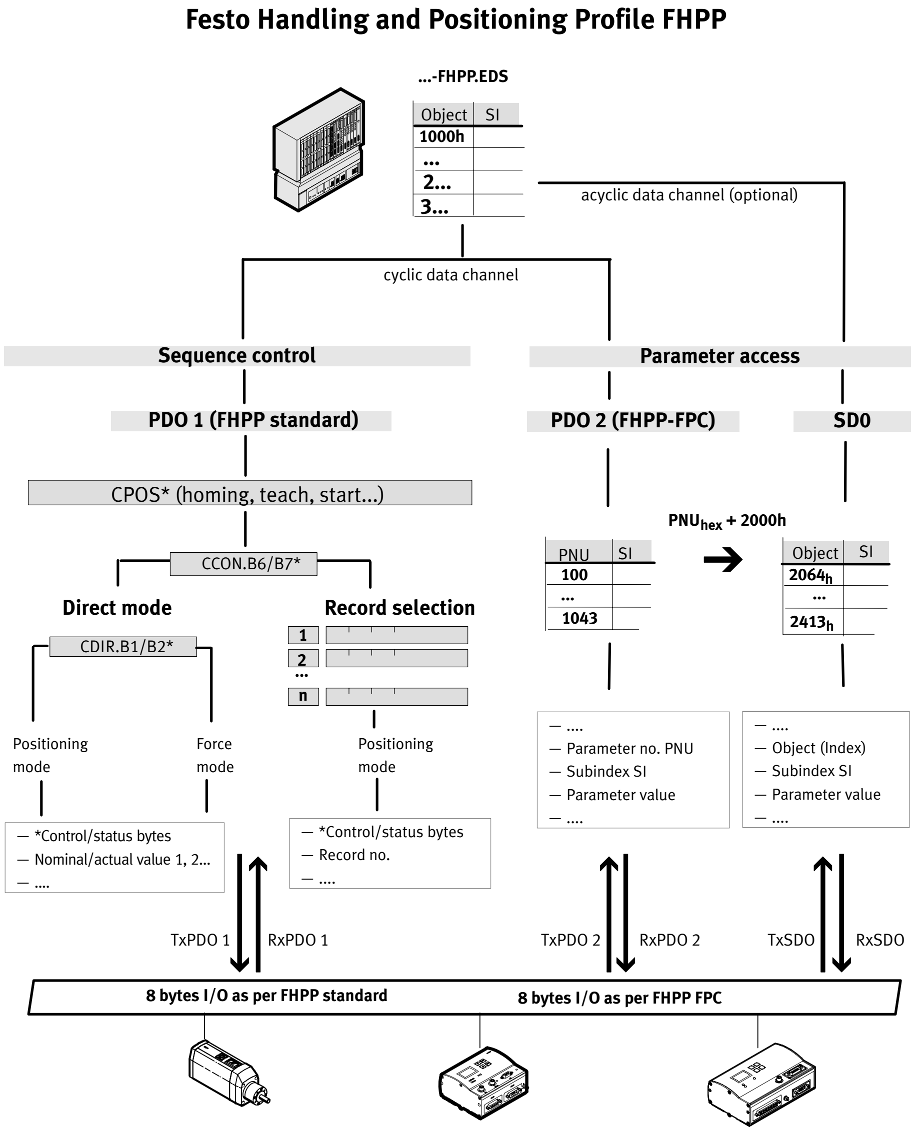


Fig. 1/3: Festo Handling and Positioning Profile (FHPP)

1.3 Commissioning options

You can parameterise and commission the SFC-LACI as follows:

– with the Festo Configuration Tool (FCT), ⟶ Section 5.3

– at the control panel (HMI, only type SFC-LACI-...-H2), ⟶ Chapters 4 and 5.

– via CANopen (CO), ⟶ Section 5.4.1

Functions		**HMI**	**FCT**	**CO**
Parametrisation	– Choice: Drive and associated parameters	x	x	x
	– Uploading/downloading of configuration data	–	x	x
	– Saving different configurations in projects	–	x	x
	– Creating a position set table	x	x	x
	– Record chaining (CO: only in the FHPP profile)	–	x	x
	– Parametrising force mode	–	x	x
	– Parametrising jog mode	–	x	x
Commissioning	– Homing (with HMI limited selection)	(x)	x	x
	– Teaching of positions	x	x	x
	– Testing positioning records	x	x	x
	– Testing record chaining (CO: only in the FHPP profile)	x	x	x
	– Testing force mode	–	x	x
	– Testing jog mode	–	x	x
	– Testing continuous setpoint specification	–	–	x
Diagnostics/ Service	– Reading and displaying diagnostic data	x	x	x
	– Oscilloscope function (trace): Graphic presentation of positioning procedures	–	x	–

Parametrisation can also be carried out with CI commands via the parametrising interface (⟶ Section B.2). Only experienced users may operate the module by means of CI commands.

Assembly

Chapter 2

Contents

2.1 General information

Caution
Uncontrolled drive movements may cause personal injury and material damage.

- Before carrying out fitting, installation and/or maintenance work, always switch off the power supply.

Caution
If a drive is mounted in a sloping or vertical position, loads may fall down and cause injury to persons.

- Check whether external safety measures are necessary (e.g. toothed latches or moveable bolts).

This prevents the work load sliding down suddenly if there is a power failure.

Please also note the following documentation:

– The operating instructions for the drive (e.g. DNCE-...-LAS)

– The instructions for the additional components (e.g. the assembly instructions for the cables).

2.2 Dimensions of the controller

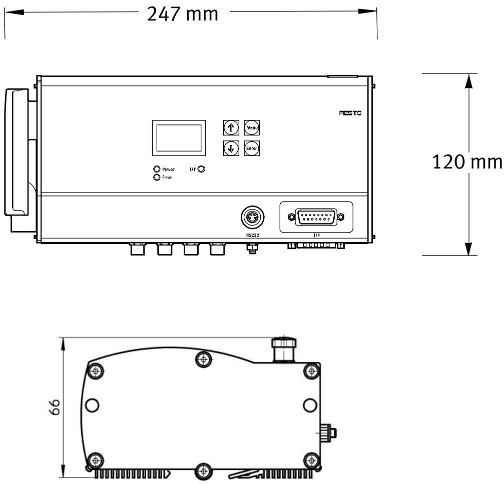


Fig. 2/1: Dimensions of the controller

2.3 Mounting the controller

You can mount the SFC-LACI in one of two ways:

– Wall mounting on a flat surface

– H-rail mounting

Note
Mount the SFC-LACI or H-rail so that there is sufficient space for **heat dissipation** (above and below at least 40 mm).

2.3.1 Wall mounting

You will need:

– A mounting surface of approximately 250 x 320 mm

– 2 sets of central supports type MUP-8/12 (accessory items)
(The four brackets are clipped into the edge of the housing, see Fig. 2/2).

– 4 tapped holes for screw size M3 with matching screws.

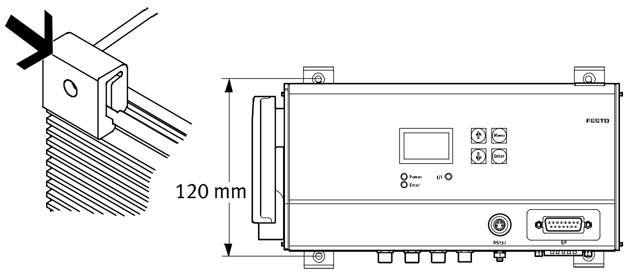


Fig. 2/2: Wall mounting

2.3.2 H-rail mounting

Procedure:

1. Make sure that the mounting surface can support the weight (approx. 1500 g) of the SFC-LACI.
2. Install an H-rail (mounting rail EN 50022 – 35x7.5 or better still 35x15).
3. With a 35x7.5 rail: Maintain a max. distance of 3.3 mm between the housing web and the H-rail:
   - If possible, use a part of the H-rail where there are no mounting screws.
   - If the SFC-LACI needs to be screwed from below: use e.g. an M6 screw as per ISO-7380ULF.
4. Hang the SFC-LACI on the H-rail as follows:
   - First from below, pressing against the tension springs, then
   - press up against the H-rail so that the SFC-LACI clicks into place.

1 H-rail

2 Tension springs

3 Distance between housing web and H-rail: 3.3 mm (rail 35x7.5)

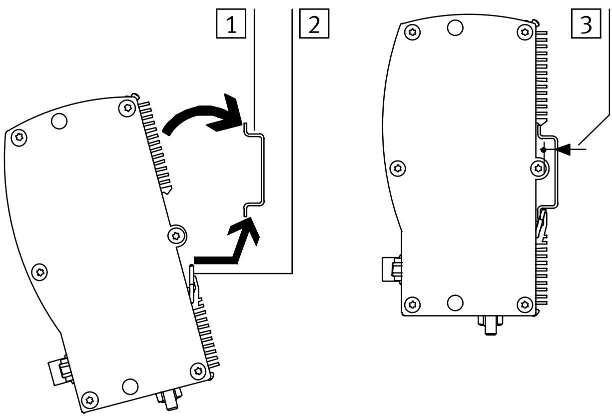


Fig. 2/3: H-rail mounting

Installation

Chapter 3

Contents

3.1 Installation overview

Warning
Before carrying out fitting, installation and/or maintenance work, always switch off the power supply.

In this way, you can avoid:

– Uncontrolled movements of the connected actuators
– Undefined switching states of the electronic components
– Damage to the electronic components

Caution
Faulty pre-assembled lines may destroy the electronics and trigger unexpected movements of the motor.

- For connecting the electric components of the system, use only the cables listed as accessories (see Tab. 3/2).
- Lay all flexible lines so that they are free of kinks and free of mechanical stress; if necessary use chain link trunking.

1 Parametrising interface (RS232)

2 Controller interface

3 Power supply

4 Earth terminal

5 Local digital I/Os

6 Motor connection (e.g. DNCE-...-LAS)

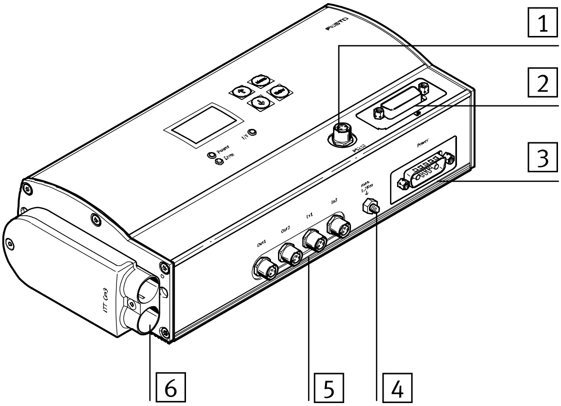


Fig. 3/1: Connections to the SFC-LACI

Connection on the SFC-LACI-CO			Description
1	Parameterising interface	M8 socket, 4-pin	RS232 interface for parameterising, commissioning and diagnosis via FCT. ⟶ Section 3.5
2	Controller interface	Sub-D plug, 9-pin	Interface for connecting to a PLC controller. ⟶ Section 3.6
3	Power supply	Sub-D plug, 7W2	Voltage connection with 2 high-current contacts and 5 low-current contacts (separate load and logic voltage supply). ⟶ Section 3.2
4	Earth terminal	Stud bolt, M4	Functional earth connection ⟶ Section 3.3
5	Local digital I/Os	M8 socket, 3-pin	Local digital inputs and outputs ⟶ Section 3.9
6	Motor connection	Plug connector, type ITT Cm3	Power supply for linear motor and sensor signals ⟶ Section 3.4

Tab. 3/1: Overview of connections

If unused plug connectors are touched, there is a danger that damage may occur to the SFC-LACI or to other parts of the system as a result of ESD (electrostatic discharge). Place protective caps on unused terminal connections in order to prevent such discharges.

Overview of cables and plugs

Connection		Cable/plug	Type
1	Parameterising interface	Programming cable	KDI-MC-M8-SUB-9-2,5
2	Controller interface	Fieldbus plug	FBS-SUB-9-BU-2x5POL-B
		Fieldbus adapter	FBA-2-M12-5POL
3	Power supply	Power supply cable	KPWR-MC-1-SUB-15HC-...
5	Local digital I/Os	Connecting cable	KM8-M8-... or NEBU-M8-...
6	Motor connection	Motor cable	NEBM-T1G6-T1G6-...
		Encoder cable	NEBM-T1G12-T1G12-...

Tab. 3/2: Overview of cables and plugs (accessories)

For complying with the IP protection class: Tighten the union nuts/locking screws on the plugs by hand; seal unused M8 connections with type ISK-M8 protective caps (accessories).

Observe the tightening torques specified in the documentation for the cables and plugs used.

Festo plugs which comply with protection class IP20:
– screw terminal adapter type FBA-1-SL-5POL,
– field bus plug FBS-SUB-9-WS-CO-K.

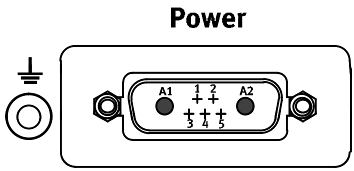
3.2 Power supply

Warning
- Use only PELV **circuits** as per IEC/DIN EN 60204-1 for the electric power supply (protective extra-low voltage, PELV).
  Take into account also the general requirements for PELV circuits as per IEC/DIN EN 60204-1.
- Use only **power supply units** that guarantee reliable electrical isolation of the operating voltage as per IEC/DIN EN 60204-1.

Protection against electric shock (protection against direct and indirect contact) is guaranteed in accordance with IEC/DIN EN 60204-1 by using PELV circuits (electrical equipment of machines, general requirements).

Note
Note that the tolerances of the voltage supply must also be observed directly at the voltage supply connection of the SFC-LACI.
- For the power supply, use only the cables specified in Tab. 3/2.
- Use regulated power supply that complies with the requirements described in Tab. 3/4.

Load voltage supply: The use of power supply units with lower output levels is possible with restricted motion dynamics and loads. To do this, you need to enter the power output of your power supply unit into the FCT (or via the CI object 6510/50h).

Connection	Pin	Designation	Function	Cable colour [1]
	01	Load voltage	+ 48 VDC load	Black, 1
	02	Load voltage	GND load	Black, 2
	1	Logic voltage	+24 VDC logic	White
	2	Logic voltage	GND logic	Brown
	3	Hardware enable	+24 VDC hardware enable	Green
	4	FE	FE[3]	– [2]
	5	Hardware enable	GND hardware enable	Yellow
	–	Plug housing	FE[3]	Earthing strap with cable lug M4
	⏚	Earth terminal (housing)	FE[3]	–

[1] Cable colours with power supply cable type KPWR-MC-1-SUB-15HC-...
[2] With cable type KPWR-MC-1-SUB-15HC-... not connected.
[3] Use only one connection; see section 3.3

Tab. 3/3: “Power” connection (voltage supply) on the SFC-LACI

Caution
Damage to the device

The power supply inputs on the SFC-LACI have no special protection against overvoltage.

- Make sure the permissible voltage tolerance is never exceeded; see Tab. 3/4.

Requirements to be met by the power supply

Voltage	Use	Currents
48 VDC +5/-10%	**Load supply** (pins A1, A2)	Nominal current (peak current): 10 A (20 A) Internal fuse: 16 A slow-blow (external as an option)
24 VDC ±10%	**Logic supply** (pins 1, 2)	Nominal current: 0.4 A Peak current: 0.8 A (without local outputs) Internal fuse: 4 A slow-blow (external as an option)
	Local outputs OUT1/2	Supply via logic supply (pins 1, 2). Max. 1 A permissible per output.
	Hardware enable (pins 3, 5)	Minimum current on contact
	Total current consumption 24 V	Dependent on the system architecture, up to 3.8 A.

Tab. 3/4: Requirements to be met by the power supply

Example of a power supply connection

1 **Connect the earth terminals of the two power supply units**

2 External fuses (as an option)

3 Switch for hardware enable

4 Earth terminals (only use one, see section 3.3)

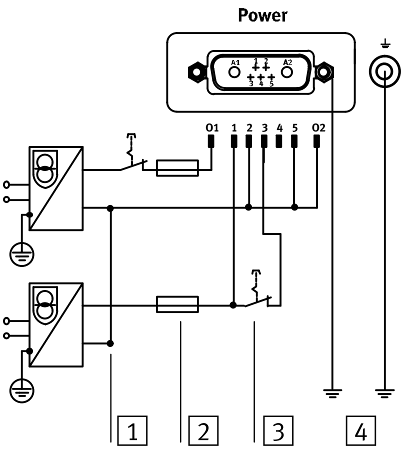


Fig. 3/2: Power supply connection example

3.2.1 Function of the hardware enable

Application of 24 VDC to pin 3 (relative to pin 5) of the power supply connection is essential for operation of the SFC-LACI.

In a similar fashion to the relay, “hardware enable” switches the load voltage on and off, whereby the voltage of the hardware enable represents the control voltage:

- Hardware enable applied: the load voltage is switched through.
- Hardware enable missing: the load voltage is blocked.

The switching on or off of the voltage of “hardware enable”, therefore, corresponds with the switching on or off of the load voltage.

The hardware enable is electrically isolated.

Use of the hardware enable is described in section 5.6.9.

3.3 Earthing

Note
- Connect **one** of the earth terminals of the SFC-LACI at low impedance (short cable with large cross-section) to the earth potential.

You can thereby avoid interference from electromagnetic sources and ensure electromagnetic compatibility in accordance with EMC directives.

To earth the SFC-LACI, use **one** of the following terminals (see Tab. 3/3):

– Earth terminal on the housing of the SFC-LACI, **or**

– Earthing strip with cable lug on the plug housing.

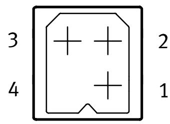
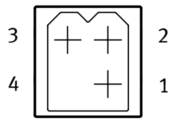
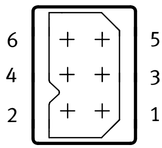
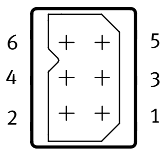
Note
Note that **only one** of the three earth terminals may be used (to avoid earth loops).

When using the earth terminal on the housing of the SFC-LACI:

- Use a suitable earthing cable with an M4 cable lug together with the accompanying nut and toothed washer.
- Tighten the nut with max. 1.7 Nm.

3.4 Motor connection

The linear motor is controlled via the motor connection and the signals from the displacement encoder are transmitted via the motor connection.

Pin	Colour	Function	Plug on the SFC-LACI
1	White	Motor: String U	
2	Brown	Motor: String V	
3	Green	Motor: String W	
4	–	–	Black plug, A
1	Yellow	Motor: String U/	
2	Grey	Motor: String V/	
3	Pink	Motor: String W/	
4	–	–	Black plug, B
1	Blue	VCC +5 V DC	
2	Red	GND	
3	White	Temperature sensor	
4	Brown	Temperature sensor GND	
5	orange	Reference switch +24 V DC	Yellow plug (sensors)
6	Grey	Reference switch input	
1	Green	Data serial +	
2	Yellow	Data serial –	
3	Black	GND	
4	Brown	VCC +5V DC	
5	Red	Pulse –	Red plug (BiSS position measuring system)
6	orange	Pulse +	

Tab. 3/5: Motor connection to the SFC-LACI

Displacement encoder for BiSS interface

The BiSS interface is a 2-wire interface for interference-immune sensor connection. In contrast to the SSI interface, the data transmission is bi-directional, which means, for example, that data can also be written into the sensor for parametrisation.

Data is transmitted via a pulse cable controlled by the master and a data cable controlled by the sensor as serial transmission. Data is written to the slave via the cycle's pulse width modulation in accordance with the "BiSS B mode" protocol specification http://www.biss-ic.de/files/BiSS_b3ds.pdf; the direc¬tion of the data cable is not switched. Pulse and data are transmitted using RS485 technology, which means a signal is sent not-inverted as well as inverted and issued at the receiver as differential input. This suppresses common-mode interference. The data are also secured by a CRC code.

The BiSS interface supports 2 read-out modes:

- The sensor data channel for fast pulse out (pulse up to 10 MHz) of the sensor information

- The parameter channel for reading and writing sensor parameters as well as for depositing user-specific data protected against zero voltage in the sensor's EEPROM

The distinction is made on the basis of the start bit, details can be referred to in the specifications given.

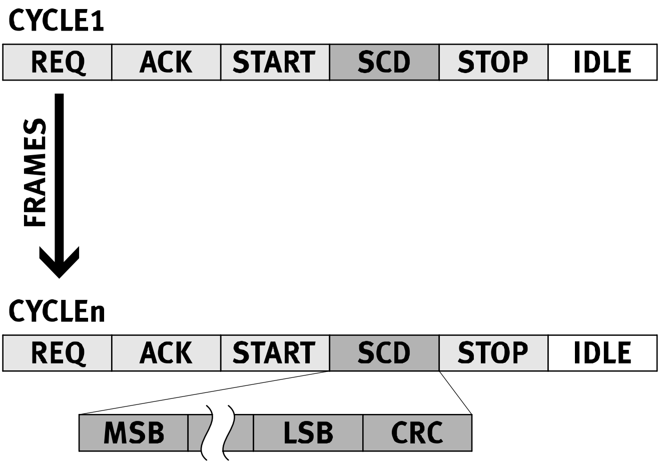


Fig. 3/3: Sensor data communication

Bits	Type	Label
[19:30]	DATA	Cycle counter 12 bit (multiturn position)
[8:18]	DATA	Angle data 11 bit (singleturn position)
[7]	Error	Error bit E1 (amplitude error)
[6]	Error	Error bit E0 (frequency error)
[0:5]	CRC	Polynomial 0x43; $x^6+x^1+x^0$ (inverted bit output)

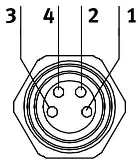
Tab. 3/6: BiSS Interface

3.5 Parameterising interface

Serial interface for parameterising, commissioning and diagnosing.

Note
For connecting a PC to the SFC-LACI, use only the cable specified in Appendix A.2.

- If necessary, remove the protective cap from the parameterising interface.
- Connect the following terminals with the programming cable:
  - the socket on the SFC-LACI
  - a serial interface COMx of the PC.

M8 socket	Description		
	1	GND	Ground
	2	RXD	RS232 [1]: Receiving cable of PC, transmitting cable of SFC-LACI
	3	TXD	RS232 [1] Transmitting cable of PC, receiving cable of SFC-LACI
	4	–	(reserved, do not use)
[1] The levels correspond to the RS232 standard.			

Tab. 3/7: Parameterising interface (RS232) of the SFC-LACI

Information on commissioning and parameterising the SFC-LACI via the parametrising interface can be found in chapter 5.3.2 and in the help system for the Festo Configuration Tool software package.
Information on transmitting CI commands via the parameterising interface can be found in Appendix B.

Note
The parameterising interface (RS232) is not electrically isolated and is not real-time capable. It is not suitable for permanent connection to PC systems, or as a control interface.

- Use this terminal only for commissioning.
- Remove the programming cable in continuous operation.
- Seal the terminal with the protective cap supplied (type ISK-M8).

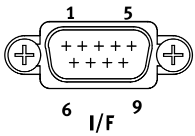
3.6 Controller interface

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

There is a 9-pin Sub-D plug on the SFC-LACI for connecting the fieldbus. This connection is used for the incoming and continuing fieldbus cables.

Note
Only fieldbus plugs of type FBS-SUB-9-BU-2x5-POL-B and FBA-2-M12-5-POL from Festo ensure conformance to IP 54.

Note the instructions in section 3.7.5 if other sub-D plugs are used.

Connection	Pin	Designation	Function	Fieldbus plug [1]
	1	n.c.	Not connected	–
	2	CAN_L	CAN bus low	A/L
	3 [5]	CAN GND	CAN bus reference potential	GND
	4	n.c.	Not connected	–
	5	Screened	Capacitive connection to housing	Clamping strap
	6 [2] [5]	GND logic [3]	Logic power GND (see Tab. 3/3)	–
		GND bus [4]	Bus interface power supply reference potential	
	7	CAN_H	CAN bus high	B/H
	8	n.c.	Not connected	–
	9 [2]	n.c. [3]	Not connected	V+
		24 V bus [4]	Power supply to the bus interface	
	–	Screening/housing	Connection to (FE) functional earth	Clamping strap

1) Pin assignment on fieldbus plug type FBS-SUB-9-BU-2x5POL-B from Festo
2) Depending on parameterisation "CAN Voltage Supply" (see section 5.2.1) or [CAN Volt.Supply] on control panel (see section 4.5.6, [CO parameters]).
3) Internal supply of the fieldbus node (default): CAN bus (pins 2, 3, 7) referred to logic voltage of the SFC-LACI.
   • Do not connect pins 6 and 9.
4) External supply of the fieldbus node: CAN bus (pins 2, 3, 7) referred to external power supply (permits electrically isolated bus connection).
   • Pin 6 and pin 9 must be supplied with 24 V.
5) Pin 3 and pin 6 are connected internally with each other in the SFC-LACI-CO.

Tab. 3/8: "I/F" terminal (control terminal) on the SFC-LACI-...-CO

Note
The screen connection at pin 5 of the fieldbus interface is capacitively connected internally to the housing. This prevents compensating currents from flowing via the screening of the fieldbus cable (see Fig. 3/4).

1 Capacitive connection

2 Housing

Fig. 3/4: Screen connection inside the SFC-LACI

3.7 Connecting the Fieldbus

3.7.1 Fieldbus cable

Note
Faulty installations or high transmission rates may cause data transmission errors as a result of signal reflections and attenuations.
Transmission errors can be caused by:

– Missing or incorrect terminating resistor
– incorrect screening/shield connection
– Branches
– Too long or not terminated branch lines
– Transmission over long distances
– Unsuitable cables

Observe the cable specifications. For information on the cable type refer to the manual for your controller or to CIA specification DS 102.

Note
If the SFC-LACI is installed in a machine on a movable mounting, the fieldbus cable must be provided with strain relief on the moving part of the machine. Please also observe the relevant regulations in EN 60204 part 1.

With external power supply to the fieldbus node, use a twisted-pair, screened 4-wire cable as the fieldbus cable. With internal power supply, a twisted 2-wire cable will generally suffice.

If the fieldbus plug FBS-SUB-9-BU-2x5POL-B is used, a cable diameter of 5 ... 10 mm is permitted.

3.7.2 Fieldbus baud rate and fieldbus length

The maximum permissible fieldbus length and length of the branch lines depends on the baud rate used. You will find detailed information in the manuals for your control system or bus interface, or in CIA specification DS 102.

Note

- Refer to the manuals for your control system or bus interface in order to ascertain which T-adapter and maximum branch line length are permitted for your controller.
- Also take into account the sum of the branch line lengths when calculating the maximum permitted length of the fieldbus cable.

3.7.3 Bus power supply

Bus supply

With external power supply to the fieldbus node of the SFC-LACI avoid excessive distances between the bus power supply and the SFC-LACI.

Caution

- When connecting the fieldbus interface and the power supply for the bus interface pay attention to the polarity.
- Connect the screen.
- With external voltage supply (see Tab. 3/8): Protect the power supply for the bus interface with an external fuse, in accordance with the number of bus slaves.

Note

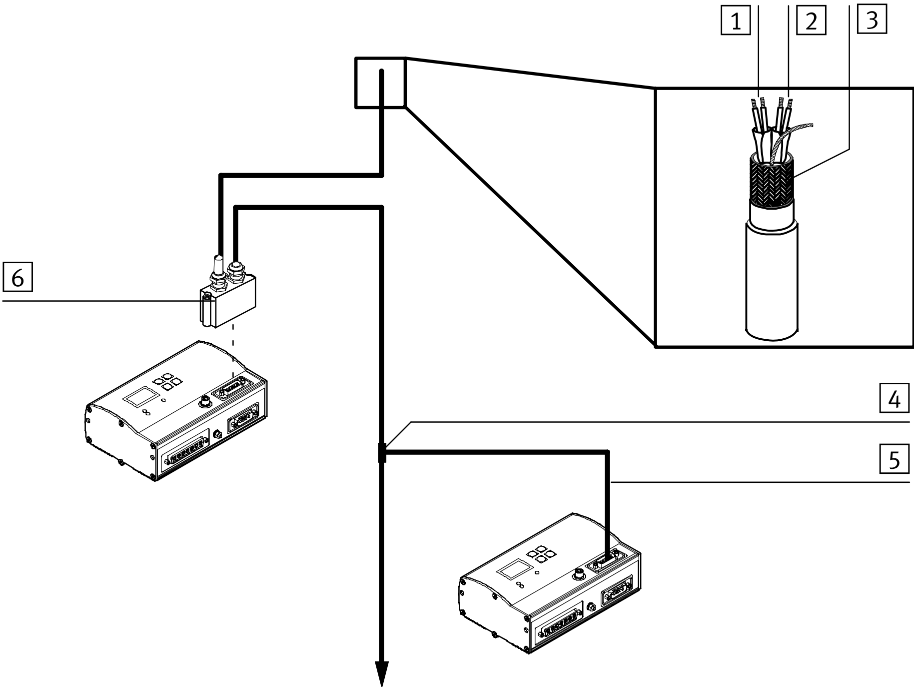
Bus slaves have different tolerances in respect of the interface supply, depending on the manufacturer. Observe this when planning the bus length and placing the power supply unit.

For the SFC-LACI, the following tolerance applies to the bus interface supply (pin 9 on the Sub-D plug):
V_{max} = 30.0 V
V_{min} = 11.0 V

Recommendation:
Place the power supply unit approximately at the centre of the bus.

3.7.4 Connection with fieldbus plugs / adapters from Festo

With Festo fieldbus plugs type FBS-SUB-9-BU-2x5POL-B or the fieldbus adapter FBA-2-M12-5POL you can connect the SFC-LACI to the fieldbus in a user-friendly manner. You can disconnect the plug from the SFC-LACI without breaking the bus connection (T-TAP function).



1 Fieldbus

2 Power supply

3 Screened

4 T-adapter (T-tap)

5 Branch line

6 Fieldbus plug with T-adapter function

Fig. 3/5: Layout of the bus interface and example of connection

Fieldbus plug FBS-SUB-9-BU-2x5POL-B (IP54)

- Observe the fitting instructions for the fieldbus plug. Tighten the two fastening screws at first by hand and then with max. 0.4 Nm.

Note
The clamp strap in the fieldbus plug from Festo is connected internally only capacitively with the metal housing of the Sub-D plug. This is to prevent compensating currents flowing through the screening of the fieldbus cable.

- Clamp the screening of the fieldbus cable under the clamp strap in the fieldbus plug. The “SLD” terminal in the fieldbus plug is optional.

1 Folding cover with inspection window

2 Clamp strap for screen connection

3 Blanking plug if connection unused

4 Fieldbus continuing (OUT)

5 Fieldbus incoming (IN)

6 Only capacitively connected

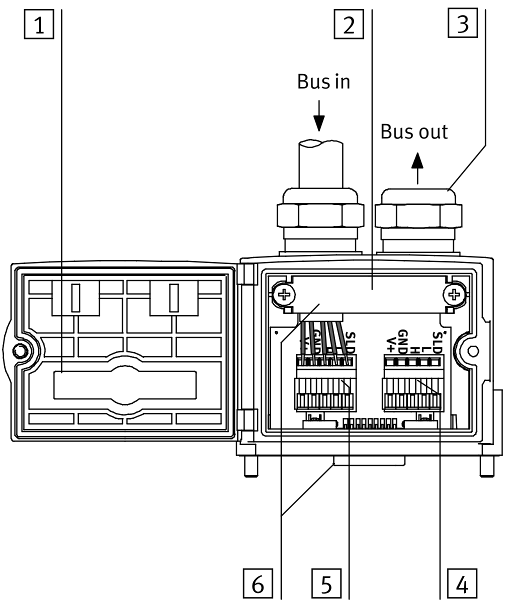
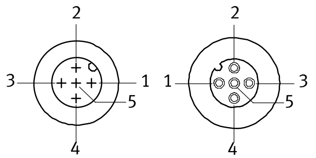
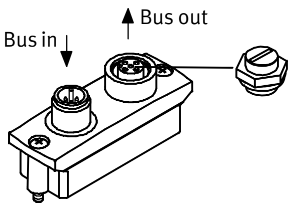


Fig. 3/6: Fieldbus plug type FBS-SUB-9-BU-2x5POL-B

M12 adapter FBA-2-M12-5POL (IP54)

The bus is connected via a 5-pin M12 socket with PG 9 screw connector. Use the second socket for the continuation of the fieldbus.

Note
- Use protective caps or blanking plugs to seal unused connections.

M12 adapter	Pin no.
 	1 Screened 2 24 VDC bus 3 0 VDC bus 4 CAN_H 5 CAN_L
 Protective cap or plug with bus termination resistor if connection is not used.	

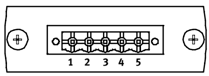
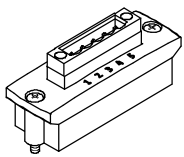
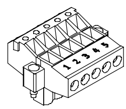
Tab. 3/9: Pin assignment of fieldbus interface (adapter for 5-pin M12 connection)

With the two M12 connections you can implement a T-adapter.

Screw terminal adapter (IP20)

With the adapter type FBA-1-SL-5POL the bus can be connected to a 2x5-pin terminal strip. Use the second row of connections for the continuing fieldbus.
The maximum permitted current at the terminals is 4 A. Use cables with a cross sectional area of min. 0.34 mm^2.

Order this adapter together with the terminal strip type FBSD-KL-2x5POL. In this way you can implement a T-adapter function.

Screw terminal adapter	**Pin no.**
	1 0 VDC bus 2 CAN_L 3 Screened 4 CAN_H 5 24 VDC bus
	 2x5-pin terminal strip

Tab. 3/10: Pin assignment of fieldbus interface (5-pin screw terminal adapter)

3.7.5 Connection with other Sub-D plugs (IP20)

If you are using the Festo type FBS-SUB-9-WS-CO-K plug or Sub-D plugs from other manufacturers, you must replace the two flat screws by which the fieldbus plug is fitted in the SFC-LACI by a bolt of type UNC 4-40/M3x5 (supplied).

Note
Note that when using Sub-D plugs from other manufacturers only IP 20 protection is attained.

Note
If both screws or stud bolts are removed simultaneously, there is a risk that the plug may be pressed into the SFC-LACI housing with the internal circuit board.

- Always leave one of the screws or stud bolts fitted while changing over.

1. First slacken just one of the mounting screws and remove it.

2. Screw one of the mounting bolts into the vacant tapped hole and tighten it.
   Maximum tightening torque: 0.48 Nm.

3. Repeat steps 1 and 2 for the other screw.

3.8 Bus termination with terminating resistors

Note
If the SFC-LACI is at the start or end of the fieldbus segment, a bus terminator is required.

- **Always** use a bus termination at both ends of the fieldbus.

If you are using T-adapters, install the terminating resistor at the unused output of the T-adapter.

Recommendation: Fit a terminating resistor in the Festo fieldbus plug for the bus termination.

1 Protective cap

2 Resistor for bus termination (120 Ω, 0.25 W)

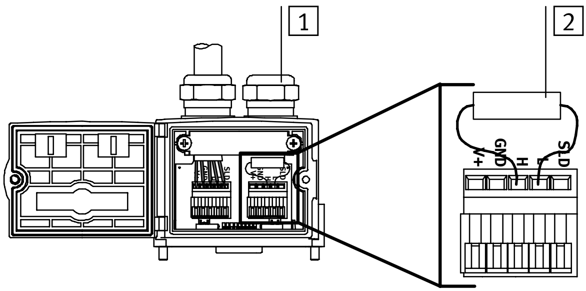


Fig. 3/7: Bus termination with resistor in fieldbus plug FBS-SUB-9-BU-2x5POL-B

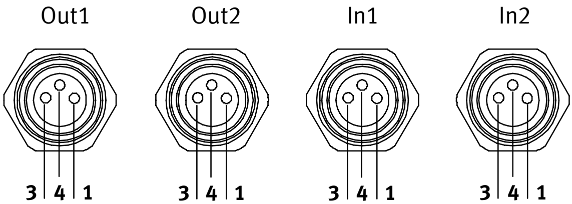
Fieldbus plug FBS-SUB-9-WS-CO-K (IP20) has an integrated switchable terminating resistor.

Install a terminating resistor using the adapters:

If the SFC-LACI you are connecting is at the end of the fieldbus, you must install a terminating resistor (120 Ω, 0.25 W) in the fieldbus socket:

- Connect the terminating resistor between the cores for CAN_H and CAN_L.

3.9 Local digital inputs and outputs



Connection	Pin	Function
Output 1 (Out1)	3	Ground (GND)
	4	Signal
	1	+24 VDC logic voltage output
Output 2 (Out2)	3	Ground (GND)
	4	Signal A
	1	Signal /A
Input 1 (In1)	3	Ground (GND)
	4	Proximity sensor contact
	1	+24 VDC voltage output for proximity sensor
Input 2 (In2)	3	Ground (GND)
	4	Proximity sensor contact
	1	+24 VDC voltage output for proximity sensor

3.9.1 Specifications of the outputs

The local digital outputs are supplied by the 24 V logic voltage (no electrical isolation). They are ESD-protected and short circuit proof, but do not have reverse polarity protection against infeed.

Caution
If 24 VDC voltage is applied and the output pins are used incorrectly, the device may be seriously damaged. Therefore:

- Do not apply voltage to the outputs.
- Note the current limitation for the outputs (max. 1 A permissible per output).

Special features of output 1 (Out1)

– Standard PLC output (active high-side switching)

Special features of output 2 (Out2)

– Differential output (can be pulse-width modulated)

– High and low-side switching (active full bridge)

– It is not used for controlling a PLC, but rather for controlling a load, e.g. to control a pulsed motor brake, a valve or a fan.

The possible uses dependent on the selected pins are described in section 5.6.10.

3.9.2 Specifications of the inputs

- Based on DIN/EN 61131, Part 2 (IEC 1131-2), type 1
- They are supplied by 24 V logic voltage (no electrical isolation)

Note
Damage to the device

The 24 VDC voltage at pin 1 does not have any special protection against overload.

- Use this connection only for proximity sensors (sensor supply).

Use of this connection as a power supply for other devices is not permitted.

- For connecting the proximity sensor, use a cable with rotating thread sleeve (union nut) on the end of the cable, e.g. an extension cable type KM8-M8-... or NEBU-M8-...
- When selecting the proximity sensor, note that the accuracy of the proximity sensor switching point may affect the accuracy of the reference point.
- During installation, note the position of the reference switch relative to the index pulse. If necessary, move the reference switch (see "INDEX PULSE WARNING", section 6.3).

The control panel (only type SFC-LACI-...-H2-...)

Chapter 4

Contents

The control panel of the SFC-LACI-...-H2 provides many functions for commissioning, parameterisation and diagnostics. An overview of the key and menu functions can be found in this chapter.

Commissioning with the control panel is described starting from section 5.2.

With the SFC-LACI-...-H0 (without control panel), you can commission the device via the parameterising interface using the Festo Configuration Tool (FCT). Instructions on this can be found in section 5.3.2.

Caution
Simultaneous or alternating attempts to access the SFC-LACI via FCT, control panel and controller interface can cause unpredictable errors.

- Make sure that the FCT, the control panel and the controller interface of the SFC-LACI are not used at the same time.
- If necessary, use the possibility of blocking parameterising and positioning functions via the control panel (HMI access, see section 5.5.2)

4.1 Design and function of the control panel

The control panel allows:

- Parameterising and referencing the drive (homing methods: to the stop and to the integrated reference switch of the drive)
- Teaching and editing the positioning records
- Execution/testing of positioning records.

1 LC display

2 Operating keys

3 LEDs
- Power (green)
- I/F (green/red)
- Error (red)

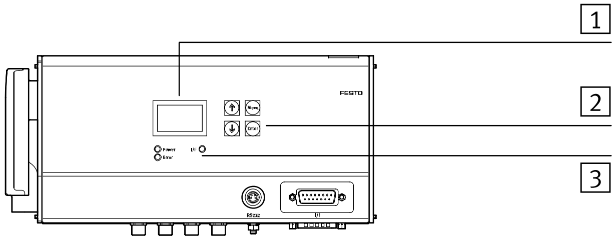


Fig. 4/1: Control panel of the SFC-LACI-...-H2

LC display — The graphic LCD shows all text in English. The display can be rotated 180°; see [LCD adjustment] menu command.

LEDs — Display of operating states (see chapter 6.2):

- Power: Power supply
- I/F: Communication via the controller interface
- Error: Error message or warning

Operator keys

Basic functions of the operator keys:

Key	Function	
Menu	MENU	Activates the main menu from the status display
	ESC	Discards the current entry and switches back in stages to the higher-order menu level or status display
	EMERG.STOP	If [HMI = on]: interrupts the current positioning procedure (⇢ Error mode; confirm with ‹Enter›, then automatic return to the status display).
Enter	OK	Confirms the current selection or entry
	SAVE	Saves parameter settings permanently in the EEPROM
	START/STOP	Starts or stops a positioning procedure (only in Demo mode). After stop: Display of current position; use ‹Menu› to return to the higher-order menu level.
↑ ↓	← →	Scrolls within a menu level in order to select a menu command.
	EDIT	Sets parameters

Tab. 4/1: Key functions (overview)

4.2 The menu system

Status display and main menu

When the logic voltage is switched on, the SFC-LACI carries out an internal check.

```
CAN–BUS INIT NO
PARAMETER ERROR

      Diagnostic <menu>
         Config <Enter>
```

During the first commissioning or when the EEPROM is deleted, the fault message “CAN-BUS INIT NO PARAMETER ERROR” will appear, as the CAN bus parameters are not parameterised (see section 5.2.1).

In the case of recommissioning (i.e. if the CANbus parameters have already been completely parameterised), the display briefly shows the Festo logo and then changes to the status display.

```
SFC–LACI...
D...
Xa = 0.00 mm

HMI:off
<Menu>
```

The **status display** shows the following information:

– The type designation of the SFC-LACI

– The type of connected drive

– The position of the drive x_a = ... (still without significance when unit is switched on)

– The current setting of the device control (HMI = Human Machine Interface)

```
→ Diagnostic
  Positioning
  Settings
  ↓          ESC <Menu>
<—>           OK <Enter>
```

```
→ HMI control
  LCD adjustment

  ↑          ESC <Menu>
<—>           OK <Enter>
```

The **main menu** is accessed from the status display using the ‹Menu› key. The currently active key function is displayed in the lower lines of the LCD display.

Menu command	Description	
→ **Diagnostic**	Displays the system data and the settings currently in effect (→ 4.3)	
→ Pos. set table	Displays the position set table	
→ Axis parameters	Displays axis parameters and data	
→ System paramet.	Displays system parameters and data	
→ CANopen Diag	Displays fieldbus parameters of the SFC-LACI	
→ SW information	Displays the operating system version (firmware)	
→ **Positioning**	Homing and positioning runs (→ 4.4)	
→ Homing	Start homing	
→ Move posit. set	Start an individual positioning record	
→ Demo posit. tab	Starts the "Demo mode"	
→ **Settings**	Parameterisation (→ 4.5)	
→ Axis type	→ not adjustable	The type of the drive is automatically detected
→ Axis parameter	→ Zero point	Offset of the axis zero point relative to the reference point
	→ SW-limit-neg	Software end position, negative; offset relative to the axis zero point
	→ SW-limit-pos	Software end position, positive; offset relative to the axis zero point
	→ Tool load	Tool load mass (e.g. gripper on front plate/piston rod)
	→ SAVE...	Saves parameters to the EEPROM
→ Homing paramet.	→ Homing method	Homing method
	→ Velocity v_rp	Speed when searching for the reference point
	→ Velocity v_zp	Speed when moving to the axis zero point
	→ SAVE...	Saves parameters to the EEPROM
→ Position set	→ Position nr	Number of the positioning record (1...31)
	→ Pos set mode	Absolute or relative positioning; if necessary, energy optimised
	→ Position	Target position
	→ Velocity	Velocity
	→ Acceleration	Acceleration
	→ Deceleration	Deceleration (Braking)
	→ Jerk Acc.	Acceleration jerk
	→ Jerk Dec.	Deceleration jerk
	→ Work load	Applied load (= workpiece mass)
	→ Time MC	Damping time
	→ SAVE...	Saves parameters to the EEPROM
→ Jog mode	Move the drive using the arrow keys	
→ CO parameter	Setting fieldbus parameters of the SFC-LACI	
→ Password edit	Set up a local password for the control panel (→ 4.5)	
→ **HMI control**	Preset the device control via the control panel (→ 4.6)	
→ **LCD adjustment**	Rotate the display 180°	

Tab. 4/2: Menu commands (overview)

4. The control panel (only type SFC-LACI-...-H2-...)

4.3 [Diagnostic] menu

In order to display the system data and the currently effective settings:

```
→ Diagnostic
   ├── Pos.set table
   ├── Axis parameter
   ├── System paramet.
   ├── CANopen Diag
   └── SW information
```

1. Select the [Diagnostic] menu in the main menu. ‹ENTER›
2. Select a menu command. ‹ENTER›

← →	You can scroll through the data with the arrow keys.
ESC	You can use the ‹Menu› key to return to the higher-order menu.

[Diagnostic] [...]	Description	
[Pos. set table]	Nr	Number of the positioning record
	a/r (e)	Absolute (a) or relative (r) positioning, (e) = energy optimised
	Pos	Target position
	Vel	Velocity
	acc *)	Acceleration
	dec *)	Deceleration (Braking)
	Work load *)	Applied load (= workpiece mass)
	Yes *)	Acceleration jerk
	jd *)	Deceleration jerk
	t_MC *)	Damping time
	*) After 5 s the lower part of the display changes.	

[Diagnostic] [...]	**Description**	
[Axis parameter]	v max	Maximum speed
	x neg	Stroke limitation: Software end position, negative
	x pos	Stroke limitation: Software end position, positive
	x zp	Offset axis zero point
	Tool load	Tool load (e.g. a gripper on the front plate or on the piston rod)
[System paramet.]	Load Power	Load voltage ok?
	VDig	Digital voltage (= Logic voltage) [V]
	I max	Max. phase current [A]
	P_Pos	Average power during last positioning procedure [W]
	t_Pos	Time taken for the last positioning procedure [s]
	Cycle	Number of positioning movements
	Mode	Unit of measurement [mm]
	Hom.meth.	The parameterised homing method: – RefS.n: Reference switch in negative direction – RefS.p: Reference switch in positive direction – Bl.pos: Fixed stop in positive direction – Bl.neg: Fixed stop in negative direction – LimS.p: Limit switch in positive direction – LimS.n: Limit switch in negative direction
	Ref. switch	Activated (switching) position of the parameterised reference switch
	Neg. Lim-Sw	Activated (switching) position of the negative limit switch
	Pos. Lim-Sw	Activated (switching) position of the positive limit switch
	T_Motor	Temperature of the linear motor [°C]
	T_LACI	Temperature of the SFC-LACI [°C]

[Diagnostic] [...]	Description	
[CANopen Diag]	Bus diagnosis	
	– Guarding Error [1]	"Node guarding" activated (if enabled in master), e.g. master shut down or cable break.
	– CAN WarningLimit [1]	Telegrams are not being received or cannot be sent (no acknowledgement at lowest CAN level), e.g. no bus connection. More than 128 CAN error frames on the bus. Regeneration with correct communication.
	– CO State stopped	"Stop" network management command received.
	– CAN Bus OFF [1]	CANbus is switched off or is not available.
	– CO State pre-op	Pre-operational, normal state after power-on before the master transmits "Start node operational".
	– State operational	"Start node operational" transmitted by master, normal operating state.
	Baud rate	Preset baud rate of the SFC-LACI
	Profiles	Data profile with which communication between the CAN master and the SFC-LACI is handled. – FHPP: The SFC-LACI is controlled as per the Festo Handling and Positioning Profile. – DS 402: The SFC-LACI is controlled as per DS 402.
	CAN Node ID	CAN address of the SFC-LACI (hexadecimal)
	Volt.Supply int./ext.	CAN interface voltage supply internal/external
[SW information]	SFC-LACI firmware version	

[1] The "Guarding Error" and "CAN WarningLimit" state displays are prioritised (regardless of the other states).

Tab. 4/3: [Diagnostic] menu

4.4 [Positioning] menu

Starting a homing run or a positioning run

Warning
Electric axes move with high force and at high speed. Collisions may cause injury.

- Make sure that nobody can place his/her hand in the positioning range of the moveable mass and that there are no objects in its path.

Note

- Before starting homing, make sure that:
  - The positioning system is set up and wired completely, and is supplied with power.
  - The parameterising is completed.
- Only start a positioning run after:
  - The reference system has been defined by homing.
  - You have checked that the software end positions are far enough away from the mechanical end positions / fixed stops (at least 1 mm).

Note
Please note that positioning records with speed v = 0 or invalid target positions (-> error “TARGET POSITION OUT OF LIMIT”) cannot be executed.

```
→ Positioning
   ├── Homing
   ├── Move posit. set
   └── Demo posit. tab
```

The “Positioning” menu includes entries for starting a homing run or a positioning run.

Note
Carry out the homing run and the positioning runs as described in the following sections:
- Homing: sections 5.2.2 to 5.2.4
- Positioning runs / test runs: section 5.2.9

[Positioning]	Description	Note
[Homing]	Starting a homing run with the set homing method	Setting the parameters: See [Settings] [Homing parameters]
[Move posit. set]	Starting a particular positioning record in the position set table - or - if the switch to the next record is parameterised: Starting a record chain	Parameterising and referencing must have been completed.
[Demo posit. tab]	Test of all positioning records in the position set table (operating mode “Demo mode”)	Parameterising and referencing must have been completed. There must be at least two positioning records in the memory.

Tab. 4/4: [Positioning] menu

Cancelling a positioning movement

EMERG. STOP	You use ‹Menu› to interrupt a positioning task (⇢ Error mode EMERG.STOP).	Menu
DEMO STOP	With ‹Enter›, you can interrupt the “Demo mode” [Demo posit tab]. The current positioning record will be executed before the axis stops. If you restart, the run will begin with positioning record 1.	Enter

4. The control panel (only type SFC-LACI-...-H2-...)

4.5 [Settings] menu

For parameterising the axis system and the positioning records:

```
→ Settings
  ├── Axis type
  ├── Axis parameter
  ├── Homing paramet.
  ├── Position set
  ├── Jog mode
  ├── CO parameter
  └── Password edit
```

1. Select the entry [Settings] in the main menu. ‹ENTER›
2. Select a menu command. ‹ENTER›

[Settings]	Description	Section
[Axis type]	The axis controlled by the SFC-LACI	4.5.1
[Axis parameter]	Teach mode for setting the axis parameters	4.5.2
[Homing paramet.]	Setting the homing method and the speed during homing	4.5.3
[Position set]	Teach mode for programming the position set table	4.5.4
[Jog mode]	Jog mode: Continuous manual travel	4.5.5
[CO parameter]	Setting the fieldbus parameters	4.5.6
[Password edit]	Setting up a password for the control panel	4.5.7

Tab. 4/5: [Settings] menu

Note
The set parameters take effect immediately after confirmation with OK ‹ENTER›.

- Use **[SAVE...]** to permanently save the settings in EEPROM. Only then will the settings be retained even after switching off the power supply or in the event of a power failure.

4.5.1 [Settings] [Axis type]

The connected drive is automatically detected.

4.5.2 [Settings] [Axis parameters]

Teach mode for setting the axis parameters

- Observe the instructions in sections 5.2.5 and 5.2.6.

[Axis parameter]	**Description**
[Zero point] *)	Offset axis zero point
[SW-limit-neg] *)	Software end position, negative
[SW-limit-pos] *)	Software end position, positive
[Tool load]	Tool mass, e.g. a gripper on the front plate/ piston rod
[SAVE...]	Save parameters in EEPROM
*) Teaching is only possible after a successful homing run.	

Note
A new homing run must always be carried out after modifying the axis zero point.

The project zero point PZ can only be set via FCT or PNU 500/ CI $21F4_h$.

4.5.3 [Settings] [Homing parameters]

Setting the homing method and the speed during homing.

- Observe the instructions in chapter 5.2.2.

[Hom. paramet.]	**Param.**	**Description**
[Homing method]	switch negative	Homing to the integrated reference switch at the retracted end position with index search
	block negative	Homing to a negative fixed stop
	block positive	Homing to positive fixed stop
	Note: Further homing methods can only be configured via FCT.	
[Velocity v_rp]	v_rp	Speed for searching for the reference point
[Velocity v_zp]	v_zp	Speed for moving to the axis zero point
[SAVE...]	Save parameters in EEPROM	

Note
A new homing run must always be carried out after modifying the homing method.

The maximum speed for homing is subject to built-in limits.

4.5.4 [Settings] [Position set]

Programming the position set table

- Observe the instructions in section 5.2.8.
- Select first the number of the desired positioning record. The following settings refer to the currently selected positioning record.

[Position set]	Param.	Description
[Position nr]	Nr	Number of the positioning record [1...31]
[Pos set mode]	[absolute/ relative]	Positioning mode absolute = Position specification refers to the project zero point relative = Position specification refers to the current position e = energy-optimized path generator
[Position] *)	xt	Target position in [mm]
[Velocity]	v	Positioning speed in [mm/s]
[Acceleration]	a	Acceleration in [mm/s^2]
[Deceleration]	d	Deceleration in [mm/s^2]
[Jerk Acc]	Yes	Acceleration jerk in [m/s^3]
[Jerk Dec]	jd	Deceleration jerk in [m/s^3]
[Work load]	m	Applied load (= workpiece mass) in [g]
Time MC	t_MC	Damping time (time between reaching the target window and setting “Motion Complete”)
[SAVE...]	Saves parameters to the EEPROM	
*)Teaching is only possible after a successful homing run.		

4.5.5 [Settings] [Jog Mode]

You can use the arrow keys to move the drive continuously (also possible without previous homing run). The software end positions have no effect here.

4.5.6 [Settings] [CO parameters]

Setting the fieldbus parameters

[CO parameter]	**Param.**	**Description**
[CAN node ID]	1 ... 127 (1 ...7fh)	Fieldbus address of the SFC-LACI. Representation: "1 dec, 1 hex"..."127 dec, 7f hex"
[CAN baud rate]	1000 kBd, 800 kBd, 500 kBd, 250 kBd, 125 kBd, 100 kBd, 50 kBd, 20 kBd, 10 kBd	Fieldbus baud rate as per settings on master.
[CAN profiles]	DS402, FHPP	Profile with which communication between the CAN master and the SFC-LACI is handled: – DS 402: Control takes place as per DS 402. – FHPP: Control takes place as per Festo Handling and Positioning Profile.
[CAN Volt.Supply]	internal, external	Power supply to the fieldbus node can take place "internally," i.e. via the logic voltage supply of the SFC-LACI, or "externally" via the fieldbus (via optocoupler electrically isolated from the logic voltage of the SFC-LACI), see section 3.6.

Tab. 4/6: Menu [Settings] [CAN parameter]

The settings in the menu [CAN parameter] are saved directly and permanently (including in the event of a power failure) in the EEPROM after confirmation with OK ‹Enter›.

4.5.7 [Settings] [Password edit]

Access via the control panel can be protected by a (local) password in order to prevent unauthorized or unintentional overwriting or modification of parameters in the device. No password has been preset at the factory (presetting = 000).

- Keep the password for the SFC-LACI in a suitable place, e.g. in the internal documentation for your system.

If the active password in the SFC-LACI is lost: The password can be deleted by entering a master password if necessary. In this case please contact your Festo service partner.

Setting up a password

Select [Password edit] in the menu [Settings]:

```
New Password:
[ ? x x ] = 0

            ESC <Menu>
EDIT <—>    SAVE <Enter>
```

Enter a password with 3 digits. The current input position is marked with a question mark.

1. Use the arrow keys to select a digit 0...9.

2. Confirm your input with ‹Enter›. The next entry position will be displayed.

3. After entering the third digit, save your setting with SAVE ‹Enter›.

4. The control panel (only type SFC-LACI-...-H2-...)

Enter password

```
Enter Password:
[ ? x x ] = 0

            ESC <Menu>
EDIT <——>   OK <Enter>
```

As soon as a password is active, it will be scanned automatically when the menu commands [Positioning], [Settings] or [HMI control] are accessed.

1. Use the arrow keys to select a digit 0...9.
2. Confirm your entry with OK ‹Enter›. The next entry position will be displayed.
3. Repeat the entry for the remaining entry positions.

When the correct password is entered, all parameterising and control functions of the control panel are enabled until the power supply is switched off.

Changing/deactivating the password

If the password has not yet been entered since the unit was switched on:

```
Enter Password:
[ ? x x ] = 0

            ESC <Menu>
EDIT <——>   OK <Enter>
```

- Select the menu item [Settings] [Password edit] and enter the existing 3 digit password:

1. Use the arrow keys to select a digit 0...9.
2. Confirm your entry with OK ‹Enter›. The next entry position will be displayed.
3. Repeat the entry for the remaining entry positions.

If the password has already been entered since the unit was switched on:

```
New Password:
[ ? x x ] = 0

            ESC <Menu>
EDIT <——>   SAVE <Enter>
```

4. Enter the new password with 3 digits. If you wish to deactivate the password, enter “000”.
5. After entering the last digit, save your setting with **SAVE** ‹Enter›.

4.6 Menu command “HMI control”

To select the menu commands [Positioning] and [Settings], the “HMI: on” setting is required. Only then is the SFC-LACI ready to process user entries on the control panel.

Caution
When control via the control panel or FCT is activated (HMI: on), the drive **cannot** be stopped with the STOP bit of the control interface.

When selecting the menu commands, you will be prompted to modify the HMI setting as necessary. You can also modify the setting directly with the menu command [HMI control].

HMI [1)]	Device control
on	– The **parameterising interface** is activated. Operation and parameterisation can be performed manually via the control panel or via FCT. – The **control interface** is deactivated. The actual status of all the inputs then has no effect. The state of the outputs is unimportant.
off	Device control is done via the control interface.
[1)] **H**uman **M**achine **I**nterface	

Access to the SFC-LACI via the control panel and FCT can be blocked by means of FHPP (“HMIAccess locked”), see section 5.5.5 (CCON.B5 LOCK).

Commissioning

Chapter 5

Contents

5.1 Preparations for commissioning

Warning
There is a danger of injury.
Electric axes can move suddenly with high force and at high speed. Collisions can lead to serious injury to human beings and damage to components.

- Make sure that nobody can reach into the operating range of the axes or other connected actuators (e.g. with a protective grille) and that no objects lie in the positioning range while the system is still connected to a power supply.

For commissioning, the mechanical system must be configured and a measuring reference system must be defined (see Tab. 1/1). The measuring system is used to define all positions and they can be approached, for example, using a positioning record from the position set table.

- Carry out parameterising and commissioning by means of the control panel or FCT, as described in the following chapters and in the FCT/plug-in help.
- Check the default settings in the [Diagnostic] menu.
- Upon completion of commissioning, note the instructions for operation in the FCT/plug-in help and in section 5.7.

5.1.1 Checking the drive

Note
During operation, the drive must not strike a stop without shock absorption.

- Use shock absorbers or buffers on all stops (exception: homing to a fixed stop).

- Before commissioning, make sure that drive and controller are completely set up and wired and that the working space is adequate for operation with an effective load.
- Observe the notes in the operating instructions for the axis used.

5.1.2 Checking the power supply

Caution
Interruption of running tasks due to inadequate load voltage supply (“LOAD POWER DOWN”)

- Make sure that the load voltage supply tolerance can be maintained at full load directly on the voltage terminal of the SFC-LACI (see chapter 3.2).

Caution
Loss of reference position due to inadequate logic voltage supply

- Always carry out homing every time the logic voltage supply is switched on or if a power failure has occurred, in order to anchor the measuring reference system to the reference point (REF).

The SFC-LACI does not carry out any positioning tasks if it is not referenced.

5.1.3 Before switching on

When the SFC-LACI is switched on, the controller interface is activated as standard [HMI = off].

Caution
Unexpected movements of the drive due to incorrect parameterising

- Make sure that there is no active ENABLE signal when switching on the SFC-LACI on the controller interface.
- Parameterise the entire system completely before activating the controller with ENABLE or [HMI = on].

5.1.4 Simultaneous attempts to access the controller

Caution
Simultaneous or alternating attempts to access the SFC-LACI via FCT, control panel and controller interface can cause unpredictable errors.

- Make sure that the FCT, the control panel and the controller interface of the SFC-LACI are not used at the same time.

Note
In the following cases, it is **not** permitted to use the **FCT** to access the SFC-LACI for purposes of writing data (e.g. downloading parameters) or for control (e.g. “Move manually” or starting a homing run):

– While the SFC-LACI is executing a positioning motion or when a motion is started during access (e.g. via the control interface or via the control panel).

– If parameterisation or operation is carried out on the SFC-LACI with the control panel.

Please note:

- Control by the FCT must not be activated while the drive is in motion or when control is being carried out via the fieldbus.

5.2 Commissioning with the control panel (only type SFC-LACI-...-H2)

Information on the button functions and the menu structure of the control panel can be found in Chapter 4.

Overview of initial commissioning

Commissioning steps	Chapter
1 Before switching on: make sure that there is no active ENABLE signal on the controller interface.	5.1.3
2 Switch on the SFC-LACI, configure the fieldbus interface, then Reset.	5.2.1
3 Set the parameters for homing: – Homing method – Search speed to homing point – Positioning speed to axis zero point	5.2.2
4 Activate control panel device control [HMI = on]	5.2.3
5 Carry out homing.	5.2.4
6 Teach the axis zero point.	5.2.5
7 Teach software end positions.	5.2.6
8 Set the tool mass.	5.2.7
9 Enter positioning records.	5.2.8
10 Carry out a test run. Check motion behaviour, reference points and working range. Optimise as required.	5.2.9
11 Check the function of the controller interface and note the instructions on operation.	5.4 ... 5.7

Tab. 5/1: Commissioning steps

5.2.1 Setting the CAN bus parameters

```
CAN–BUS INIT NO
PARAMETER ERROR

      Diagnostic <Menu>
         Config <Enter>
```

- Switch the SFC-LACI on. During first commissioning or when the EEPROM has been deleted, the fault message “CAN-BUS INIT NO PARAMETER ERROR” will appear.

In order to set the CAN bus parameters during first commissioning or after deletion of the EEPROM:

- Select Config ‹Enter›.

```
SFC–LACI...
D...
Xa = 0.00 mm

HMI:off
<Menu>
```

In order to modify the CAN bus parameters when recommissioning (i.e. if these parameters have already been completely parameterised):

- Select [Settings] [CO parameters] [...] (see also section 4.5).

1. Select the desired CAN bus parameters with the arrow keys (details: see next page).
2. Press ‹Enter› to display the current setting.
3. If necessary, modify the setting with the arrow keys.
4. Accept the setting with OK ‹Enter›. The setting is saved against network failure.

Note
The set CAN bus parameters first become effective after “Power off/on” or after a software reset (object 20F1/03h/ PNU 127).

```
→ Settings
  CO parameter
  └─ CAN node ID
```

Station number (CAN node ID)

– Permitted station numbers: 1 ... 127.

```
   CAN Node ID

  110 dec, 6e hex

            ESC <Menu>
EDIT <—>    OK <Enter>
```

– An invalid station number is preset (shown on control panel as “???”).
  This is to make sure that a correct address is set during commissioning or exchange.

```
→ Settings
  CO parameter
  └─ CAN baud rate
```

Baud rate (CAN baud rate)

– Possible baud rates:
  1000 kBd (1 MBaud), 800 kBd, 500 kBd, 250 kBd,
  125 kBd, 100 kBd, 50 kBd, 20 kBd, 10 kBd.

```
   CAN baud rate

     1000 kBd

            ESC <Menu>
EDIT <—>    OK <Enter>
```

– An invalid baud rate is preset (shown on control panel as “???”).
  This is to make sure that a correct baud rate is set during commissioning or exchange.

```
→ Settings
  CO parameter
  └─ CAN profile
```

Data profile (CAN profile)

– Possible data profiles:

  – FHPP:
    Control and parameterising of the SFC-LACI is made as per the Festo Handling and Positioning Profile.

  – DS 402:
    Control and parameterising of the SLC-LACI is made in accordance with DS 402.

```
   CAN profile

      FHPP

            ESC <Menu>
EDIT <—>    OK <Enter>
```

– An invalid data profile is preset (shown on control panel as “???”).
  This is to make sure that the correct data profile is set during commissioning or exchange.

i

For information on the data profile see section 1.2.2.

```
→ Settings
  CO parameter
  └─ CAN volt.supply
```

```
    CAN volt.supply

       internal

            ESC <Menu>
EDIT <——>   OK <Enter>
```

CAN voltage supply (CAN volt. supply)

– The following settings are possible: internal/external

– Internal voltage supply is preset.

Note
This parameter becomes effective immediately (not after switching on again or after a software reset).

Further information on the CAN voltage supply see section 3.6, Tab. 3/8.

5.2.2 Setting the homing parameters

The homing point is determined as follows, depending on the homing method:

- by means of the drive's integrated reference switch with a subsequent index search (recommended) or
- by means of a fixed stop (to be fitted externally by the customer).

For homing to the switch, only the drive's integrated reference switch can be selected on the control panel. Use the FCT for parameterising if you require further options.

The homing process is described in section 1.1.6.

You can set two different speeds for searching for the reference point and for the subsequent run to the axis zero point. The maximum possible speed is subject to built-in limits.

When homing to a fixed stop:

1. Measure the distance between your reference point and the retracted end position ($Offset_{Ref}$ ⟶ Tab. 1/3).

2. Enter the value (± 1 mm) in FCT or via the object 6410/16h / PNU 1055.

Note
Controller inaccuracies

If you do not enter the offset of the reference point, control inaccuracies (e.g. overshooting) can occur with small (100 mm) and large nominal strokes (400 mm).

When homing to the drive's integrated reference switch, the reference point position is known (6 mm) and must not be entered. This reference switch must not be moved.

Caution
Damage to components when the permissible impact pulse is exceeded.

- Operate the drive only with the permitted load (see operating instructions for the drive).
- If necessary, limit the maximum current (motor force) during homing using:
  - FCT - or
  - CI object 6073h / PNU 1034 "Max. current".

Setting parameters

```
→ Settings
  Homing paramet.
  ├─ Homing method
  ├─ Velocity v_rp
  ├─ Velocity v_zp
  └─ SAVE...
```

1. Set the following:
   – Homing method [Homing method]
   – Search speed for ascertaining the reference point [Velocity v_rp]
   – Speed of travel to axis zero point [Velocity v_zp].
2. Accept each setting with OK ‹Enter›. The setting will then take effect in the drive.
3. Save the parameter settings in EEPROM with the **[SAVE]** menu command. Only then will the settings be retained if the power supply is switched off or if there is a power failure.

5.2.3 Activating device control

```
  Diagnostic
  Positioning
  Settings
→ HMI control
  LCD adjustment
```

- Enable the control panel so that it can control the SFC-LACI [HMI = on]. This deactivates at the same time the controller interface of the SFC-LACI.

Caution
When control via the control panel or FCT is activated (HMI:on), the drive **cannot** be stopped with the STOP bit of the control interface.

```
PLEASE WAIT
COMMUT.–POINT
EVALUATION IS
ACTIVE
```

Commutation point search:
When the controller is enabled for the first time with the ENABLE signal or [HMI = on], the drive will spend a few seconds determining its commutation point (vibrations).

5.2.4 Carrying out homing

Overview

Warning
Danger of injury!

Electric axes move with high force and at high speed. Collisions can lead to serious injury to human beings 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.

Caution
When the homing method is changed, the axis zero point offset is reset to the factory settings (see section 5.2.5). Existing parameterised software end positions and target positions already set in the position set table are shifted together with the axis zero point.

- Always carry out homing after changing the homing method.
- Teach the offset of the axis zero point again if needed.

If the axis zero point is modified:

- Teach the software end positions and the target positions again if needed.

The homing process is described in section 1.1.6.

Start homing

```
→ Positioning
   ├── Homing
   ├── Move posit set
   └── Demo posit tab
```

1. Select [Positioning] [Homing].

2. Start homing with START ‹Enter›.

If necessary, homing can be interrupted with the **‹Menu› key (STOP)**.

If a reference signal is not found when homing to the drive's integrated reference switch before the drive has reached a fixed stop or a limit switch, then the drive will reverse and searches for the switch in the opposite direction (see section 1.1.6). If a reference signal is still not found, the SFC-LACI stops and reports an error (HOMING ERROR). Homing must be repeated after the error message has been acknowledged:

1. Acknowledge the error message with ‹Enter›.

2. If necessary, check the functioning of the reference switch.

3. Check the settings of the parameters.

4. If required, use the arrow keys to move the drive into a different position (Menu [Settings] [Jog Mode]).

5. Repeat homing.

5.2.5 Teach the axis zero point

Factory setting

Axis zero point with:
– Homing to reference switch: 0 mm
– Homing to negative fixed stop: +1 mm
– Homing to a positive fixed stop: -1 mm

Note
Risk of overloading when homing to stop:
The drive must not press continuously against a mechanical stop (excessive heating).

- Make sure that the axis zero point is at least 1 mm away from the mechanical stop.

This causes the drive to leave the mechanical stop after recognising the reference point.

If necessary, teach the **axis zero point**:

Warning
The drive will move during teaching.

- Make sure that nobody can reach into the positioning range of the moveable load and that there are no objects in its path.

```
→ Settings
  Axis parameter
  ├── Zero point
  ├── SW–limit–neg
  ├── SW–limit–pos
  └── SAVE
```

1. Select [Settings] [Axis parameter] [Zero point].
2. Move the drive manually to the desired axis zero point using the arrow keys.
3. Accept the position reached with OK ‹Enter›.
4. Save the parameter settings in EEPROM with the **[SAVE]** menu command.
5. Perform homing again (see section 5.2.4). When homing is concluded, the drive stands at the new axis zero point.

Note
If the axis zero point is modified:

Existing software end positions and the target positions in the position set table will be shifted together with the axis zero point.

- Teach the software end positions and the target positions again if needed.

The project zero point PZ can only be set via FCT or PNU 500/ Object 21F4h.

5.2.6 Teach software end positions

Factory settings

by homing method:

Homing method	Factory settings [mm]
Reference switch (AZ: 0 mm)	SW-limit-neg = 0 SW-limit-pos = (nominal stroke - 10)
Negative stop (AZ: +1 mm)	SW-limit-neg = 0 SW-limit-pos = nominal stroke
Positive stop (AZ: -1 mm)	SW-limit-neg = -nominal stroke SW-limit-pos = 0

If necessary, teach the **software end positions**:

1. Select [Settings] [Axis parameter] [SW-limit-neg] or [SW-limit-pos].
2. Move the drive with the arrow keys.

Note
During operation, the drive must not strike a stop without shock absorption.

- Parameterise the software end positions at least 1 mm from the nearest end stop.

3. Accept the position reached with OK ‹Enter›. The setting will then take effect.
4. Save the parameter settings in EEPROM with **[SAVE]**. Only then will the settings be retained even after switching off the power supply or in the event of a power failure.

5.2.7 Setting the tool mass

The weight of tools (e.g. grippers) on the front plate (or piston rod) of the drive has to be entered here.

1. Select [Settings] [Axis parameter] [Tool load].
2. Set the tool mass with the arrow keys.
3. Accept the setting with OK ‹Enter›. The setting will then take effect in the drive.
4. Save the parameter settings in EEPROM with the **[SAVE]** menu command.

The applied load (= mass of the individual workpieces), on the other hand, is entered in the positioning records ([Settings][Position set][Work load]).

5.2.8 Teaching positioning records

Requirements:

– The axis must be set up completely, wired and supplied with voltage.

– The SFC-LACI has been correctly parameterised.

– Homing has been carried out successfully.

– The axis zero point and the software end positions have been set correctly.

Enter the positioning records as follows:

```
→ Settings
  Position set
    ├─ Position nr
    ├─ Pos set mode
    ├─ Position
    ├─ Velocity
    ├─ Acceleration
    ├─ Deceleration
    ├─ Jerk Acc.
    ├─ Jerk Dec.
    ├─ Work load
    ├─ Time MC
    └─ SAVE
```

1. Activate the desired positioning record (1...31) with [Settings] [Position set] [Position nr].

2. Add or correct the positioning mode of the positioning record:

   - Select [Pos set mode] and use the arrow keys to select the positioning mode:
     absolute (a) = absolute position specification, related to the project zero point,
     relative (r) = relative position specification, related to the current position,
     energy-optimised (..e) = higher dynamics with less heating, however the parameterised position profile (trapezium) will not be retained exactly.

   - Accept the value with OK ‹Enter›.

Note
If the positioning mode is modified:
- In the next step, check an already existing target position for plausibility.

3. Teach the target position of the position record:
   - Select [Position].
   - Move the drive manually to the desired target position with the arrow keys.
   - Accept the position reached with OK ‹Enter›. The setting of the target position and the positioning mode will then take effect in the drive.
4. Set the speed:
   - Select [Velocity].
   - Set the nominal speed with the arrow keys.
   - Accept the setting with OK ‹Enter›. The setting will then take effect in the drive.
5. Set the remaining parameters of this positioning record to appropriate values. Note:
   – "Jerk": The jerk in [m/s³] is the first derivative of the acceleration. Lower values result in gentler movement. "Jerk Acc": Jerk when accelerating. "Jerk Dec": Jerk when decelerating.

   – "Work load": Mass of the individual workpieces, see section 5.2.7.

   – "Time MC" (damping time): The time between reaching the target position window and setting MC "Motion complete"). See Fig. 5/9.
6. Save this position record in EEPROM with **[SAVE]**.
7. Enter the next positioning record.

5.2.9 Test run

1. Enter several positioning records (→ 5.2.8).

   - You may wish to set target positions at the limits of the positioning range in order to check the software end positions.

   - You may wish to set (e.g.) various speeds.

```
→ Positioning
   ├── Homing
   ├── Move posit set
   └── Demo posit tab
```

2. Select [Positioning] [Move posit. set] in order to process a certain positioning record — or —

3. Select [Positioning] [Demo posit tab] in order to process all positioning records. At least two positioning records must be entered in the position set table in order that this function can be used.

i

In the “Demo mode” [Demo posit tab], all positioning records in the position set table are executed one after the other. If the position set table contains a positioning record with speed v = 0, this positioning record and all following records will not be executed; the positioning cycle will be continued with positioning record 1.

4. Start the test run.

   With the **EMERG.STOP ‹Menu›** you can interrupt the current positioning task immediately.

   With DEMO STOP ‹Enter› you can end the positioning cycle [Demo posit tab]. However, the set currently being executed is completed first.

   - Check the positioning behaviour.

   - Check the displayed positions of the axis.

5. If necessary, optimise the previous settings.

5.3 Commissioning with FCT

The Festo Configuration Tool (FCT) is the software platform for configuring and commissioning different components and devices from Festo.

The FCT consists of the following components:

– A framework as program start and entry point with uniform project and data management for all supported types of devices.

– Plug-ins for the special requirements of each device type (e.g. SFC-LACI) with the necessary descriptions and dialogues. The plug-ins are managed and started from the framework.

Printed information

In order to use the complete help or parts of it independently of a PC, you can use one of the following options:

- Use the "Print" button in the Help window to print individual pages of the Help or all the pages of a book directly from the table of contents for the help.
- Print a prepared version of the help in Adobe PDF format:

Printed version	**Directory**	**File**
FCT help (Framework)	...(FCT installation directory)\Help\	– FCT_en.pdf
Plug-in help (SFC-LAC)	...(FCT installation directory)\HardwareFamilies\Festo\SFC-LAC\V...\Help\	– SFC-LAC_en.pdf

In order to use the printed version in Adobe PDF format, you will require Adobe Reader.

5.3.1 Installing the FCT

> **Note**
> FCT plug-in SFC-LAC V 3.0.0 supports the motor controller SFC-LACI-...-CO with firmware version V1.00.
>
> Check with later versions of the SFC-LACI whether an updated plug-in is provided. If necessary, consult Festo.

> **Note**
> Administrator rights are required for installing the FCT.

The FCT is installed on your PC with an installation program.

1. Close all programs.
2. Place the "Festo Configuration Tool" CD in your CD ROM drive. If Auto-Run is activated on your system, the installation starts automatically and you can skip steps 3 and 4.
3. Select [Execute] in the Start menu.
4. Enter D:\setup (if necessary replace D with the letter of your CD ROM drive).
5. Follow the instructions on the screen.

5.3.2 Procedure

Starting the FCT

1. Connect the SFC-LACI to your PC via the parameterising interface (RS232), ⟶ chapter 3.5.

2. Start the FCT:
   Double click on the FCT icon on the desktop
   – or –
   Switch to Windows and select the entry [Festo Software] [Festo Configuration Tool] in the menu [Start].

3. Create a project in the FCT or open an existing project. Add a device to the project with the SFC-LAC plug-in.

Instructions on parameterising and commissioning

FCT framework

Information on working with projects and on inserting a device in a project can be found in the help for the FCT framework with the command [Help] [Contents FCT general].

Plug-in SFC-LAC

The SFC-LAC plug-in for the FCT supports all the steps necessary for commissioning an SFC-LACI. The necessary parameterisation can be executed offline, i.e. without the SFC-LACI being connected to the PC. This enables preparation for the actual commissioning, e.g. in the design office when a new system is planned.

Further information can be found in the plug-in help: Command [Help] [Contents of installed plug-ins] [Festo (manufacturer name)] [SFC-LAC (plug-in name)].

Device control

When the SFC-LACI is switched on, the controller interface is activated as standard [HMI = off].

Caution
Unexpected movements of the drive due to incorrect parameterising

- Make sure that there is no active ENABLE signal when switching on the SFC-LACI on the controller interface.
- Parameterise the entire system completely before activating the controller with ENABLE (controller interface), “Enable” (FCT), or [HMI = on] (control panel).

In order that the Festo Configuration Tool can control the connected SFC-LACI, the control interface of the SFC-LACI must be deactivated and control must be enabled for the FCT. The actual status of the control bit ENABLE then has no effect.

- To do this, go to the “Project output” window, select the “Operate” tab and, under “Device Control”, activate the “FCT” checkbox.
  The controller interface of the SFC-LACI will then be deactivated and Control Enable will be set for the FCT.

5.4 Commissioning on a CANopen master

The following sections detail the configuration and addressing of the SFC-LACI on a CANopen interface and a CANopen master.

The following standard specifications have been taken into account:

Standard specifications	
DS 201 to DS 207	CAN Application Layer CAL
DS 301, V4.02	The Draft Standard 301 is based on the CAL communication profile.
DS 402, V2.0	The Draft Standard 402 defines the activation of drives within CANopen.

In order to understand this section, you should be familiar with CANopen and the specifications DS 301 and DS 402.

5.4.1 Overview of commissioning on the field bus

The following steps are required for commissioning the SFC-LACI as a fieldbus participant:

1. Set the following on the SFC-LACI:

Settings	Description
CAN address	Permitted address range: 1 ... 127 [1)]
CAN baud rate	Permitted baud rates: 1000, 800, 500, 250, 125, 100, 50, 20, 10 kbit/s
CAN data profile	See section 1.2.2: – FHPP – DS 402 The communications profile is in both cases DS 301.
CAN power supply	Supply to CAN interface; see section Tab. 3/8. – Internal power supply – External power supply
[1)] May be restricted by the master used	

- on the control panel (only with type SFC-LACI-...-H2, see section 4.5.6 and 5.2.1 or
- with the Festo Configuration Tool (see help for the Festo Configuration Tool).

2. Configure the CANopen master (⟶ 5.4.2):
   – install the EDS file,
   – or make settings manually.

3. Test the fieldbus connection in online mode.

5.4.2 Configuration of the CANopen master (“I/O configuration”)

Configuration with EDS file

EDS files are available for configuring the CANopen master. These files are installed with the aid of the configuration software of the CANopen master. For the procedure: see the manuals for the software.

Obtainable from:
The accompanying CD in the “CANopen” folder or the Festo Internet site in the “Download Area”: www.festo.com

For the SFC-LACI, you will require **one** of the following EDS files (in English):

- For data profile FHPP:
  SFC-LACI-H0-CO-FHPP.eds
  SFC-LACI-H2-CO-FHPP.eds
- For data profile DS 402:
  SFC-LACI-H0-CO-DS402.eds
  SFC-LACI-H2-CO-DS402.eds

Manual configuration

Manufacturer ID:

- 1Dh

Profile ID depending on the profile:

- FHPP: 12Dh
- DS 402: 420192h

5.4.3 Communication

Pre-operational

When the slaves are switched on, they assume the status "pre-operational" and wait for the master. This status serves exclusively for parameterising via SDOs.

Operational

After parameterising has been carried out, the CANopen master can switch slaves into the operational status with a special network management telegram (NMT).

In this status, communication via SDOs and PDOs is possible. With the aid of the NMT telegrams you can switch between the states.

The PDOs of the SFC-LACI are assigned as follows:

Object	Communication parameter	
1400h	RPDO 1	– transmission type = 255 [1)]
1401h	RPDO 2	
1800h	TPDO 1	– transmission type = 255 [1)] – Inhibit time = 0 – event timer = disabled
1801h	TPDO 2	
[1)] asynchronous transmission (event triggered)		

This parameterisation corresponds to the asynchronous (event triggered) transmission which is standard with most masters. Conversion to e.g. synchronous transmission is possible if the communication parameters are written with the appropriate values from the DS 301 communication profile, but modifying the mapping is not possible.

5.4.4 Parameterising via SDOs

DS402

With data profile DS402, parameterising takes place via SDOs with the aid of the object numbers as per appendix C.2.

FHPP

With data profile FHPP, conversion is required for parameterising via SDOs: 2000h + PNU in hexadecimal representation.
Example of access to the object “Cycle number:”

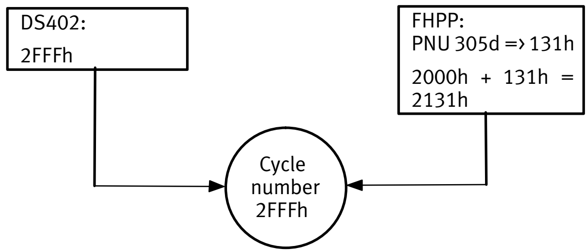


Fig. 5/1: Parameterising via SDO

For parameterising via the PDO2 (FHPP-FPC, see appendix B.2), conversion is not required.

5.4.5 PDO mapping

The mapping is pre-set and cannot be altered by the user (“static mapping”).

Note
If the data on the master side are not in the same form, but saved, i.e. as byte array:

- Note that the representation of words and double words appears in the “little endian” representation when transmitted via CAN (lower-value byte first).

PDO mapping in FHPP

The first PDO (8 bytes I/O data) is intended for the operating modes Record Select and Direct Mode, the second PDO (8 bytes I/O data) is used for FPC (Festo Parameter Channel) parameterisation.

Receive PDO 1 (FHPP standard)

Operation mode	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Record selection	CCON	CPOS	Record No.	Reserved	Reserved			
Direct mode			CDIR	Setpoint value 1	Setpoint value 2			

Receive PDO 2 (FHPP-FPC)

Function	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Parameterisation	Reserved	Sub-index	Task identifier + parameter number		Parameter value			

Transmit PDO 1 (FHPP standard)

Operation mode	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Record selection	SCON	SPOS	Record No.	RSB	Actual position			
Direct mode			SDIR	Actual value 1				

Transmit PDO 2 (FHPP-FPC)

Function	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Parameterisation	Reserved	Sub-index	Task identifier + parameter number		Parameter value			

PDO mapping in DS 402

<table>
<tr><th colspan="8">Receive PDO 1 (DS402) 1)</th></tr>
<tr><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 colspan="2">Control word 6040h</td><td>Record no. 2032h</td><td>Operating mode 6060h</td><td colspan="4">Nominal value:
– Positioning mode: setpoint (nominal) position 607Ah
– Force mode: nominal torque 6071h
– Interpolated position mode: data 60C1h</td></tr>
<tr><td colspan="8">1) Evaluation sequence:
– Read the operating mode 6060h
– Accept record number 2032h
– Accept nominal value (only if set number 0 is for “direct set”. Otherwise the value from the record list applies to the specified record).
– Execute control word 6040h.</td></tr>
</table>

<table>
<tr><th colspan="8">Receive PDO 2 (DS402) 1)</th></tr>
<tr><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 colspan="4">Velocity 6081h</td><td colspan="4">Work item mass 20E0/06h</td></tr>
<tr><td colspan="8">1) The velocity and work item mass are only accepted if the record number received via PDO 1 is 0 for “Direct record.” It is not possible to overwrite the set list by PDO.</td></tr>
</table>

Transmit PDO 1 (DS402)							
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Status word 6041h		Record no. 2032h	Operating mode 6061h	Actual value [1] – Actual position 6064h – Actual torque/force 6077h			
[1] With the Transmit PDO in asynchronous (event-triggered) default setting a modification in sizes 6064h or 6077h is **not** assessed as an event, no T-PDO will be triggered (avoids high bus load due to jitter). If a reply message from the actual position is desired, the T-PDO must be configured as a cyclically sent T-PDO.							

Transmit PDO 2 (DS402)							
Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Reserved (this PDO is not supported).							

5.5 Festo Profile for Handling and Positioning (FHPP)

5.5.1 FHPP operating modes

The FHPP operating modes differ regarding their contents and the meaning of the cyclic I/O data and in the functions which can be accessed in the SFC-LACI.

Operation mode	Description
Record select	A total of 31 positioning records (=positioning tasks) can be saved in the SFC-LACI. A record contains all the parameters which are required for a positioning task. The record number is transferred in the cyclic I/O data.
Direct mode	The task is transferred directly in the I/O telegram. Only the most important nominal values (target position, speed) are thereby transferred. Supplementary parameters (e.g. acceleration) are defined via the parameterisation.

Tab. 5/2: Overview of FHPP operating modes

The operating mode is switched by the control byte CCON (see below) and indicated in the status byte SCON. Definition by means of parameterising is not possible. Switching between modes is only permitted in the “Drive disabled” or “Drive enabled” status.

Record selection

Preset operating mode when the SFC-LACI is started up.

The SFC-LACI has 31 records (1 ... 31), which contain all the information necessary for a positioning task (+ record 0 = homing).

The record number that the SFC-LACI is to process at the next start is transferred in the output data of the master. The input data contains the record number that was processed last. The positioning job itself does not need to be active.

The SFC-LACI cannot function autonomously, i.e. it does not have its own user program. However, record switching can be used to define a sequence of records.

There are also 3 records with special functions (which cannot be executed in Record Selection mode):

– Record 32 contains the parameters for the Jog mode.

– Record 33 contains the parameters for Direct mode.

– Record 34 is the set for the FCT software.

Direct mode

In direct mode (also called direct order) positioning tasks are formulated directly in the output data of the master.

Positioning mode

The typical application dynamically calculates the nominal target values for each job or just for some jobs. Adaptation to different workpiece sizes is therefore possible. It is not sensible here to parameterise the record list again each time. The positioning data are managed completely in the PLC and sent to the SFC-LACI.
Operating mode of the SFC-LACI: "Profile position mode"

Force mode

Alternatively, setpoint values relative to the rated motor current can be specified in direct mode. With linear motors, this results in a force (force control).
Operating mode of the SFC-LACI: "Profile torque mode"

FHPP Continuous Mode

Continuous setpoint specification: Specification of changeable position values at millisecond frequency (typically 4...10 ms).
Operating mode of the SFC-LACI: "FHPP continuous mode"

5.5.2 Structure of the cyclic I/O data (FHPP standard)

FHPP standard contains 8 bytes of input and 8 bytes of output data:

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data / **Input data**	Bytes 1 and 2 (fixed) are retained in each operating mode and transmit control and status bytes for enabling the SFC-LACI and for setting the operating modes.		Bytes 3 to 8 depend on the operating mode selected (Direct mode, Record select) and transmit further control and status bytes 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, – Further setpoint and actual values depending on the operating mode.					

I/O data: Record selection

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	Actual position			

I/O data: Direct mode

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data	CCON	CPOS	CDIR	**Setpoint value 1** (velocity)	**Setpoint value 2** (position, force/torque...)			
Input data	SCON	SPOS	SDIR	**Actual value 1** (velocity, force/ torque...)	**Actual value 2** (actual position)			

Further 8 bytes I/O as per FHPP-FPC
In the cyclic data a further 8 bytes input data and 8 bytes output data are permitted for transferring parameters in accordance with the FPC protocol (Festo Parameter Channel) ⟶ section B.2.

Assignment of the control bytes (overview)

CCON	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 (F) RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode selection		Block HMI access	–	Acknow-ledge fault	Clamping unit	Stop	Enable drive
CPOS	**B7 –**	**B6 CLEAR**	**B5 TEACH**	**B4 JOGN**	**B3 JOGP**	**B2 (F) HOM**	**B1 (F) START**	**B0 HOLD**
	–	Delete remaining path	Teach value	Jog nega-tive	Jog posi-tive	Start homing	Start position-ing job	Halt
CDIR (only direct mode)	**B7 FUNC**	**B6 FAST**	**B5 XLIM**	**B4 CONTT**	**B3 CONT**	**B2 COM2**	**B1 COM1**	**B0 ABS**
	–	–	Deactivate stroke limit	Continu-ous mode toggle	Continu-ous mode	Control mode (posi-tion, force, ...)		Absolute/ relative
– : reserved; (F): edge-sensitive								

Assignment of the status bytes (overview)

SCON	**B7 OPM2**	**B6 OPM1**	**B5 HMI**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 OPEN**	**B0 ENABLED**
	Acknowledgement of operating mode		Control hierarchy	Load voltage applied	Error	Warning	Operation enabled	Drive enabled
SPOS	**B7 REF**	**B6 STILL**	**B5 DEV**	**B4 MOV**	**B3 TEACH**	**B2 MC**	**B1 ACK**	**B0 HOLD**
	Drive ref-erenced	Downtime monitor-ing	Following error	Axis moves	Acknow-ledge teach or sample	Motion complete	Acknow-ledge start	Halt
SDIR (only direct mode)	**B7 FUNC**	**B6 FAST**	**B5 XLIM**	**B4 VLIM**	**B3 CONT**	**B2 COM2**	**B1 COM1**	**B0 ABS**
	–	–	Stroke limit reached	Velocity limit reached	–	Reply message con-trol mode (position, force, ...)		Absolute/ relative
– : reserved.								

5.5.3 Description of the I/O data (Record select)

Description of the output data: Record selection		
Byte	**EN**	**Description**
1	CCON	Control bytes, see section 5.5.5.
2	CPOS	
3	Record number	Pre-selection of record number (0...31)
4 ... 8	–	Reserved (= 0)

Description of the input data: Record selection		
Byte	**EN**	**Description**
1	SCON	Status bytes, see section 5.5.6.
2	SPOS	
3	Record number	Reply message of record number (0...31)
4	RSB	Record status byte
	Bit 0 RC1: **1**st **R**ecord **C**haining	For record chaining: = 0: First chaining condition not configured / not reached = 1: First chaining condition reached *)
	Bit 1 RCC: **R**ecord **C**haining **C**omplete	For record chaining (only valid when MC =1): = 0: Record chaining interrupted. At least one chaining condition was not reached. = 1: Record chain was processed to the end of the chain.
5 ... 8	Position, ...	Feedback of the position in increments
*) The first chaining condition is reached when, after the first record with chaining, Motion Complete = 1.		

5.5.4 Description of the I/O data (Direct mode)

Output data – Direct mode

Byte	**EN**	**Description**
1	CCON	Control bytes, see section 5.5.5.
2	CPOS	
3	CDIR	
4	Velocity	In % of the basic speed (compare PNU 540 / CI 21F8h)
5 ... 8	Position, force, ...	Position in increments, or force in % of the rated force

Input data – Direct mode

Byte	**EN**	**Description**
1	SCON	Status bytes, see section 5.5.6.
2	SPOS	
3	SDIR	
4	Velocity	In % of the basic speed (PNU 540 / CI 21F8h)
	Force	In % of the rated force (see 5.5.7, point 7)
5 ... 8	Position	Position in increments

5.5.5 Description of the control bytes CCON, CPOS, CDIR

CCON

With control byte 1 (CCON) all the states which must be available in all operating modes are controlled. The cooperation of the control bits can be found under the description of the drive functions in section 5.6.

Control byte 1 (CCON)

Bit	EN	Description
B0 **ENABLE**	**Enable** Drive	= 1: Drive (controller) enable = 0: Drive (controller) blocked
B1 **STOP**	**Stop**	= 1: Enable drive. Any error will be deleted. = 0: STOP active: The axis stops with the fast stop ramp (Quick Stop) or with the normal stop ramp (compare PNU 1020/605Dh). The positioning task counts as finished.
B2 **BRAKE**	**Brake**	If the SFC-LACI is **not** in the “ready” state (status word does not equal “operation_enable”): = 0: Close brake / clamping unit = 1: Open brake / clamping unit. In the “ready” status, the controller takes over the control of the brake output. Controlling the output via the PLC is then not possible.
B3 **RESET**	**Reset** Fault	With a rising edge a fault is acknowledged and the fault number is deleted.
B4	–	reserved, must be at 0
B5 **LOCK**	**Lock** HMI access	Controls access to the parameterisation interface: = 1: MMI and FCT may only observe the drive, the device control (HMI control) cannot be taken over by MMI and FCT. = 0: MMI or FCT may take over the device control (in order to modify parameters or to control inputs)
B6 **OPM1**	Select **Op**erating **M**ode	= 00: Record selection = 01: Direct mode = 10: Reserved = 11: Reserved
B7 **OPM2**		

CPOS

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

Control byte 2 (CPOS)

Bit	EN	Description
B0 **HALT**	**Halt**	= 1: HOLD is not active = 0: HALT is activated. The axis stops with a defined braking ramp, the positioning job remains active (with B6 the remaining path can be deleted).
B1 **START**	**Start** Positioning Task	With a **rising edge** the current setpoint data will be transferred and positioning started (record 0 = homing).
B2 **HOM**	Start **Hom**ing	With a **rising edge** homing is started with the set parameters.
B3 **JOGP**	**Jog p**ositive	The drive moves at the specified speed in the direction of larger actual values, providing the bit is set. The movement begins with the rising edge and ends with the falling edge.
B4 **JOGN**	**Jog n**egative	The drive moves in the direction of smaller actual values, see bit 3.
B5 **TEACH**	**Teach** Actual Value	With a falling edge the current actual value of the position will be transferred to the setpoint value register of the currently addressed positioning record, see section 5.6.3. The teach target is defined with PNU 520.
B6 **CLEAR**	**Clear** Remaining Path	In the “HALT” status, a signal edge causes the positioning task to be deleted and transfer to the “Ready” status.
B7 **–**	–	Reserved, must be set to 0.

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 value is absolute = 1: Setpoint value is relative to last setpoint value
B1 **COM1**	**Co**ntrol **M**ode	= 00: Positioning mode = 01: Force control = 10: Reserved = 11: Positioning mode energy optimised
B2 **COM2**		
B3 **CONT**	**Cont**inuous Mode	Continuous setpoint specification: = 0: Inactive = 1: Active
B4 **CONTT**	**Cont**inuous Mode Toggle	Must be toggled for every specified cycle to ensure that new specifications are recognised.
B5 **XLIM**	Stroke (**X**-) **Lim**it not active	In force mode = 0: Stroke monitoring active = 1: Stroke monitoring not active
B6 **FAST**	–	reserved, must be at 0
B7 **FUNC**	–	reserved, must be at 0

5.5.6 Description of the status bytes SCON, SPOS, SDIR (RSB)

Status byte 1 (SCON)

Bit	EN	Description
B0 **ENABLED**	Drive **Enabled**	= 0: Drive blocked, 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 applied = 1: Warning applied
B3 **FAULT**	**Fault**	= 0: No fault = 1: A fault exists or a fault reaction is active. Fault number in diagnostic memory
B4 **24VL**	**V**oltage **L**oad	= 0: No load voltage = 1: Load voltage applied
B5 **HMI**	Drive Control	= 0: Device control by PLC/fieldbus = 1: Device control by FCT/MMI
B6 **OPM1**	**Op**erating **M**ode	= 00: Record select (standard) = 01: Direct mode = 10: Reserved = 11: Reserved
B7 **OPM2**		

Status byte 2 (SPOS)

Bit	EN	Description
B0 **HALT**	**Halt**	= 0: Hold is active = 1: Hold is not active, axis can be moved
B1 **ACK**	**Ack**nowledge Start	= 0: Ready for start (reference, jog) = 1: Start carried out
B2 **MC**	**M**otion **C**omplete	= 0: Positioning job active = 1: Positioning job completed, where applicable with error Note: MC is set after device is switched on (status "Drive blocked")
B3 **TEACH**	Acknowledge **Teach / Sampling**	Depending on the setting in PNU 354: – PNU 354 = 0: **Display of the teach status** SPOS.B3 = 0: Ready for teaching SPOS.B3 = 1: Teaching carried out, actual value is transferred – PNU 354 = 1: **Display of the sampling status** SPOS.B3 = 0: No edge. SPOS.B3 = 1: An edge has appeared. New position value available. For position sampling: see section 5.6.12
B4 **MOV**	Axis is **Mov**ing	= 0: Speed of the axis < limit value = 1: Speed of the axis >= limit value
B5 **DEV**	**Dev**iation Warning	= 0: No following error = 1: Following error active
B6 **STILL**	Stand**still** warning	= 0: After MC, axis remains in tolerance window = 1: After MC, axis remains outside tolerance window
B7 **REF**	Axis is **Ref**erenced	= 0: Drive is not referenced (homing run must be carried out) = 1: Drive is referenced

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 feedback	= 00: Positioning mode = 01: Force control = 10: Reserved = 11: Positioning mode energy optimised
B2-COM2		
B3-CONT	**Cont**inuous Mode	Continuous setpoint specification: = 0: Inactive = 1: Active
B4-VLIM	Speed (**V**-) **Lim**it reached	With force control: = 1: Speed limit reached = 0: Speed limit not reached
B5-XLIM	Stroke (**X**-) **Lim**it reached	With force control: = 1: Stroke limit value reached = 0: Stroke limit value not reached
B6-FAST	–	Reserved
B7-FUNC	–	Reserved

5.5.7 Examples of control and status bytes (FHPP standard)

On the following pages you will find typical examples of control and status bytes as per FHPP standard:

1. Creating readiness to operate – Record selection
2. Creating readiness to operate - Direct mode
3. Fault handling
4. Homing
5. Positioning using record selection
6. Direct mode: Positioning mode
7. Direct mode: Force mode

A description of the finite state machine for SFC-LACI can be found in section B.1.

0. Safeguard device control

Step/ Description	Control bytes									Status bytes								
	Byte	B7	B6	B5	B4	B3	B2	B1	B0	Byte	B7	B6	B5	B4	B3	B2	B1	B0
0.1 Device control HMI = on	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	0	0	0	0	0	0	SCON	0	0	**1**	**1**	0	0	0	0
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	0	SPOS	0	0	0	0	0	**1**	0	0
0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive																		

Tab. 5/3: Control and status bytes “Device control active”

Description of 0. Safeguard device control:

0.1 Device control via the parameterising interface (control panel or FCT) is activated.
For controlling the SFC-LACI via the control interface, this device control must first be deactivated via the parameterising interface (HMI = off).

1.Create readiness to operate – Record select

Step/ Description	Control bytes									Status bytes								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
1.1 Basic status	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	0	0	0	0	0	0	SCON	0	0	**0**	**1**	0	0	0	0
(device control HMI = off)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	0	SPOS	0	0	0	0	0	**1**	0	0
1.2 Disable device control by FCT/HMI (optional)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	x	x	**1**	x	x	0	x	x	SCON	x	x	**0**	x	x	x	x	x
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	x	x	x	x	x	x	x	SPOS	x	x	x	x	x	x	x	x
1.3 Enable drive, enable operation	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	**0**	**0**	x	x	0	0	**1**	**1**	SCON	**0**	**0**	0	1	0	0	**1**	**1**
(record selection)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	**1**	SPOS	0	0	0	0	0	1	0	**1**
0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive																		

Tab. 5/4: Control and status bytes “Creating readiness to operate – Record selection”

Description of 1. Create readiness to operate:

1.1 Basic status of the drive when the supply voltage has been switched on.
→ Step 1.2 or 1.3

1.2 Optionally: Disable device control via FCT/HMI using CCON.B5 = 1 (LOCK). → Step 1.3

1.3 Enable drive in Record Select mode.
→ Homing: Example 4, Tab. 5/7.

If there are faults after switching on or after setting CCON.B0 (ENABLE):
→ Fault handling: see example 3, Tab. 5/6 and chapter 6.3 “Error messages”.

2.Create readiness to operate – Direct mode

Step/Description	Control bytes									Status bytes								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
2.1 Basic status	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	0	0	0	0	0	0	SCON	0	0	**0**	**1**	0	0	0	0
(device control HMI = off)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	0	SPOS	0	0	0	0	0	**1**	0	0
2.2 Disable device control by FCT/HMI (optional)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	x	x	**1**	x	x	0	x	x	SCON	x	x	**0**	x	x	x	x	x
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	x	x	x	x	x	x	x	SPOS	x	x	x	x	x	x	x	x
2.3 Enable drive, enable operation	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	**0**	**1**	x	x	0	0	**1**	**1**	SCON	**0**	**1**	0	1	0	0	**1**	**1**
(direct mode)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	**1**	SPOS	0	0	0	0	0	1	0	**1**
0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive																		

Tab. 5/5: Control and status bytes “Create readiness to operate – Direct mode”

Description of 2. Create readiness to operate:

2.1 Basic status of the drive when the supply voltage has been switched on.
⟶ Step 2.2 or 2.3

2.2 Optionally: Disable device control via FCT/HMI using CCON.B5 = 1 (LOCK). ⟶ Step 2.3

2.3 Enable drive in Direct mode.
⟶ Homing: Example 4, Tab. 5/7.

If there are faults after switching on or after setting CCON.B0 (ENABLE):
⟶ Fault handling: see example 3, Tab. 5/6 and chapter 6.3 “Error messages”.

3. Fault handling

Step/ Description	Control bytes									Status bytes								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
3.1 Error	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	x	x	x	x	x	0	x	x	SCON	x	x	x	x	**1**	x	x	x
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	x	x	x	x	x	x	x	SPOS	x	x	x	x	x	**0**	x	x
3.2 Warning	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	x	x	x	x	x	0	x	x	SCON	x	x	x	x	x	**1**	x	x
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	x	x	x	x	x	x	x	SPOS	x	x	x	x	x	**0**	x	x
3.3 Acknowledge fault	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	x	x	x	**F**	0	x	1	SCON	0	x	0	1	**0**	**0**	0	0
with CCON.B3 (RESET)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	x	x	SPOS	x	0	0	0	0	**1**	**0**	1
3.4 Acknowledge fault	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	x	x	x	0	0	x	**N**	SCON	0	x	0	1	**0**	**0**	x	**0**
with CCON.B0 (ENABLE)	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	x	x	SPOS	x	0	0	0	0	**1**	x	x

0: Logic 0; 1: Logic 1; x: not relevant (optional);
F: Positive edge N: Negative edge

Tab. 5/6: Control and status bytes “Fault handling”

Description to 3. Fault handling

Description of errors and warnings see section 6.3.

3.1 An error is shown with SCON.B3 FAULT.
→ Positioning can no longer be undertaken.

3.2 A warning is shown with SCON.B2 WARN.
→ Positioning can still be undertaken.

3.3 Acknowledge fault with positive edge at CCON.B3 (RESET).
→ Fault bit SCON.B3 FAULT or SCON.B2 WARN is reset.
→ SPOS.B2 MC will be set.
→ Drive is ready to operate.

– or –

3.4 Acknowledge fault with negative edge at CCON.B0 ENABLE.
→ Fault bit SCON.B3 FAULT or SCON.B2 WARN is reset.
→ SPOS.B2 MC will be set.
→ Create readiness again
(see examples 1, Tab. 5/4 and 2, Tab. 5/5)

Caution
After the removal of ENABLE, the drive is no longer under position control. This may cause injury to people and material damage.

– With vertical or sloping drive mountings, the moving mass could possibly slide down.

4. Homing (requires status 1.4 or 1.5)

Step/Description	**Control bytes**									**Status bytes**								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
4.1 Start homing	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	x	x	x	0	0	1	1	SCON	0	x	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	**F**	0	1	SPOS	0	0	0	0	0	**0**	**1**	1
4.2 Homing running	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	x	x	x	0	0	1	1	SCON	0	x	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	**1**	0	1	SPOS	0	0	0	**1**	0	0	1	1
4.3 Homing finished	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	x	x	x	0	0	1	1	SCON	0	x	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	**0**	0	1	SPOS	**1**	0	0	0	0	**1**	0	1
0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive																		

Tab. 5/7: Control and status bytes "Homing"

Description to 4. Homing:

4.1 A positive edge at CPOS.B2 HOM starts homing. The start is confirmed with SPOS.B1 ACK (Acknowledge start) as long as CPOS.B2 HOM is set.

4.2 Movement of the axis is shown with SPOS.B4 MOV.

4.3 After successful homing, SPOS.B2 MC and SPOS.B7 REF will be set.

If there are faults during homing:
⟶ Fault handling: see example 3, Tab. 5/6.

5. Positioning record select (requires states 1.3/2.3 and 4.)

Step/Description	Control bytes									Status bytes								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
5.1 Preselect record number (control byte 3)	Byte 3	Record number								Byte 3	Record number							
	Record No.	Record no. (1...31)								Record No.	Previous record no. (1...31)							
5.2 Start task	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	x	x	0	0	1	1	SCON	0	0	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**F**	1	SPOS	1	0	0	0	0	**0**	1	1
5.3 Task running	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	x	x	0	0	1	1	SCON	0	0	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**1**	1	SPOS	1	0	0	**1**	0	0	**1**	1
	Byte 3	Record number								Byte 3	Record number							
	Record No.	Record no. (0...31)								Record No.	Current record no. (0...31)							
5.4 Task finished	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	0	x	x	0	0	1	1	SCON	0	0	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**0**	1	SPOS	1	0	0	**0**	0	**1**	**0**	1
	Byte 5...8	Reserved								Byte 5...8	Position							
	–	Reserved								Actual posi-tion	Actual position (increments)							
0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive																		

Tab. 5/8: Control and status bytes "Positioning record select"

Description of 5. Positioning Record Select:

(steps 5.1 ... 5.4 conditional sequence)

When the readiness to operate is created and homing has been carried out, a positioning task can be started.

5.1 Preselect record number: Byte 3 of the output data
0 = Homing
1...31 = Programmable positioning records

5.2 With CPOS.B1 START the preselected positioning task will be started. The start is confirmed with SPOS.B1 (Acknowledge start) as long as CPOS.B1 START is set.

5.3 Movement of the axis is shown with SPOS.B4 MOV.

5.4 At the end of the positioning task, SPOS.B2 MC (Motion Complete) will be set.

If there are faults during positioning:
⟶ Fault handling: see example 3, Tab. 5/6.

6. Direct mode: Positioning mode (requires states 1.3/2.3 and 4.)

Step/ Description	Control bytes Byte	B7	B6	B5	B4	B3	B2	B1	B0	Status bytes Byte	B7	B6	B5	B4	B3	B2	B1	B0
6.1 Preselect position and speed (control bytes 4 and 5...8)	Byte 4 Vel-ocity	RVelocity Velocity preselect (0...100%)								Byte 4 Vel-ocity	RVelocity Velocity reply message (0...100%)							
	Byte 5...8 Set-point pos.	Position Setpoint position (increments)								Byte 5...8 Act. pos.	Position Actual position (increments)							
6.2 Start task	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**F**	1	SPOS	1	0	0	0	0	**0**	**1**	1
	Byte 3	FUNC	FAST	XLIM	VLIM	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XLIM	VLIM	CONT	COM2	COM1	ABS
	CDIR	0	0	0	0	0	0	0	**S**	SDIR	0	0	0	0	0	0	0	**S**
6.3. Task running	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**1**	1	SPOS	1	0	0	**1**	0	0	1	1
6.4 Task finished	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**0**	1	SPOS	1	0	0	**0**	0	**1**	0	1

0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive
S: Positioning condition: 0 = absolute; 1 = relative

Tab. 5/9: Control and status bytes “Positioning mode Direct Mode”

Description of Direct Mode – Positioning mode:

(step 6.1 ... 6.4 conditional sequence)

When the readiness to operate is created and homing has been carried out, a setpoint position must be preselected.

6.1 The setpoint position is transferred in increments in bytes 5...8 of the output word.
The setpoint speed is transferred in % of the base value in byte 3 (0 = no speed; 100 = base value).

6.2 With CPOS.B1 START the preselected positioning task will be started. The start is confirmed with SPOS.B1 (Acknowledge start) as long as CPOS.B1 START is set.

6.3 Movement of the axis is shown with SPOS.B4 MOV.

6.4 At the end of the positioning task, SPOS.B2 MC (Motion Complete) will be set.

If there are faults during positioning:
→ Fault handling: see example 3, Tab. 5/6.

7. Direct mode – Force mode (requires states 1.3/2.3 and 4.)

Step/Description	**Control bytes**									**Status bytes**								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
7.1 Specify setpoint value	4	not relevant								4	Actual value in % of the rated force							
	5...8	Setpoint value in % of the rated force								5...8	Actual position in increments							
7.2 Prepare force control	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	0	1	SPOS	1	0	0	0	0	1	0	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	**S**	x	0	0	**1**	0	SDIR	0	0	**0**	x	0	0	**0**	0
7.3 Start task	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**F**	1	SPOS	1	0	0	0	0	**0**	**1**	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	S	x	0	0	1	0	SDIR	0	0	0	0	0	0	1	0
7.4 Task running (setpoint value not reached)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**x**	1	SPOS	1	0	0	**1**	0	0	x	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	S	x	0	0	1	0	SDIR	0	0	0	**1**	0	0	1	0
7.5 Task running (setpoint value reached)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**x**	1	SPOS	1	0	0	**0**	0	**1**	x	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	S	x	0	0	1	0	SDIR	0	0	0	**0**	0	0	1	0

Step/Description	Control bytes									Status bytes								
	Byte	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**	**Byte**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
7.6 Task discontinued (stroke limit or software end position reached)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	1	1	SCON	0	1	0	1	0	0	1	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**x**	1	SPOS	1	0	0	0	0	**1**	x	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	S	x	0	0	1	0	SDIR	0	0	**1**	0	0	0	**0**	0
7.7 Stop task (e. g. with STOP)	Byte 1	OPM2	OPM1	LOCK	–	RESET	BRAKE	STOP	ENABL	Byte 1	OPM2	OPM1	HMI	24VL	FAULT	WARN	OPEN	ENABL
	CCON	0	1	x	x	0	0	**0**	1	SCON	0	1	0	1	0	0	**0**	1
	Byte 2	–	CLEAR	TEACH	JOGN	JOGP	HOM	START	HALT	Byte 2	REF	STILL	DEV	MOV	TEACH	MC	ACK	HALT
	CPOS	x	0	0	0	0	0	**x**	1	SPOS	1	0	0	0	0	1	x	1
	Byte 3	FUNC	FAST	XUM	–	CONT	COM2	COM1	ABS	Byte 3	FUNC	FAST	XUM	VUM	CONT	COM2	COM1	ABS
	CDIR	0	0	S	x	0	0	1	0	SDIR	0	0	0	0	0	0	**0**	0

0: Logic 0; 1: Logic 1; x: not relevant (optional); F: Edge positive
S: Path limitation (stroke limit): 0 = Stroke limit active, 1 = Stroke limit not active

Tab. 5/10: Control and status bytes “Direct Mode – Force Mode”

Description of force mode:

When the readiness to operate is created and homing has been carried out, a setpoint must be preselected and the force control must be prepared.

7.1 Specify the setpoint value in % of the rated motor force. Value range: 30...100% (values under 30% are rounded up to 30%).

7.2 Prepare force control Set bit CDIR.B1 COM1 and if desired set bit CDIR.B5 XLIM for the stroke limitation.

7.3 Start the job with CPOS.B1 START. The start is confirmed with SPOS.B1 (Acknowledge start) as long as CPOS.B1 START is set.

7.4 or 7.5
Depending on whether the setpoint value is reached or not, the relevant bits in the status will be set.

7.6 The job will be finished automatically when the stroke limit or software end position is reached. Switching is made again to position control.

7.7 The task can be discontinued by the controller e.g. with STOP.

If there are faults during force mode: see example 3, Tab. 5/6 Fault handling.

Note
Modification of the setpoint value with force mode is only possible with a new starting edge when the last specified position (MC) has been reached.

5.6 Drive functions

5.6.1 Homing

When the device is switched on, homing must be carried out before a positioning task can be executed.

The drive homes against a stop or a reference switch. A stop is reached when there is an increase in the motor current at the same time as the drive shaft comes to a stop. As the drive must not position continuously against the stop, it must move at least 1 mm into the stroke range again (offset axis zero point).

Sequence:

1. Search for the reference point in accordance with the configured method.
2. Move from reference point to axis zero point (offset axis zero point).
3. Set at axis zero point:
   Actual position = 0 – project zero point offset (i.e. -PZ).

Overview of parameters involved (see also section B.3.9)				
Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Offset axis zero point	x	1010	607Ch
	Homing method	x	1011	6098h
	Homing speeds	x	1012	6099h
	Homing required	–	1014	23F6h
	Maximum homing current	x	1015	23F7h
Start (FHPP)	CPOS.B2 = positive edge: start homing			
Feedback (FHPP)	SPOS.B1 = positive edge: acknowledge start SPOS.B7 = drive is referenced			
Condition	Device control by PLC/fieldbus; controller in the "Operation enabled" status; no jogging command is present			

Tab. 5/11: Parameters involved in homing

Homing methods [1)]

Hex	Dec	Description
01h	1	Search for limit switch in negative direction with index search
02h	2	Search for limit switch in positive direction with index search
07h	7	Search for reference switch in positive direction with index search
0Bh	11	Search for reference switch in negative direction with index search
EFh	-17	Search for stop in a negative direction. The point found is the reference position. As the axis must not stand still at the stop, the offset axis zero point must be ≠ 0.
EEh	-18	Search for stop in a positive direction. The point found is the reference position. As the axis must not stand still at the stop, the offset axis zero point must be ≠ 0.

1) For a detailed description of the homing methods, see section 1.1.6.

Tab. 5/12: Overview of homing methods

5.6.2 Jog mode

In the “Operation enabled” status, the drive can be jogged to the left/right. This function is usually used for

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

Sequence

1. When one of the signals “Jog left / Jog right” is set, the drive starts to move slowly. Due to the slow speed, a position can be defined very accurately.
2. If the signal remains set, the speed will, after the expiry of “Duration of phase 1”, be increased until the maximum configured speed is reached. In this way large strokes can be traversed quickly.
3. When the signal changes to 0, the drive is braked.
4. The drive stops automatically if it reaches a software end position (providing the drive is referenced, otherwise the software end positions are not checked). The software end position is not exceeded, the path for stopping depends on the ramp set. The jog mode can be exited here with Jogging = 0.

[1] Low speed phase 1 (slow travel)

[2] Maximum speed for phase 2

[3] Acceleration/delay

[4] Duration of phase 1

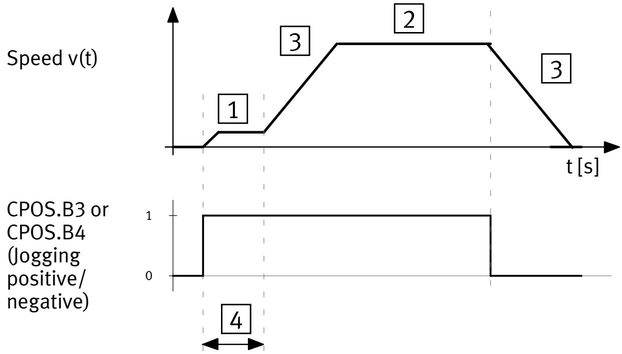


Fig. 5/2: Sequence diagram for jog mode

Overview of parameters involved (see section B.3.8)

Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Speed Phase 2 [2]	x	531	20ED/21h
	Acceleration or deceleration [3]	x	532	20EE/21h
	Duration phase 1 [4]	x	534	20E9/21h
Start (FHPP)	CPOS.B3 = 1: Jog positive (forwards) CPOS.B4 = 1: Jog negative (backwards)			
Feedback (FHPP)	SPOS.B4 = 1: Drive moving SPOS.B2 = 0: Motion Complete			
Requirements	Device control by PLC/fieldbus Controller must be in status “Operation enabled”			

Tab. 5/13: Parameters involved in jog mode

5.6.3 Teaching via fieldbus

Position values can be taught via the fieldbus. Previously taught position values will then be overwritten.

Sequence

1. The drive is moved to the desired position using the jog mode.

2. The user must make sure that the desired parameter is selected. For this, the parameter "Teach target" and, if applicable, the correct record address must be entered.

Teach target (PNU 520)	**Taught is**
= 1 (specification)	Target position in position record. – Record selection: Positioning record after control byte 3 – Direct mode: Positioning record after PNU 400
= 2	Axis zero point
= 3	Project zero point
= 4	Lower software end position
= 5	Upper software end position

Tab. 5/14: Overview of teach targets

3. Teaching takes place via the handshake of the bits in the FHPP control and status bytes CPOS/SPOS:

1 Ready for teaching

2 Value transferred

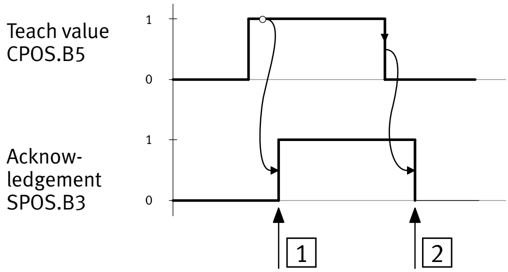


Fig. 5/3: Handshake when teaching

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 + motor controller there will be inaccuracies of several millimetres even at a speed of only 100 mm/s.

Overview of parameters involved (see sections B.3.7 and B.3.8)				
Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Teach target	– 1)	520	21FCh
	Record number	– 1)	400	2033h
Start (FHPP)	CPOS.B5 = falling edge: Teach value			
Feedback (FHPP)	SPOS.B3 = 1: Value transferred			
Condition	Device control by PLC/fieldbus Controller must be in status “Operation enabled”			
1) Teaching is made possible in the Festo Configuration Tool by means of special functions.				

Tab. 5/15: Parameters involved in teaching

5.6.4 Record selection: Carrying out a record

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

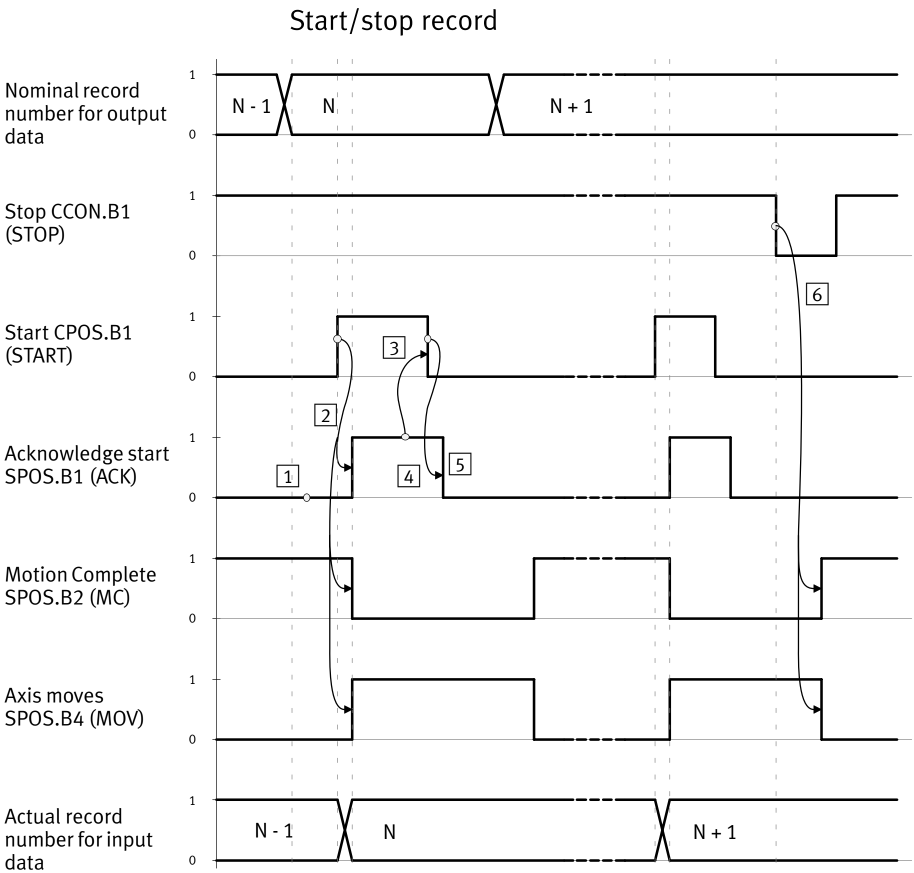
- Moving to any position from positions in the record list,
- Processing a positioning profile by linking records,
- Known target positions that seldom change (formulation change).

Sequence

1. Set the desired record number in the output data of the master. Until the start, the controller replies with the number of the record last processed.
2. With a rising edge at START (CPOS.B1) the controller accepts the record number and starts the positioning job.
3. The controller signals with the rising edge at "Acknowledge Start" that the PLC output data has been accepted and the positioning job is now active. The positioning command will be processed irrespective of whether CPOS.B1 START has been reset to zero or not.
4. When the record is concluded, SPOS.B2 MC is set.

Causes of faults:

- Homing has not been carried out.
- The target position is unreachable.
- Invalid record number.



1 Requirement: “Acknowledge start” = 0

2 Rising edge at START causes the new record number N to be accepted and “Acknowledge start” to be set.

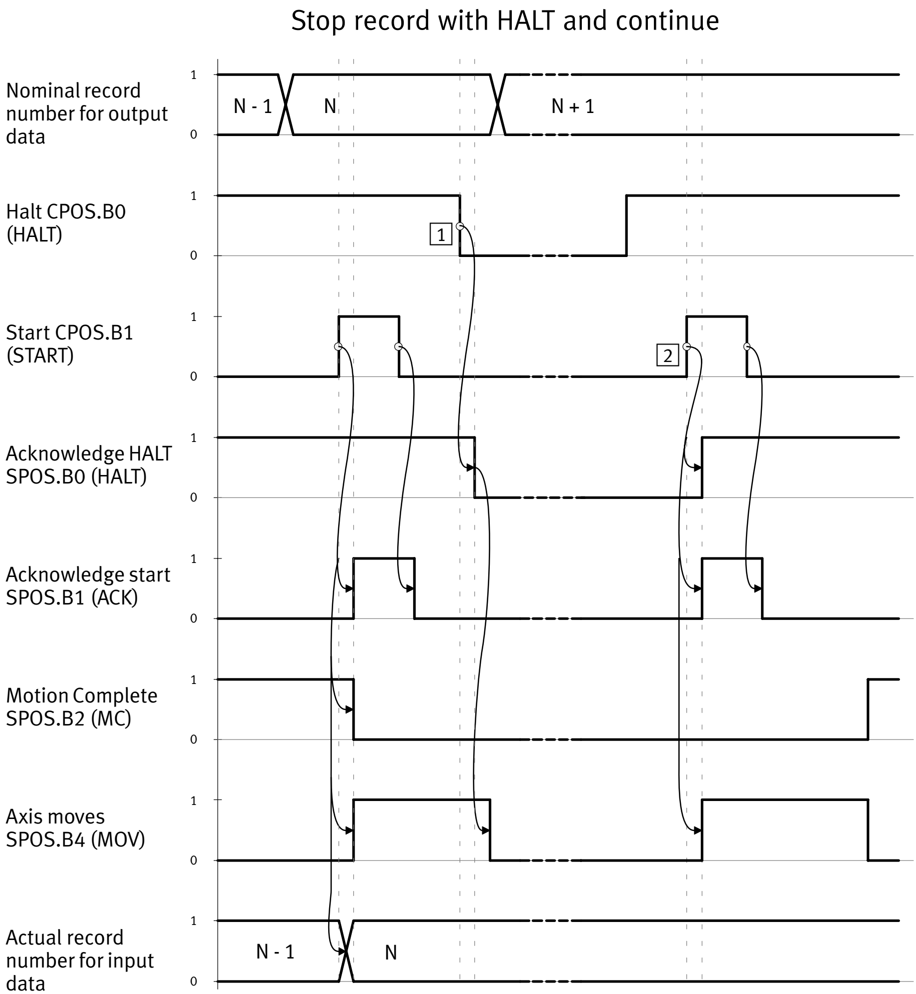
3 As soon as “Acknowledge start” is recognised by the PLC, START may be set to 0 again.

4 The controller reacts with a falling edge at “Acknowledge start”.

5 As soon as “Acknowledge start” is recognised by the PLC, the next record number may be started.

6 A currently running positioning task can be stopped with STOP.

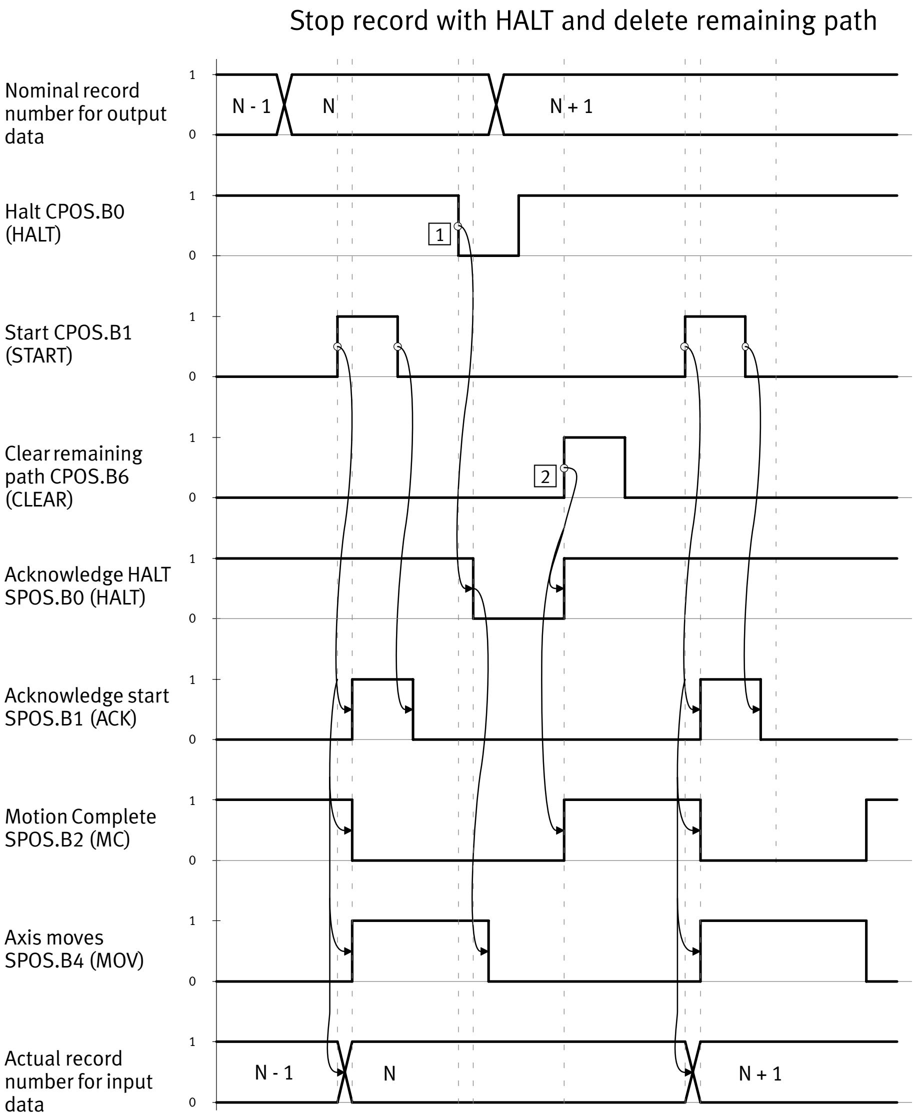
Fig. 5/4: Sequence diagram for start/stop record



1 Record is stopped with HALT, the actual record number N is retained, “Motion Complete” remains reset.

2 Rising edge at START starts record N again, “Acknowledge HALT” is set.

Fig. 5/5: Stop sequence diagram with HALT and continue



1 Interrupt record

2 Delete remaining path

Fig. 5/6: Sequence diagram: Stop record with HALT and delete remaining path

Parameters involved (record selection)

The entries in the positioning table can be written via the fieldbus (PNU 401...417).

The composition of the positioning table as per FHPP is described in appendix B.3.7. Record chaining is described in section 5.6.5.

Overview of parameters involved (see section B.3.7)				
Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Mode (absolute/relative/energy optimised)	x	401	20E0/01h
	Target position	x	404	20E0/02h
	Speed	x	406	20E0/03h
	Acceleration	x	407	20E0/04h
	Deceleration (= Braking)	x	408	20E0/0Ah
	Acceleration jerk	x	409	20E0/05h
	Mass of the workpieces (without tool mass)	x	410	20E0/06h
	Damping time	x	415	20E6h 20E0/07h
	Deceleration jerk	x	417	20E0/0Bh
Start (FHPP)	CPOS.B1 = positive edge: Start Jogging and referencing have priority.			
Feedback (FHPP)	SPOS.B2 = 0: Motion Complete SPOS.B1 = positive edge: Acknowledge start SPOS.B4 = 1: Drive moving			
Requirements	Device control by PLC/fieldbus. Controller must be in status "Operation enabled". Record number must be valid			

Tab. 5/16: Parameters involved in Record Select mode

5.6.5 Record selection: Switching to next record

Switching to the next record (= record chaining) allows a sequence of records to be defined. To do this, for every record in the table you can specify whether another record should be processed afterwards (PNU 402), and if so, then which record (PNU 416) is to be processed after which delay (PNU 405).

Overview of supplementary parameters (see Tab. 5/16)				
Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Switch to next record yes/no?	x	402	20EBh 20E0/01h
	Delay time in [ms]: The time between Motion Complete (MC) for a record with record chaining and the start of the next positioning record.	x	405	20E4h 20E0/08h
	Number of the next positioning record	x	416	20E5h 20E0/09h
Feedback (FHPP)	PNU 400/2: Active position record Status byte 4 RSB.B0 RC1 = 1: First record chaining completed (regarded as completed when MC = 1 after the first chained record). Status byte 4 RSB.B1 RCC = 1: Record chain has been processed to the end of the chain (only valid when MC = 1)			
Notes (FHPP)	The CCON.STOP bit stops the active sequence and discards the current motion task. With the bit CPOS.HALT a sequence can be stopped; it can be continued and concluded if CPOS.START is set again.			

Tab. 5/17: Additional parameters for switching to next record

The remaining parameters and sequences reflect the record selection (⟶ 5.6.4).

5.6.6 Direct mode: Specification of a position or force

In the status “Operation enabled” a positioning task is formulated directly in the I/O data which are transmitted via the field bus. The setpoint values for position or force/torque are managed in the PLC.

The function is used in the following situations:

– Moving to any position.

– The target positions are unknown during planning or change frequently (several different work item positions).

A positioning profile using chained records can be externally implemented by the master.

Procedure for specifying a position:

1. The user sets the desired position setpoint, the speed, and the mode (absolute/relative/energy optimised) into the PLC output data.
2. With a rising edge at START (CPOS.B1) the controller accepts the setpoint position and starts the positioning job.
3. After the start, you must wait for MC (SPOS.B2) before a new start can be made.
4. When the setpoint position is reached, MC is set.

Procedure for specifying a force:

Notes on force control
Control of the motor force occurs indirectly via current regulation. All force specifications refer to the rated motor force (relative to the rated motor current). The actual force at the axis should be calculated/checked and then set with external measuring devices during commissioning.

Force control is prepared when the control mode is switched over. The drive stands with the position controlled. The signal MC (Motion Complete) is used in this control mode to mean "Force value reached".

After the setpoint value has been specified, the force is built up by the start signal (START bit) in the direction of the sign of the setpoint value. The speed is limited to the value in the parameter "Speed limit". Once this speed has been reached, the bit "Speed limit reached" is set in the status byte SDIR.

When the setpoint value has been reached, taking into account the target window and the time window, the "MC" signal is set. The force continues to be controlled.

If the path set in the path/stroke monitoring (relative to the starting position) is exceeded, the bit "Stroke limit reached" is set in the status byte SDIR. The drive is braked with the emergency stop ramp, held with the position controlled at the current position, and the "MC signal" is set.

The smallest permitted force setpoint value is 30% of the rated force. If smaller values are specified, these will be raised to 30%.

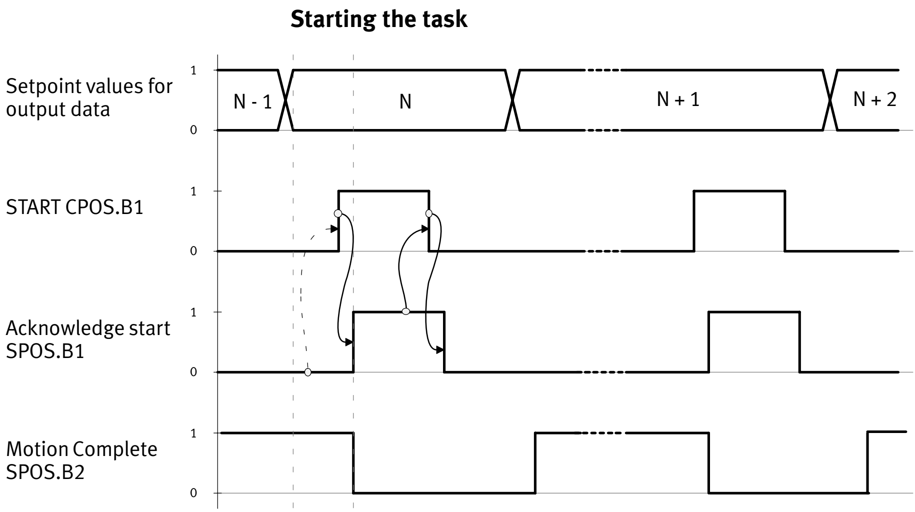


Fig. 5/7: Starting the task

The sequence of the remaining control and status bits as well as the functions HALT and STOP react as with the function Record Select, see Fig. 5/4, Fig. 5/5 and Fig. 5/6.

Causes of faults:

– No referencing carried out.

– When specifying a position: the target position is outside the software end positions.

Overview of parameters involved (see section B.3.8)				
	Description	**FCT**	**PNU**	**CI**
Positioning mode	Basic velocity	x	540	21F8h
	Acceleration	x	541	20EE/22h
	Deceleration	x	542	20EF/22h
	Acceleration jerk	x	543	20E7/22h
	Applied load	x	544	20E8/22h
	Deceleration jerk	x	547	21E1/22h
	Damping time	x	1023	20E6/22h
Force control 1)	Stroke limitation	x	510	60F6/01h
	Minimum force (fix 30 % of the rated value)	x	511	60F6/05h
	Maximum force	x	512	6072h
	Force target window (tolerance)	x	552	60F6/03h
	Force damping time in [ms]	x	553	60F6/04h
	Max. permitted speed	x	554	60F6/02h
Start (FHPP)	CPOS.B1 START = positive edge			
Feedback (FHPP)	SPOS.B2 = 0: Motion complete SPOS.B1 = positive edge: Acknowledge start SPOS.B4 = 1: Drive moving			
Prerequisites	Device control by PLC/field bus Controller must be in status “Operation enabled”			

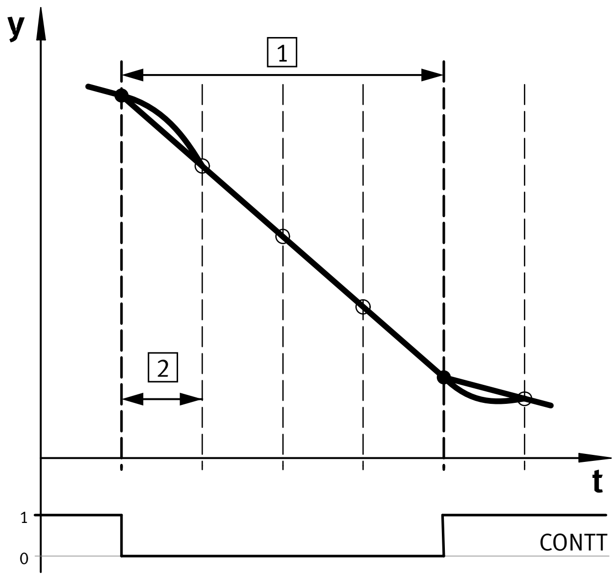
1) Further parameters:

6071h	Target torque	6076h	Rated torque
6077h	Actual torque	6087h	Torque slope
6088h	Torque profile type	CDIR.B5	Stroke limitation active/inactive

Tab. 5/18: Parameters involved in Direct Mode

5.6.7 Direct mode: Continuous setpoint specification (Continuous Mode)

With continuous setpoint specification (Following mode) the higher level controller continuously specifies position values at fixed time intervals (typically 4...10 ms). Since this time interval is usually longer than a position controller cycle (350 µs, the controller independently interpolates the values between two specified position values. At every specified interval, the CDIR.B4 CONTT (“Toggle-Bit”) must be toggled to ensure that any new interval is recognised.



1 Specified interval (PNU 570)

2 Position controller cycle (350 µs)

Fig. 5/8: Continuous setpoint specification (FHPP Continuous Mode)

Continuous setpoint specification can be used to travel curved paths or for coupling axis motion (use of several axes).

Overview of parameters involved (see section B.3.8)				
Parameters involved	**Description**	**FCT**	**PNU**	**CI**
	Interpolation time, i.e. the time interval used by the higher level controller for sending position setpoints.	–	570	20B6h
Start (FHPP)	CDIR.B3 CONT = 1 CPOS.B1 START = positive edge, must remain set while the setpoint specification is active. CDIR.B4 CONTT = 0 ‹=› 1 (“Toggle-Bit”) CCON.B1 STOP stops the setpoint specification. CPOS.B0 HALT has no intermediate stop function and behaves in a similar manner to the CCON.B1 STOP bit. A negative edge at CPOS.B1 START also stops the setpoint specification.			
Feedback (FHPP)	SDIR.B3 CONT = 1			
Condition	Device control by PLC/fieldbus Controller must be in status “Operation enabled”			

Tab. 5/19: Parameters used for continuous setpoint specification

5.6.8 Standstill monitoring

With the standstill monitoring it is clear that the target position window is exited at a standstill.

When the target position has been reached and MC is signalled in the status word, the drive switches to the "standstill" state and bit SPOS.B6 STILL (standstill monitor) is reset. If, in this status, the drive is removed from the standstill position window for a defined time due to external forces or other influences, the bit SPOS.B6 STILL will be set.

As soon as the drive is in the standstill position window again for the standstill monitoring time, the bit SPOS.B6 STILL is reset.

1 Target position
2 Actual position
3 Standstill monitoring (SPOS.B6)
4 Motion Complete (SPOS.B2)
5 Standstill position window
6 Target position window
7 Damping time (Position window time)
8 Standstill monitoring time

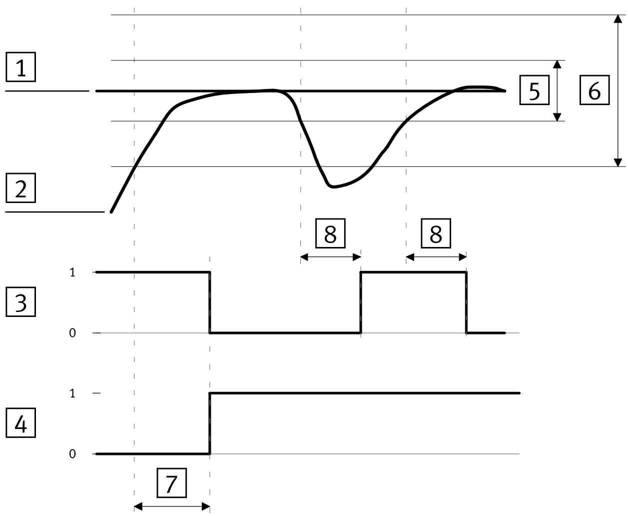


Fig. 5/9: Standstill monitoring

Standstill monitoring becomes inactive when the standstill position window is set to "0".

Overview of parameters involved (see section B.3.9)				
Parameter	**Description**	**FCT**	**PNU**	**CI**
	Setpoint position	–	1040	6062h
	Actual position	–	1041	6064h
	Standstill position window	–	1042	2040h
	Standstill monitoring time	–	1043	2041h
Start (FHPP)	SPOS.B2 = positive edge: Motion Complete			
Feedback (FHPP)	SPOS.B6 = 1: Drive has moved out of standstill position window.			
Condition	Device control by PLC/fieldbus Controller in “Operation enabled” state			

Tab. 5/20: Parameters involved in standstill monitoring

5.6.9 Using hardware enable

Reaction

Controller not enabled

If the controller enable is not set (no ENABLE signal at the controller interface and [HMI=off] on the control panel):

If the hardware enable is missing, the “Power” LED flashes. The SFC-LACI can be parameterised, however, and records the position of the drive.

Controller enabled

If the controller enable is set:

When the hardware enable is removed, the load voltage is switched off.

Caution
If the drive is not under position control after the removal of “hardware enable”, this may cause injury to people and material damage

– If the hardware enable is removed during a current positioning procedure, then the mass continues to move due to inertia.
– With vertical or sloping drive mountings, the moving mass will then slide down.

Also note:

When the hardware enable is removed, the load voltage is switched off immediately. However, several seconds can pass before the SFC-LACI reports the error “Load Power Down” and a brake closes (if present).

5.6.10 Using the local digital outputs

Purpose

The outputs can be used for the following:

- Displaying an internal logical status of the SFC-LACI, (e.g. occurrence of an error)
- A display of certain values not being reached (e.g. position values)
- Controlling a brake/clamping unit (see 5.6.11)
- Operating a fan, DC motor or similar

Switching logic

Positive switching logic: when the output is set (switching state true, logic “1”), the output is set to 24 V. If the output is not set, to 0 V (or in Out2 with PWM, to high impedance).

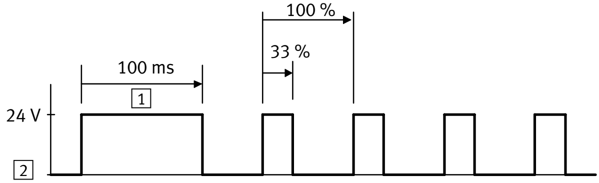
Negative switching logic: when the output is set, the output is set to 0 V (or in Out2 with PWM, to high impedance). If the output is not set: to 24 V.

PWM (only Out2)

With pulse-width modulation (PWM), a pulsed signal is output. When using as a brake output, a continuous signal is initially output for 100 ms when the output is set (CI 6510/1Ah).

PWM value

The PWM value is the duty cycle during a period of time (frequency: approx. 20 kHz), in the following diagram, 33%:



1 only when using as a brake output 2 high impedance

Fig. 5/10: PWM value

Behaviour depending upon pin use

Out1

Standard	When the output is set, a continuous signal (24 V) appears. If the output is not set: 0 V.
Inverted	By "inverting" the output: when the output is set, 0 V applied. If the output is not set: 24 V.

Out2

Signal A – Signal /A

For the connection of the consumer between pin 4 (signal A) and pin 1 (signal /A), i.e. use of the differential output:

PWM value 1...100%: Positive switching logic. If the output is not set, the two pins are highly resistive. Change of polarity due to the output being inverted (exception: when used for brake plus only at pin 4).

PWM value 0%: Always 24 V. Setting/resetting the output causes polarity change. Polarity presetting can be changed by inverting the output.

Signal A – ground

For the connection between pin 4 (signal A) and pin 3 (ground):

PWM value 1...100%: Positive switching logic. If the output is not set, pin 4 is highly resistive. Do not operate inverted.

PWM value 0%: Positive switching logic. If the output is not set, pin 4 is not highly resistive, but at 0 V. Negative switching logic due to the output being inverted.

Signal /A – ground

For the connection between pin 1 (signal /A) and pin 3 (ground):

PWM value 1...100%: Positive switching logic. If the output is not set, pin 1 is highly resistive. Always operate inverted. Cannot be used for a brake since with the parameter setting for brake plus is always at pin 4.

PWM value 0%: Negative switching logic. If the output is not set, pin 4 is not highly resistive, but at 0 V. Positive switching logic due to the output being inverted.

Overview of parameterisation of Out2

Basis settings

The behaviour is set via

– Operating mode of object 2422/01h: Values 1 (brake), 2 (digital signal) or 3 (output compare)

– PWM value of object 2422/0Ah: Values 0...100%

– Setting “inverted” object 2422/09h: Value 0 = not inverted, otherwise inverted.

Without PWM

Without pulse-width modulation, the following options are available:

1. PWM value 0, operating mode 1 (does not matter whether inverted) – or – operating mode 2 / 3 and not inverted. If the output is set: O = 24 V, /O = 0 V. If the output is reset: O = 0 V, /O = 24 V.

2. PWM value 0, operating mode 2 or 3 and inverted. If the output is reset: O = 24 V, /O = 0 V. If the output is set: O = 0 V, /O = 24 V, therefore completely the opposite to point 1.

With PWM

When the PWM is not inverted (if the output is set), O = 24 V, /O = 0 V during the active PWM time; in the non-active PWM time, the two pins are highly resistive.
If the output is reset, the two pins are highly resistive the whole time.

3. PWM value not equal to 0, operating mode 1, does not matter whether inverted: PWM-modulated brake. In the first 100 ms, PWM value = 100%, after that the specified value applies.

4. PWM value not equal to 0, operating mode 2 or 3, not inverted: is the PWM-modulated output.

5. PWM value not equal to 0, operating mode 2 or 3, inverted: is the PWM-modulated inverted output. The behaviour is just the same as it is in point 4, only the two output pins are swapped: during the active PWM time, /O = 24 V, O = 0 V.

Overview of the parameters for the local digital outputs Out 1/2			
Parameter / Description	**PNU**	**FCT**	**CI**
Out 1/2: Status of the outputs (set / not set) Bit — Value — Display 0 — 0x00000001 — Status Brake 25 — 0x02000000 — Status Out1 26 — 0x04000000 — Status Out2	304	x	60FE/01h
Out 1/2: Mask Bit — Value — Function 25 — 0x02000000 — Activates the display of Out1 in 60FE/01h 26 — 0x04000000 — Activates the display of Out2 in 60FE/01h	304	–	60FE/02h
Out 1: Use Value — Out 1 is used as: 0 — No function 1 — Brake output (see 5.6.11) 2 — “Digital signal display” (see FCT) 3 — “Output/Compare” (see FCT)	1240	x	2421/01h
Out 1: Setting condition Value — The output is set dependent upon: 1 — Position comparison 2 — Force comparison 3 — Speed comparison 4 — Record number comparison 10h — Ready 11h — Motion complete 12h — Error 13h — Sample in 14h — (reserved) 15h — ON (during setting of this bit, the output is set immediately)	1241	x	2421/02h
Out 1: Resetting condition (delay: see 2421/08h) Value — The output is reset dependent upon: 1 — Position comparison + delay 2 — Force comparison + delay 3 — Speed comparison + delay 4 — Record number comparison + delay 10h — Ready + delay 11h — Motion complete + delay 12h — Error + delay 13h — Sample in + delay 14h — Delay 15h — OFF (during setting of this bit, the output is reset immediately)	1242	x	2421/03h

Parameter / Description	PNU	FCT	CI
Out 1: Value for setting condition The saved value that when reached means that the comparison condition is considered fulfilled in accordance with 2421/02h. With record number comparison: bit number ≙ record number: bit 1 = record 1 (bit 0: do not use). Example: 0x6 = in record1 and also in record2, the condition is considered fulfilled and the output is set.	1243	x	2421/04h
Out 1: Value for resetting condition As above, but in accordance with 2421/03h for the resetting condition.	1244	x	2421/05h
Out 1: Setting condition rising/falling Value = 0: The output is set if the reference value accrued from lower values has been reached in accordance with 2421/04h. Value = 1: The output is set if the reference value accrued from higher values has been reached in accordance with 2421/04h.	1245	x	2421/06h
Out 1: Resetting condition rising/falling Value = 0: The output is reset if the reference value accrued from lower values has been reached in accordance with 2421/05h. Value = 1: The output is reset if the reference value accrued from higher values has been reached in accordance with 2421/05h.	1246	x	2421/07h
Out 1: Delay Delay time in [ms] after a resetting condition has occurred. The output is not reset until the delay time has expired (= switch-off delay).	1247	x	2421/08h
Out 1: Inverted 0 = not inverted; 1 = inverted This setting is not taken into account when the output is used for a brake/clamping unit (see 2421/01h).	1248	x	2421/09h

Parameter / Description	PNU	FCT	CI
Out2: Use Value Out 2 is used as: 0 No function 1 Brake output (see 5.6.11) 2 Digital signal display (see FCT) 3 "Output/Compare" (see FCT)	1250	x	2422/01h
Out 2: Setting condition Value The output is set dependent upon: 1 Position comparison 2 Force comparison 3 Speed comparison 4 Record number comparison 10h Ready 11h Motion complete 12h Error 13h Sample in 14h (reserved) 15h ON (during setting of this bit, the output is set immediately)	1251	x	2422/02h
Out 2: Resetting condition (delay: see 2422/08h) Value The output is reset dependent upon: 1 Position comparison + delay 2 Force comparison + delay 3 Speed comparison + delay 4 Record number comparison + delay 10h Ready + delay 11h Motion complete + delay 12h Error + delay 13h Sample in + delay 14h Delay 15h OFF (during setting of this bit, the output is reset immediately)	1252	x	2422/03h
Out 2: Value for setting condition The saved value that when reached means that the comparison condition is considered fulfilled in accordance with 2422/02h. With record number comparison: bit number ≙ record number: bit 1 = record 1 (bit 0: do not use). Example: 0x6 = in record1 and also in record2, the condition is considered fulfilled and the output is set.	1253	x	2422/04h
Out 2: Value for resetting condition As above, but in accordance with 2422/03h for the resetting condition.	1254	x	2422/05h

Parameter / Description	**PNU**	**FCT**	**CI**
Out 2: Setting condition rising/falling Value = 0: The output is set if the reference value accrued from lower values has been reached in accordance with 2422/04h. Value = 1: The output is set if the reference value accrued from higher values has been reached in accordance with 2422/04h.	1255	x	2422/06h
Out 2: Resetting condition rising/falling Value= 0: The output is reset if the reference value accrued from lower values has been reached in accordance with 2422/05h. Value= 1: The output is reset if the reference value accrued from higher values has been reached in accordance with 2422/05h.	1256	x	2422/07h
Out 2: Delay Delay time in [ms] after a resetting condition has occurred. The output is not reset until the delay time has expired (= switch-off delay).	1257	x	2422/08h
Out 2: Inverted 0 = not inverted; 1 = inverted This setting is not taken into account when the output is used for a brake/clamping unit (see 2422/01h).	1258	x	2422/09h
Out 2: PWM value Duty cycle during a period of time. See Fig. 5/10. Values: 1...100 %. Value = 0 deactivates the pulse-width modulation.	1259	x	2422/0Ah

Tab. 5/21: Parameters for the local digital outputs

5.6.11 Using a brake/clamping unit

One of the local digital outputs (Out1 or Out2) can be used to control a brake/clamping unit. Options here are a continuous signal or, in the case of Out2, both a continuous and a pulsed signal (PWM, see Fig. 5/10).

The parameterisation can easily be carried out via FCT. Note the detailed functional descriptions in the help section for plug-in SFC-LAC.

Note
When using the DNCE/DFME-...-LAS-...-**C** clamping unit: The clamping unit may not be closed until the drive is at standstill. It must be opened before a new positioning motion begins.

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

Overview of parameters when using a brake/clamping unit			
Parameter / Description	**PNU**	**FCT**	**CI**
Out1: Use Value = 1: Out1 is the defined brake output	1240	x	2421/01h
Out2: Use Value = 1: Out2 is the defined brake output	1250	x	2422/01h
Switch-on delay Time in [ms] between setting the enable (ENABLE = 1) or a START signal (if the automatic brake is activated) and the start of a positioning motion. The brake can open completely in this period of time. Values: 0...500 ms.	1310	x	6510/17h
Switch-off delay Time in [ms] between the removal of the enable (ENABLE = 0) or the expiry of the activation time of the automatic brake and the switching off of the SFC-LACI's output stage. In this period of time, the SFC-LACI continues to control the position, and the brake can close completely. Values: 0...500 ms.	1311	x	6510/18h
Activation time of the automatic brake Time in [s] between the completion of a positioning motion ("Motion complete") and the resetting of the brake output (providing in this period of time there is no new START signal). The switch-off delay follows after the activation time. Value = 0 deactivates the automatic brake.	1312	x	6510/19h
PWM value Duty cycle during a period of time. See Fig. 5/10. Values: 1...100%. Value = 0 deactivates the pulse-width modulation.	1259	x	2422/09h
Display of brake status Bit 0 = 1 / 0: The configured brake output is set / not set.	304	x	60FE/01h

Tab. 5/22: Parameters when using a brake/clamping unit

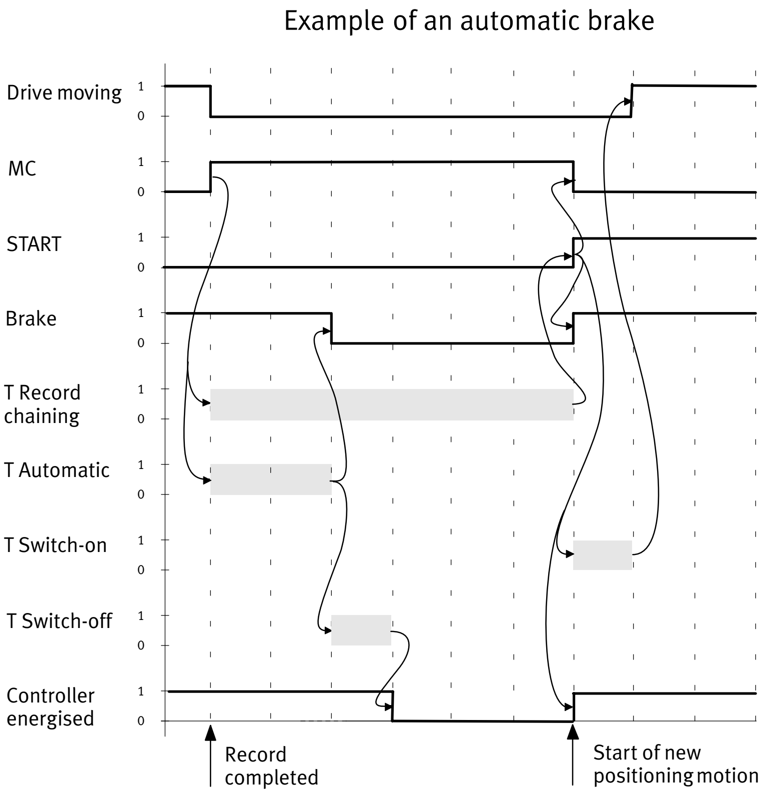


Fig. 5/11: Pulse-time diagram – automatic brake

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

After the time for switching to next record has expired, there is a new internal START signal, the drive, however, does not start to move until the switch-on delay has expired.

5.6.12 Position sampling (on-the-fly measurement)

A local digital input (IN1 or IN2) not occupied by the reference or limit switch can be used as a fast sample input. With a falling (depending on configuration: a rising) edge at the configured sample input, the current position value is written into a register of the SFC-LACI and can afterwards be read out (PNU 350 or 351) by the higher-level control system (PLC/IPC).

Overview of parameters for position sampling (on-the-fly measurement)

Parameter / Description	PNU	FCT	CI
Input that is going to be used for the position sampling: Value = 0: none / value = 1: IN1 / value = 2: IN2	1305	x	6510/16h
Trigger mode: – Value = 1: “cyclic” (continuous) = record position for every rising (depending on configuration: and/or falling) edge – Value = 2: “single” (one-time) = record position only for the first rising (depending on configuration: and/or falling) edge	352	x	204A/01h
Edge status: – Value = 0: An edge was not registered. Writing 0 resets both edge events to 0. – Value = 1: A falling edge has occurred and a new position value was stored. – Value = 2: A rising edge has occurred and a new position value was stored. – Value = 3: A rising and a falling edge have occurred, the respective position values were stored.	353	–	204A/02h

Parameter / Description	PNU	FCT	CI
Transfer edge status to FHPP status byte SPOS and status word (CI object 6041h) – Value = 0: If an edge occurs (see subindex 02h), this event is **not** displayed in the status word. **Writing 0** resets bit 14 to 0 in the status word. – Value = 1: If a rising edge occurs (see subindex 02h), bit 14 is set in the status word. – Value = 2: If a falling edge occurs (see subindex 02h), bit 14 is set in the status word. – Value = 3: If a rising or a falling edge occurs (see subindex 02h), bit 14 is set in the status word. With fieldbus: Display in SPOS.B3 TEACH – If the corresponding values are set, bit 3 in the FHPP status byte SPOS no longer displays the teach status, but the sampling status.	354	–	204A/03h
Control byte sampling: – Value = 0: No reaction to edges. Writing value = 0: switch off position sampling – Value = 1: The SFC-LACI reacts to falling edges. In trigger mode “single”: writing value = 1 resets the status (subindex 02h) of a falling edge and allows a position to be recorded again. – Value = 2: The SFC-LACI reacts to rising edges. In trigger mode “single”: writing value = 2 resets the status (subindex 02h) of a rising edge and allows a position to be recorded again. – Value = 3: The SFC-LACI reacts to rising edges and to falling edges. In trigger mode “single”: writing value = 3 resets the status (subindex 02h) of all edges and allows a position to be recorded again.	355	x	204A/04h
Position value for a rising edge in [increments]	350	–	204A/05h
Position value for a falling edge in [increments]	351	–	204A/06h

Tab. 5/23: Parameters for position sampling (on-the-fly measurement)

5.7 Notes on operation

Warning
There is a danger of injury.
Electric axes can move suddenly with high force and at high speed. Collisions can lead to serious injury to human beings and damage to components.

- Make sure that nobody can reach into the operating range of the axes or other connected actuators (e.g. with a protective grille) and that no objects lie in the positioning range while the system is still connected to a power supply.

Caution
Not using the parameterising interface as designated causes injury to people and material damage

The parameterising interface (RS232) is

– not electrically isolated and

– not real-time capable.

It is not intended for permanent connection to PC systems or as a controller interface.

Controlling the SFC-LACI via RS232 requires, among other things, a risk assessment by the user, ambient conditions free of interference and reliability of data transmission e.g. via the control program of the higher-order control system.

- Note that control of the SFC-LACI via the RS232 does not comply with designated use.
- Use the connection only for parameterising, commissioning and diagnosis.

Caution
Errors in the parameterisation can cause injury to people and material damage if you enable the controller with ENABLE.

- Make sure that there is no active ENABLE signal when switching on the SFC-LACI on the controller interface.
- Parameterise the entire system completely before activating the controller with ENABLE or [HMI = on].

Caution
The SFC-LACI does not carry out any positioning tasks if it is not referenced. In the following cases, carry out a homing run to reference the SFC-LACI:

– **Every time** the logic voltage supply is connected (or after every failure).
– When the homing method is changed.
– When the axis zero point is modified.

Note
When setting ENABLE for the first time after switch-on (or when activating the device control on the control panel for the first time using [HMI:on]), the SFC-LACI carries out a commutation point search (the drive vibrates gently). If the drive is not freely movable and the commutation point search cannot be performed successfully, then an error is reported and the SFC-LACI will not carry out a homing run or any positioning tasks.

- Make sure that the drive can move freely when ENABLE is set.

Note
Damage to components

Movement to the mechanical end positions is not permitted during operation.

Note
Observe the instructions in the documentation for the drives and additional components used.

Password protection

The factory setting does not provide active protection by a password. All download and control functions can be blocked in order to prevent unauthorised or unintentional overwriting or modification of parameters in the device.

- Recommendation:
  Protect your settings against undesired modifications with a password:
  - FCT password protection (8 characters, see Help for SFC-LAC plug-in)
  - HMI password protection on the control panel of the SFC-LACI-...-H2-... (3 characters, see section 4.5)

Service and maintenance

The SFC-LACI-... motor controllers are maintenance-free. However, follow the maintenance instructions for the drive and the additional components.

Diagnostics and error display

Chapter 6

Contents

6.1 Diagnostics options

Overview organised according to the type of the diagnostic information:

Type of diagnostic information	Access via ...	see ...
General status display	LEDs on the SFC-LAC	Section 6.2
	FCT: virtual LEDs in the “Device status” window	Help for plug-in
	FHPP status bytes SCON and SPOS	Section 5.5.2
The current error message in plain text	SFC-LAC control panel (type ...-H2 only)	Section 6.3
	FCT: Text field in the “Device status” window	Help for plug-in
Diagnostic memory: the last 16 messages	FCT: in the “Diagnosis” window (with existing device connection)	Help for plug-in
	FPC: The second 8 bytes of the cyclic field bus communication can also transfer the contents of the diagnostic memory.	Sections B.2.1 and 6.4
Diagnosis via CANopen	Emergency messages Node guarding DS402 status word	Section 6.5
Parameterising	Control panel: in the [Diagnosis] menu	Section 4.3
	FCT	Help for plug-in

Tab. 6/1: Diagnostic information according to type

Overview organised according to the type of access to the diagnostic information:

Access	Brief description	Advantages/ features	Detailed description
LEDs	The LEDs indicate the readiness to operate, positioning status, errors and bus status.	Fast "on-the-spot" recognition of errors	Section 6.2
Control panel of an SFC-LACI-...-H2	On the LCD display: Messages, warnings and faults	Fast "on-the-spot" diagnosis	Section 6.3
	In the [Diagnostic] menu: Diagnostic data, operating mode, current position set, target and actual positions, speed as well as information on communication via the fieldbus	Detailed "on-the-spot" diagnosis	Section 4.3
Festo Configuration Tool	With active device connection: – Display of the current position set, target and actual positions as well as speed. – Display of the operating mode, special outputs and operating states as well as error messages of the SFC-LAC. – Display of the bus status – Display of the diagnostic memory	Detailed diagnosis during commissioning	Help for plug-in SFC-LAC
Fieldbus	– Emergency messages – Node guarding – FHPP status bytes SCON and SPOS – DS402 status word	Simple diagnosis via the fieldbus	Section 6.5
	– Extended access to diagnostic data, e.g. diagnostic memory (via FPC) – Scanning the device status and communication status via SDO	Detailed diagnosis via the fieldbus	Sections 6.4 and 6.6

Tab. 6/2: Diagnostic information as per access

6.2 LED status displays

Power supply

POWER	Status
green	Logic and load voltages applied.
flashing	Logic voltage is present. Load voltage is **not** present or missing hardware enable
off	There is no voltage.

Tab. 6/3: LED “Power”

Malfunction indicator

ERROR	Status
red	Error. The SFC-LACI is not ready for operation.
flashing	Warning. Check cause and rectify if necessary; see section 6.3.
off	No internal malfunction indicated

Tab. 6/4: LED “Error”

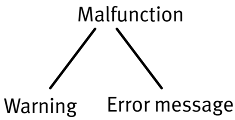
Bus status

I/F [1]		GREEN	Bus – operating status (status machine)
	ON OFF	ON	**“Operational”** – System in “operational” status
	ON OFF	FLASHES ONCE	**“Stopped”** – Master has sent Stop signal (transition status, system again in pre-operational status).
	ON OFF	FLASHES	**“Pre-operational”** – SFC-LACI not yet set by CAN master to “Operational mode” (but SDOs are available).
I/F [1]		**RED**	**Bus – connection**
	ON OFF	OFF	**Connection error-free**
	ON OFF	FLASHES ONCE	**“Warning Limit reached”** – Several communication errors have occurred or the SFC-LACI receives no reply (master switched off or cable break).
	ON OFF	FLASHES TWICE	**“Node guarding error”** – Node Guarding error occurred (only if activated). If occurring simultaneously, has priority over “Warning Limit reached”
	ON OFF	ON	**Bus parameter not parameterised, bus failed or external CAN supply missing** – e.g. at power-on, if not all bus parameters (node ID, DS402/FHPP, baud rate) are parameterised.

[1] Two-colour LED as per DS 303-3. If occurring simultaneously, the red LED has priority – no “mixed” display of red and green.

Tab. 6/5: “I/F” LED

6.3 Error messages



Malfunctions can have different levels of severity. A warning or a fault message is displayed depending on the level of severity.

Messages

Messages inform about operating states.

Message	Cause
Attention! Motor moves...	Message before the start of a positioning movement. After confirmation with the ‹ENTER› button the drive moves.
Please wait! Commut. Point evaluation is active	The commutation point is being sought. The drive vibrates for a few seconds.

Warnings

Warnings have no influence on the behaviour of the drive. The cause of the warning should be eliminated in order that it does not lead to a fault.

If a warning occurs, the fault LED will flash and the SCON.B2 WARN output will be set (FHPP status bits, see 5.5.2).

Warning	Cause	PNU 215	Fault no.*)
INDEX PULSE WARNING	During homing: The homing switch signal lies too close to the index pulse. In some cases this can mean that no reproducible reference position can be determined. • See section 6.7.	0x0001	84
WARNING MOTOR COLD	Temperature of the linear motor < -10 °C. Increase ambient temperature if necessary.	0x0002	108
WARNING MOTOR HOT	Temperature of the linear motor 70...75 °C, check for possible overloading of the drive; check the mechanical system, e.g. for sluggishness; reduce ambient temperature.	0x0004	109
WARNING SFC-LACI COLD	Temperature < -10	0x0008	74
WARNING SFC-LACI HOT	Temperature 80...85 °C	0x0010	75
STANDSTILL WARNING	The axis has moved outside the standstill tolerance window.	0x0020	36
ILLEGAL RECORD WARNING	Non-permitted record number.	0x0040	3

*) Fault number in the diagnostic memory, see section 6.4.

Error messages

The drive is stopped in the event of an error. The fault LED is illuminated, the output SCON.B3 FAULT is set.

1. Rectify the cause of the error.
2. Acknowledge the error message:
   - Using ‹Enter› on the control panel.
   - Using the "Acknowledge Error" button in the FCT.
   - via the field bus with a rising edge of the RESET signal CCON.B3 or with a falling edge of the ENABLE signal.

Caution
If the drive is not under position control after the removal of ENABLE, this may cause injury to people and material damage

- With vertical or sloping drive mountings, the moving mass might slide down; see section 1.1.3.

Errors	Possible cause and remedy	PNU	Fault no.*)
PLEASE ENFORCE HOMING RUN	When starting a positioning record. Possible causes: – Valid homing run has not yet been carried out. – The drive is no longer referenced (e.g. due to logic voltage failure or because the homing method or the axis zero point was changed). • Carry out a homing run.	PNU 205 0x0200	1
TARGET POSITION OUT OF LIMIT	The specified target position is outside the permitted positioning range. • Check software end positions, target position and reference (absolute or relative).	PNU 205 0x0800	2
INTERPOLATION CYCLE TIME	– For FHPP Continuous Mode: missing position specification, missing toggle bit. – With DS402 interpolated position mode: SYNC gap › 1.5 • interpolation time.	PNU **208** 0x0001	7
*) Fault number in the diagnostic memory, see section 6.4.			

Errors	**Possible cause and remedy**	**PNU**	**Fault no.*)**
LIMIT SWITCH ACTIVATED	A limit switch has been actuated. • Check the positioning dynamics (overswing?), e.g. using trace diagrams in the FCT. • Check switches and cables.	PNU **208** 0x004	8
BLOCK DURING JOG MODE	A fixed stop was reached in jog mode.	PNU **208** 0x008	9
POSITION ERROR	Drag error. Possible causes: – The drive is blocked. – Speed, acceleration, jerk or load is too great.	PNU 205 0x0400	31
HOMING ERROR	Error during homing Possible causes: – Homing interrupted – Reference switch defective • If necessary, check the function of the reference switch. • Repeat homing. • Contact Festo service.	PNU 205 0x0100	32
POSITION PLAUSIBILITY ERROR	Fault while searching for the commutation point. • Acknowledge the error. The search is restarted. – If several drives are fitted in a system that can vibrate: Carry out commutation point search **one after the other** (see PNU 1072 / 2051h).	PNU 205 0x4000	40

*) Fault number in the diagnostic memory, see section 6.4.

Errors	Possible cause and remedy	PNU	Fault no.*)
COMMUTATION POINT ERROR	Commutation point is invalid. Possible cause and remedy: – The drive is blocked: Ensure freedom of movement. – Excessive load: Reduce the load. – Controller parameter wrongly set: Determine the relevant controller parameter and set it to the correct value. To do this, you may have to perform a commutation point search without a load (remove the load, correctly set the tool mass and applied load), start the axis, connect the load (correctly set the tool mass and applied load), determine the new controller parameters (see FCT help on controller parameterisation), reparameterise the drive and then restart the commutation point search with new controller parameters. – The drive remains directly at a hard end stop. Vibration motion is therefore not possible in the direction of the end stop. The following conditions are necessary in order to find the commutation point: Cushion the end points / make them soft (e.g. rubber bumper). – The axis is not fastened stiffly enough: Stiffen the axis mounting. – The effective load is not fastened stiffly enough on the axis: Stiffen the load mass mounting. – Effective load can vibrate: Form stiffer load; modify intrinsic frequency of the load. – If several drives are fitted in a system that can vibrate: Carry out commutation point search **one after the other** (see PNU 1072 / 2051h). Contact the Festo service department if these measures do not produce the desired results.	PNU 205 0x8000	41
HARDWARE ERROR SFC-LACI	Device fault SFC-LACI, e.g. EEPROM defective • Contact Festo service.	PNU 205 0x0001	51
LOAD-POWER DOWN	Load voltage < 36 V or missing hardware enable – Voltage drops under load: Power supply too weak, cable too long, cable cross-section too small? – Hardware enable connection: see 3.2	PNU 205 0x0080	70

*) Fault number in the diagnostic memory, see section 6.4.

Errors	Possible cause and remedy	PNU	Fault no.*)
DIGITAL-POWER-DOWN	Logic voltage < 15 V – Voltage drops under load: Power supply too weak, cable too long, cable cross-section too small?	PNU 205 0x0040	71
OVERCURRENT POWER STAGE	Output stage current consumption too high, e.g. due to short circuit. • Contact Festo service.	PNU **208** 0x002	72
ERROR SFC-LACI HOT	Temperature > 85 °C • Remain within all limit values and check the mechanical system, e.g. for sluggishness. • Reduce the ambient temperature. • Improve the heat dissipation.	PNU 205 0x0020	73
ELGO SENSOR / COMMUNICATION ERROR	Position sensor faulty • Contact Festo service.	PNU 205 0x0004	82
CAN COMMUNICATION ERROR	CAN communication fault • Contact Festo service.	PNU 205 0x0002	83
i^2t-ERROR	Current monitoring i^2t Possible cause: The drive is blocked, load/dynamics too high. • Check the drive mechanics. • Reduce load/dynamic response; increase the pause times.	PNU 205 0x1000	100
ERROR MOTOR HOT	Temperature of the linear motor > 75 °C • Remain within all limit values and check the mechanical system, e.g. for sluggishness. • Reduce the ambient temperature. • Improve the heat dissipation.	PNU 205 0x0010	101
MOTOR STOP ERROR	The positioning procedure is discontinued on the control panel with EMERG.STOP (‹Menu› key). • Acknowledge the error.	PNU 205 0x2000	106
HARDWARE ERROR DRIVE	Wire break on temperature sensor • Contact Festo service.	PNU 205 0x0008	107

*) Fault number in the diagnostic memory, see section 6.4.

Errors	**Possible cause and remedy**	**PNU**	**Fault no.*)**
CANbus Init No parameter	Configuration of at least one bus parameter missing	PNU 207 0x0001	121
CAN_BUS_OFF	The CAN controller has detected a switched-off bus.	PNU 207 0x0010	122
RX_QUEUE_OVER-RUN	More CAN telegrams received than could be proces-sed (stack fault).	PNU 207 0x0004	123
TX_QUEUE_OVER-RUN	Not all the CAN telegrams to be sent could be sent: Bus load too high? (stack fault)	PNU 207 0x0008	
CAN_CONTROL-LER_ QUEUE_OVERRUN	CAN controller fault	PNU 207 0x0020	
ERROR_ NODE_GUARDING	No node guarding signal came from the higher-order controller.	PNU 207 0x0002	124
*) Fault number in the diagnostic memory, see section 6.4.			

Tab. 6/6: Error messages

6.4 Diagnostic memory

The diagnostic memory contains the last 16 diagnostic messages. It is backed up if possible in the event of power failure. If the memory is full, the oldest element will be overwritten (ring buffer).

Structure of the diagnostic memory				
Parameters [1]	PNU 200 ($20C8_h$)	PNU 201 ($20C9_h$)	PNU 202 ($20CA_h$)	PNU 203 ($20CB_h$)
Format	uint8	uint16	uint32	uint32
Meaning	Diagnostic event	Fault number	Time stamp	Cycle number
Subindex 1	Current diagnostic message			
Subindex 2	Previous diagnostic message			
...	...			
Subindex 16	Oldest diagnostic message			
[1] See section B.3.5.				

Tab. 6/7: Diagnostic memory: structure

Configuration of the diagnostic memory with parameter CO /CI 20CCh (PNU 204)

SI	Description	Specification	Min	Max
1	= 1: Record incoming and outgoing*) faults = 2: Record only incoming faults *) Outgoing fault = Acknowledge the fault	1	1	2
2	= 1: Resolution time stamp 10 ms = 2: Resolution time stamp 1 ms	1	1	2
3	Deleting the diagnostic memory – Writing with value = 1 deletes the diagnostic memory. – Read will always reply with value = 1.	0	0	1
4	Read the number of entries in the diagnostic memory	0	0	16

Tab. 6/8: Diagnostic memory: configuration

The faults are divided into logical groups according to the fault numbers.

Group	Name	Comment
0	–	No fault active
1 ... 19	Processing error	Examples: No homing run, nominal position outside software end positions, nominal value calculation not possible. Although the system is OK, a user command cannot be processed. In most cases there is a fault in operation. Source: sequence control, controller
20..29	Parameter fault	Example: Software end positions outside the working stroke. A parameter lies within the limit values so that it can be written by the user. During the new calculation of the controller, it was ascertained that it is not permitted in the context of the other parameters. Note: non-permitted parameters are rejected by the parameter protocol and do not generate a fault in the controller
30..49	Controller	Examples: Positioning timeout, homing not successful, drag error too large, ... The task could not be processed correctly. No hardware fault is recognised here. Source: controller
50..69	Initialisation	Fault in initialising the controller
70..79	Run time of controller	Fault in controller run time: undervoltage, checksum
80 ... 89	–	Reserved
90 ... 99	–	Reserved
100 ... 109	Run time of motor	Run time of motor: undervoltage, overtemperature, etc.
110 ... 119	–	Reserved
120 ... 139	Fieldbus fault	e.g. NodeGuardingError with CAN, baud rate fault, ...

Tab. 6/9: Overview of fault numbers

A detailed description of the faults is provided in section 6.3.

6.5 Diagnosis via CANopen

The SFC-LACI supports the following diagnostic possibilities via CANopen:

– FHPP status bytes (see section 5.5.2):
  – SCON.B2: WARN – Warning
  – SCON.B3: FAULT – Fault
  – SPOS.B5: DEV – Drag error
  – SPOS.B6: STILL – Standstill monitoring

– Node guarding, if activated (see section 6.5.1).

– Emergency messages (see section 6.5.2).

6.5.1 Node guarding (reaction to bus failure)

In order that a CAN bus failure can be detected, node guarding must be activated (default: switched off).

In the case of actuators it is advisable to monitor the master for failure in order to provide an appropriate emergency shutdown strategy.

Then the CANBUS master is monitored based on monitoring of activation with the configured monitoring time (see DS 301). When monitoring is activated, the configured emergency stop response (Fault reaction option code object 605Eh, PNU 1021) is executed and the drive is stopped.

Select the “Guard time” with reference to the dynamics of the system.

Refer to your master documentation for details on how to activate node guarding.

6.5.2 Emergency messages

Faults, but not warnings, are signalled by emergency messages as per DS 301 and DS 402, regardless of the configured device profile.

Fault code	Type of fault	Fault register
2310	I^2t-fault	Bit 1
4200	Monitoring the motor temperature	Bit 3
4300	Temperature monitoring LAC	Bit 3
5000	Hardware fault SFC-LACI (e.g. EEPROM defective)	Bit 5
5112	Load voltage monitoring	Bit 2
5113	Logic voltage < 15 V	Bit 2
5300	Hardware error drive	Bit 5
5441	Homing error	Bit 5
6310	No homing performed prior to positioning task	Bit 5
6320	Target position too large/small	Bit 5
7122	Motor emergency stop – or – commutation point is invalid	Bit 5
7300	ELGO sensor error	Bit 5
7500	Motor fault	Bit 5
8600	Error searching for the commutation point	Bit 5
8611	Drag error	Bit 5
Communication emergency messages as per DS 301 may also be signalled.		

Tab. 6/10: Emergency messages

6.6 Diagnosis via parameter channel (FPC)

The Festo parameter channel offers the following possibilities of access to diagnostic information:

Diagnosis	PNU	Section
Diagnostic memory	– PNU 200 ... 204	See sections B.3.5 and 6.4
Errors	– PNU 205 – PNU 207 – PNU 208	See sections B.3.5 and 6.3
Warnings	– PNU 215	See sections B.3.5 and 6.3
CANopen diagnosis	– PNU 206	See section B.3.5

6.7 Warning "Index pulse warning"

In the homing run to the proximity sensor, the drive initially moves into the switching range of the sensor and then reverses. After the switching range is exited, the SFC-LACI searches for the nearest index pulse. This applies as the homing point.

Note
Material damage due to moved measuring reference system

The following situation arises if the switching point of the proximity sensor and the index pulse lie very close to one another: Should the switching point move (e.g. due to temperature influence) such that it then lies behind the index pulse, then the SFC-LACI will use the index pulse after that as a reference point. The entire measuring reference system would then be offset by 2 mm in DFME-...-LAS, in DNCE-...-LAS: by 5 mm.

Remedy:

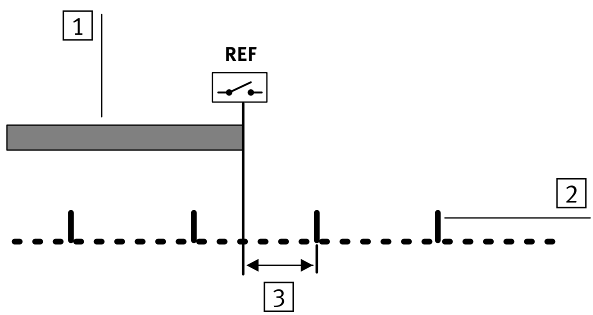
1. Check the distance of the switching point to the index pulse: see FCT, "Homing" page, "Homing" register (or CI 2FFE/0Dh, see Appendix B).

2. Then move the proximity sensor a few tenths of a mm.

1 Switching range of the proximity sensor

2 Index pulses (every 2 or 5 mm)

3 Recommended position: in the centre between two index pulses



Technical appendix

Appendix A

Contents

A.1 Technical data

General	
Protection class of the entire system according to EN 60529	IP54 (plug connector inserted or fitted with protective cap)
Relative air humidity (at 25 °C)	0 ... 95%, non-condensing
Temperature range	Operation: 0 ... +40 °C Storage / Transport -20 ... +60 °C
SFC-LACI temperature monitoring	Warning message at temperature › 80 °C Shutdown at temperature › 85 °C (restart only when temperature falls below 80 °C)
Electromagnetic compatibility (EMC) [1)] (interference immunity and interference emission)	See declaration of conformity (www.festo.com)
Vibration	As per DIN EN 60068, part 2-6: 0.15 mm travel at 10 ... 58 Hz 2 g acceleration at 60 ... 150 Hz
Shock	As per DIN EN 60068, part 2-27: ±15 g at 11 ms duration 5 shocks per direction
Assembly	Wall or H-rail mounting
Dimensions	Approx. 247 x 120 x 66 mm (without plug)
Weight	Approx. 1500 g

[1)] The component is solely intended for use in industrial environments.

Electrical data	
Load voltage supply – Nominal voltage – Nominal current (max. continuous motor current) – Peak current	Power connection, pins A1, A2 48 VDC (+5/-10%) (Load power down: ≤ 36 V) 10 A 20 A
Logic voltage supply – Nominal voltage – Peak current	Power connection, pins 1, 2 24 VDC ± 10% 3.8 A (when using the local digital outputs, see section 3.2).

Electrical data	
Protection against electric shock (protection against direct and indirect contact as per IEC/DIN EN 60204-1)	By means of PELV power circuit (Protected Extra-Low Voltage)
Parameterising interface specification	RS232, 38400 Baud, see chapter 3.5.

CANopen data	
Version – Physical layer – Data link layer	 As per ISO 11898 (corresponding to DS 102) as per CAN specification 2.0
CAN protocol	As per DS 301 and DS 402
Manufacturer ID	29 (0x1D)
Profile ID (device type)	Depending on data profile: – DS 402: 131474 (0x00420192) – FHPP: 301 (0x0000012d)
Address range (node ID).	1 ... 127
Baud rate	10, 20, 50, 100, 125, 250, 500, 800 and 1000 kBaud
Interface – Plug connector – Electrical isolation (see sections 3.6, 4.5.6 and 5.2.1) – Integrated bus termination	 Sub-D, 9 pole, plug connector Parameter “CAN Voltage Supply”: – Internal: no electrical isolation (default) – External: electrical isolation No
Cable type	Depends on length of cable and fieldbus baud rate, see controller manual or DS 102.

A.2 Accessories

Connection	Cable/Plugs	Type	Length [m]
Controller interface	Fieldbus plug	FBS-SUB-9-BU-2x5POL-B (IP54) FBS-SUB-9-WS-CO-K (IP20)	–
	Fieldbus adapter	FBA-2-M12-5POL (IP54) FBA-1-SL-5POL (IP20)	–
Power supply	Power supply cable	KPWR-MC-1-SUB-15HC-...	2.5 / 5 / 10
Motor	Motor cable	NEBM-T1G6-T1G6-...	2.5 / 5 / 10
	Encoder cable	NEBM-T1G12-T1G12-...	2.5 / 5 / 10
Parameterising interface	Programming cable	KDI-MC-M8-SUB-9-2,5	fix 2.5

Protective caps	Type	Comment
Protective caps for the parameterising interface and the local digital inputs and outputs	ISK-M8	10 items per bag

Wall mounting	Type	Comment
2 sets of central supports (4 brackets)	MUP-8/12	2 items per bag
Wall mounting requires 4 additional M3 screws with cylindrical head.		

H-rail mounting
Recommended: On a DIN mounting rail in accordance with EN 50022: width 35 mm, height 15 mm.

User’s manual	
German	GDCP-SFC-LACI-CO-DE
English	GDCP-SFC-LACI-CO-EN
French	GDCP-SFC-LACI-CO-FR
Italian	GDCP-SFC-LACI-CO-IT
Spanish	GDCP-SFC-LACI-CO-ES
Swedish	GDCP-SFC-LACI-CO-SV

A.3 Converting the units of measurement

The CI interface works with increments [Inc, Inc/s, Inc/s^2, Inc/s^3].

DNCE-...-LAS

The distance between two index lines (= north or south pole of the magnetic displacement encoder) is **5 mm**. The resolution of the measurement system is 11 bits, which is the same as 2048_d (800_h) increments. The increments are calculated by means of interpolation. This results in the following conversions (all figures are decimal):

[inc] ⇢ [mm]

$$\text{mm} = \frac{\text{x Inc}}{\text{2048 Inc}} \times 5 \text{ mm}$$

[mm] ⇢ [inc]

$$\text{Inc} = \frac{\text{x mm}}{\text{5 mm}} \times 2048 \text{ Inc}$$

DFME-...-LAS

The distance between two index lines (= north or south pole of the magnetic displacement encoder) is **2 mm**. The resolution of the measurement system is 11 bits, which is the same as 2048_d (800_h) increments. The increments are calculated by means of interpolation. This results in the following conversions (all figures are decimal):

[inc] ⇢ [mm]

$$\text{mm} = \frac{\text{x Inc}}{\text{2048 Inc}} \times 2 \text{ mm}$$

[mm] ⇢ [inc]

$$\text{Inc} = \frac{\text{x mm}}{\text{2 mm}} \times 2048 \text{ Inc}$$

Parametrising as per FHPP-FPC

Appendix B

Contents

B.1 Finite state machine FHPP

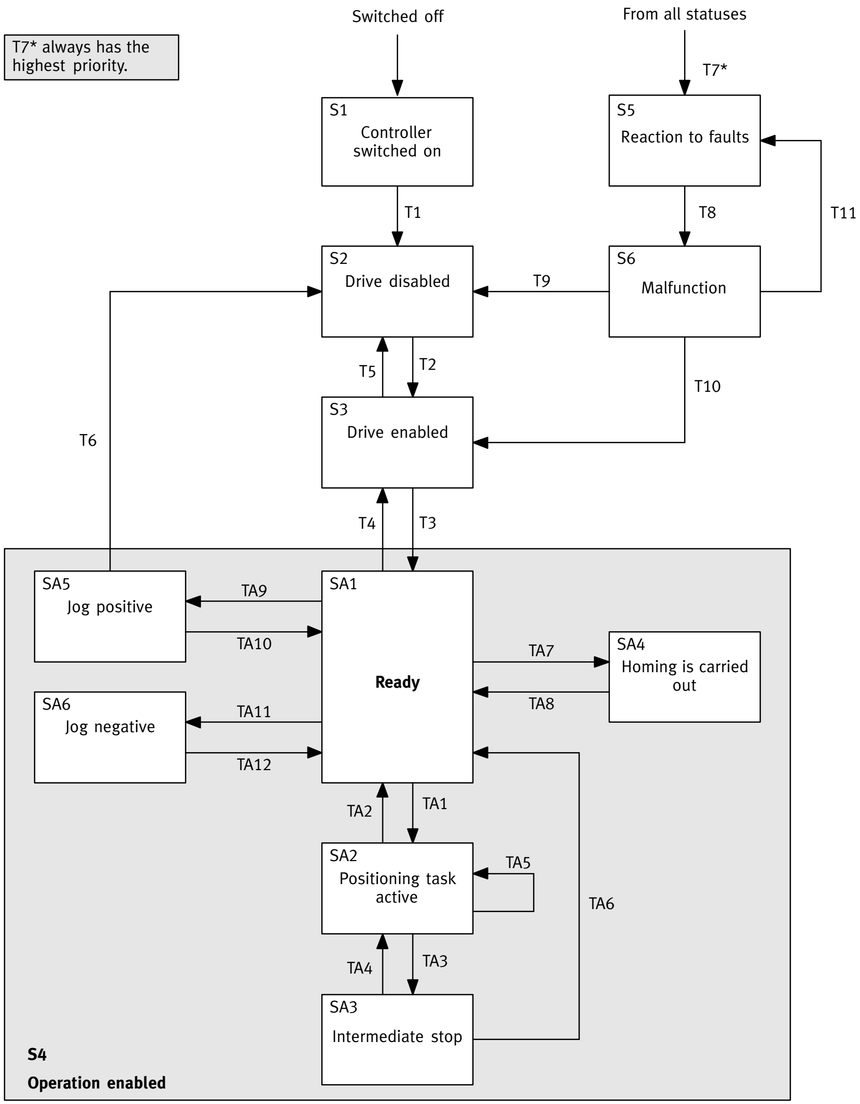


Fig. B/1: Finite state machine

Notes on representing the finite state machine:

The transition T3 changes to state S4, which itself contains its own sub-state machine, the states of which are marked with “SAx” and the transitions of that are marked with “TAx”. This enables an equivalent circuit diagram to be used, in which the internal states SAx are omitted:

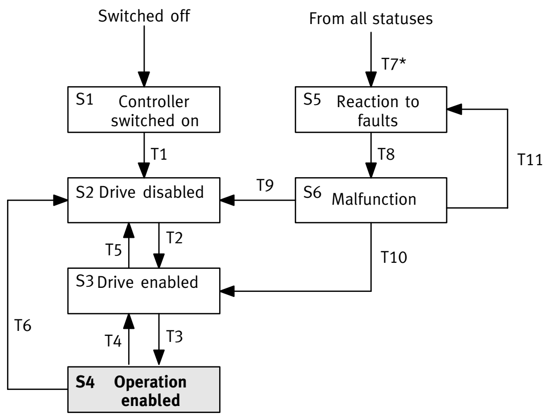


Fig. B/2: Finite state machine equivalent circuit diagram

Transitions T4, T6 and T7* are executed from every sub-state SAx and automatically have a higher priority than any transition TAx. Such a structure is a simplification. It is not therefore necessary to define out of each SAx state a separate transition as per S3 for the reaction to STOP (S3: Drive is controlled).

Reaction to faults

T7 (“Fault recognised”) has the highest priority and receives the asterisk “*”.

T7 is then derived from S5 and S6 when an error of higher priority occurs. As a result, a serious error can displace a slight error.

B.1.1 Create readiness to operate

With the transitions only those internal conditions are named which are new. There must therefore not be any faults for T2.

T	Internal conditions	Actions of the user
T1	SFC-LACI was switched on. An error cannot be ascertained.	
T2	Load voltage applied. Fieldbus master must be higher-order controller.	ENABLE = 1 (drive enabled) CCON = xxx0.xxx**1**
T3		STOP = 1 CCON = xxx0.xx**1**1
T4		STOP = 0 CCON = xxx0.xx**0**1
T5		ENABLE = 0 CCON = xxx0.xxx**0**
T6		ENABLE = 0 CCON = xxx0.xxx**0**
T7*	Fault recognised.	
T8	Reaction to fault completed, drive stopped.	
T9	There is no longer a fault. It was a serious error.	RESET = 0 → 1 (acknowledge fault) CCON = xxx0.**P**xxx
T10	There is no longer a fault. It was a simple error.	RESET = 0 → 1 (acknowledge fault) CCON = xxx0.**P**xx1
T11	Fault still exists.	RESET = 0 → 1 (acknowledge fault) CCON = xxx0.**P**xx1
Key: P = positive edge, N = negative edge, x = any		

B.1.2 Positioning

Fundamentally, the following applies:
Transitions T4, T6 and T7* always have priority.

TA	Internal conditions	Actions of the user
TA1	Referencing is running.	START = 0→1 (Start positioning) HALT = 1 CCON = xxx0.xx11 CPOS = 0xx0.00P1
TA2	Motion Complete = 1 The current record is completed. The next record is not to be carried out automatically	“HALT” status is any CCON = xxx0.xx11 CPOS = 0xxx.xxxx
TA3	Motion Complete = 0	HALT = 1→0 CCON = xxx0.xx11 CPOS = 0xxx.xxxN
TA4		START = 0→1 (Start positioning) HALT = 1 CCON = xxx0.xx11 CPOS = 00xx.xxP1
TA5	Record selection: – A single record is finished. – The next record is processed automatically.	CCON = xxx0.xx11 CPOS = 0xxx.xxx1
	Direct mode: – A new positioning task has arrived.	CCON = xxx0.xx11 CPOS = 0xxx.xx**1**1
TA6		CLEAR = 0→1 (Clear remaining path) CCON = xxx0.xx11 CPOS = 0Pxx.xxxx
TA7		HOM = 0→1 (Start homing) HALT = 1 CCON = xxx0.xx11 CPOS = 0xx0.0Px1
TA8	Homing concluded or HALT.	Only for HALT: HALT = 1→0 CCON = xxx0.xx11 CPOS = 0xxx.xxxN
Key: P = positive edge, N = negative edge, x = any		

TA	Internal conditions	Actions of the user
TA9		Jog positive = 0→1 HALT = 1 CCON = xxx0.xx11 CPOS = 0xx0.Pxx1
TA10		Either – Jog positive = 1→0 – CCON = xxx0.xx11 – CPOS = 0xx0.Nxx1 or – HALT = 1→0 – CCON = xxx0.xx11 – CPOS = 0xxx.xxxN
TA11		Jog negative = 0→1 HALT = 1 CCON = xxx0.xx11 CPOS = 0xxP.0xx1
TA12		Either – Jog negative = 1→0 – CCON = xxx0.xx11 – CPOS = 0xxN.xxx1 or – HALT = 1→0 – CCON = xxx0.xx11 – CPOS = 0xxx.xxxN
Key: P = positive edge, N = negative edge, x = any		

Special features dependent on operating mode:

Record selection

– No restrictions.

Direct mode

– TA2: The condition that no new record may be processed no longer applies.

– TA5: A new record can be started at any time.

B.2 Parameterisation via FPC

The “Festo Parameter Channel” is used for transferring parameters in the PDO2 with the data profile FHPP (see section 5.4.5).

Alternatively, the parameterisation can take place via SDOs (for converting the parameter numbers, see section 5.4.4).

B.2.1 Structure of the Festo Parameter Channel (FPC)

The “Festo Parameter Channel” is used for transmitting parameters. It consists of 8 octets:

FPC (PDO2)	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	0	IND	PKE (ParID)		PWE (ParVal)			
Input data	0	IND	PKE (ParID)		PWE (ParVal)			
IND PKE PWE	Subindex Parameter identifier: PNU and AK Parameter value: – with double word: bytes 5...8 – with word: bytes 7, 8 – with byte: byte 8							

Tab. B/11: Structure of the Festo parameter channel (FPC)

Element	**Description**
Parameter identifier PKE (Parameter identifier ParID)	Contains: – Parameter number PNU: Identifies a parameter. – Task or response identifier (AK): describes the type of task / reply.
Subindex (IND)	Addresses an element of an array parameter.
Parameter value PWE (Parameter value ParVal)	Value of the parameter. If a task cannot be carried out, an error number will be transmitted in the reply (see B.2.2).

Tab. B/1: Parameter channel elements

Parameter identifier (PKE)

The parameter identifier contains the Task or Response identifier (AK) and the parameter number (PNU).

PKE (ParID)																
	Byte 3								**Byte 4**							
Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Job	ReqID (AK)				res.	PNU (parameter number)										
Reply	ResID (AK)				res.	PNU (parameter number)										

ReqID (AK) Request Identifier – job identifier (read, write, ...)
ResID (AK) Response Identifier (transferred value, error, ...)
The Task or Response identifier indicates the type of task or reply (see section B.2.2).
PNU Parameter number – serves for identifying or addressing the relevant parameters.

Tab. B/2: Structure of parameter identifier (PKE)

B.2.2 Task identifiers, response identifiers and error numbers

Task identifiers:

ReqID	**Description**	**Response identifier**	
		Positive	**Negative**
0	No job	0	–
1	Request parameter [1)]	1, 2	7
2	Modify parameter value (word) [1)]	1	7
3	Modify parameter value (double word) [1)]	2	7
6	Request parameter (array)	4, 5	7
7	Modify parameter value (array, word)	4	7
8	Modify parameter value (array, double word)	5	7
11	Modify parameter value (byte) [1)]	11	7
12	Modify parameter value (array, byte)	12	7

1) When using task numbers for simple variables to access parameters implemented as an array, the subindex is ignored or set to 0. This means that the first element of an array is always addressed.
2) Jobs with non-supported job numbers (ReqID) will be answered with Response identifier 7 and error number 22.

Tab. B/3: Task identifiers

If the task cannot be carried out, response identifier 7 as well as the appropriate error number will be transmitted.

Response identifiers:

ResID	Description
0	No reply
1	Parameter transferred (word)
2	Parameter transferred (double word)
4	Parameter value transferred (array, word)
5	Parameter value transferred (array, double word)
6	Number of array elements transferred
7	Task cannot be carried out (with error number, see following table)
11	Parameter value transferred (byte)
12	Parameter value transferred (array, byte)

Tab. B/4: Response identifiers

If the task cannot be carried out, an error number will be transmitted in the reply telegram (octets 7 and 8 of the FPC range).

Error number		Description
0	0x00	Non-permitted PNU The parameter does not exist.
1	0x01	Parameter value cannot be modified (read only)
3	0x03	Faulty subindex
4	0x04	No array
5	0x05	Incorrect data type
9	0x09	Description data do not exist
11	0x0A	No control sovereignty
13	0x0C	Text not legible in cyclic exchange
22	0x16	Impermissible: attributes, number of elements, PNU or IND
24	0x18	Write request: number of values not permitted

Tab. B/5: Error numbers

B.2.3 Rules for job reply processing

Rules	Description
1	If the master sends the identifier for “No task”, the SFC-LACI replies with the response identifier for “No reply”.
2	A job or reply telegram always refers to a single parameter.
3	The master must continue to send a task until it receives the appropriate reply from the SFC-LACI.
4	The master recognises the reply to the job placed: – by evaluating the Response identifier, – by evaluating the parameter number (PNU), – if applicable, by evaluating the subindex (IND), – If applicable, by evaluating the parameter value.
5	The SFC-LACI provides the reply until the master sends a new task.
6	a) A write task, even with cyclic repetition of the same task, will only be carried out once by the SFC-LACI. b) Between two consecutive jobs with the same Job identifier (AK), parameter number (PNU) and subindex (IND), the Job identifier 0 (no job) must be sent and the Response identifier 0 (no reply) must be awaited. This ensures that an “old” reply is not interpreted as a “new” reply.

Tab. B/6: Rules for job reply processing

Sequence of parameter processing

Caution
Observe the following when modifying parameters:
An FHPP write signal referring to a modified parameter may only occur when the Response identifier "Parameter value transferred" is received for the relevant parameter and if applicable for the index.

If, for example, a position value in a position set table is to be modified and if movement is then to be made to this position, the positioning command must not be given until the SFC-LACI has completed the modification of the position register and confirmed this.

Caution
In order to be sure that an "old" reply cannot be interpreted as a "new" reply, the Job identifier 0 (no job) must be sent and the Response identifier 0 (no reply) must be awaited between two consecutive jobs with the same Job identifier (AK), parameter number (PNU) and subindex (IND).

Evaluating errors

In the case of jobs which cannot be carried out, the slave replies as follows:

– Output of response identifier = 7

– Output an error number in bytes 7 and 8 of the parameter channel (FPC).

B.2.4 Example of parameterising via FPC (PDO2)

A record in the position set table can be parameterised via FPC in the following manner:

Step 1

Output status of the 8 bytes of FPC data:

	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x00	0x**0**0	0x00	0x00	0x00	0x00	0x00
Input data	0x00	0x00	0x**0**0	0x00	0x00	0x00	0x00	0x00

Step 2

Write record number 1 with absolute positioning:
PNU 401, subindex 2 – Modify parameter value, array, byte:
ReqID 12 (0xC) with value 0x00.

	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x**02**	0x**C1**	0x**91**	Unused	Unused	Unused	0x**00**
Input data	0x00	0x**02**	0x**C1**	0x**91**	0x00	0x00	0x00	0x**00**

Step 3

After receiving the input data with ResID 0xC send output data with ReqID = 0x0 and wait for input data with ResID = 0x0:

	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x02	0x**0**1	0x91	Unused	Unused	Unused	0x00
Input data	0x00	0x02	0x**0**1	0x91	0x00	0x00	0x00	0x00

Step 4

Write record number 1 with target position 0x1234 (decimal 4660 increments):
PNU 404, subindex 2 – Modify parameter value, array, double word: ReqID 8 (0x8) with value 0x00001234.

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x02	0x**81**	0x**94**	0x**00**	0x**00**	0x**12**	0x**34**
Input data	0x00	0x02	0x**81**	0x**94**	0x**00**	0x**00**	0x**12**	0x**34**

Step 5

After receiving the input data with ResID 0x8 send output data with ReqID = 0x0 and wait for input data with ResID = 0x0:

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x02	0x**0**1	0x94	0x00	0x00	0x12	0x34
Input data	0x00	0x02	0x**0**1	0x94	0x00	0x00	0x12	0x34

Step 6

Write record number 1 with speed 0x7743 (decimal 30531 increments/s):
PNU 406, subindex 2 – Modify parameter value, array, double word: ReqID 8 (0x8) with value 0x00007743.

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x02	0x**81**	0x**96**	0x**00**	0x**00**	0x**77**	0x**43**
Input data	0x00	0x02	0x**81**	0x**96**	0x**00**	0x**00**	0x**77**	0x**43**

Step 7

After receiving the input data with ResID 0x8 send output data with ReqID = 0x0 and wait for input data with ResID = 0x0:

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
	Reserved	Sub-index	ReqID/ResID + PNU		Parameter value			
Output data	0x00	0x02	0x**0**1	0x94	0x00	0x00	0x77	0x43
Input data	0x00	0x02	0x**0**1	0x94	0x00	0x00	0x77	0x43

B.3 Reference FHPP parameters (PNU)

B.3.1 Parameter groups

Group	PNU	Description
Device data	100..199	Device identification and device-specific settings, version numbers, identifier words, etc.
Diagnostic memory	200...299	Memory for diagnostic events: fault numbers, fault time, incoming/outgoing event
Process data	300...399	Current nominal and actual values, local I/Os, status data etc.
Position set table (= Record list)	400...499	A record contains all the setpoint value parameters required for a positioning procedure.
Project data	500...599	Basic project settings. Maximum speed and acceleration, project zero point offset, etc. → These parameters form the basis of the position set table.
Factor group	600...699	(reserved)
Axis data Electric drives 1	1000...1099	All axis-specific parameters for electric drives. Gear factor, feed constant, reference parameter, etc.
Axis data Electric drives 2	1200...	Enhancements

B.3.2 Overview of parameter numbers (PNU)

Available FHPP parameters with

- parameter number (PNU) for parameterising as per FPC (PDO 2),
- parameter number (SDO) for parameterising via SDO (conversion: see 5.4.4)
- and the relevant CI objects.

Name	FHPP		CI
	PNU (SDO)	**SI**	
Device data (→ B.3.4)			
Manufacturer hardware version BCD	**100** (2064h)	–	2069h
Manufacturer firmware version BCD	**101** (2065h)	–	206Ah
FHPP version	**102** (2066h)	–	2066h
Version FCT plug-in BCD	**104** (2068h)	1...2	206Bh
Version axis interface	**106** (206Ah)	–	2FFDh
Supported drive modes	**112** (2070h)	–	6502h
Controller serial number	**114** (2072h)	1...12_d	2072h
Controller type	**115** (2073h)	–	20E3h
Manufacturer device name	**120** (2078h)	1...30_d	1008h
User device name	**121** (2079h)	1...25_d	20FDh
Drive manufacturer	**122** (207Ah)	1...30_d	6504h
HTTP drive catalogue address	**123** (207Bh)	1...30_d	6505h
Festo order number	**124** (207Ch)	1...30_d	6503h
Device control	**125** (207Dh)	–	207Dh
HMI parameter	**126** (207Eh)	1...4	20FFh
Data memory control	**127** (207Fh)	1...3	20F1h

Name	FHPP		CI
	PNU (SDO)	**SI**	
CMXR: Interoperability	**150** (2096h)	–	2FF8h
CXMR: Configuration control word	**151** (2097h)	–	6510/F0h
Diagnostic memory (→ B.3.5)			
Diagnostic event	**200** (20C8h)	1...16_d	20C8h
Error number	**201** (20C9h)	1...16_d	20C9h
Time stamp	**202** (20CAh)	1...16_d	20CAh
Additional information	**203** (20CBh)	1...16_d	20CBh
Diagnostic memory parameter	**204** (20CCh)	1...4	20CCh
Device errors	**205** (20CDh)	–	2FF1h
CANopen diagnosis	**206** (20CEh)	1...6	2FF4h
Extended device errors A	**207** (20CFh)	–	2FFAh
Extended device errors B	**208** (20D0h)	–	2FFBh
Extended device errors C	**209** (20D1h)	–	2FFCh
Device warnings	**215** (20D7h)	–	2FF2h
Processing data (→ B.3.6)			
Position monitoring	**300** (212Ch)	1...2	2800h
Torque monitoring	**301** (212Dh)	1...2	2801h
Digital inputs	**303** (212Fh)	–	60FDh
Digital outputs	**304** (2130h)	1...2	60FEh
Cycle number	**305** (2131h)	–	2FFFh
Velocity monitoring	**310** (2136h)	1...2	2802h
FHPP status data	**320** (2140h)	1...2	20A0h
FHPP control data	**321** (2141h)	1...2	20A1h
Control word (see appendix C.3.3)	**330** (214Ah)	–	6040h

Name	FHPP		CI
	PNU (SDO)	SI	
Status word (see appendix C.3.3)	**331** (214Bh)	–	6041h
Operation mode (see appendix C.3.3)	**332** (214Ch)	–	6060h
Operation mode display (see appendix C.3.3)	**333** (214Dh)	–	6061h
Position sampling – position rising edge	**350** (215Eh)	–	204A/05h
Position sampling – position falling edge	**351** (215Fh)	–	204A/06h
Position sampling – trigger mode	**352** (2160h)	–	204A/01h
Position sampling – status	**353** (2161h)	–	204A/02h
Position sampling – status mask	**354** (2162h)	–	204A/03h
Position sampling – control byte	**355** (2163h)	–	204A/04h
Position set table (record list → B.3.7)			
Record number FHPP	**400** (2190h)	1...3	2033h
Record control byte 1	**401** (2191h)	$1...34_d$	20EAh
Record control byte 2	**402** (2192h)	$1...32_d$	20EBh
Record target position	**404** (2194h)	$1...34_d$	20ECh
Record delay	**405** (2195h)	$1...32_d$	20E4h
Record velocity	**406** (2196h)	$1...32_d$	20EDh
Record acceleration	**407** (2197h)	$1...32_d$	20EEh
Record deceleration	**408** (2198h)	$1...33_d$	20EFh
Record jerk acceleration	**409** (2199h)	$1...33_d$	20E7h
Record work load	**410** (219Ah)	$1...33_d$	20E8h
Record position window time	**415** (219Fh)	$1...33_d$	20E6h
Record following record	**416** (21A0h)	$1...32_d$	20E5h
Record jerk deceleration	**417** (21A1h)	$1...33_d$	21E1h

Name	FHPP		CI
	PNU (SDO)	**SI**	
Project data (→ B.3.8)			
Project data – general project data			
Project zero point	**500** (21F4h)	–	21F4h
Software end positions	**501** (21F5h)	1...2	607Bh
Max. velocity	**502** (21F6h)	–	607Fh
Max. acceleration	**503** (21F7h)	–	60C5h
Motion profile type	**506** (21FAh)	–	6086h
Project data – force control			
Stroke limit	**510** (21FEh)	–	60F6/01h
Min. torque/force	**511** (21FFh)	–	60F6/05h
Max. torque/force	**512** (2200h)	–	6072h
Torque profile type	**513** (2201h)	–	6088h
Project data – teach-in			
Teach target	**520** (2208h)	–	21FCh
Project data – jog mode			
Jog mode velocity phase 2	**531** (2213h)	–	20ED/21h
Jog mode acceleration/deceleration	**532** (2214h)	–	20EE/21h
Jog mode time phase 1	**534** (2216h)	–	20E9/21h
Project data – direct mode positioning mode			
Direct mode base velocity	**540** (221Ch)	–	21F8h
Direct mode acceleration	**541** (221Dh)	–	20EE/22h
Direct mode deceleration	**542** (221Eh)	–	20EF/22h
Direct mode jerk acceleration	**543** (221Fh)	–	20E7/22h
Direct mode work load	**544** (2220h)	–	20E8/22h

Name	FHPP		CI
	PNU (SDO)	**SI**	
Direct mode jerk deceleration	**547** (2223h)	–	21E1/22h
Project data – direct mode force mode			
Torque slope	**550** (2226h)	–	6087h
Force target window	**552** (2228h)	–	60F6/03h
Force damping time	**553** (2229h)	–	60F6/04h
Force mode speed limit	**554** (222Ah)	–	60F6/02h
Project data – direct mode FHPP continuous mode			
Interpolation time	**570** (223Ah)	–	20B6h
Axis data electric drives 1 (→ B.3.9 ff.)			
Axis data electric drives 1 – mechanical			
Polarity	**1000** (23E8h)	–	607Eh
Encoder resolution	**1001** (23E9h)	1...2	608Fh
Gear ratio	**1002** (23EAh)	1...2	6091h
Feed constant linear axis	**1003** (23EBh)	1...2	6092h
Position factor	**1004** (23ECh)	1...2	6093h
Axis parameter	**1005** (23EDh)	1...6	20E2h
Axis data electric drives 1 – homing			
Offset axis zero point	**1010** (23F2h)	–	607Ch
Homing method	**1011** (23F3h)	–	6098h
Homing velocities	**1012** (23F4h)	1...2	6099h
CMXR: Homing acceleration	**1013** (609Ah)	–	609Ah
Homing required	**1014** (23F6h)	–	23F6h
Homing max. torque/force	**1015** (23F7h)	–	23F7h

Name	FHPP		CI
	PNU (SDO)	**SI**	
Axis data electric drives 1 – control parameters			
Quick stop option code	**1019** (23FBh)	–	605Ah
HALT option code	**1020** (23FCh)	–	605Dh
Fault reaction / STOP option code	**1021** (23FDh)	–	605Eh
Target position window	**1022** (23FEh)	–	6067h
Position window time direct	**1023** (23FFh)	–	20E6/22h
Position control parameter set	**1024** (2400h)	18...21d	60FBh
Motor data	**1025** (2401h)	1, 3	6410h
Drive data	**1026** (2402h)	1...7	6510h
I^2t Value	**1027** (2403h)	–	6410/04h
Max phase current	**1028** (2404h)	–	6410/05h
Quick stop deceleration	**1029** (2405h)	–	6085h
Axis data electric drives 1 – electronic type plate			
Motor type	**1030** (2406h)	–	6402h
Max. current	**1034** (240Ah)	–	6073h
Motor rated current	**1035** (240Bh)	–	6075h
Motor rated torque	**1036** (240Ch)	–	6076h
Axis data electric drives 1 – standstill monitoring			
Position demand value	**1040** (2410h)	–	6062h
Position actual value	**1041** (2411h)	–	6064h
Standstill position window	**1042** (2412h)	–	2040h
Standstill timeout	**1043** (2413h)	–	2041h

Name	FHPP		CI
	PNU (SDO)	**SI**	
Axis data electric drives 1 – supplementary parameters			
Drag fault window	**1044** (2414h)	–	6065h
Drag fault timeout	**1045** (2415h)	–	6066h
Commutation point	**1050** (241Ah)	–	6410/11h
Measurement system resolution	**1051** (241Bh)	–	6410/12h
Measurement system pitch	**1052** (241Ch)	–	6410/13h
Nominal power	**1053** (241Dh)	–	6410/14h
Actual power	**1054** (241Eh)	–	6410/15h
Offset reference point	**1055** (241Fh)	–	6410/16h
Commutation status	**1056** (2420h)	–	2050h
Record power consumption	**1057** (2421h)	–	6410/17h
Positioning time	**1058** (2422h)	–	6410/18h
Actual current	**1059** (2423h)	–	6410/19h
Actual coil temperature	**1060** (2424h)	–	6410/31h
Max. coil temperature	**1061** (2425h)	–	6410/32h
Lower coil temperature threshold	**1062** (2426h)	–	6410/33h
Upper coil temperature threshold	**1063** (2427h)	–	6410/34h
Output stage temperature SFC-LACI	**1066** (242Ah)	–	6510/31h
Output stage max temperature SFC-LACI	**1067** (242Bh)	–	6510/32h
Output stage lower threshold temperature	**1068** (242Ch)	–	6510/33h
Output stage upper threshold temperature	**1069** (242Dh)	–	6510/34h
Power supply	**1070** (242Eh)	–	6510/50h
Tool load	**1071** (242Fh)	–	6510/51h
Start delay commutation	**1072** (2430h)	–	2051h

Name	FHPP		CI
	PNU (SDO)	**SI**	
Local digital output 1 – function	**1240** (24D8h)	–	2421/01h
Local digital output 1 – trigger ON	**1241** (24D9h)	–	2421/02h
Local digital output 1 – trigger OFF	**1242** (24DAh)	–	2421/03h
Local digital output 1 – value ON	**1243** (24DBh)	–	2421/04h
Local digital output 1 – value OFF	**1244** (24DCh)	–	2421/05h
Local digital output 1 – direction value ON	**1245** (24DDh)	–	2421/06h
Local digital output 1 – direction value OFF	**1246** (24DEh)	–	2421/07h
Local digital output 1 – delay	**1247** (24DFh)	–	2421/08h
Local digital output 1 – inverted	**1248** (24E0h)	–	2421/09h
Local digital output 2 – function	**1250** (24E2h)	–	2422/01h
Local digital output 2 – trigger ON	**1251** (24E3h)	–	2422/02h
Local digital output 2 – trigger OFF	**1252** (24E4h)	–	2422/03h
Local digital output 2 – value ON	**1253** (24E5h)	–	2422/04h
Local digital output 2 – value OFF	**1254** (24E6h)	–	2422/05h
Local digital output 2 – direction value ON	**1255** (24E7h)	–	2422/06h
Local digital output 2 – direction value OFF	**1256** (24E8h)	–	2422/07h
Local digital output 2 – delay	**1257** (24E9h)	–	2422/08h
Local digital output 2 – inverted	**1258** (24EAh)	–	2422/09h
Local digital output 2 – PWM value	**1259** (24EBh)	–	2422/0Ah
Limit switch polarity	**1300** (2514h)	–	6510/11h
Limit switch selector	**1301** (2515h)	–	6510/12h
Homing switch selector	**1302** (2516h)	–	6510/13h
Homing switch polarity	**1303** (2517h)	–	6510/14h
Limit switch deceleration	**1304** (2518h)	–	6510/15h

Name	**FHPP**		**CI**
	PNU (SDO)	**SI**	
Sample input	**1305** (2519h)	–	6510/16h
Limit switch polarity	**1306** (251Ah)	–	6510/1Ch
Brake delay time switch ON	**1310** (251Eh)	–	6510/17h
Brake delay time switch OFF	**1311** (251Fh)	–	6510/18h
Automatic brake time	**1312** (2520h)	–	6510/19h

Tab. B/7: Overview of FHPP parameters

B.3.3 Representation of the parameter entries

1 2 3 4 5 6

Encoder resolution

PNU	**1001**	**1...2**	**Array**	**uint32**	**rw**
Description	Encoder resolution in increments / revolutions The encoder resolution is fixed and cannot be modified by the user. The calculated value is derived from the fraction (encoder increments/ motor revolution).				
Encoder increments	1001	1			
	Value range: 0 ... 2^{32}-1 Default: 500				
Motor revolutions	1001	2			
	Fixed = 1				
CI	608Fh	01h...02h		uint32	rw

7 8 9

1 Name of the parameter

2 Parameter number (PNU)

3 Subindices of parameter, if present

4 Class

5 Variable type

6 Read/write permission: r = read only
w = write only
rw = read and write

7 Description of the parameter

8 If applicable: Explanation of the subindices

9 Relevant CI object (specify “DS402”: also available via DS402)

Fig. B/1: Representation of the parameter entries

B.3.4 Device data

Manufacturer hardware version BCD					
PNU	**100**	**–**		**uint16**	**r**
Description	Hardware version, specified in BCD (binary coded decimal): xxyy (xx = main version, yy = secondary version)				
CI	2069h	00h		uint16	r
	DS402: see object 1009h				

Manufacturer firmware version BCD					
PNU	**101**	**–**		**uint16**	**r**
Description	Firmware version, specified in BCD (binary coded decimal): xxyy (xx = main version, yy = secondary version)				
CI	206Ah	00h		uint16	r
	DS402: see object 100Ah				

Version FHPP					
PNU	**102**	**–**		**uint16**	**r**
Description	Version number of FHPP in BCD (binary coded decimal): xxyy (xx = main version, yy = secondary version)				
CI / DS402	2066h	00h		uint16	r

Version FCT plug-in BCD					
PNU	**104**	**1...2**	**Array**	**uint16**	**r**
Description					
FCT PlugIn min.		1			r
	Minimum necessary FCT version in BCD (binary coded decimal): Format = “xxyy” (xx = main version, yy = secondary version).				
FCT plug-in opt.		2			r
	Optimum FCT version in BCD (binary coded decimal): Format = “xxyy” (xx = main version, yy = secondary version).				
CI / DS402	206Bh	01...02h		uint16	r
	See CI objects 2067h and 2068h.				

Version axis interface					
PNU	**106**	**–**	**–**	**uint16**	**r**
Description	Version number of the axis interface				
CI / DS402	2FFDh	00h		uint16	r

Supported drive modes					
PNU	**112**			**uint32**	**r**
Description	Supported operation modes. Fix = 69h (105d) Bit 0: Profile position mode Bit 1: (Velocity mode) Bit 2: (Profile velocity mode) Bit 3: Profile torque mode Bit 4: (reserved) Bit 5: Homing mode Bit 6: FHPP continuous mode / interpolated position mode Bit 7...31: (reserved)				
CI / DS402	6502h	00h		uint32	r

Controller serial number					
PNU	**114**	**1...12_d**		**char**	**r**
Description	Serial number of the controller, e.g.: "K402P1212345"				
CI / DS402	2072h	00h		V-string	r

Controller type					
PNU	**115**	**–**		**uint16**	**r**
Description	SFC-LACI-...-IO: 0x10 = without display; 0x11 = with display SFC-LACI-...-PB: 0x12 = without display; 0x13 = with display SFC-LACI-...-CO: 0x14 = without display; 0x15 = with display SFC-LACI-...-DN: 0x16 = without display; 0x17 = with display				
CI / DS402	20E3h	00h		uint16	r

Manufacturer device name					
PNU	**120**	**1...30_d**		**char**	**r**
Description	Manufacturer's name for the device: SFC-LACI-...				
CI / DS402	1008h	00h		V-string	r

User device name					
PNU	**121**	**1...25_d**		**char**	**rw**
Description	Device name assigned by user. Max. 24 characters (ASCII, 7-bit). Default: "motor001"				
CI / DS402	20FDh	00h		V-string	rw

Drive manufacturer					
PNU	**122**	**1...30_d**		**char**	**r**
Description	Festo AG & Co. KG				
CI / DS402	6504h	00h		V-string	r

HTTP drive catalogue address (HTTP address of manufacturer)					
PNU	**123**	**1...30$_d$**		**char**	**r**
Description	www.festo.com				
CI / DS402	6505h	00h		V-string	r

Festo order number					
PNU	**124**	**1...30$_d$**		**char**	**r**
Description	Order number for SFC-LACI				
CI / DS402	6503h	00h		V-string	r

Device control					
PNU	**125**	**–**		**uint8**	**rw**
Description	Corresponds to “HMI control” on the control panel and “FCT” on the FCT. 0 (0x00): Controller interface (PROFIBUS) OFF, control via HMI (= control panel) and FCT ON 1 (0x01): Controller interface ON (default), control via HMI and FCT OFF				
CI / DS402	207Dh	00h		uint8	rw

HMI parameters (control panel parameters)					
PNU	**126**	**1...4**		**uint8**	**r**
Description	Control panel settings (SFC-LACI-...-H2 only)				
LCD current	126	1			
	Brightness. Values: 1...5. Default: 5.				
LCD contrast	126	2			
	Contrast. Values: 0...63 (0x00 ... 0x3F). Default: 0				
Measure	126	3			
	Unit of measurement system on the control panel (see 20D0/01h) Fixed = 1: millimetre, e.g. mm, mm/s, mm/s^2				
Scaling factor	126	4			
	Number of post-decimal positions (see 20D0/02h) Fixed = 2: 2 post-decimal positions				
CI / DS402	20FFh	01h...04h		uint8	r

Data memory control					
PNU	**127**	**1...3**		**uint8**	**w**
Description	Commands for EEPROM				
Delete EEPROM	127	1			
	Fixed: 16 (0x10): Delete data in EEPROM. Once the object has been written, and after power off/on, the data in the EEPROM are reset to the factory settings.				
Save data	127	2			
	The data in EEPROM will be overwritten with the current user-specific settings. Fix 1 (0x01): Save data.				
Reset device	127	3			
	0x10: Reset device (EEPROM is not erased, state is identical to that after switching off/on).				
CI / DS402	20F1h	01h...03h		uint8	w

Note
All user-specific settings will be lost on deletion (except for cycle number). The status after deletion corresponds to the standard factory setting.

- Always carry out a first commissioning after deleting the EEPROM.
- When the EEPROM is deleted, the fieldbus address is also reset.

CMXR: interoperability (compatibility with CMXR)					
PNU	**150**	**–**		**uint8**	**rw**
Description	0 = normal operation (default); 1 = CMXR-compatible				
CI / DS402	2FF8h	00h		uint8	rw

CMXR: configuration control word (control word for CMXR)					
PNU	**151**	**–**		**uint16**	**r**
Description	This object was only included for reasons of compatibility. It has no functional influence (as of 05/2009).				
CI / DS402	6510h	F0h		uint16	r

B.3.5 Diagnosis

Description of the method of operation of the diagnostic memory: see section 6.4.

Diagnostic event					
PNU	**200**	**1...16$_d$**		**uint8**	**r**
Description	**Type** of fault or diagnostic information saved in the diagnostic memory. Displays whether an incoming or outgoing fault is saved. Value — Type of diagnostic event 0 (0x00) No fault (or diagnostic message deleted) 1 (0x01) Incoming fault 2 (0x02) Outgoing fault 3 (0x03) (reserved) 4 (0x04) Overrun time stamp				
Event 1	200	1			
	Active diagnostic event				
Event 2	200	2			
	Previous diagnostic event				
Event ...	200	...			
	...				
Event 16	200	16			
	Oldest saved diagnostic event				
CI / DS402	20C8h	01...10$_h$		uint8	r

Fault number					
PNU	**201**	**1...16$_d$**		**uint16**	**r**
Description	Fault number saved in the diagnostic memory, serves for identifying the fault. Fault numbers with descriptions: see section 6.3.				
Event ...	201	...			
	see PNU 200.				
CI / DS402	20C9h	01h...10h		uint16	r

Time stamp					
PNU	**202**	**1...16$_d$**		**uint32**	**r**
Description	Time point of the diagnostic event since device was switched on, in the time unit as per PNU 204/2.				
Event ...	202	...			
	see PNU 200.				
CI / DS402	20CAh	01h...10h		uint32	r

Additional information					
PNU	**203**	**1...16$_d$**	**0...15**	**uint32**	**r**
Description	Number of movement cycles at the time a fault comes or goes. See PNU 305.				
Event ...	202	...	...		
	see PNU 200.				
CI	20CBh	01h...10h		uint32	r

Diagnostic memory parameters					
PNU	**204**	**1...4**		**uint8**	**r(w)**
Description	Configuration of the diagnostic memory.				
Fault type	204	1			rw
	1 (0x01): Record incoming and outgoing*) faults (default) 2 (0x02) Log only incoming faults *) Outgoing fault = Acknowledge the fault.				
Resolution	204	2			rw
	1 (0x01): Resolution time stamp 10 ms (default) 2 (0x02): Resolution time stamp 1 ms				
Clear memory (delete memory)	204	3			rw
	Clear diagnostic memory by writing value = 1. Read will always reply with value = 1.				
Number of entries	204	4			r
	Number of entries in the diagnostic memory				
CI / DS402	20CCh	01h...04h		uint8	rw/r

Device errors					
PNU	**205**	**–**		**uint16**	**rw**
Description	Reading or deleting the error message(s). Explanations of the error messages can be found in chapter 6.3 “Diagnosis”. **Writing ‹0›:** Delete all error messages (in 2FF1h, 2FFAh, 2FFBh and 2FFCh) **Read:** Bit 0 (0x1) HARDWARE ERROR SFC-LACI Bit 1 (0x2) CAN COMMUNICATION ERROR Bit 2 (0x4) ELGO SENSOR/COMMUNICATION ERROR Bit 3 (0x8) HARDWARE ERROR DRIVE Bit 4 (0x10) ERROR MOTOR HOT Bit 5 (0x20) ERROR SFC-LACI HOT Bit 6 (0x40) DIGITAL POWER DOWN Bit 7 (0x80) LOAD POWER DOWN Bit 8 (0x100) HOMING ERROR Bit 9 (0x200) PLEASE ENFORCE HOMING RUN Bit 10 (0x400) POSITION ERROR (following error) Bit 11 (0x800) TARGET POSITION OUT OF LIMIT Bit 12 (0x1000) i^2t-ERROR Bit 13 (0x2000) MOTOR STOP ERROR Bit 14 (0x4000) POSITION PLAUSIBILITY ERROR Bit 15 (0x8000) COMMUTATION POINT ERROR				
CI / DS402	2FF1h	00h		uint16	rw

CANopen diagnosis					
PNU	**206**	**1...6**	**Array**	**uint8**	**r**
Description	Read out the CANopen diagnostic data				
LED state	206	1			
	0x00 No error 0x01 Error counter limit reached 0x02 Guarding/Heartbeat error 0x04 CANbus off 0x10 Status: “STOP” 0x20 Status “pre-operational” 0x40 Status “operational”				
Baud code	206	2			
	CAN bus baud rate Values: 0...8 ≙ 1000, 800, 500, 250, 125, 100, 50, 20, 10 kBaud				
–	206	3			
	(reserved)				
CAN ID	206	4			
	Value range: 1 ... 127 (0x01 ... 0x7F). Default: 255 (0xFF)				
Profiles	206	5			
	0 = DS402; 1= FHPP				
–	206	6			
	(reserved)				
CI / DS402	2FF4h	01h...06h		uint8	r

Extended device errors A					
PNU	**207**	**–**		**uint16**	**rw**
Description	Reading or deleting the error message(s). Explanations of the error messages can be found in chapter 6.3 “Diagnosis”. **Writing ‹0›:** Delete all error messages (in 2FF1h, 2FFAh, 2FFBh and 2FFCh) **Reading:** Bit 0 (0x1) CANbus init no parameter Bit 1 (0x2) ERROR_NODE_GUARDING Bit 2 (0x4) RX_QUEUE_OVERRUN Bit 3 (0x8) TX_QUEUE_OVERRUN Bit 4 (0x10) CAN_BUS_OFF Bit 5 (0x20) CAN_CONTROLLER_QUEUE_OVERRUN				
CI / DS402	2FFAh	00h		uint16	rw

Extended device errors B					
PNU	**208**	**–**		**uint16**	**rw**
Description	Reading or deleting the error message(s). Explanations of the error messages can be found in chapter 6.3 “Diagnosis”. **Writing ‹0›:** Delete all error messages (in 2FF1h, 2FFAh, 2FFBh and 2FFCh) **Reading:** Bit 0: ERROR INTERPOLATION CYCLE TIME (with FHPP continuous mode: missing position specification, missing toggle bit) Bit 1: OVERCURRENT POWER STAGE Bit 2: LIMIT SWITCH ACTIVATED Bit 3: BLOCK DURING JOG MODE				
CI / DS402	2FFBh	00h		uint16	rw

Extended device errors C					
PNU	**209**	**–**		**uint16**	**rw**
Description	(reserved)				
CI / DS402	2FFCh	00h		uint16	rw

<table>
<tr><th colspan="6">Device warnings</th></tr>
<tr><td>PNU</td><td>215</td><td>–</td><td></td><td>uint16</td><td>rw</td></tr>
<tr><td>Description</td><td colspan="5">Reading or deleting the active warning(s).
Explanations of the error messages can be found in chapter 6.3 “Diagnosis”.
Writing ‹0›: Delete all warnings
Reading: Bit 0 INDEX WARNING
Bit 1 WARNING MOTOR COLD
Bit 2 WARNING MOTOR HOT
Bit 3 WARNING SFC-LACI COLD
Bit 4 WARNING SFC-LACI HOT
Bit 5 STANDSTILL WARNING
Bit 6 ILLEGAL RECORD WARNING
Bit 7...15 (reserved)</td></tr>
<tr><td>CI / DS402</td><td>2FF2h</td><td colspan="2">00h</td><td>uint16</td><td>rw</td></tr>
</table>

B.3.6 Process data

Position monitoring					
PNU	**300**	**1...2**		**int32**	**r**
Description					
Position actual value		1			
	Actual position in increments				
Position demand value		2			
	Controller setpoint position in increments				
CI / DS402	2800h	01h...02h		int32	r

Torque/force monitoring					
PNU	**301**	**1...2**		**int16**	**r**
Description					
Torque actual value		1			
	Actual force in permil of rated force. Values: 0...65535.				
Torque demand value		2			
	Setpoint force in permil of rated force. Values: -1000...+1000.				
CI / DS402	2801h	01h...02h		int16	r

Digital inputs					
PNU	**303**	**–**		**uint32**	**r**
Description	Mapping the digital inputs Bit 0: Negative limit switch Bit 1: Positive limit switch Bit 2: Reference switch Bit 3...15: reserved (= 0) Only with FHPP control: Bit 16 ... 20: Current record number (compare control byte 3) Bit 21: STOP (CCON.B1) Bit 22: ENABLE (CCON.B0) Bit 23: START (CPOS.B1) Bit 24 ... 31: reserved (= 0) Always: Bit 24: Sample input Bit 25...31: reserved (= 0)				
CI / DS402	60FDh	00h		uint32	r

Digital outputs					
PNU	**304**	**1...2**		**uint32**	**r**
Description	Mapping the digital outputs				
Digital outputs	304	1			
	Bit 0: Status of brake Bit 1...15: (reserved) Bit 16 : MC Bit 17: READY Bit 18: EA_ACK Bit 19: ERROR Bit 20...24: (reserved) Bit 25: Status Out1 Bit 26: Status Out2				
Mask	304	2			
	Bit 25: Activates the display of Out1 in 60FE/01h Bit 26: Activates the display of Out2 in 60FE/01h				
CI / DS402	60FEh	01h...02h		uint32	r

Cycle number					
PNU	**305**	**–**		**uint32**	**r**
Description	Number of positioning records executed, homing runs etc.				
CI / DS402	2FFFh	00h		uint32	r

Velocity monitoring					
PNU	**310**	**1...2**		**int32**	**r**
Description					
Velocity actual value		1			
	Actual speed value in [inc/s]				
Velocity demand value		2			
	Speed setpoint value in [inc/s]				
CI / DS402	2802h	01h...02h		int32	r

FHPP status data					
PNU	**320**	**1...2**	**Record**		**r**
Description	FHPP input data (8 bytes of status date), 4 bytes each, consistent.				
		1		uint32	
	FHPP status bytes 1-4 (SCON, SPOS, ...)				
		2		int32	
	FHPP status bytes 5-8 (actual position)				
CI / DS402	20A0h	01h...02h		uint32	r

FHPP control data					
PNU	**321**	**1...2**	**Record**	**uint32**	**r**
Description	FHPP output data (8 bytes of control data), 4 bytes each, consistent.				
		1			
	FHPP control bytes 1-4 (CCON, CPOS, ...)				
		2			
	FHPP control bytes 5-8 (setpoint position)				
CI / DS402	20A1h	01h...02h		uint32	r

PNU 330, 331, 332 and 333: see appendix C.3.3.

Position sampling – position rising edge					
PNU	**350**	**–**	**Var**		**r**
Description	Position for a rising edge in [increments]. See 5.6.12.				
CI / DS402	204Ah	**05h**		int32	r

Position sampling – position falling edge					
PNU	**351**	**–**	**Var**		**r**
Description	Position for a falling edge in [increments]. See 5.6.12.				
CI / DS402	204Ah	**06h**		int32	r

Position sampling – trigger mode					
PNU	**352**	**–**	**Var**		
Description	Continuous or one-time recording. See 5.6.12.				
CI / DS402	204Ah	**01h**		uint16	

Position sampling – status					
PNU	**353**	**–**	**Var**		
Description	Specifies whether an edge was registered. See 5.6.12.				
CI / DS402	204Ah	02h		uint8	

Position sampling – status mask					
PNU	**354**	**–**	**Var**		
Description	Display in the status byte SPOS and status word 6041h. See 5.6.12.				
CI / DS402	204Ah	03h		uint8	

Position sampling – control byte					
PNU	**355**	**–**	**Var**		
Description	Reaction to rising or falling edges. See 5.6.12.				
CI / DS402	204Ah	04h		uint8	

B.3.7 Position set table (record list)

Parameterising: With FHPP, record selection for reading and writing is done via the **subindex** of the PNUs 401 ... 417.

Posi-tioning record	**Sub-index**	**PNU 401** **RCB1**	**PNU 402** **RCB2**	**PNU 404** **Target position**	**PNU 405** **Wait time**	**...**	**PNU 417**
0	00	Homing					
1	01	...	...	...	...	...	...
2	02	...	...	...	...	...	...
...	...	...	...	...	...	...	...
31	31	...	...	...	...	...	...

Tab. B/8: Position set table structure (record list)

Record pointer: The active record for **positioning or teaching** is selected via **PNU 400**.

FHPP record number

PNU	**400**	**1...3**	**Array**	**uint8**	**r(w)**
Description					
Record number	400	1			rw
	Record pointer for positioning and teaching. It is also valid when the drive is not in Record Select mode (e.g. during teaching). For record selection this parameter is transferred in the cyclic I/O data. Value range: 0 ... 34 (0x00 ... 0x22). Values: 0 (0x00): Homing (positioning record 0) 1 (0x01): Positioning record 1 2 (0x02): Positioning record 2 ...: Positioning record ... 31 (0x1F): Positioning record 31 32 (0x20): Jog mode 33 (0x21): Direct mode 34 (0x22): FCT positioning record				
Active record	400	2			r
	The number of the active record. Relevant for record chaining.				
Record status byte	400	3			r
	Contains FHPP status byte 4 with information on record chaining (see section 5.5.2).				
CI	2033h	01h...03h		uint8	r(w)
	Note: The object 2032h is intended for access via DS402.				

Record control byte 1					
PNU	**401**	**1...34$_d$**		**uint8**	**rw**
Description	Settings for record selection: – Relative/absolute positioning – Path generator, standard/energy optimised Values: 0x00 Target position is absolute, standard path generator (default) 0x01 Target position is relative to last nominal value, standard path generator 0x06 Target position is absolute, energy optimised path generator 0x07 Target position is relative to last nominal value, energy optimised path generator Note: The energy optimised path generator enables higher dynamics with less heat, the parameterised positioning curve (a trapeze as e.g. in Fig. 5/2) is not maintained exactly. The parameterised maximum values for speed and acceleration may be slightly exceeded.				
Record 0 (positioning record 0)	401	1			
	Do not use (Homing)				
Record 1 (positioning record 1)	401	2			
	Record control byte 1 Positioning record 1				
Record ... (positioning record ...)	401	...			
	Record control byte 1 Positioning record 2...30				
Record 31 (positioning record 31)	401	32			
	Record control byte 1 Positioning record 31				
Jog mode	401	33			
	Record control byte 1 for jog mode				
Direct mode	401	34			
	Record control byte 1 for direct mode				
CI	20EAh	01h ... 22h		uint8	rw
	Note: Object 20E0h/01h is intended for access via DS402.				

Record control byte 2

PNU	**402**	**1...32$_d$**	**Array**	**uint8**	**rw**
Description	For record selection: Step enabling condition for chained records (see section 5.6.5). Values: Bit 0: = 0 No record chaining = 1 Record chaining Bit7: = 0 Record chaining is not locked out; = 1 Record chaining is locked out				
Record 0 (positioning record 0)	402	1			
	Do not use (Homing)				
Record 1 (positioning record 1)	402	2			
	Record control byte 2 Positioning record 1				
Record ... (positioning record ...)	402	...			
	Record control byte 2 Positioning record 2 ... 30				
Record 31 (positioning record 31)	402	32			
	Record control byte 2 Positioning record 31				
CI	20EBh	01h ... 20h		uint8	rw
	Note: Not used with DS402.				

Target position					
PNU	**404**	**1...34$_d$**		**int32**	**rw**
Description	Target positions in [increments]				
Record 0 (positioning record 0)	404	1			
	Do not use (Homing)				
Record 1 (positioning record 1)	404	2			
	Target position of positioning record 1				
Record ... (positioning record ...)	404	...			
	Target position of positioning record 2 ... 30				
Record 31 (positioning record 31)	404	32			
	Target position of positioning record 31				
Jog mode	404	33			
	Target position for jog mode				
Direct mode	404	34			
	Target position for direct mode				
CI	20ECh	01h ... 22h		int32	rw
	Note: Object 20E0h/02h is intended for access via DS402.				

Record delay (positioning record delay)					
PNU	**405**	**1...32$_d$**		**int32**	**rw**
Description	Waiting time for record chaining (= set chaining): The time between "Motion Complete" of a chained positioning record and the start of the next positioning record. Value range: 1...60000 ms				
Record 0 (positioning record 0)	405	1			
	Do not use (Homing)				
Record 1 (positioning record 1)	405	2			
	Delay after positioning record 1				
Record ... (positioning record ...)	405	...			
	Delay after positioning record 2 ... 30				
Record 31 (positioning record 31)	405	32			
	Delay after positioning record 31				
CI	20E4h	01h ... 20h		int32	rw
	Note: Object 20E0h/08h is intended for access via DS402.				

Velocity					
PNU	**406**	**1...32_d**		**uint32**	**rw**
Description	Velocity in [increments/s]				
Record 0 (positioning record 0)	406	1			
	Do not use (Homing)				
Record ... (positioning record ...)	406	...			
	Nominal speed value positioning record 1 ... 30				
Record 31 (positioning record 31)	406	32 (20h)			
	Nominal speed value positioning record 31				
CI	20EDh	01h ... 20h		uint32	rw
	Subindex 20ED/21h: → PNU 531 (Speed in jog mode) Note: Object 20E0h/03h is intended for access via DS402.				

Acceleration					
PNU	**407**	**1...32$_d$**		**uint32**	**rw**
Description	Nominal acceleration value in increments/s^2. The value applies only to positioning, with force control the value is ignored. Value range: 0x400 ... 0x03A98000 Default: 0x006D6000				
Record 0 (positioning record 0)	407	1			
	Do not use (Homing)				
Record ... (positioning record ...)	407	...			
	Nominal acceleration value positioning record 1 ... 30				
Record 31 (positioning record 31)	407	32 (20h)			
	Nominal acceleration value positioning record 31				
CI	20EEh	01h ... 20h		uint32	rw
	Subindex 20EE/21h: ⟶ PNU 532 (Speed in jog mode) Subindex 20EE/22h: ⟶ PNU 541 (Speed in direct mode) Note: Object 20E0h/04h is intended for access via DS402.				

Deceleration					
PNU	**408**	**1...33$_d$**		**uint32**	**rw**
Description	Deceleration in [increments/s^2]. The value applies only to positioning, with force control the value is ignored.				
Record 0 (positioning record 0)	408	1			
	Do not use (Homing)				
Record ... (positioning record ...)	408	...			
	Deceleration positioning record 1 ... 30				
Record 31 (positioning record 31)	408	32 (20h)			
	Positioning record deceleration 31				
Jog mode	408	33 (21h)			
	Deceleration in jog mode				
CI	20EFh	01h ... 21h		uint32	rw
	Subindex 20EF/22h: → PNU 542 (Deceleration in direct mode) Note: Object 20E0h/0Ah is intended for access via DS402.				

Jerk acceleration					
PNU	**409**	**1...33$_d$**		**uint32**	**rw**
Description	Acceleration jerk in [increments/s^3]. The internal calculation is done with 1/10 of the value.				
Record 0 (positioning record 0)	409	1			
	Do not use (Homing)				
Record ... (positioning record ...)	409	...			
	Jerk for position records 1 ... 30				
Record 31 (positioning record 31)	409	32 (20h)			
	Jerk for position record 31				
Jog mode	409	33 (21h)			
	Jerk in jog mode				
CI	20E7h	01h ... 21h		uint32	rw
	Subindex 20E7/22h: → PNU 543 (Jerk in direct mode) Note: Object 20E0h/05h is intended for access via DS402.				

Work load (applied load)					
PNU	**410**	**1...33$_d$**		**uint32**	**rw**
Description	Applied load: Mass in [g] of the workpiece to be transported by a positioning record. Note: The mass of a tool mounted on the piston rod (or front plate) of the drive, which remains the same for all positioning records, is entered in object 6510/51h.				
Record 0 (positioning record 0)	410	1			
	Do not use (Homing)				
Record ... (positioning record ...)	410	...			
	Applied load for positioning records 1 ... 30				
Record 31 (positioning record 31)	410	32 (20h)			
	Applied load for positioning record 31				
Jog mode	410	33 (21h)			
	Applied load in jog mode				
CI	20E8h	01h ... 21h		uint32	rw
	Subindex 20E8/22h: → PNU 544 (Applied load in direct mode) Note: Object 20E0h/06h is intended for access via DS402.				

Position window time (damping time)					
PNU	**415**	**$1...33_d$**		**uint16**	**rw**
Description	Damping time in milliseconds [ms]. If the actual position has been in the target position window for this amount of time, the "Motion complete" bit is set in the status word. Also referred to as "Adjustment time". Value range: 1 ... 60000 ms. Default: 10 ms.				
Record 0 (positioning record 0)	415	1			
	Do not use (Homing)				
Record ... (positioning record ...)	415	...			
	Damping time for position records 1...30				
Record 31 (positioning record 31)	415	32 (20h)			
	Damping time for position record 31				
Jog mode	415	33 (21h)	32 (20h)		
	Damping time in jog mode				
CI	20E6h	01h ... 21h		uint16	rw
	Subindex 20E6/22h: → PNU 1023 (Damping time for positioning in direct mode) Note: Object 20E0h/07h is intended for access via DS402. 6068h contains the damping time of the currently active record.				

Following record					
PNU	**416**	**1...32$_d$**		**uint8**	**rw**
Description	The subsequent positioning record for a positioning record with a chaining condition = 1. Value range: 1...31				
Record 0 (positioning record 0)	410	1			
	Do not use (Homing)				
Record ... (positioning record ...)	410	...			
	The position record following position record 1...30.				
Record 31 (positioning record 31)	410	32 (20h)			
	The record following record 31.				
CI	20E5h	01h ... 20h		uint8	rw
	Note: Object 20E0h/09h is intended for access via DS402.				

Jerk deceleration					
PNU	**417**	**1...33$_d$**		**uint32**	**rw**
Description	Jerk when decelerating in [increments/s^3]. The internal calculation is done with 1/10 of the value.				
Record 0 (positioning record 0)	417	1			
	Do not use (Homing)				
Record ... (positioning record ...)	417	...			
	Jerk for deceleration of position records 1 ... 30				
Record 31 (positioning record 31)	417	32 (20h)			
	Jerk for deceleration of position record 31				
Jog mode	417	33 (21h)	32 (20h)		
	Jerk deceleration in jog mode				
CI	21E1h	01h ... 21h		uint32	rw
	Subindex 21E1/22h: → PNU 547 (Jerk when decelerating in direct mode) Note: Object 20E0h/08h is intended for access via DS402.				

B.3.8 Project data

General project data

Project zero point (offset project zero point)					
PNU	**500**	**–**		**int32**	**rw**
Description	Offset of the project zero point PZ to the axis zero point AZ. Reference point for target positions with absolute positioning (compare PNU 401 and 404).				
CI / DS402	21F4h	00h		int32	rw

Software end positions					
PNU	**501**	**1...2**		**int32**	**rw**
Description	Software end positions in increments. Plausibility rule: Min. limit ≤ Max. limit Factory settings: see section 5.2.6.				
Lower limit (lower limit value)	501	1			
	Lower software end position: offset to axis zero point				
Upper limit (upper limit value)	501	2			
	Upper software end position: offset to axis zero point				
CI / DS402	607Bh	01h...02h		int32	rw

Max. speed (max. permitted speed)					
PNU	**502**	**–**		**uint32**	**r**
Description	Max. permitted speed in [Inc/s]				
CI / DS402	607Fh	00h		uint32	r

Max. acceleration (max. permitted acceleration)					
PNU	**503**	**–**		**uint32**	**r**
Description	Max. permitted acceleration/deceleration in [Inc/s^2]				
CI / DS402	60C5h	00h		uint32	r

Motion profile type (ramp profile)					
PNU	**506**	**–**		**int16**	**r**
Description	Drive motion profile. Fixed = -1 (linear ramp).				
CI / DS402	6086h	00h		int16	r

Force mode

Stroke limit					
PNU	**510**	**–**		**uint32**	**rw**
Description	Maximum permitted stroke with force control. The distance of the actual position from the start position must not be more than the amount specified in this parameter. In this way you can ensure that, if force control is activated by mistake (e.g. missing work item), the axis will not perform an uncontrolled movement. This parameter is taken into account in all control modes in which the position controller is not active in the status "Operation enabled". Monitoring can be deactivated when bit RCB1.B5 is set.				
CI / DS402	60F6h	01h		uint32	rw

Min. torque/force (min. permitted force/torque)					
PNU	**511**	**–**		**uint16**	**r**
Description	The lowest permitted torque of the motor in per mill of the rated value (6076h / PNU1036). Fixed = 300.				
CI / DS402	60F6h	05h		uint16	r

Max. torque/force (max. permitted force/torque)					
PNU	**512**	**–**		**uint16**	**rw**
Description	The highest permitted torque of the motor in per mill of the rated value (6076h / PNU 1036). Values: 0...1000.				
CI / DS402	6072h	00h		uint16	rw

Torque/force profile type					
PNU	**513**	**–**		**int16**	**r**
Description	Type of profile with which a force modification is undertaken. Fixed = 0: linear ramp.				
CI / DS402	6088h	00h		int16	r

Teaching

Teach target					
PNU	**520**	**–**		**uint8**	**rw**
Description	Teach target: The parameter that is described in the next teach command with the actual position (see section 5.6.3). Values: 1 (0x01): Target position in positioning record (default). – With Record selection: positioning record as per FHPP control bytes – With Direct mode: positioning record corresponding to PNU=400 2 (0x02): Axis zero point 3 (0x03): Project zero point 4 (0x04): Lower software end position 5 (0x05): Upper software end position				
CI / DS402	21FCh	00h		uint8	rw

Jog mode

Jog mode speed phase 2

PNU	**531**	**–**		**uint32**	**rw**
Description	Jog mode: speed in phase 2 (fast travel) in [inc/s]				
CI	20EDh	21h		uint32	rw

Jog mode acceleration

PNU	**532**	**–**		**uint32**	**rw**
Description	Acceleration in [inc/s^2]				
CI	20EEh	21h		uint32	rw

Jog mode time phase 1

PNU	**534**	**–**		**uint32**	**rw**
Description	Jog mode: duration of phase 1 (slow travel) in [ms]. Default: 2000				
CI	20E9h	21h		uint32	rw

Direct mode: Positioning mode

Direct mode base velocity

PNU	**540**	**–**		**uint32**	**rw**
Description	Reference value for speed specifications in FHPP direct mode. The master transmits a percent value, which is multiplied by the base value to reach to the final setpoint speed.				
CI	21F8h	00h		uint32	rw

Direct mode acceleration

PNU	**541**	**–**		**uint32**	**rw**
Description	Acceleration in direct mode in [Inc/s^2]				
CI	20EEh	22h		uint32	rw

Direct mode deceleration

PNU	**542**	**–**		**uint32**	**rw**
Description	Deceleration in direct mode in [Inc/s^2]				
CI	20EFh	22h		uint32	rw

Direct mode jerk acceleration

PNU	**543**	**–**		**uint32**	**rw**
Description	Jerk when accelerating in direct mode in [Inc/s^3]. The internal calculation is done with 1/10 of the value.				
CI	20E7h	22h		uint32	rw

Direct mode working load					
PNU	**544**	**–**		**uint32**	**rw**
Description	Applied load = mass of the workpiece in [g]. Note: The mass of a tool mounted on the piston rod (or front plate) of the drive, which remains the same for all positioning records, is entered in object 6510/51h.				
CI	20E8h	22h		uint32	rw

Direct mode jerk deceleration					
PNU	**547**	**–**		**uint32**	**rw**
Description	Jerk when decelerating in direct mode in [Inc/s^3]. The internal calculation is done with 1/10 of the value. Note: The damping time when positioning in direct mode is specified in PNU 1023.				
CI	21E1h	22h		uint32	rw

Direct mode: Force mode

Torque/force slope (change of force)					
PNU	**550**	**–**		**uint32**	**r**
Description	Speed with which the force changes				
CI / DS402	6087h	00h		uint32	r

Force target window					
PNU	**552**	**–**		**uint16**	**rw**
Description	Target window of the force: this is the amount by which the actual force may differ from the setpoint force in order to be interpreted as still being in the target window. The width of the window is twice the value transferred, with the target position in the centre of the window. The value is specified in 1/1000 of the nominal value (6076h / PNU 1036). Value range: 0...65535. Default: 100				
CI / DS402	60F6h	0**3**h		uint16	rw

Force damping time					
PNU	**553**	**–**		**uint16**	**rw**
Description	Damping time of the force: if the actual force has been in the target window this amount of time, the “Motion complete” bit will be set in the status word. Value range: 0...30000 ms. Default: 100 ms.				
CI / DS402	60F6h	0**4**h		uint16	rw

Force mode speed limit					
PNU	**554**	**–**		**uint32**	**rw**
Description	Maximum permitted velocity with active force control. In this way you can ensure that, if force control is activated by mistake (e.g. work item missing), the axis will not undergo uncontrolled acceleration and move at high speed against a stop. This parameter is taken into account in all control modes in which the position controller is not active in the status "Operation enabled."				
CI / DS402	60F6h	02h		uint32	rw

Direct mode: FHPP continuous mode

Interpolation time					
PNU	**570**	**–**		**uint16**	**rw**
Description	Time gap between two position specifications in “FHPP continuous mode” in [1/10 ms]. Value range: 0 ... 65535. See section 5.6.7.				
CI / DS402	20B6h	00h		uint16	rw

B.3.9 Axis parameters for electric drives 1

Mechanical parameters

Polarity (reversal of direction)					
PNU	**1000**	**–**		**uint8**	**r**
Description	Fixed = 1 (not adjustable)				
CI / DS402	607Eh	00h		uint8	r

Encoder resolution					
PNU	**1001**	**1...2**		**uint32**	**r**
Description	Measurement system resolution. Reflects 6410/12h.				
Encoder increments	1001	1			
	Number of increments between two index pulses. Fixed = 2048				
Motor revolutions	1001	2			
	Fixed = 1				
CI / DS402	608Fh	01h...02h		uint32	r

Gear ratio					
PNU	**1002**	**1...2**		**uint32**	**r**
Description	Gear unit ratio (1:1 for linear motors)				
Motor revolutions	1002	1			
	Fixed = 1				
Shaft revolutions	1002	2			
	Fixed = 1				
CI / DS402	6091h	01h...02h		uint32	r

Feed constant linear axis					
PNU	**1003**	**1...2**		**uint32**	**r**
Description	Measurement graduation: distance in [µm] between two index pulses. Reflects 6410/13h.				
Feed	1003	1			
	DFME-...-LAS: fixed = 2000 µm. DNCE-...-LAS: fixed = 5000 µm.				
Shaft revolutions	1003	2			
	Fixed = 1				
CI / DS402	6092h	01h...02h		uint32	r

Position factor					
PNU	**1004**	**1...2**		**uint32**	**r**
Description	Number of sensor increments per 1 measured unit of feed. Position factor $= \frac{\text{Encoder resolution * Gear unit ratio}}{\text{Feed constant}}$				
Numerator	1004	1			
	Position factor – numerator				
Denominator	1004	2			
	Position factor – denominator				
CI / DS402	6093h	01h...02h		uint32	r

Axis parameter

PNU	**1005**	**1...6**	**Record**	**uint32**	**rw**
Description	Axis parameter				
Axis length	1005	1			
	Axis length in increments				
–	1005	2			
	(reserved)				
–	1005	3			
	(reserved)				
Axis type	1005	4			
	0x10 = DFME-32-100; 0x11 = DFME-32-200; 0x12 = DFME-32-320; 0x13 = DFME-40-100; 0x14 = DFME-40-200; 0x15 = DFME-40-320; 0x16 = DFME-40-400 0x20 = DNCE-32-100; 0x21 = DNCE-32-200; 0x22 = DNCE-32-320; 0x23 = DNCE-40-100; 0x24 = DNCE-40-200; 0x25 = DNCE-40-320; 0x26 = DNCE-40-400				
–	1005	5			
	(reserved)				
Axis installation position	1005	6			
	Mounting position of the axis: 0 = horizontal, 1 = vertical.				
CI / DS402	20E2h	01h...06h		uint32	rw

Parameter for homing

Offset axis zero point					
PNU	**1010**	**–**		**int32**	**rw**
Description	Offset of the axis zero point AZ to the reference point REF in [increments] (= distance from reference point). Factory settings: see chapter 5.2.5. The drive is no longer referenced after the axis zero point has been modified.				
CI / DS402	607Ch	00h		int32	rw

Homing method					
PNU	**1011**	**–**		**uint8**	**rw**
Description	Homing method. Values Function 1 (0x01): Search for limit switch in negative direction with index search 2 (0x02): Search for limit switch in positive direction with index search 7 (0x07): Search for reference switch in positive direction with index search 11 (0x0B): Search for reference switch in negative direction with index search -18 (0xEE): Search for stop in positive direction -17 (0xEF): Search for stop in negative direction The drive is no longer referenced after the homing method has been modified.				
CI / DS402	6098h	00h		uint8	rw

Homing velocities					
PNU	**1012**	**1...2**		**int32**	**rw**
Description	Speeds during homing				
Search REF (search for REF)	1012	1			
	Speed when searching for the reference point REF in [inc/s]				
Search AZ (search for AZ)	1012	2			
	Speed of travel to the axis zero point AZ in [inc/s]				
CI / DS402	6099h	01h...02h		int32	rw

CMXR: Homing acceleration					
PNU	**1013**	**–**		**uint32**	**rw**
Description	This object was only included for reasons of compatibility. It has no functional influence (as of 05/2009).				
CI / DS402	609Ah	00h		uint32	rw

Homing required					
PNU	**1014**	**–**		**uint8**	**r**
Description	Defines whether or not homing must be carried out after switching on in order to carry out positioning tasks. Fixed = 0: Homing run must be carried out.				
CI / DS402	23F6h	00h		uint8	r

Homing max. torque/force					
PNU	**1015**	**–**		**uint8**	**rw**
Description	Maximum force during homing in [%]. Value range: 10...100.				
CI / DS402	23F7h	00h		uint8	rw

Controller parameters

Quick stop option code					
PNU	**1019**	**–**		**uint16**	**r**
Description	Fixed = 6: Remain in stop with fast stop ramp and in the status "Fast stop active". Enables status transfer 16. See finite state machine in appendix C.1				
CI / DS402	605Ah	00h		uint16	r

HALT option code					
PNU	**1020**	**–**		**int16**	**rw**
Description	Describes the reaction to a **HALT** signal at the controller interface (CPOS.B0 HALT). 0x01: Braking using the ramp of the current positioning record (default) 0x02: Braking using quick stop deceleration as per PNU 1029				
CI / DS402	605Dh	00h		int16	rw

Fault reaction / STOP option code					
PNU	**1021**	**–**		**int16**	**rw**
Description	Describes the reaction to an **error** or to a **STOP** signal at the controller interface (CCON.B1 STOP). 0x01: Braking using the ramp of the current positioning record 0x02: Braking using quick stop deceleration as per PNU 1029 (default)				
CI / DS402	605Eh	00h		int16	rw

Target position window					
PNU	**1022**	**–**		**uint32**	**rw**
Description	Tolerance window in increments [inc] Amount by which the current position may deviate from the target position, in order that it may still be regarded as being within the target window. The width of the window is twice the value transferred, with the target position in the centre of the window. Value range: 0 ... Stroke Default: 102 Inc				
CI / DS402	6067h	00h		uint32	rw

Direct mode position window time					
PNU	**1023**	**–**		**uint16**	**rw**
Description	Damping time (= adjustment time) in direct mode in milliseconds [ms] If the actual position has been in the target position window this amount of time, the bit “Target reached” will be set in the status word (= Motion complete). Value range: 1 ... 60000 ms. Default: 10 ms. See. PNU 415 (record-specific damping times in record selection) and 6068h (damping time of the active record).				
CI / DS402	20E6h	22h		uint16	rw

Position control parameter set					
PNU	**1024**	**18d...21d**		**int32**	**rw**
Description		**Caution: Risk of injury to people and damage to property.** The factory settings for the controller parameters should only be modified in exceptional cases. Unfavourable settings can lead to uncontrollable behaviour of the entire system. • Only change the controller parameters with the aid of FCT. • Follow the instructions in FCT for the controller parameters.			
Position controller: closed loop natural frequency	1024	18_d (CI: 12h)			
	Position controller: circuit frequency. Value range: 1...1000				
Position controller: damping	1024	19_d (CI:13h)			
	Position controller: damping. Value range: 100...5000				
Current controller: gain	1024	20_d (CI:14h)			
	Current controller: gain. Value range: 100...10000				
Current controller: integrating time constant	1024	21_d (CI:15h)			
	Current controller: I-share. Value range: 1...15000				
CI / DS402	60FBh	12h...15h		int32	rw

Motor data					
PNU	**1025**	**1, 3**		**uint32**	**r**
Description	Drive data				
Serial number	1025	1			
	Serial number of the motor				
I^2t factor	1025	3			
	I^2t factor. See PNU 1027.				
CI / DS402	6410h	01h, 03h		uint32	r

Drive data (data of the SFC-LACI)					
PNU	**1026**	**Various**		**uint32**	**r(w)**
Description	General data of the SFC-LACI.				
Output stage temp.	1026	1 (CI:01h)			r
	Temperature of the SFC-LACI in °C. Range: -20...+120 °C				
Output stage max. temp.	1026	2 (CI:02h)			r
	Highest temperature measured to date for the SFC-LACI, in °C. Stored in EEPROM.				
Max. current	1026	4 (CI: 04h)			rw
	Current limiting. Identical to PNU 1034 / 6073h and 6510/41h.				
Device control	1026	6 (CI: 06h)			rw
	Identical to PNU 125 / 207Dh. Bit 0 = 0: Control interface OFF, control via HMI or FCT ON Bit 0 = 1: Control interface ON To enable FCT control after the control interface has been switched off, set ENABLE OPERATION in the Control Word as well (object 6040h).				
Controller serial number	1026	7 (CI: 07h)			r
	Serial number of the SFC-LACI				
CI / DS402	6510h	Various		uint32	r(w)
Further subindices of 6510h: see section C.3.					

I2t value					
PNU	**1027**	**–**		**uint32**	**r**
Description	Actual I^2t value. See PNU 1025/4.				
CI / DS402	6410h	04h		uint32	r

Max phase current					
PNU	**1028**	**–**		**uint32**	**rw**
Description	Max. string current. Value range: 0...20000 mA. Default: 15000 mA.				
CI / DS402	6410h	05h		uint32	rw

Quick stop deceleration ramp					
PNU	**1029**	**–**		**uint32**	**rw**
Description	Deceleration during quick stop, in [increments/s^2]				
CI / DS402	6085h	00h		uint32	rw

Electronic type plate

Motor type					
PNU	**1030**	**–**		**uint16**	**r**
Description	Classification of the motor. Fixed: 0x0000.				
CI / DS402	6402h	00h		uint16	r

Maximum current					
PNU	**1034**	**–**		**uint16**	**rw**
Description	Maximum motor current in per mill of rated current (PNU 1035). **Note:** The current limitation also limits the max. possible speed (or force). Higher setpoint speeds may not therefore be reached, or the drive stops. During homing: At greatly reduced values combined with high travelling resistance, there is a danger that the drive will come to a standstill and the SFC-LACI will wrongly recognize a stop.				
CI / DS402	6073h	00h		uint16	rw

Rated motor current					
PNU	**1035**	**–**		**uint32**	**rw**
Description	Nominal current of the motor in [mA]. The value is fixed.				
CI / DS402	6075h	00h		uint32	rw

Rated motor torque/force					
PNU	**1036**	**–**		**uint32**	**rw**
Description	Nominal force of the linear motor in [mN]. The value is fixed.				
CI / DS402	6076h	00h		uint32	rw

Objects of the standstill monitoring

Position demand value					
PNU	**1040**	**–**		**int32**	**r**
Description	Controller setpoint position in [increments]				
CI / DS402	6062h	00h		int32	r

Position actual value					
PNU	**1041**	**–**		**int32**	**r**
Description	Current position of the drive in [increments]				
CI / DS402	6064h	00h		int32	r

Standstill position window					
PNU	**1042**	**–**		**uint32**	**rw**
Description	Standstill position window in [increments]: Amount by which the drive may move after “Motion complete”, until the standstill monitoring responds.				
CI / DS402	2040h	00h		uint32	rw

Standstill timeout					
PNU	**1043**	**–**		**uint16**	**rw**
Description	Standstill monitoring time in [ms}: Time during which the drive must be outside the standstill position window before the standstill monitoring responds. Value range: 0...65535 (0xFFFF). Default: 80				
CI / DS402	2041h	00h		uint16	rw

B.3.10 Supplementary parameters

Following error window					
PNU	**1044**	**–**		**uint32**	**rw**
Description	Permissible size of a following error (offset between actual position and setpoint position). Write 0xFFFFFFFF = following error monitoring OFF				
CI / DS402	6065h	00h		uint32	rw

Following error timeout					
PNU	**1045**	**–**		**uint16**	**rw**
Description	Time that a following error may remain larger than the value specified in PNU 1044 before a following error is reported. Value range: 1...60000. Default: 80 ms.				
CI / DS402	6066h	00h		uint16	rw

Commutation point					
PNU	**1050**	**–**		**int32**	**r**
Description	Commutation point (is determined automatically) [increments]				
CI / DS402	6410h	11h		int32	r

Measurement system resolution					
PNU	**1051**	**–**		**uint32**	**rw**
Description	Number of increments between two index pulses (fixed = 2048)				
CI / DS402	6410h	12h		uint32	rw

Measurement system pitch					
PNU	**1052**	**–**		**uint32**	**r**
Description	Measurement graduation: distance [µm] between two index pulses				
CI / DS402	6410h	13h		uint32	r

Nominal power					
PNU	**1053**	**–**		**uint32**	**r**
Description	Nominal power of the linear motor in [W]				
CI / DS402	6410h	14h		uint32	r

Actual power					
PNU	**1054**	**–**		**uint32**	**r**
Description	Actual power of the linear motor in [W]				
CI / DS402	6410h	15h		**uint32**	r

Offset reference point					
PNU	**1055**	**–**		**int32**	**rw**
Description	Distance in increments from the reference point to the retracted end position. Must be stated when homing to a stop. See Tab. 1/3.				
CI / DS402	6410h	16h		int32	rw

Commutation status					
PNU	**1056**	**–**		**uint8**	**r**
Description	State of the commutation point search 0x00: No commutation (default) 0x01: Commutation point search active 0x10: Commutation point successfully found 0xFE: Fault in commutation (POSITION PLAUSIBILITY ERROR) 0xFF: Fault in commutation (COMMUTATION POINT ERROR)				
CI / DS402	2050h	00h		uint8	r

Position record power consumption					
PNU	**1057**	**–**		**uint32**	**r**
Description	Power consumption in [W] during last positioning record.				
CI / DS402	6410h	17h		uint32	r

Positioning time					
PNU	**1058**	**–**		**uint32**	**r**
Description	Duration of the last positioning motion in [ms].				
CI / DS402	6410h	18h		uint32	r

Actual current					
PNU	**1059**	**–**		**int32**	**r**
Description	Actual current in [mA]				
CI / DS402	6410h	19h		int32	r

Actual coil temperature (temperature of the linear motor coils)					
PNU	**1060**	**–**		**int16**	**r**
Description	Measuring range: -20...+120 °C				
CI / DS402	6410h	31h		int16	r

Max. coil temp					
PNU	**1061**	**–**		**int16**	**r**
Description	Highest coil temperature measured to date (= motor). Is saved in EEPROM. Measuring range: -20...+120 °C.				
CI / DS402	6410h	32h		int16	r

Lower coil temp threshold					
PNU	**1062**	**–**		**uint16**	**rw**
Description	Lower temperature threshold of the coils (= motor): 70 °C. A warning is triggered when this temperature is reached.				
CI / DS402	6410h	33h		uint16	rw

Upper coil temp threshold					
PNU	**1063**	**–**		**uint16**	**rw**
Description	Upper temperature threshold of the coils (= motor): 75 °C An error message is triggered when this temperature is reached. Restart only after the temperature has dropped below the lower threshold (see PNU 1062).				
CI / DS402	6410h	34h		uint16	rw

Output stage temperature					
PNU	**1066**	**–**		**int16**	**r**
Description	Temperature of the SFC-LACI output stage. Range: -20...+120 °C.				
CI / DS402	6510h	31h		int16	r

Output stage max temp					
PNU	**1067**	**–**		**int16**	**r**
Description	Highest temperature measured to date for the SFC-LACI, in °C. Stored in EEPROM.				
CI / DS402	6510h	32h		int16	r

Output stage lower threshold temperature					
PNU	**1068**	**–**		**uint16**	**rw**
Description	Lower temperature threshold for SFC-LACI: 80 °C A warning is triggered when this temperature is reached.				
CI / DS402	6510h	33h		uint16	rw

Output stage upper threshold temperature					
PNU	**1069**	**–**		**uint16**	**rw**
Description	Upper temperature threshold for SFC-LACI: 85 °C. When this temperature is reached, an error message is triggered. Restart only after the temperature has dropped below the lower threshold (see PNU 1068).				
CI / DS402	6510h	34h		uint16	rw

Power supply					
PNU	**1070**	**–**		**int32**	**rw**
Description	Output of power supply unit in [W]. Value range: 0...3000 W. Default: 960 W. The nominal power rating must be stated exactly. Rounding up (e.g. from 960 W to 1000 W) is not permitted.				
CI / DS402	6510h	50h		int32	rw

Tool load					
PNU	**1071**	**–**		**uint32**	**rw**
Description	Tool load, e.g. a gripper on the front plate (or piston rod) of the drive.				
CI / DS402	6510h	51h		uint32	rw

Delay for commutation start					
PNU	**1072**	**–**		**uint32**	**rw**
Description	Waiting time [ms] between ENABLE and the start of the commutation point search. Default = 0 ms. During the search for the commutation point the drive vibrates. If several drives are fitted in a system which can vibrate and if the search for the commutation point is made at the same time, it may happen that the vibrations are superimposed and the complete system vibrates in an uncontrolled manner. The drives cannot then complete the search for the commutation point successfully. • In this case, start the search for the commutation point at staggered intervals: – by enabling the drives at staggered intervals via the PLC/IPC or – via this object.				
CI / DS402	2051h	00h		uint32	rw

Local digital output 1 – function					
PNU	**1240**	**–**	**–**	**uint8**	**rw**
Description	Out1: Use. See section 5.6.10.				
CI / DS402	2421h	01h		uint8	rw

Local digital output 1 – trigger ON					
PNU	**1241**	**–**	**–**	**uint8**	**rw**
Description	Out1: Setting condition. See section 5.6.10.				
CI / DS402	2421h	02h		uint8	rw

Local digital output 1 – trigger OFF					
PNU	**1242**	**–**	**–**	**uint8**	**rw**
Description	Out1: Resetting condition. See section 5.6.10.				
CI / DS402	2421h	03h		uint8	rw

Local digital output 1 – value ON					
PNU	**1243**	**–**	**–**	**int32**	**rw**
Description	Out1: Setting with record number comparison. See section 5.6.10.				
CI / DS402	2421h	04h		int32	rw

Local digital output 1 – value OFF					
PNU	**1244**	**–**	**–**	**int32**	**rw**
Description	Out1: Resetting with record number comparison. See section 5.6.10.				
CI / DS402	2421h	05h		int32	rw

Local digital output 1 – direction value ON					
PNU	**1245**	**–**	**–**	**uint8**	**rw**
Description	Out1: Edge type for setting condition. See section 5.6.10.				
CI / DS402	2421h	06h		uint8	rw

Local digital output 1 – direction value OFF					
PNU	**1246**	**–**	**–**	**uint8**	**rw**
Description	Out1: Edge type for resetting condition. See section 5.6.10.				
CI / DS402	2421h	07h		uint8	rw

Local digital output 1 – delay					
PNU	**1247**	**–**	**–**	**uint16**	**rw**
Description	Out1: Delay time for resetting. See section 5.6.10.				
CI / DS402	2421h	08h		uint16	rw

Local digital output 1 – inverted					
PNU	**1248**	**–**	**–**	**uint8**	**rw**
Description	Out1: Invert. See section 5.6.10.				
CI / DS402	2421h	09h		uint8	rw

Local digital output 2 – function					
PNU	**1250**	**–**	**–**	**uint8**	**rw**
Description	Out2: Use. See section 5.6.10.				
CI / DS402	2422h	01h		uint8	rw

Local digital output 2 – trigger ON					
PNU	**1251**	**–**	**–**	**uint8**	**rw**
Description	Out2: Setting condition. See section 5.6.10.				
CI / DS402	2422h	02h		uint8	rw

Local digital output 2 – trigger OFF					
PNU	**1252**	**–**	**–**	**uint8**	**rw**
Description	Out2: Resetting condition. See section 5.6.10.				
CI / DS402	2422h	03h		uint8	rw

Local digital output 2 – value ON					
PNU	**1253**	**–**	**–**	**int32**	**rw**
Description	Out2: Setting with record number comparison. See section 5.6.10.				
CI / DS402	2422h	04h		int32	rw

Local digital output 2 – value OFF					
PNU	**1254**	**–**	**–**	**int32**	**rw**
Description	Out2: Resetting with record number comparison. See section 5.6.10.				
CI / DS402	2422h	05h		int32	rw

Local digital output 2 – direction value ON

PNU	**1255**	**–**	**–**	**uint32**	**rw**
Description	Out2: Edge type for setting condition. See section 5.6.10.				
CI / DS402	2422h	06h		uint8	rw

Local digital output 2 – direction value OFF

PNU	**1256**	**–**	**–**	**uint8**	**rw**
Description	Out2: Edge type for resetting condition. See section 5.6.10.				
CI / DS402	2422h	07h		uint8	rw

Local digital output 2 – delay

PNU	**1257**	**–**	**–**	**uint16**	**rw**
Description	Out2: Delay time for resetting. See section 5.6.10.				
CI / DS402	2422h	08h		uint16	rw

Local digital output 2 – inverted

PNU	**1258**	**–**	**–**	**uint8**	**rw**
Description	Out2: Invert. See section 5.6.10.				
CI / DS402	2422h	09h			rw

Local digital output 2 – PWM value

PNU	**1259**	**–**	**–**	**uint16**	**rw**
Description	Out2: PWM value. See section 5.6.10.				
CI / DS402	2422h	0Ah		uint16	rw

Limit switch polarity					
PNU	**1300**	**–**	**–**	**int16**	**rw**
Description	Limit switch type: 0 = no limit switch, 1 = N/C contact, 2 = N/O contact				
CI / DS402	6510h	11h		int16	rw

Limit switch selector					
PNU	**1301**	**–**	**–**	**int16**	**rw**
Description	Input for limit switch. 0 none 1 IN0 = limit switch negative IN1 = limit switch positive 2 IN0 = limit switch positive IN1 = limit switch negative 3 IN0 = limit switch negative IN2 = limit switch positive 4 IN0 = limit switch positive IN2 = limit switch negative 5 IN1 = limit switch negative IN2 = limit switch positive 6 IN1 = limit switch positive IN2 = limit switch negative				
CI / DS402	6510h	12h		int16	rw

Homing switch selector					
PNU	**1302**	**–**	**–**	**int16**	**rw**
Description	Input for reference switch: 0 = none, 1 = IN0, 2 = IN1, 3 = IN2				
CI / DS402	6510h	13h		int16	rw

Homing switch polarity					
PNU	**1303**	**–**	**–**	**int16**	**rw**
Description	Reference switch type: 0 = N/C contact, 1 = N/O contact				
CI / DS402	6510h	14h		int16	rw

Limit switch deceleration					
PNU	**1304**	**–**	**–**	**int32**	**rw**
Description	Limit switch deceleration: decelerating in [m/s^2] with limit switch signal				
CI / DS402	6510h	15h		int32	rw

Sample input					
PNU	**1305**	**–**	**–**	**uint32**	**rw**
Description	Input for on-the-fly measurement (position sampling) Value = 1: sampling at IN1; value = 2: sampling at IN2. See 5.6.12.				
CI / DS402	6510h	16h		uint32	rw

Limit switch polarity					
PNU	**1306**	**–**	**–**	**uint8**	**rw**
Description	Type of proximity switch used for position sampling. 0 = N/C contact, 1 = N/O contact				
CI / DS402	6510h	1Ch		uint8	rw

Brake delay time switch ON					
PNU	**1310**	**–**	**–**	**uint16**	**rw**
Description	Brake: switch on delay, see section 5.6.11				
CI / DS402	6510h	17h		uint16	rw

Brake delay time switch OFF					
PNU	**1311**	**–**	**–**	**uint16**	**rw**
Description	Brake: switch-off delay, see section 5.6.11				
CI / DS402	6510h	18h		uint16	rw

Automatic brake time					
PNU	**1312**	**–**	**–**	**uint16**	**rw**
Description	Activation time of the automatic brake. See section 5.6.11.				
CI / DS402	6510h	19h		uint16	rw

Object directory DS402 and CI

Appendix C

Contents

C.1 Finite state machine DS402

Deviation: see transfer 19

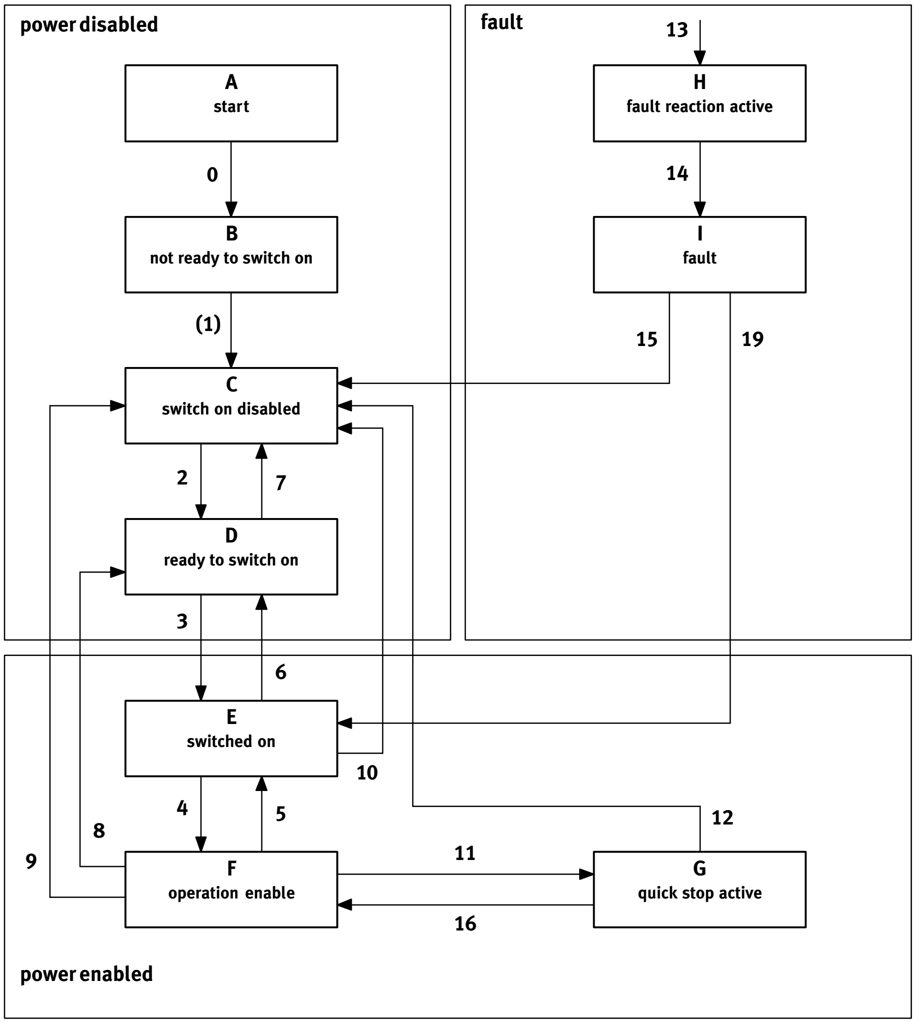


Fig. C/2: Finite state machine 402 with deviations

Description of the states

Status	Description
A “Start”	This state is assumed at power-on, on reset or when a reset command is entered via the fieldbus. After execution of the startup code, power to the power section is cut and the status branches to B.
B “Not ready to switch on”	In this status logic self-tests are carried out. Internal working variables are initialised. The mechanical brake is actuated, if fitted. The power supply to the power section remains cut. The fieldbus interface is initialised and communication enabled. The CI is initialised at the serial interface.
C “Switch on disabled”	The supply to the power section remains cut. The fieldbus and/or CI communication initialised in status B is started, enabling controller parameters, program records etc. to be modified. As from this status, changes of state are possible only by way of fieldbus commands or if a serious error has occurred.
D “Ready to switch on”	Power to the power section is switched on, power section self-tests requiring no movement of the axis are carried out. By way of fieldbus and/or CI communication controller parameters, program records etc. can be modified (see also status E).
E “Switched on”	This status is practically identical to status D. In accordance with DS402, power to the power section **must** be switched on in E, whereas in D it **may** be switched on.
F “Operation enable”	The drive waits for positioning tasks and executes them. Normal operating status after successful initialisation.
G “Quick stop active”	The Quick stop function has been activated. The drive runs as parameterised (ramp) and then stops. The power section and motor remain switched on, acceptance of positioning tasks is refused.

Status	Description
H “Fault reaction active”	This status can be assumed from any situation if a serious error is detected. The parameterised error response (emergency ramp, immediate stop etc.) is executed. Communication via the fieldbus is maintained, parameter modifications are permitted. The motor remains switched on.
I “Fault”	In this status the motor remains switched on, provided the error which has occurred permits. Otherwise the output stage is disabled and the mechanical brake is actuated. No more positioning movements are executed.

Tab. C/9: Description of the states

Description of the transfer conditions

Condition for status transfer	Description
0 “Start” -> “Not ready to switch on”	This status transition always takes place unconditionally after a (re)start.
1 “Not ready to switch on” -> “Switch on disabled”	The self-test of the 5 V logic has been completed successfully. Communication via the fieldbus can, but does not have to be already active. No special signal levels from DS402 are required for the change of status (automatic transfer).
2 “Switch on disabled” -> “Ready to switch on”	Fault reset = 0, Quick stop = 1, Enable voltage = 1, Switch on = 0. No serious error.
3 “Ready to switch on” -> “Switched on”	Fault reset = 0, Enable operation = 0, Quick stop = 1, Enable voltage = 1, Switch on = 1. Note: In DS402 the same status transition also for Enable Operation = 1, rest the same. This combination is also provided for transitions 4 and 16 however, but in 4 there is a conflict. So this combination is not applied here. No serious error.
4 “Switched on” -> “Operation enable”	Fault reset = 0, Enable operation = 1, Quick stop = 1, Enable voltage = 1, Switch on = 1. No serious error.

Condition for status transfer	Description
5 "Ready to switch on" -> "Switched on"	Fault reset = 0, Enable operation = 0, Quick stop = 1, Enable voltage = 1, Switch on = 1. No serious error.
6 "Switched on" -> "Ready to switch on"	Fault reset = 0, Quick stop = 1, Enable voltage = 1, Switch on = 0. No serious error.
7 "Ready to switch on" -> "Switch on disabled"	Fault reset = 0, Enable voltage = 0 or Fault reset = 0, Quick stop = 0, Enable voltage = 1. No serious error.
8 "Operation enable" -> "Ready to switch on"	Fault reset = 0, Quick stop = 1, Enable voltage = 1, Switch on = 0. No serious error.
9 "Operation enable" -> "Switch on disabled"	Fault reset = 0, Enable voltage = 0. No serious error.
10 "Switched on" -> "Switch on disabled"	Fault reset = 0, Enable voltage = 0 or Fault reset = 0, Quick stop = 0, Enable voltage = 1. No serious error.
11 "Operation enable" -> "Quick stop active"	Fault reset = 0, Quick stop = 0, Enable voltage = 1. No serious error.
12 "Quick stop active" -> "Switch on disabled"	Fault reset = 0, Enable voltage = 0, Disable voltage = 1. No serious error.
13 From anywhere to "Fault reaction active"	Serious error, dependent on the device technology employed, which forces normal operation to be aborted. The status transition is independent of the control signals currently being sent.
14 "Fault reaction active" -> "Fault"	The cause of the fault must be eliminated (e.g. overheating, temperature reduced to permissible level). The emergency stop reaction is completed. A positive edge comes from the fieldbus on Fault Reset.
15 "Fault" -> "Switch on disabled"	Fault Reset = positive edge and at least one of the signals Enable Operation, Quick Stop, Enable Voltage and Switch on **not** 1. No serious error.

Condition for status transfer	Description
16 “Quick stop active” -> “Operation enable”	Fault reset = 0, Enable operation = 1, Quick stop = 1, Enable voltage = 1, Switch on = 1. Transfer defined via “Quick stop option code” 605Ah. No serious error.
19 “Fault” -> “Switched on”	Fault reset = positive edge, Enable operation = 1, Quick stop = 1, Enable voltage = 1, Switch on = 1. **Note:** This transition is not included in the DS402 profile. However, it is required for drives with non-self-locking shut-off characteristics, so as to avoid uncontrolled movement under load when the drive is switched off.

Tab. C/10: Description of the transfer conditions

C.2 Object directory DS402 and CI

A detailed description can be found in

– the appendix B.3.4 (sorted according to PNU, see table column FHPP – PNU) or

– in the appendix C.3 (DS402 and CI objects).

Several objects are available via CI, but not via DS402 (e.g. the fieldbus address 2FF3h). Use here FCT or a terminal program (⟶ Appendix C.4).

Name	Object		DS	CI	FHPP	⟶
	Index	Sub	402		PNU	
Group 1xxx: Communication profile area						
Device type	1000h	–	x	x	–	C.3
Error register	1001h	–	x	–	–	C.3
Predefined error field	1003h	1...n	x	–	–	C.3
COB-ID Sync message	1005h	–	x	–	–	C.3
Manufacturer device name	1008h	–	x	x	120	B.3.4
Manufacturer hardware version	1009h	–	x	x	–	C.3
Manufacturer firmware version	100Ah	–	x	x	–	C.3
Guard time	100Ch	–	x	–	–	C.3
Life time factor	100Dh	–	x	–	–	C.3
COB-ID Emergency message	1014h	–	x	–	–	C.3
Emergency inhibit time	1015h	–	x	–	–	C.3
Identity object	1018h	1...4	x	–	–	C.3
Receive PDO 1/2 communication parameters	1400h 1401h	1...5	x	–	–	C.3
Receive PDO 1/2 mapping	1600h 1601h	1...4	x	–	–	C.3

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Transmit PDO 1/2 communication parameters	1800h 1801h	1...5	x	–	–	C.3
Transmit PDO 1/2 mapping	1A00h 1A01h	1...4	x	–	–	C.3
Group 2xxx: Manufacturer specific profile area						
CMXR: Extended status word	2000h	1	x	x	–	C.3
Record number	2032h	1	x	x	–	C.3
Record number	2033h	1...3	–	x	400	B.3.7
Standstill position window	2040h	–	x	x	1042	B.3.9
Standstill timeout	2041h	–	x	x	1043	B.3.9
Position sampling – trigger mode	204Ah	1	x	x	352	B.3.6
Position sampling – status		2	x	x	353	
Position sampling – status mask		3	x	x	354	
Position sampling – control byte		4	x	x	355	
Position sampling – position rising edge		5	x	x	350	
Position sampling – position falling edge		6	x	x	351	
Commutation status	2050h	–	x	x	1056	B.3.10
Delay for commutation start	2051h	–	x	x	1072	B.3.10
FHPP version	2066h	–	x	x	102	B.3.4
Version FCT plug-in min.	2067h	–	–	x	–	C.3
Version FCT plug-in opt.	2068h	–	–	x	–	C.3
Manufacturer hardware version BCD	2069h	–	–	x	100	B.3.4
Manufacturer firmware version BCD	206Ah	–	–	x	101	B.3.4
Version FCT plug-in BCD	206Bh	1...2	–	x	104	B.3.4
Controller serial number	2072h	–	x	x	114	B.3.4

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Device control	207Dh	–	x	x	125	B.3.4
FHPP status data	20A0h	1...2	x	x	320	B.3.6
FHPP control data	20A1h	1...2	x	x	321	B.3.6
Interpolation time	20B6h	–	–	x	570	B.3.8
Axis interface 1	20BAh	1...Ah	–	x	–	C.3
Axis interface 2	20BBh	1...3h	–	x	–	C.3
Diagnostic event	20C8h	1...10h	x	x	200	B.3.5
Error number	20C9h	1...10h	x	x	201	
Time stamp	20CAh	1...10h	x	x	202	
Additional information	20CAh	1...10h	x	x	203	
Diagnostic memory administration	20CCh	1...4	x	x	204	
HMI scaling	20D0h	1...2	x	x	–	C.3
Record table element CI	20E0h	1...Bh	x	x	–	C.3
Axis parameter	20E2h	1...6	x	x	1005	B.3.9
Controller type	20E3h	–	x	x	115	B.3.4
Record delay	20E4h	1...20h	x	x	405	B.3.7
Record following record	20E5h	1...20h	x	x	416	B.3.7
Position window time (incl. Jog mode)	20E6h	1...21h	x	x	415	B.3.7
Direct mode position window time		22h	x	x	1023	B.3.9
Jerk acceleration (incl. Jog mode)	20E7h	1...21h	x	x	409	B.3.7
Direct mode jerk acceleration		22h	–	x	543	B.3.8
Workpiece load (incl. Jog mode)	20E8h	1...21h	x	x	410	B.3.7
Direct mode work load		22h	–	x	544	B.3.8
Jog mode slow motion time	20E9h	21h	–	x	534	C.3

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Record control byte 1	20EAh	1...22h	x	x	401	B.3.7
Record control byte 2	20EBh	1...20h	x	x	402	B.3.7
Target position	20ECh	1...22h	x	x	404	B.3.7
Record velocity	20EDh	1...20h	x	x	406	B.3.7
Jog mode velocity phase 2		21h	–	x	531	B.3.8
Record acceleration	20EEh	1...20h	x	x	407	B.3.7
Jog mode acceleration		21h	–	x	532	B.3.8
Direct mode acceleration		22h	–	x	541	B.3.8
Deceleration (incl. Jog mode)	20EFh	1...21h	x	x	408	B.3.7
Direct mode deceleration		22h	–	x	542	B.3.8
Data memory control	20F1h	1...3	x	x	127	B.3.4
Trace control	20F2h	1...Ah	x	x	1900	C.3
CI Checksum active	20F3h	–	–	x	–	C.3
FCT password	20FAh	1...2	–	x	–	C.3
Local password	20FBh	–	–	x	–	C.3
User device name	20FDh	–	x	x	121	B.3.4
HMI parameter	20FFh	1...4	x	x	126	B.3.4
Jerk deceleration (incl. Jog mode)	21E1h	1...21h	–	x	417	B.3.7
Direct mode jerk deceleration		22h	–	x	547	B.3.8
Project zero point	21F4h	–	x	x	500	B.3.8
Direct mode base velocity	21F8h	–	–	x	540	B.3.8
Teach target	21FCh	–	x	x	520	B.3.8
Homing required	23F6h	–	x	x	1014	B.3.9
Homing max. torque/force	23F7h	–	x	x	1015	B.3.9

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Local digital output 1 – function	2421h	1	x	x	1240	B.3.10
Local digital output 1 – trigger ON		2	x	x	1241	
Local digital output 1 – trigger OFF		3	x	x	1242	
Local digital output 1 – value ON		4	x	x	1243	
Local digital output 1 – value OFF		5	x	x	1244	
Local digital output 1 – direction value ON		6	x	x	1245	
Local digital output 1 – direction value OFF		7	x	x	1246	
Local digital output 1 – delay		8	x	x	1247	
Local digital output 1 – inverted		9	x	x	1248	
Local digital output 2 – function	2422h	1	x	x	1250	B.3.10
Local digital output 2 – trigger ON		2	x	x	1251	
Local digital output 2 – trigger OFF		3	x	x	1252	
Local digital output 2 – value ON		4	x	x	1253	
Local digital output 2 – value OFF		5	x	x	1254	
Local digital output 2 – direction value ON		6	x	x	1255	
Local digital output 2 – direction value OFF		7	x	x	1256	
Local digital output 2 – delay		8	x	x	1257	
Local digital output 2 – inverted		9	x	x	1258	
Local digital output 2 – PWM value		Ah	x	x	1259	
Position monitoring	2800h	1...2	–	x	300	B.3.6
Torque/force monitoring	2801h	1...2	–	x	301	B.3.6
Velocity monitoring	2802h	1...2	–	x	310	B.3.6
Communication error	2FF0h	–	–	x	–	C.3
Device errors	2FF1h	–	x	x	205	B.3.5

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Device warnings	2FF2h	–	x	x	215	B.3.5
CANbus address	2FF3h	–	–	x	–	C.3
CANopen diagnosis	2FF4h	1...6	x	x	206	B.3.5
CANbusData rate	2FF5h	–	–	x	–	C.3
Profiles (DS402 / FHPP)	2FF6h	–	–	x	–	C.3
CANbus voltage supply	2FF7h	–	x	x	–	C.3
CMXR: Interoperability	2FF8h	–	x	x	150	B.3.4
Extended device errors A	2FFAh	–	x	x	207	B.3.5
Extended device errors B	2FFBh	–	x	x	208	B.3.5
Extended device errors C	2FFCh	–	x	x	209	B.3.5
Version axis interface	2FFDh	–	x	x	106	B.3.4
Cycle number	2FFFh	–	x	x	305	B.3.6
Group 6xxx: Standardised device profile area						
Control word	6040h	–	x	x	330	C.3
Status word	6041h	–	x	x	331	C.3
Quick stop option code	605Ah	–	x	x	1019	B.3.9
HALT option code	605Dh	–	x	x	1020	B.3.9
Fault reaction / STOP option code	605Eh	–	x	x	1021	B.3.9
Operation mode	6060h	–	x	x	332	C.3
Operation mode display	6061h	–	x	x	333	C.3
Demand position	6062h	–	x	x	1040	B.3.9
Actual position	6064h	–	x	x	1041	B.3.9
Following error window	6065h	–	x	x	1044	B.3.10
Following error timeout	6066h	–	x	x	1045	B.3.10

Name	Object Index	Sub	DS 402	CI	FHPP PNU	→
Target position window	6067h	–	x	x	1022	B.3.9
Position window time	6068h	–	x	x	–	C.3
Demand velocity	606Bh	–	x	x	–	C.3
Actual velocity	606Ch	–	x	x	–	C.3
Target torque/force	6071h	–	x	x	–	C.3
Max. torque/force	6072h	–	x	x	512	B.3.8
Max. current	6073h	–	x	x	1034	B.3.9
Motor rated current	6075h	–	x	x	1035	B.3.9
Motor rated torque/force	6076h	–	x	x	1036	B.3.9
Actual torque/force	6077h	–	x	x	–	C.3
Target position	607Ah	–	x	x	–	C.3
Software end positions	607Bh	1...2	x	x	501	B.3.8
Offset axis zero point	607Ch	–	x	x	1010	B.3.9
Polarity	607Eh	–	x	x	1000	B.3.9
Max. velocity	607Fh	–	x	x	502	B.3.8
Profile velocity	6081h	–	x	x	–	C.3
Profile acceleration	6083h	–	x	x	–	C.3
Profile deceleration	6084h	–	x	x	–	C.3
Quick stop deceleration	6085h	–	x	x	1029	B.3.9
Motion profile type	6086h	–	x	x	506	B.3.8
Torque/force slope	6087h	–	x	x	550	B.3.8
Torque/force profile type	6088h	–	x	x	513	B.3.8
Encoder resolution	608Fh	1...2	x	x	1001	B.3.9
Gear ratio	6091h	1...2	x	x	1002	B.3.9

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Feed constant linear axis	6092h	1...2	x	x	1003	B.3.9
Position factor	6093h	1...2	x	x	1004	B.3.9
CMXR: Velocity encoder factor	6094h	1...2	x	x	–	C.3
CMXR: Acceleration factor	6097h	1...2	x	x	–	C.3
Homing method	6098h	–	x	x	1011	B.3.9
Homing velocities	6099h	1...2	x	x	1012	B.3.9
CMXR: Homing acceleration	609Ah	–	x	x	1013	B.3.9
Interpolation type	60C0h	–	x	x	–	C.3
Interpolation data	60C1h	1...2	x	x	–	C.3
Interpolation cycle time	60C2h	1...2	x	x	–	C.3
SYNC configuration	60C3h	1...2	x	x	–	C.3
Buffer configuration	60C4h	1...6	x	x	–	C.3
Max. acceleration	60C5h	–	x	x	503	B.3.8
Torque/force mode: stroke limit	60F6h	1	x	x	510	B.3.8
Torque/force mode: speed limit		2	x	x	554	
Torque/force mode: force target window		3	x	x	552	
Torque/force mode: force damping time		4	x	x	553	
Torque/force mode: min. torque/force		5	x	x	511	
Position control parameter set	60FBh	12h ... 15h	x	x	1024	B.3.9
Digital inputs	60FDh	–	x	x	303	B.3.6
Digital outputs	60FEh	1...2	x	x	304	B.3.6
Motor type	6402h	–	x	x	1030	B.3.9

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Motor data	6410h	1, 3	x	x	1025	B.3.9
I2t value		4	x	x	1027	
Max phase current		5	x	x	1028	
Commutation point		11h	x	x	1050	B.3.10
Measurement system resolution		12h	x	x	1051	
Measurement system pitch		13h	x	x	1052	
Nominal power		14h	x	x	1053	
Actual power		15h	x	x	1054	
Offset reference point		16h	x	x	1055	
Record power consumption		17h	x	x	1057	
Positioning time		18h	x	x	1058	
Actual current		19h	x	x	1059	
Actual coil temperature		31h	x	x	1060	
Max. coil temperature		32h	x	x	1061	
Lower coil temp threshold		33h	x	x	1062	
Upper coil temp threshold		34h	x	x	1063	
Supported drive modes	6502h	–	x	x	112	B.3.4
Festo order number	6503h	–	x	x	124	B.3.4
Drive manufacturer	6504h	–	x	x	122	B.3.4
HTTP drive catalogue address	6505h	–	x	x	123	B.3.4

Name	Object		DS	CI	FHPP	→
	Index	Sub	402		PNU	
Drive data	6510h	1...7	x	x	1026	B.3.9
Limit switch polarity		11h	x	x	1300	B.3.10
Limit switch selector		12h	x	x	1301	
Homing switch selector		13h	x	x	1302	
Homing switch polarity		14h	x	x	1303	
Limit switch deceleration		15h	x	x	1304	
Sample input		16h	x	x	1305	
Brake delay time switch on		17h	x	x	1310	
Brake delay time switch off		18h	x	x	1311	
Automatic brake time		19h	x	x	1312	
Limit switch polarity		1Ch	x	x	1306	
Output stage temperature		31h	x	x	1066	
Max. output stage temp		32h	x	x	1067	
Output stage lower threshold temp		33h	x	x	1068	
Output stage upper threshold temp		34h	x	x	1069	
Drive data		41,43, A0h	x	x	–	C.3
Power supply		50h	x	x	1070	B.3.10
Tool load		51h	x	x	1071	
CMXR: Configuration control word		F0h	x	x	151	B.3.4

Tab. C/1: CANopen and CI object directory

C.3 Object descriptions

Representation of DS402 and CI objects

Password

DS402 / CI	**20FAh**	**01h...02h**	**Array**	**V-string**	**rw/r**
Description	Managing the FCT password, entering the super password.				
FCT password	20FAh	01h		V-string	
	Password for the FCT software Value: ‹........› (fixed 8 characters, ASCII, 7-bit) Default: ‹00000000› (status upon delivery and after resetting)				
Super password	20FAh	02h		V-string	
	Entering the super password. Resets all passwords (FCT password and HMI password, object 20FB). Contact Festo Service if you require the super password.				

1 Name of the parameter

2 Object number

3 Subindices of the parameter

4 Class of the element

5 Type of the element

6 Description of the parameter

7 If applicable: description of the subindices

8 Read/write permission:
r = read only,
w = write only,
rw = read and write

Fig. C/1: Representation of DS402 and CI objects

C.3.1 Communication profile area

Device type					
DS402 / CI	**1000h**	**–**	**Var**	**uint32**	**r**
Description	Classification of the device type and the function. Bit: 31 ... 16 / 15 ... 0 Additional information / Device profile number Values dependent on data profile (object 2FF2/05h / PNU 206): Device profile number: DS 402: 402 (0x0192) FHPP: 301 (0x012D) Additional information: DS 402: 66 (0x0042) – Type code for servo drive FHPP: 0 (0x0000) – not used				

Error register					
DS402	**1001h**	**–**	**Var**	**uint8**	**r**
Description	Internal errors are stored in the error register. The error register is part of the emergency object. Bit: Description 0 Generic error: error occurring (Or-linking of bits 1 to 7) 1 Current: I2t error 2 Voltage: voltage monitoring error 3 Temperature: overtemperature of motor 4 Communication error (overrun, error state) 5 Missing homing, error in homing, non-permitted target position, drag error, general hardware error, error in search for commutation point 6 Reserved, fix = 0 7 Reserved, fix = 0 Values: 0 = no error; 1 = error.				

Pre-defined error field					
DS402	**1003h**	**00h...FEh**	**Array**	**uint32**	**rw/r**
Description	Error memory for emergency object. The object stores the errors reported by way of the emergency object. Each new error is stored in subindex 01h; the previous errors move one subindex down each time a new one is added.				
Number of errors		00h			rw
	Number of recorded errors as from subindex 01h. Value range 0 ... 0xFE The error field can be cleared by writing ’0’.				
Standard error field (latest error)		01h			r
	Last stored error. The error numbers comprise 16 bits of error code (lower 2 bytes – LSB, see section 6.5.2, error code in Tab. 6/10) and 16 bits of additional information (upper 2 bytes = 0).				
Standard error field (error ...)		02h...FEh			r
	Previously stored errors. See subindex 01h.				

COB-ID SYNC message					
DS402	**1005h**	**–**	**Var**	**uint32**	**rw**
Description	COB ID of synchronisation object (SYNC); see DS 301 specification. Synchronous transfer can be set if the entries in the communication parameters of the PDOs are modified. For this an entry to this object by the master is essential; see DS 301 specification. Default: 128 (0x80)				

Manufacturer hardware version					
DS402 / CI	**1009h**	**00h**	**Var**	**V-string**	**r**
Description	Hardware version in format = “V.xx.yy” (xx = main version, yy = secondary version) Compare object 2069h				

Manufacturer firmware version					
DS402 / CI	**100Ah**	**00h**	**Var**	**V-string**	**r**
Description	Firmware version in format = “V.xx.yy” (xx = main version, yy = secondary version) Compare PNU 101 / object 206Ah				

Guard time					
DS402	**100Ch**	**–**	**Var**	**uint16**	**rw**
Description	Monitoring time in [ms]. To define the “Life time” for the “Life guarding protocol” the guard time in ms is multiplied by the “Life time factor” (object 100Dh). Default: 0 (monitoring switched off) Value range: 0 ... 32767 (0x0000 ... 0x7FFF)				

Life time factor					
DS402	**100Dh**	**–**	**Var**	**uint8**	**rw**
Description	Multiplication factor for the guard time (object 100Ch). Default: 0. Value range: 0 ... 255 (0x00 ... 0xFF)				

COB-ID emergency object					
DS402	**1014h**	**–**	**Var**	**uint32**	**rw**
Description	COB ID of emergency object (EMCY); see DS 301 specification. The emergency protocol is supported. Default: 128 + Node ID (0x80 + Node ID)				

Inhibit time EMCY					
DS402	**1015h**	**–**	**Var**	**uint16**	**rw**
Description	Inhibit time for the emergency message. The value is multiplied by 100 μs. Default: 0				

Identity object					
DS402	**1018h**	**01h...04h**	**Record**	**uint32**	**r**
Description	Device identification				
Vendor ID (manufacturer ID)		01h			
	Manufacturer identifier for Festo. Fixed: 29 (0x1D)				
Product code		02h			
	Product code for the Festo configurator				
Revision number		03h			
	Firmware version, e.g. 0x 0001 000A for version 1.10				
Serial number		04h			
	See object 6510/07h or 6510/A0h.				

Receive PDO communication parameter					
DS402	**1400h, 1401h**	**01h...05h**	**Record**	**uint32, uint8, uint16**	**rw**
Description	Communication parameters of PDOs 1 and 2 which the device can receive: – PDO 1: Object 1400h – PDO 2: Object 1401h				
COB ID for PDO	1400h, 1401h	01h		uint32	
	COB ID used by the PDO. – PDO 1: Default: 0x200 + Node ID – PDO 2: Default: 0x300 + Node ID				
Transmission type	1400h, 1401h	02h		uint8	
	Transmission type Default: 255 (0xFF) – Event-triggered asynchronous transmission Value range: 0 ... 255 (0x00 ... 0xFF)				
Inhibit time	1400h, 1401h	03h		uint16	
	Inhibit time, not used for RPDO. Fixed: 0 (0x0000).				
(Reserved)	1400h, 1401h	04h		–	
	Reserved				
Event timer	1400h, 1401h	05h		uint16	
	Event counter in [ms]. Default: 0 (0x0000)				

Receive PDO 1 mapping parameter					
DS402	**1600h**	**01h...05h**	**Record**	**uint32**	**r**
Description	Mapping parameters of PDO 1 which the device can receive. No dynamic mapping possible. The specified mapping depends on the selected device profile.				
PDO mapping	1600h	01h...05h		uint32	
	PDO mapping for the n-th mapped application object, depending on the selected data/device profile:				

Subindex	FHPP	DS 402
01h	Fixed: 0x30000008	Fixed: 0x60400010
02h	Fixed: 0x30010008	Fixed: 0x20320108
03h	Fixed: 0x30020008	Fixed: 0x60600008
04h	Fixed: 0x30030008	Fixed: 0x607A0020
05h	Fixed: 0x30040020	–

Receive PDO 2 mapping parameter					
DS402	**1601h**	**01h...04h**	**Record**	**uint32**	**r**
Description	Mapping parameters of PDO 2 which the device can receive. No dynamic mapping possible. The specified mapping depends on the selected device profile.				
PDO mapping	1601h	01h...04h		uint32	
	PDO mapping for the n-th mapped application object, depending on the selected data/device profile:				

Subindex	FHPP	DS 402
01h	Fixed: 0x30100008	Fixed: 0x60810020
02h	Fixed: 0x30110008	Fixed: 0x20E00620
03h	Fixed: 0x30120010	–
04h	Fixed: 0x30130020	–

Transmit PDO communication parameter					
DS402	**1800h, 1801h**	**01h...05h**	**Record**		**rw**
Description	Communication parameters of PDOs 1 and 2 which the device can transmit: – PDO 1: Object 1800h – PDO 2: Object 1801h				
COB ID for PDO	1800h, 1801h	01h		uint32	
	COB ID used by the PDO. – PDO 1: Default: 0x180 + Node ID – PDO 2: Default: 0x280 + Node ID				
Transmission type	1800h, 1801h	02h		uint8	
	Transmission type Default: 255 (0xFF) – Event-triggered asynchronous transmission Value range: 0 ... 255 (0x00 ... 0xFF)				
Inhibit time	1800h, 1801h	03h		uint16	
	Inhibit time. Default: 0				
(Reserved)	1800h, 1801h	04h		–	
	Reserved, must not be implemented (access attempts are answered with abort code).				
Event timer	1800h, 1801h	05h		uint16	
	Event counter in [ms]. Default: 0 (0x0000)				

Transmit PDO 1 mapping parameter					
DS402	**1A00h**	**01h...05h**	**Record**	**uint32**	**r**
Description	Mapping parameters of PDO 1 which the device can transmit. No dynamic mapping possible. The specified mapping depends on the selected device profile.				
PDO mapping	1A00h	01h...05h			
	PDO mapping for the n-th mapped application object, depending on the selected data/device profile: Subindex – FHPP – DS 402 01h – Fixed: 0x30200008 – Fixed: 0x60410010 02h – Fixed: 0x30210008 – Fixed: 0x20320108 03h – Fixed: 0x30220008 – Fixed: 0x60610008 04h – Fixed: 0x30230008 – Fixed: 0x60640020 05h – Fixed: 0x30240020				

Transmit PDO 2 mapping parameter					
DS402	**1A01h**	**01h...04h**	**Record**	**uint32**	**r**
Description	Mapping parameters of PDO 2 which the device can transmit. No dynamic mapping possible. The specified mapping depends on the selected device profile.				
PDO mapping	1A01h	01h...04h			
	PDO mapping for the n-th mapped application object, depending on the selected data/device profile: Subindex – FHPP – DS 402 (not used) 01h – Fixed: 0x30300008 – Fixed: 0x60410010 02h – Fixed: 0x30310008 – Fixed: 0x20320108 03h – Fixed: 0x30320010 – Fixed: 0x60610008 04h – Fixed: 0x30330020 – Fixed: 0x60640020				

C.3.2 Manufacturer specific profile area

CMXR: Extended status word					
DS402 / CI	**2000h**	**01h**	**Array [1)]**	**uint32**	**r**
Description					
	2000h	01h		uint32	r
	Bit 0 = 1: Drive is referenced Bit 1 = 1: Commutation angle found Bit 2 = 1: “Ready for enable”				
[1)] Pseudo-array for compatibility					

Record number					
DS402 / CI	**2032h**	**01h**	**Array [1)]**	**uint8**	**rw**
Description	Selection of a positioning record (record pointer): – from the CI object for the position record table Object 20E0 (record table element) or – from the individual objects Object 607Ah: Target position Object 6081h: Profile velocity Object 6083h: Profile acceleration Object 2084h: Profile deceleration				
Record number	2032h	01h		uint8	
	Read or write record number. Values: 0 (0x00): DS402 position record (in direct mode: setpoint specification via PDOs). 1 (0x01): Reserved, **do not** use (FCT position record) 2 (0x02): Homing (position record 0) 3 (0x03): Position record 1 (default) 4 (0x04): Position record 2 ... Positioning record ... 33 (0x21): Position record 31				
[1)] Pseudo-array for compatibility					

Version FCT plug-in min.					
CI	**2067h**	**00h**	**Var**	**V-string**	**r**
Description	Minimum FCT version required. Format = “xx.yy” (xx = main version, yy = secondary version).				

Version FCT plug-in opt.					
CI	**2068h**	**00h**	**Var**	**V-string**	**r**
Description	Optimum FCT version. Format = “xx.yy” (xx = main version, yy = secondary version).				

HMI scaling (control panel settings)					
DS402 / CI	**20D0h**	**01h, 02h**	**Array**	**uint8**	**r**
Description	Units of measurement and decimal places on the control panel. See CI object 20FFh / PNU 126.				
Measuring unit		01h			
	Definition of unit of measurement. The setting for the system of measurement only affects the display. All parameters are converted to the given unit of measurement only during writing or reading. Note: The SFC-LAC operates internally with metric units; the CI interface with increments. Values: fixed = 1 (0x01): millimetres, e.g. mm, mm/s, mm/s^2				
Scaling size		02h			r
	Number of places after the decimal point. Fixed = 2.				

Record_Table_Element (element in position record table)

DS402 / CI	20E0h	01h...0Bh	Record	Various	rw
Description	Editing the entries in the positioning record table: 1 Selection of line with object 2032_h (record pointer). 2 Select column under subindex 20E0: 01...0B				

		20E0/01	20E0/02 ↓	20E0/03	20E0/04	20E0/05	20E0/...
	Record number	**RCW**	**Target position**	**Velocity**	**Acceler-ation**	**Profile jerk**	**...**
	02						
2032h⟶	03	‹1›	**‹...›**				
	...						

The values are only saved in the position record table with this command; no movement is made. The subindices 02h...06h refer to the objects 607A, 6081, 6083, 2036 and 2037. Different data types are appropriately converted when reading and writing.

Record control word (RCW)	20E0h	01h	uint16	rw
	Record control word (SSW) Bit0: =0 absolute position specified; =1 relative position specified Bit1..2: =00 Standard path generator; =11 Energy optimised path generator Bit3..7: Not used (=0) Bit8: Only with FHPP: =0 no record chaining; =1 record chaining Bit9..14: Not used (=0) Bit15: Only with FHPP: = 0 record chaining is not blocked; =1 record chaining blocked			
Target position	20E0h	02h	int32	rw
	Target position in increments (see 607Ah). Value range: $-2^{31}...+(2^{31}-1)$ (0x80000000...0x7FFFFFFF). Default: 0			
Velocity	20E0h	03h	int32	rw
	Speed in increments/s (see 6081h). Value range: 0...3072000 (0x002EE000) Inc/s ≙ 0...3000 mm/s. Default: 0.			
Acceleration	20E0h	04h	int32	rw
	Acceleration in increments/s^2 (see 6083h). Value range:1024...61440000 (0x400...0x3A98000) Inc/s^2 ≙ 1...60000 mm/s^2 Default: 7168000 (0x6D6000) ≙ 7000 mm/s^2.			

Jerk acc. (Jerk)	20E0h	05h	uint32	rw
	Jerk acceleration in increments/s^3 Value range: 0x19000...0x1E848000 inc/s^3 (≙ 1...5000 m/s^3) Default: 0x2710000 inc/s^3 ≙ 400 m/s^3			
Work load	20E0h	06h	uint32	rw
	Mass of a work item [g] for a position record. Value range: HME-16: 0...10000 g HME-25: 0...25000 g.			
Damping time	20E0h	07h	uint16	rw
	Damping time in milliseconds [ms]. If the actual position has been in the target position window for this amount of time, the “Motion complete” bit is set in the status word. Values: 1 ... 60000 ms			
Delay	20E0h	08h	int32	rw
	Only with FHPP: For record chaining (=set chaining): The time between “Motion Complete” of a chained positioning record and the start of the next positioning record. Value range: 1...60000 ms			
Following record	20E0h	09h	uint8	rw
	The subsequent positioning record for a positioning record with a chaining condition = 1.			
Deceleration	20E0h	0Ah	int32	rw
	Nominal deceleration value for braking, in increments/s^2. The value applies only to positioning, with force control the value is ignored. Values: see 04h.			
Jerk dec. (Jerk)	20E0h	0Bh	uint32	rw
	Jerk when decelerating in [increments/s^3]. Values: see 05h.			

Jog mode slow motion time					
DS402 / CI	**20E9h**	**21h**	**Var**	**uint32**	**rw**
Description	Values: 0 ... 0xFFFFFFFF. Default: 2000 [ms]				

Trace buffer control (measurement recording)					
DS402 / CI	**20F2h**	**01...0Ah**	**Record**	**Various**	
Description	Settings for recording positioning procedures using the Festo Configuration Tool (FCT)				

CI checksum active (CI checksum required)

CI	20F3h	00h	Var	uint8	rw
Description	When checksum checking is activated, the CI commands to the SFC-LAC must be provided with a checksum (see Tab. C/2). The checksum is calculated as per Tab. C/5. Example: Deactivate checksum: “=20F300:0012” (12 = checksum). The CI terminal integrated into the FCT automatically uses checksums. Values: 0x00: deactivated (default); 0x01: activated				

FCT password

CI	20FAh	01h, 02h	Array	V-string	rw/w
Description	Managing the passwords				
FCT password		01h			rw
	Password for the FCT software Value: ‹........› (fixed 8 characters, ASCII, 7-bit) Default: ‹00000000› (status upon delivery and after reset)				
Super password		02h			w
	Entering the super password. Resets all passwords (FCT password and HMI password, object 20FB). Contact Festo Service if you require the super password.				

Local password (HMI password)

CI	20FBh	00h	Var	V-string	rw
Description	Managing the (local) HMI password to enable certain functions executed via the control panel. Value: ‹........› (fixed 8 characters, ASCII, 7-bit) Only the first 3 characters are evaluated. Default: ‹**000**00000› (status upon delivery and after reset)				

Communication error (transmission error)

CI	**2FF0h**	**00h**	**Var**	**uint16**	**r**
Description	Special object; see section C.4.5. In the case of a transmission error, the value ‹0x00FF› will be transferred instead of the usual response.				

CANbus address (CAN address)

CI	**2FF3h**	**00h**	**Var**	**uint8**	**rw**
Description	Fieldbus address of the SFC-LAC. Values: 0 ... 127 (0x00 ... 0x7F) Default: 255 (0xFF, invalid address)				

CANbus data rate (CANbus transmission rate)

CI	**2FF5h**	**00h**	**Var**	**uint8**	**rw**
Description	CAN bus baud rate. Values: 0...8 ≙ 10, 20, 50, 100, 125, 250, 500, 800 and 1000 kbaud				

Profiles (device profile DS402 or FHPP)

CI	**2FF6h**	**00h**	**Var**	**uint8**	**rw**
Description	0 = DS402. 1 = FHPP				

CANbus voltage supply

DS402 / CI	**2FF7h**	**00h**	**Var**	**uint8**	**rw**
Description	0 = internal supply; 1 = external supply				

C.3.3 Standardised device profile area

Control word					
DS402 / CI	**6040h**	**00h**	**Var**	**uint16**	**rw**
Description	Modify the current controller status or trigger an activity. As status modifications require a certain amount of time, all status modifications triggered via the control word must be read back via the status word (6041h). Further commands cannot be written via the control word until the requested status can be read in the status word. Bit assignment: see Tab. C/2. Description of the DS402 finite state machine: see section C.1.				
Special features for access via the CI interface	If this object is accessed via the CI interface, the following special features must be observed compared with access via the fieldbus interface: – “Reset fault” (bit 7) as per DS 402 processing with positive edge, but via CI the level will be evaluated. – START bit (bit 4) with reference travel and positioning: as per DS402 edge-triggered, but via CI the level will be evaluated. 0-set interpreted as stop. – “HMI access locked” (bit 14): only accessible via the fieldbus. – Switch to “Operation enable” may simultaneously contain action-triggering bits (START, Jog, ...). – Shortened status transitions: – “Operation disable” command or “Switch on” (same coding): “OPERATION ENABLE” status -> “READY TO SWITCH ON”. “READY TO SWITCH ON” status -> “SWITCHED ON”. – “Disable voltage” command (bit 1 = 0, rest irrelevant) – all states -> “READY TO SWICH ON”. – “Operation enable” command (all states) -> “OPERATION ENABLE”. – “Voltage disable” and “Quick stop” commands -> “READY TO SWITCH ON” Bit assignment: see Tab. C/2. Typical values for access via the CI interface: see Tab. C/3.				

Bit	Value	Description
0...8		The bits 0...8 are only used together: – for access via the fieldbus: see DS402, – for access via the CI interface: see Tab. C/3.
9	0x0200	Reserved (= 0)
10	0x0400	
11	0x0800	Jog mode positive (like FHPP CPOS.B3)
12	0x1000	Jog mode negative (like FHPP CPOS.B4)
13	0x2000	Teach (like FHPP CPOS.B5)
14	0x4000	In direct mode: 0 = normal path generator; 1 = energy optimised. **Note:** Only available for control via the fieldbus, not via CI.
15	0x8000	In direct mode: 0 = configured values for acceleration and deceleration 1 = symmetrical ramp (deceleration = acceleration) **Note:** Only available for control via the fieldbus, not via CI.

Tab. C/2: Bit assignment control word 6040h

Value	Function
0x000F	ENABLE OPERATION, controller enable
0x000D	VOLTAGE DISABLE, end stage off
0x001F	Start ABSOLUTE movement
0x005F	Start RELATIVE movement
0x010F	Stop movement
0x008F	Reset fault + ENABLE OPERATION
0x004F	Set target position as RELATIVE.

Tab. C/3: Typical values control word (only for access via CI)

Status word					
DS402 / CI	**6041h**	**00h**	**Var**	**uint16**	**r**
Description	Reading the controller state. Bit assignment: see Tab. C/4. **Note for access via the CI interface:** If this object is accessed via the CI interface, the following special features must be observed compared with access via the fieldbus interface: – Bit 4 in CI reversed polarity relative to DS 402. – In the FAULT state, when power is applied to the axis, the state is indicated not as xxx8, but as xxxA, i. e. “Switched on” is set.				

<table>
<tr><th>Bit</th><th>Value</th><th colspan="2">Description</th></tr>
<tr><td>0</td><td>0x0001</td><td>Ready to switch on</td><td rowspan="7">Bits 0 ... 3, 5 and 6 show the status of the device
(x ... irrelevant for this status)
Value (binary) Status
xxxx xxxx x0xx 0000 Not ready to switch on
xxxx xxxx x1xx 0000 Switch on disabled
xxxx xxxx x01x 0001 Ready to switch on
xxxx xxxx x01x 0011 Switched on
xxxx xxxx x01x 0111 Operation enabled
xxxx xxxx x00x 0111 Quick stop active
xxxx xxxx x0xx 1111 Fault reaction active
xxxx xxxx x0xx 1000 Fault</td></tr>
<tr><td>1</td><td>0x0002</td><td>Switched on</td></tr>
<tr><td>2</td><td>0x0004</td><td>Operation enabled</td></tr>
<tr><td>3</td><td>0x0008</td><td>Fault</td></tr>
<tr><td>4</td><td>0x0010</td><td>Voltage enabled</td></tr>
<tr><td>5</td><td>0x0020</td><td>Quick stop</td></tr>
<tr><td>6</td><td>0x0040</td><td>Switch on disabled</td></tr>
<tr><td>7</td><td>0x0080</td><td colspan="2">Warning</td></tr>
<tr><td>8</td><td>0x0100</td><td colspan="2">Drive is moving (like FHPP SPOS.B4)</td></tr>
<tr><td>9</td><td>0x0200</td><td colspan="2">Higher-order controller (“Remote”, like FHPP SCON.B5)</td></tr>
<tr><td>10</td><td>0x0400</td><td colspan="2">Target reached (= Motion complete)
(parameterisable via 6067h and 6068h)</td></tr>
<tr><td>11</td><td>0x0800</td><td colspan="2">I^2t error (“Internal limit active”)</td></tr>
<tr><td>12</td><td>0x1000</td><td colspan="2">Depends on operating mode (object 6060h):
– Profile position mode: “Setpoint_acknowledge”
– Homing mode: “Homing_attained”
– Profile torque mode: is running
– Interpolated position mode: IP mode active</td></tr>
<tr><td>13</td><td>0x2000</td><td colspan="2">Depends on operating mode (object 6060h):
– Positioning mode: Following error
– Homing mode: “Homing_error”
– Profile torque mode: Stroke limit reached
– Interpolated position mode: Reserved</td></tr>
<tr><td>14</td><td>0x4000</td><td colspan="2">Teach acknowledge (confirmation of a teach procedure)</td></tr>
<tr><td>15</td><td>0x8000</td><td colspan="2">Drive is referenced.</td></tr>
</table>

Tab. C/4: Bit assignment status word 6041h

Operation mode					
DS402 / CI	**6060h**	**00h**	**Var**	**int8**	**rw**
Description	Operation mode of the controller: 0xF9: FHPP continuous mode (-7d) 0xFE: Demo mode (fixed sequence) 0x01: Profile position mode (positioning mode) 0x04: Profile torque mode (force mode) 0x06: Homing mode (reference run) 0x07: Interpolated position mode				

Operation mode display					
DS402 / CI	**6061h**	**00h**	**Var**	**int8**	**r**
Description	Reading the operating mode of the controller. Values see object 6060h.				

Position window time (damping time)					
DS402 / CI	**6068h**	**00h**	**Var**	**int8**	**r**
Description	Damping time of the relevant active record in [ms]. Compare PNU 415.				

Velocity demand value (current speed setpoint value)					
DS402 / CI	**606Bh**	**00h**	**Var**	**int32**	**r**
Description	Current nominal velocity value for speed regulator. Value range: -2^{31} ... $+(2^{31}-1)$ [increments/s]				

Velocity actual value (current velocity actual value)					
DS402 / CI	**606Ch**	**00h**	**Var**	**int32**	**r**
Description	Current actual velocity value for speed regulator. Value range: -2^{31} ... $+(2^{31}-1)$ [increments/s]				

Target torque					
DS402 / CI	**6071h**	**00h**	**Var**	**int16**	**rw**
Description	Nominal value for force control. Specified in 1/1000 of rated value (PNU 512). Transmitted in the PDO1 as with device profile DS402. Value range: 300 ... 1000 permil.				

Actual torque/force					
DS402 / CI	**6077h**	**00h**	**Var**	**int16**	**r**
Description	Actual value in force mode. Specified in 1/1000 of rated value (PNU 512).				

Target position					
DS402 / CI	**607Ah**	**00h**	**Var**	**int32**	**rw**
Description	Defining or reading a target position in increments. This position will be saved in the position table in the column intended in the line addressed by object 2032. No movement is made at this point. For values, see 20E0/02_h.				

Profile velocity					
DS402 / CI	**6081h**	**00h**	**Var**	**int32**	**rw**
Description	Final speed for a positioning procedure in increment/s. This position will be saved in the position table in the column intended in the line addressed by object 2032. No movement is yet made. For values, see 20E0/03_h.				

Profile acceleration					
DS402 / CI	**6083h**	**00h**	**Var**	**uint32**	**rw**
Description	Acceleration for a positioning movement (see 6081) in increments/s^2. For values, see 20E0/04_h.				

Profile deceleration					
DS402 / CI	**6084h**	**00h**	**Var**	**uint32**	**rw**
Description	Deceleration for a positioning movement (see 6081h) in increments/s^2. For values, see 20E0/0Ah.				

CMXR: Velocity encoder factor (speed factor for CMXR)					
DS402 / CI	**6094h**	**01h, 02h**	**Array**	**uint32**	**r**
Description					
Numerator		01h			
	Encoder resolution * 1000 = 2 048 000				
Denominator		02h			
	Measurement graduation: distance in [µm] between two index pulses. Values: 2000 (DFME) / 5000 (DNCE)				

CMXR: Acceleration factor					
DS402 / CI	**6097h**	**01h, 02h**	**Array**	**uint32**	**r**
Description					
Numerator		01h			
	Encoder resolution * 1000 = 2 048 000				
Denominator		02h			
	Measurement graduation: distance in [µm] between two index pulses. Values: 2000 (DFME) / 5000 (DNCE)				

Interpolation type					
DS402 / CI	**60C0h**	**00h**	**Var**	**int16**	**rw**
Description	Fixed = -2: Interpolation manufacturer-specific				

Interpolation data					
DS402 / CI	**60C1h**	**01h, 02h**	**Record**		**rw**
Description	Interpolation data record				
Demand position		01h		int32	
	Setpoint position value				
Control word		02h		uint8	
	Always = 0 for absolute interpolation				

Interpolation cycle time					
DS402 / CI	**60C2h**	**01h, 02h**	**Record**		**rw**
Description	Interpolation time				
Cycle time		01h		uint8	
	Time units 4...10 or 40...100				
Time base		02h		int8	
	Time basis 1 ms (-3) or 1/10 ms (-4)				

SYNC configuration					
DS402 / CI	**60C3h**	**01h, 02h**	**Array**		**rw**
Description					
Synchronize on group		01h		uint8	
	Fixed = 0: Standard SYNC telegram				
SYNC every event		02h		uint8	
	Fixed = 1: for each SYNC event				

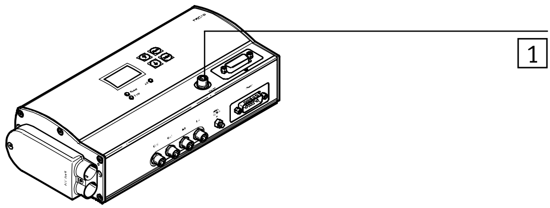
Buffer configuration					
DS402 / CI	**60C4h**	**01h...06h**	**Record**		
Description					
Max. buffer size		01h		uint32	r
	Maximum buffer size. Fixed = 0 (no buffer used).				
Actual buffer size		02h		uint32	rw
	Actual buffer size. Fixed = 0.				
Buffer organisation		03h		uint8	rw
	Buffer organisation. Fixed = 0.				
Buffer position		04h		uint16	rw
	Buffer position Fixed = 0.				
Size of data record		05h		uint8	rw
	Size of data records in bytes. Fixed = 4.				
Buffer clear		06h		uint8	w
	Write “0”: Do not permit access to 60C1h (no nominal values are transferred). Write “1”: Permit access to 60C1h.				

Drive data (data of the SFC-LAC)				
DS402 / CI	**6510h**	**Various**	**Record**	**r(w)**
Description	General data of the SFC-LAC.			
Max. current		41h	uint16	rw
	Identical to 6073h/PNU1034.			
Device control		43h	uint16	rw
	Identical to PNU 125 / 207Dh and PNU 1026/06.			
Controller serial number		A0h	uint32	r
	Serial number of the controller in format 0xDDMYYSSS: DD (Day): 8 bits: 0x01...0x1F M (Month): 4 bits: 0x1...0xC YY (Year): 8 bits: 0x00...0x63 SSS (Serial number): 12 bits: 0x001...0xFFF			

C.4 The CI interface

C.4.1 Using the parameterising interface

The parameterising interface (RS232) can be used to access the objects of the “Command Interpreter” (CI) for the SFC-LACI. The FCT accesses the CI objects, too.



1 Parameterising interface (RS232)

Caution
Not using the parameterising interface as designated causes injury to people and material damage

The parameterising interface (RS232) is

– not electrically isolated and

– not real-time capable.

It is not intended for permanent connection to PC systems or as a controller interface.

Controlling the SFC-LACI via RS232 requires, among other things, a risk assessment by the user, ambient conditions free of interference and reliability of data transmission e.g. via the control program of the higher-order control system.

- Note that control of the SFC-LACI via the RS232 does not comply with designated use.
- Use the connection only for parameterising, commissioning and diagnosis.

C.4.2 Accessing the CI objects

CI objects are accessed via

– FCT or

– a terminal program.

Caution
Faulty parameterisation can cause personal injury and material damage.

Incorrect parameterisation of the CI objects can cause the controller to react unexpectedly and the motor may start uncontrolled.

- It is preferable to use the FCT or the control panel for parameterising and commissioning.
  The FCT and control panel take into account mutual dependencies between the objects and, in part, prevent incorrect parameter settings.
- Use CI commands only if you already know their effects and if they are permitted for your SFC-LACI. Note that some commands reorganise or delete parts of the memory.
- Select the commands in accordance with the object list in section C.2. Observe the associated detailed descriptions.
- Use the CI commands only in special cases which require direct access to the controller.

C.4.3 Access via a terminal program

For data transmission you will require a commercially-available terminal program or the integrated CI terminal of the SFC-LAC plug-in in the Festo Configuration Tool.

1. Connect the SFC-LACI to your PC (see section 3.5).

2. Configure your PC's COM interface:

Settings of the COM interface	
Transmission speed (baud rate)	38400 Baud
Data format	Asynchronous character frame: – 1 start bit – 8 data bits – No parity bit – 1 stop bit

Tab. C/1: Settings of the COM interface

3. You can use the following command to initialise data transmission and determine the SFC-LACI's response readiness:

Command	Reply
1 <CR>	**11** <CR>

C.4.4 Composition of the CI commands

The CI objects implemented in the SFC-LACI are based on CANopen DS 402:

Group 1xxx	Objects for device description
Group 2xxx	Festo objects
Group 6xxx	Objects as per CANopen

The “CiA Draft Standard 402” deals with the implementation of CANopen in drive controllers.

Access procedure

Every object has a unique number (index, subindex) which is used for accessing the object.

The higher-order controller sends the controller either a write command (WRITE) to modify an object, or a read command (READ) to read out an object.

For each command the higher-order controller receives a response which either contains the value read or, in the case of a write command, serves as an acknowledgement. The transmitted value (1, 2 or 4 data bytes) depends on the data type of the object to be read or written.

WRITE (W)

Write commands (W) transfer a value in the specified format to the SFC-LACI. As a response, write commands are echoed character by character from the SFC-LACI. A checksum ‹PS› is inserted in front of the ‹CR› (“Carriage Return”).

READ (R)

Read commands (R) transfer a value from the SFC-LACI. The response contains the read value. A checksum ‹PS› is inserted in front of the ‹CR›.

All commands are entered as a character sequence without empty spaces. A hex character is a Char character in hex format.

Syntax of the read and write commands

Acc [1]	Command	Reply
W W [2]	=IIIISS:‹Value›‹CR› =IIIISS:‹Value›**‹PS›**‹CR›	=IIIISS:‹Value›‹PS›‹CR›
R R [2]	?IIIISS‹CR› [2] ?IIIISS**‹PS›**‹CR›	=IIIISS:‹Value›‹PS›‹CR›
1) Access: W = write, R = read 2) When checksum checking is activated (Object 20F3h)		

Tab. C/2: Syntax of a CI command / CI reply

Syntax	Explanation
"= ", "?"	Initial character for write or read commands
IIII	Index in 4 hexadecimal digits
SS	Subindex in 2 hexadecimal digits If the addressed object does not have subindices, ‹00› is specified.
":"	Separating character
‹Value›	Data in a format depending on data type
‹PS›	Checksum in 2 hexadecimal digits
‹CR›	End character ‹Carriage Return› ($0D)

Tab. C/3: Syntax elements of a CI command / CI reply

Data type

The transmitted value (1, 2 or 4 data bytes as hex number) depends on the data type of the object to be read or written. The following data types are supported:

Type	**Hex**	**Format**
UINT8	2H	8 bits without sign: 0...255
INT8		8 bits with sign: -128 ... 127
UINT16	4H	16 bits without sign: 0 ... 65535
INT16		16 bits with sign: -32768 ... 32767
UINT32	8H	32 bits without sign: 0 ... (2^{32} - 1)
INT32		32 bits with sign: -2^{31} ... +(2^{31} - 1)
V-string	Corresponds to the preset string	

Tab. C/4: Data types

All values are transferred in hexadecimal digits; one character represents 4 bits; and is known as a tetrad ‹Tn›. The first tetrad transferred contains the higher-value bits of the value. Generally: Tetrad ‹Tn› contains the bits b_n...b_{n+3}

Example: UINT8

Dec	**26**							
Hex	1				A			
Bin	0	0	0	1	1	0	1	0
	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
	Tetrad T_4				**Tetrad T_0**			

Note
All length specifications (even speeds and similar) are saved in increments in the controller and are not converted into the relevant measuring unit system until they are written or downloaded.

The transfer of values via the CI interface assumes a conversion in **increments**, see section A.3.

C.4.5 Checking the data

Permitted value ranges

Transferred parameters and values are checked by the SFC-LACI before being accepted.

Note
In the case of invalid parameters or values, an error message will not appear in the response; rather, the received value will always be returned (Echo).

Recommendation:
Check that values have been written correctly by downloading the current contents of the object with a subsequent Read command. The higher level controller must compare the sent command with the "Echo" from the SFC-LACI and check the checksum.

Note
The following applies when writing the objects:
- Discrete values (values from a value list): an invalid value will not be accepted; the previously valid value will be retained.
- Continuous values (e.g. lengths, speeds, etc.): an impermissible value will be limited to the nearest permitted value.

Error messages

If there are errors in the commands (e.g. syntax errors, transmission errors), the value ‹0x00FF› will be transmitted (object 2FF0h) instead of the usual reply. Possible causes:

- Incorrect initial character, separating character or empty character
- Incorrect hex digit
- Incorrect value type

Checksum ‹PS›

If checksum checking of telegrams received from the SFC-LACI was activated (see CI object 20F3h), then the higher level controller must also provide a checksum before the termination character (CR = Carriage return) (for syntax, see Tab. C/2).

If the SFC-LACI detects a deviation in the checksum, then - instead of the usual response - the value ‹0xFFFF› will be transferred (see Object 2FF0h).

The checksum of the **command** is calculated based on the case (upper/lower case). The checksum of the **response** is always based on upper case.

Checksum ‹PS›	
Calculation	Sum of all ASCII characters sent, reduced to 1 byte. W: ‹PS› = "=IIIISS:‹Value›" modulo 256 R: ‹PS› = "?IIIISS" modulo 256 **Example:** Command =IIIISS:‹Value›‹CR› =20F300:00 ASCII-› = 2 0 F 3 0 0 : 0 0 HEX 3D+32+30+46+33+30+30+3A+30+30 Sum 212h Mod 256 212h mod 100h = 12h Response =20F300:00**12**
Format	2 Hexadecimal digits, UINT8

Tab. C/5: Checksum

Index

Appendix D

Contents

A

B

C

D

J

K

L

M

O

P

R

S