Rexroth Sytronix

SvP 7020 PFC 03
Variable-Speed Positioning of Hydraulic Axes

Functional description
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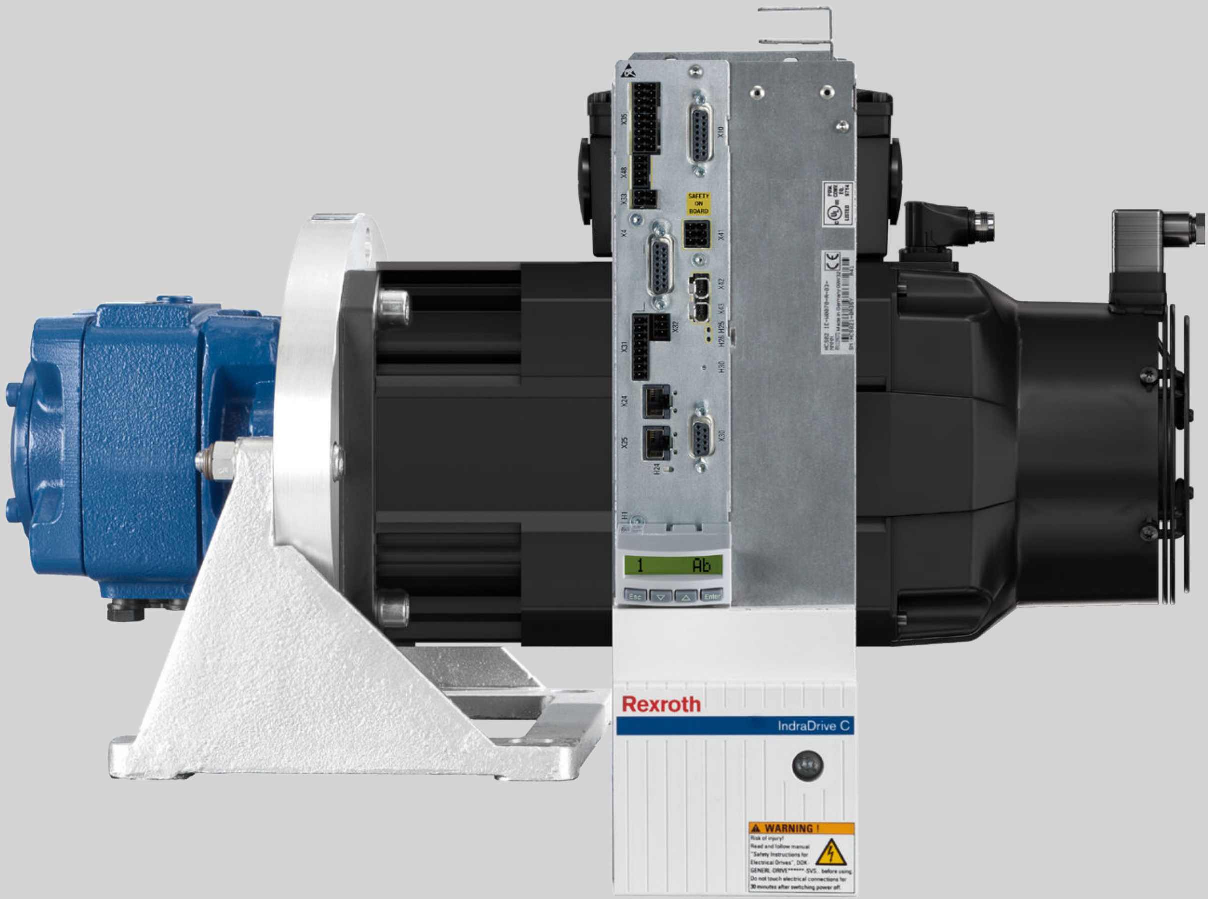
Edition 02



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See tab. 1-1 "Record of revisions" on page 1

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1 Sytronix system overview

1.1 About this documentation

Editions of this documentation

Edition	Release date	Notes
01	2021-02-23	First edition
02	2022-10-31	Extension of functions PFC03V04

Tab. 1-1: Record of revisions

This document describes the functions and features of the variable-speed pump system SvP 7020 PFC. This drive solution can be used in presses, hydraulic positioning axes and control applications.

The main difference between the product ranges 7020 and 5020 lies in the drive units. Sytronix 7020 uses drive units of the IndraDrive product range. Sytronix 5020 uses Rexroth EFC frequency converters. Besides, there are differences in terms of type and extent of communication and bus interfaces, as well as in terms of additional functionality and user interfaces.

The following software/parameter file package is described in this document:

- Position Force Control (PFC): for axis control applications with x/F control.

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1.2 Explanation of signal words and the Safety alert symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

1.3 Introducing the product

The variable-speed pump drives of the Sytronix series cover a wide portfolio of pumps, controllers, motors and software that are suitable for many applications. Rexroth support machine manufacturers with project panning by using simulation models for system design and component selection. The best system components can be selected thanks to scalable power and function.

If a cascaded system is used, multiple Sytronix drives can be interconnected to produce the flow rate required for the process in an efficient way. Sytronix systems are available as preconfigured systems or individually configured components.

Rexroth provide variable-speed pump drives of three performance classes:

Medium dynamics

Sytronix FcP – frequency-controlled pump drive

FcP systems are suited for standard applications with constant pressure control for open hydraulic systems up to 90 kW. Typical applications include machine tools, as well as secondary axis motions in different applications, such as presses.

Sytronix DRn – constant pressure system with hydromechanical pressure control

DRn systems combine a variable-speed drive and an axial piston pump of variable displacement. They are characterized by good dynamics and a high overload capacity. The pump independently controls the required pressure, and the frequency converter sets the optimum speed in terms of energy efficiency and noise. The system is particularly well suited for retrofitting existing installations and has been designed for the performance range of 4 kW and higher.

High dynamics

Sytronix SvP – servo-variable pump drive

SvP systems use the high dynamics of synchronous motors with permanent magnets and thus achieve significant energy savings. Their functions include axis control in open and closed hydraulic circuits that requires high dynamic performance, as well as advanced electric and electrohydraulic control. Plastics converting machines and presses are the main applications for this technology.

High performance and dynamics

Sytronix DFEn – variable-speed drive using a pump with electronic pressure and flow rate control

DFEn systems are suited for high performance applications that demand the best value for money. These systems use axial piston pumps of variable displacement and are particularly suitable for retrofitting existing systems. The drives feature functions for axis control and provide high performance in open hydraulic circuits. This makes them suitable for use in machines with multiple hydraulic functions.

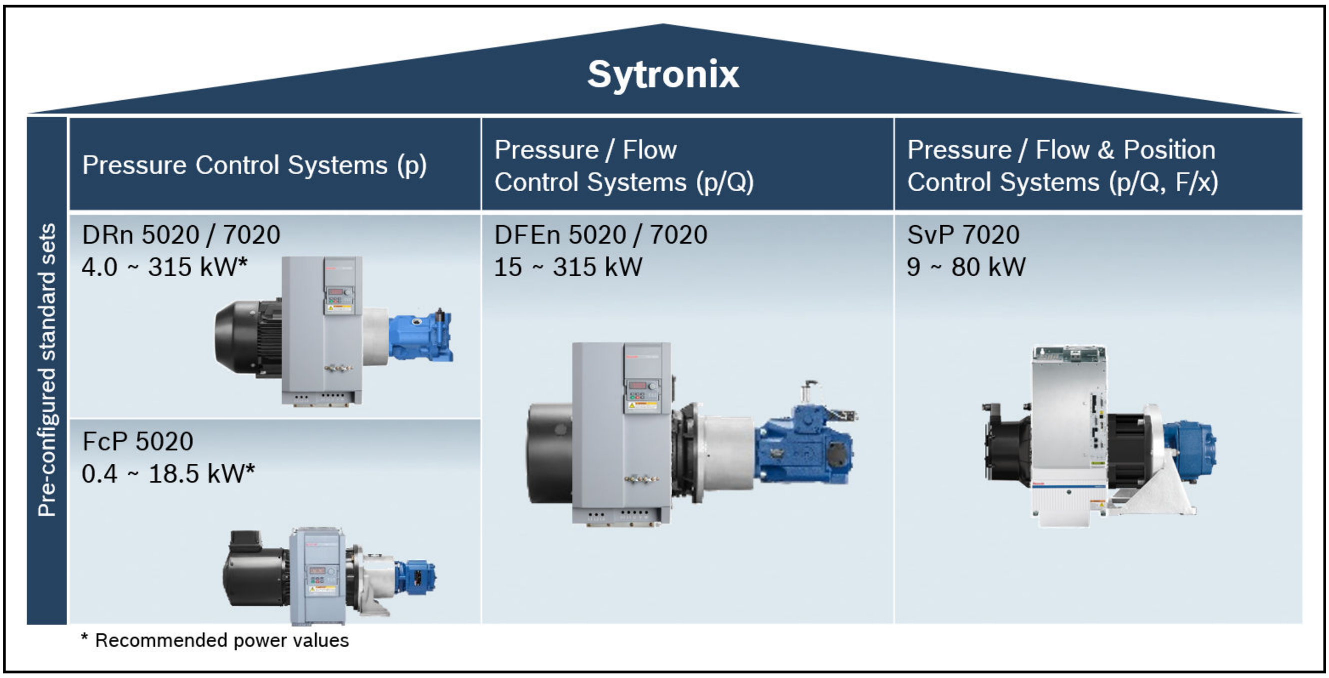


Fig. 1-1: Sytronix house

1.4 Range of applications

Axis control (open-loop and closed-loop)

- In closed hydraulic circuits, the variable-speed drives of Sytronix SvP provide dynamic and extensive electric and electrohydraulic control options. In open hydraulic circuits, the Sytronix DFEn system with electronic pump control of pressure/flow rate (p/Q) represents an alternative. DFEn-based hydraulic drives extend the performance range and are suited for machines with multiple hydraulic circuits.
- In cascaded systems, multiple Sytronix drives operate together to efficiently produce the flow rate required for the process.

Constant pressure systems

- In constant pressure systems, the cost-saving Sytronix FcP/DRn drives with VFD-operated asynchronous motors are compatible with conventional drives up to 315 kW.

The figure below shows different applications for Sytronix solutions.

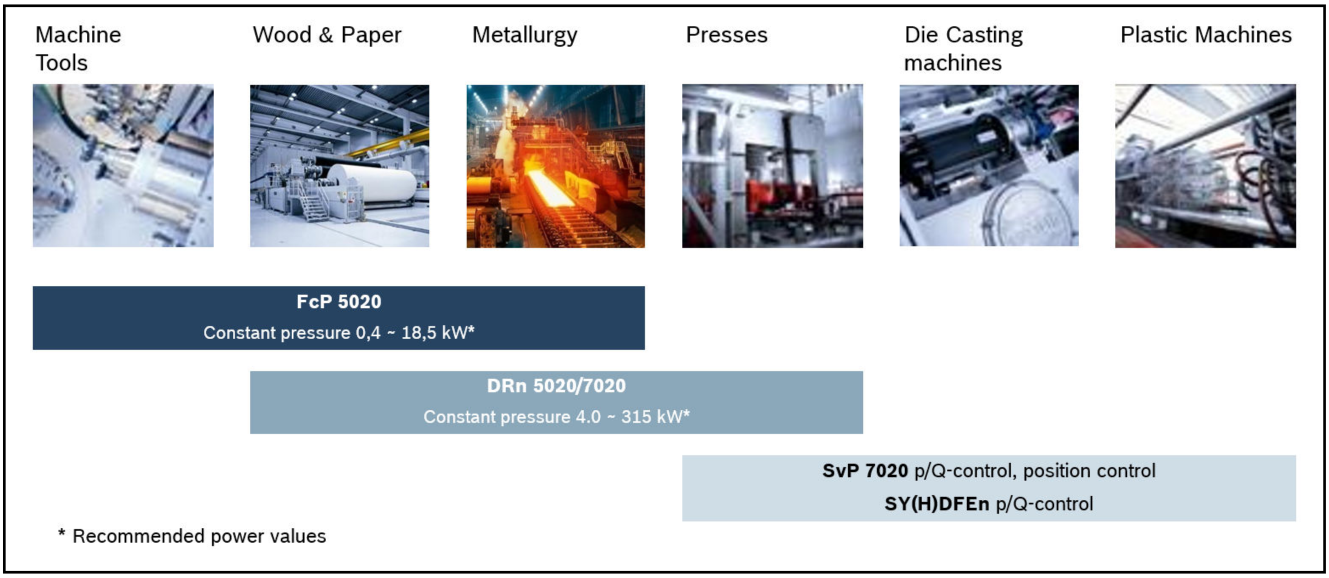


Fig. 1-2: Sytronix solution

1.5 Sytronix components

Introduction

The motor-pump units described in the product catalog (R999000332) can be used in combination with the drive units of the IndraDrive range. Drives with converters (IndraDrive C, IndraDrive Cs) or inverters (IndraDrive M) with the SvP 7020 solutions are suited for this purpose.

The IndraDrive units consist of a power section and a control section for controlling servo and standard motors. The part of the drive controller with the control functions and interfaces for installation in the power section is called control section. The power component contains the power electronics for controlling the motors and includes the control section. The IndraDrive C range, such as HCS, uses a three-phase current and generates different voltages and frequencies from the three phase current. The IndraDrive M range, such as HMS, is connected to a DC current source with DC bus and generates different voltages and frequencies for controlling the motor speed and the torque from the DC current source with DC bus..

Main features of IndraDrive units:

- Performance range from 100 W to 4 MW
- High degree of overload capacity
- Compact design for applications with a single axis
- Can be connected to a converter for cost-saving solutions
- Direct connection to three-phase current from 200 to 500 VAC

1.6 Accessories

An extensive portfolio of accessories is available for Sytronix systems.

Mains filter Mains filters ensure that the EMC limit values are complied with and suppress leakage currents generated by capacitors.

Braking resistors Braking resistors convert excessive energy in the DC bus into heat.

Mains chokes Mains chokes reduce the harmonics in the power grid and increase the continuous power of the DC bus.

Motor and encoder cables
Motor and encoder cables connec the motor to the drive unit.

Auxiliary components
Accessories for connecting modules, such as HAS01, including contact bars, fixing devices etc. The accessories include shielded motor cables for connection to drive units (HAS02), mounting flanges (HAS07) and cables for commissioning (RKB0001).

1.7 Software/parameter file packages

Introduction
The table below shows different options for combining the software/parameter file packages with the Sytronix solution PFC.

Hardware				Software/parameter file	
				PFC03VRS	
				CSH02.1	
				Hydraulic servo axis	
System	Drive	Motor	Pump	p/Q control	x/F control
SvP 7020	HMS	MS2N, MSK	PGM, PGH, A4, A10	-	X

X Available
- not available

Tab. 1-2: Overview of the software/parameter file for SvP 7020

Commissioning tool
The “IndraWorks Ds/D/MLD“ commissioning tool (version 15V12 and higher) is used to commission the variable-speed pump systems SvP 7020.

Important features
This section specifies the functions contained in the software/parameter file (PFC).

Functions	PFC02VRS	PFC03V02	PFC03V04
Position control	x	x	x
Closed-loop force control	x	x	x
Alternating control between position and force	x	x	x
Additive velocity feedforward control in force controller	-	-	x
Open-loop velocity control	x	x	x
Controlled deceleration in operation mode "Drive Halt" (AH)	-	-	x
Active vibration damping, state controller	x	x	x
Two-point control of variable displacement pump	x	x	x
Continuous swivel angle control	-	x	x
Pulsation compensation for axial piston pump	-	x	x
Holding function	-	-	x
Continuous controller output adjustment to changes in the hydraulic advance	x	x	x

Functions	PFC02VRS	PFC03V02	PFC03V04
Automatic rapid mode/press mode switching	x	x	x
Automatic parameter set switching, position controller - rapid mode/ press mode (2 sets)	x	x	x
Manual parameter set switching, position controller (4 sets)	x	x	x
Pressure/force command value limitation	x	x	x
Pressure/force command value ramp	x	x	x
Actual pressure value filter (PT1 for analog value)	x	x	x
Speed limitation, pump	x	x	x
Acceleration limitation, pump	x	x	x
Sensor monitoring (cable break)	x	x	x
Pressure sensors in cylinder chambers A and B	x	x	x
Pressure sensors in cylinder chambers A, B and C	-	x	x
Tank pressure monitoring	x	x	x
System pressure monitoring	-	x	x
System pressure increase	-	-	x
Pilot oil pressure monitoring	-	x	x
Oil temperature monitoring	x	x	x
Monitoring the operating range of A10 pump	-	-	x
Status display pressure/force	-	-	x
Status display via RGB LED	-	x	x
Support of decentralized IO	-	x	x
Configurable scaling (units, decimal places, ...)	x	x	x
Input validation (parameter handling)	x	x	x
Diagnostics/error handling	x	x	x

x Available
- Not available

Tab. 1-3: Overview of functions for PFC firmware package

Type code and overview of the software/parameter files

Product	Product name	Application type	Version/ release	Language/ attribute	Firmware/ target version	Applicative enhancement	Functional enhancement
FWS-	MLDSYx-	PFC-	03V02- 03V04-	D0-	MP21-	NNNNNNNN-	01

FWS	Software/parameter file (compiled MLD project)
MLDSYx	IndraDrive MLD with SYTRONIX technology function
PFC	Position Force Control
xxVxx	Version identification
D0	German and English
MP21	FWA-INDRV*-MPx-21VRS-D5-x-SYX-xx
NNNNNNNN	No applicative extension
01	Extension of functions, Field Data Acquisition (FDA)

Tab. 1-4: Overview of types

Hardware and firmware requirements

To use the "Sytronix software 03VRS", the IndraDrive solution needs the following firmware and hardware for the drive:

Product name	Type	Type code	Brief description	Firmware
Position Force Control (PFC)	Sytronix_7020	FWS-MLDSYx-PFC-xxVxx-D0-MP21-NNNNNNNN-01	System function for axis with alternating position/ force control	MPx-21VRS

Tab. 1-5: Assignment of the Sytronix technology functions to the IndraDrive firmware

See also chapter 5 "Introduction and basic principles of PFC" on page 21

2 Safety instructions

2.1 About this chapter

The product is manufactured according to the generally accepted codes of practice. However, there is still a risk of personal injury and damage to property.

Observe the general safety instructions in this chapter and the safety instructions and instructions for action in these operating instructions. This helps to avoid personal risks, damage to property and faults.

- Read this documentation completely and thoroughly before working with the product.
- Keep this documentation in a location where it is accessible to all users at all times.
- Always include the required documentation when you pass the product on to third parties.

2.2 Intended use

The product is an electro-hydrostatic drive system.

The Sytronix system is exclusively intended for being integrated in a machine or for being assembled with other components to form a machine or a power unit. It is only allowed to commission the Sytronix system, if it has been integrated in the machine for which it is intended.

The Sytronix system may be used as follows:

- For pressure-controlled hydraulic supply (for SvP: with alternating flow rate change, position control alternating with pressure or force control.
- By itself, the Sytronix system is not suited to execute safety-relevant functions. Safety-relevant functions can be implemented with the drive-integrated safety technology or with a higher-level Safety control.

☞ In the Sytronix system, there is no validation of the command values and actual values (pressure, force, position, speed and velocity) provided.

- Make sure that the validation is executed in the machine control.

The application-specific adjustment of the parameters during initial commissioning is allowed.

The product is intended exclusively for industrial use and not for private usage.

Operation according to the intended use also implies that you have read and understood this documentation completely, especially chapter 2 “Safety instructions“.

2.3 Improper use

Any use other than described as intended use is improper use and therefore not allowed.

Bosch Rexroth AG does not assume any liability for damage caused by improper use. The user assumes all risks involved with improper use.

2.4 Qualification of personnel

The operations described in this documentation require basic knowledge of mechanics, hydraulics and electrics, as well as knowledge of the corresponding terms. For transporting and handling the product, additional knowledge of how to handle lifting gear and the necessary attachment devices is required. In order to ensure safe use, these activities may only be carried out by an expert in the respective field or an instructed person under the direction and supervision of an expert.

Experts are those who are able to recognize potential hazards and apply the appropriate safety measures due to their professional training, knowledge and experience, as well as their understanding of the relevant conditions pertaining to the work to be undertaken. An expert must observe the relevant specific professional rules.

These additional qualifications are required:

- Knowledge of how to wire electrical components
- Knowledge of how to parameterize the application software
- Knowledge of hydraulics
- Basic knowledge of control technology

2.5 General safety instructions

- Observe the valid regulations on accident prevention and environmental protection.
- Observe the safety regulations and provisions of the country in which the product is used/applied.
- Exclusively use Rexroth products in technically perfect condition.
- Observe all notices on the product.
- Persons who install, operate, dismount or maintain Rexroth products must not consume any alcohol, other drugs or pharmaceuticals that may affect their ability to respond.
- Only use accessories and spare parts approved by the manufacturer to eliminate the risk of injury due to unsuitable spare parts.
- Comply with the technical data and ambient conditions specified in the product documentation.
- If unsuitable products are installed or used in safety-relevant applications, unintended operational states can occur in these applications, which can cause personal injury and damage to property. Therefore, use the product only in safety-relevant applications, if this use is expressly specified and permitted in the documentation of the product.
- You may commission the product only when it has been established that the final product (for example, a machine or system), in which the Rexroth product is installed, complies with national regulations, safety regulations and standards relevant for the application.

2.6 Product- and technology-related safety instructions

⚠ WARNING **Danger of life, risk of injury, serious injury during work on a system which is under pressure.**

- Switch off all power-transmission-components and connections (electric, pneumatic, hydraulic) according to the manufacturer´s details and secure them against restarting.
- Ensure that the motor-pump-unit is completely depressurized.
- Do not disconnect any cable connections, plumbing connections and components as long as the motor-pump-unit is retaining pressure.

⚠ WARNING **Danger to life, risk of injury due to electric shock. High electric voltage over 50 volt.**

- De-energize the part of the installation before you mount the motor-pump-unit or connector or terminal box connections.
- Secure the plant against restarting.
- Do measures and tests only with firmly connected protective conductor of components on the provided points.
- Please always wait 30 minutes after switch-off, so live capacitors discharge before they have access to electric components. To exclude andy danger due to any contact, measure electric voltage of live parts before working.
- Do not touch any electric junctions of live components.

⚠ WARNING **Danger to life, risk of injury by electric shock. High housing voltage and high leakage current.**

- Before switching on and before commissioning, ground or connect the motor-pump-unit components to the equipment grounding conductors at the grounding points.
- Connect the equipment grounding conductors of the motor-pump-unit components permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Use at least 10mm² copper cross-section for the total path of the equipment grounding conductor.

⚠ WARNING **Danger of fire, explosion and pollution due to existing oil dust due to defective or improperly assembled sealings!**

- Do not do any welding on or near pressurized motor-pump-units.
- Keep away open fire or ignition source from motor-pump-units.

⚠ WARNING **Protection against electromagnetic and magnetic fields during operation and mounting**

Electromagnetic and magnetic fields!

Health hazard for persons with active implantable medical devices (AIMD) such as pacemakers or passive metallic implants.

- Hazards for the above-mentioned groups of persons by electromagnetic and magnetic fields in the immediate vicinity of drive controllers and the associated current-carrying conductors.
- Entering these areas can pose an increased risk to the above-mentioned groups of persons. They should seek advice from their physician.
- If overcome by possible effects on above-mentioned persons during operation of drive controllers and accessories, remove the exposed persons from the vicinity of conductors and devices.

⚠ CAUTION **Risk of injury by improper handling. Injury by crushing, shearing, cutting, hitting!**

Protection during handling and mounting:

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

⚠ CAUTION **Risk of burns, risk of injury due to hot surfaces of the motor-pump-unit.**

- Do only touch surfaces of the motor-pump-unit with protective gloves or do not work on hot surfaces. During or after operation, temperatures can be over 60°C (140°F).
- Before accessing, let the motor-pump-unit cool down for a sufficiently long time.
- Observe the protective measures of the plant manufacturer.

⚠ CAUTION **Health risk due to contact with hydraulic fluid.**

Impairment to health, like eye injury, skin injury and contamination possible:

- Avoid contact with hydraulic oil.
- Observe the safety instructions of the manufacturer when working with hydraulic oil.
- Use personal protective equipment (e.g. safety glasses, safety shoes, protective gloves, suitable working clothes).
- Consult a doctor if hydraulic oil contacts your eyes or bloodstream or is swallowed.

⚠ CAUTION **Risk of injury, danger of slipping due to greasy surfaces.**

- Make the danger zone safe and designate it as such.
- Use an oil binding agent to contain spilled or excess hydraulic fluid.
- Use personal protective equipment (e.g. safety shoes, protective gloves, suitable working clothes, ...).
- Remove and dispose of the contaminated oil binding agent in accordance with the national regulations.

⚠ CAUTION **Risk of injury due to uncontrolled discharge hydraulic fluid on the motor-pump unit.**

- Immediately switch-off the machine in case of an error (emergency stop switch).
- Identify and remove the reason for leakage.
- Do not try to stop or to seal the leakage or the oil jet with a cloth.
- Avoid contact with high pressure oil discharge.
- Perform regular visual inspections on the motor-pump unit and all oil-bearing components.

⚠ CAUTION **Risk of injury by improper handling of batteries**

Batteries consist of active chemicals in a solid housing. Therefore, improper handling can cause injury or property damage:

- Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
- Do not attempt to recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries, do not damage the electrical parts installed in the devices.
- Only use the battery types specified for the product.

☞ Environmental protection and disposal! The batteries contained in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separately from other waste. Observe the national regulations of your country.

2.7 Obligations of the machine end-user

The machine end-user of products of Bosch Rexroth AG must provide their personnel with training for the following topics on a regular basis:

- Observance and use of operating instructions and the applicable legal provisions.
- Intended operation of the product.
- Observance of the instructions of the factory security offices and the machine end-user's working instructions.
- Behavior in case of an emergency.

☞ Bosch Rexroth offers training courses that support your qualification in specific fields. You can find an overview of training contents on the Internet under http://www.boschrexroth.de/didactic.

The operation of installations, systems and machines basically requires the implementation of a holistic IT security concept which is state-of-the-art in terms of technology. Accordingly, Bosch Rexroth products and their properties must be considered as components of installations, systems and machines for their holistic IT security concept.

Unless otherwise documented, Bosch Rexroth products are designed for operation in local, physically and logically secured networks with access restrictions for authorized persons, and they are not classified according to IEC 62443-4-2.

3 General information on damage to property and damage to the product

The warranty only applies to the delivered configuration.

Warranty claims will be rejected in the case of improper installation, commissioning and operation as well as in the case of use not in accordance with the intended purpose and/or improper handling.

NOTICE

Inadmissible mechanical load!

Impact or shock forces on the Sytronix system and attached components may damage or even destroy it.

- Do not hit on the drive shaft of the unit.
- Never use the Sytronix system as a handle or step. Do not place/put any objects on top of it.

NOTICE

Foreign particles and dirt in the Sytronix system!

Risk of damage, wear and malfunctions due to ingress of dirt and foreign particles.

- During installation, ensure utmost cleanliness in order to prevent foreign particles such as welding beads or metal chips from getting into the hydraulic lines.
- Before commissioning, make sure that all hydraulic connections are tight and that all seals and closing elements of plug-in connections are correctly installed and not damaged.
- When filling the system with hydraulic fluid, filter the fluid with a suitable filtering system to minimize contamination with solid particles and water in the system.
- Do not use cotton waste or linty cloths for cleaning.
- Take care that no cleaning agents enter the hydraulic system.

NOTICE

Wear!

Wear may lead to malfunctions.

- Carry out the prescribed maintenance work at the time intervals specified in the operating instructions.

NOTICE

Environmentally harmful hydraulic fluid!

Leaking hydraulic fluid leads to environmental pollution.

- Immediately remedy any leakage.
- Dispose of the hydraulic fluid in accordance with the national regulations in your country.

NOTICE

Insufficient pressure!

If the pressure falls below the specified value, damage can occur or the product be destroyed.

- Make sure that the pressure cannot fall under the prescribed minimum value.

NOTICE

Insufficient hydraulic fluid!

If you commission or operate the Sytronix system without or with insufficient hydraulic fluid, the control system is immediately damaged or even destroyed.

- When commissioning or re-commissioning a machine or system, make certain that the housing chamber as well as the suction and working lines of the Sytronix system are filled with hydraulic fluid and remain filled during operation.

NOTICE

Corrosion due to water and saltwater!

Contact with salt water leads to increased corrosion. Thus, mounting screws and plug screws as well as moveable components may be chemically corroded and damaged and thus cause leakage and oil getting into the environment.

- So take suitable corrosion protection measures, e.g. by means of an anti-corrosion coating.

4 Symbols and their use

Action symbols

Use "action symbols" to commission and to operate the devices and the software.

The action symbols indicate the following:

- The symbol illustrates the action to be carried out.
- The arrow indicates the specific position the action is to be applied to.
- The numbers indicate the order in which subsequent actions have to be executed. There are six steps per screen shot at most.

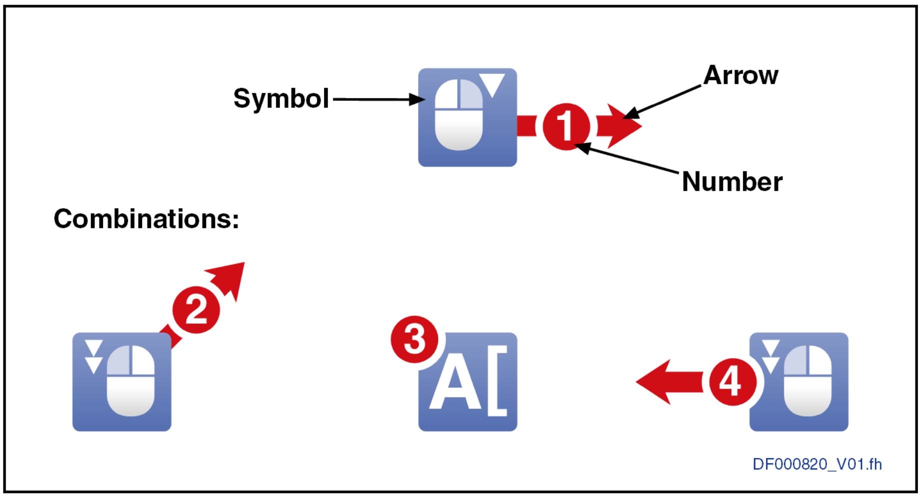


Fig. 4-1: Combinations of action symbols

Action symbol	Meaning
	**Left-click:** Click using the **left mouse button**.
	**Double click: Double click** using the **left mouse button**.
	**Right-click:** Click using the **right mouse button**.
	**Drag:** Click the left mouse button and keep it pressed. Move the mouse to the target position (continued in the next symbol).
	**Drop:** Release the mouse button at the target position.

Action symbol	Meaning
	**Text input:** Enter your text.
	**Note:** Note or compare information, e.g. a results list, information on the device display, comparison of input data with connected devices.

Tab. 4-1: Action symbols

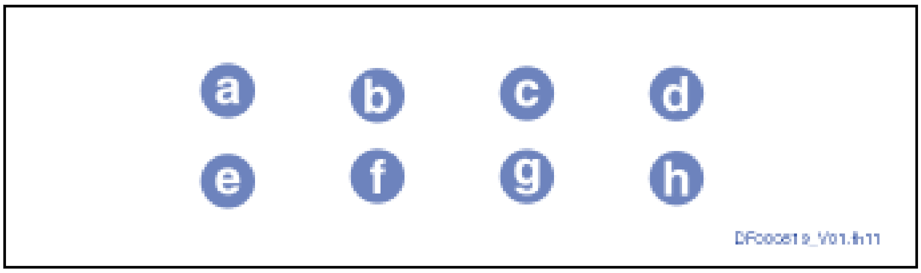


Fig. 4-2: Bullets

The bullets sub-divide steps or are used as markers (e.g. to describe different areas in a screen shot).

Other symbols

Symbol	Meaning
	Information
	Mail
	Internet address
	Question
	Note, warning

Tab. 4-2: Other symbols

Keyboard symbols

Symbol	Name
	Cancel
	Alternative

Symbol	Name
	Paste
	Enter
	Delete
	Space
	Arrow left
	Arrow up
	Arrow right
	Arrow down
	Ctrl
	Shift

Tab. 4-3: Keyboard symbols

5 Introduction and basic principles of PFC

5.1 Structural overview

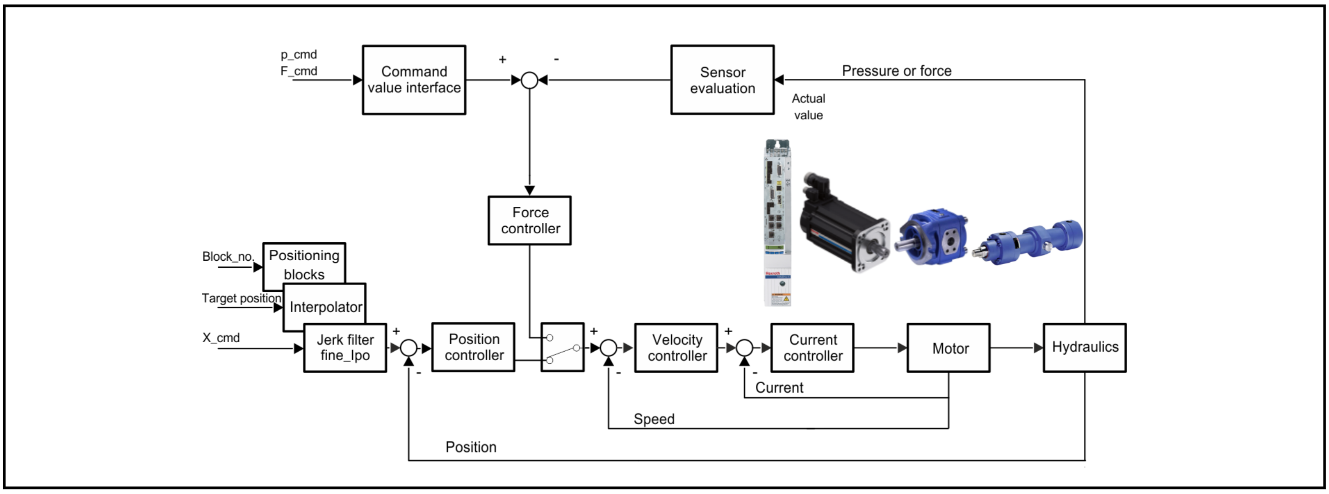


Fig. 5-1: PFC, structural overview

5.2 System requirements/components

Hardware

Sytronix unit (motor-pump group), cylinder (hydraulic or mechanical), power section (HCS02/HCS03/HMS01/HMS02), control section (CSH02.1), axis-side position encoder (in case of electromechanical solution, encoder on motor side is sufficient); if required, sensors for force/pressure control and, if required, microSD card for PFC functions.

☞ Pressure values always refer to the atmospheric pressure. This applies to both pump data and sensor values.

Firmware

FWA-INDRV*-MPC-21VRS-D5-1-SYX-ML

FWA-INDRV*-MPC-21VRS-D5-1-SYX-MA

As of release MPC21V16

Tools

Engineering PC with IndraWorks MLD/D/Ds 15V16

Technology function/software

PFC03VRS

Functional package/license for IndraMotion MLD

Since the PFC software/parameter file is based on an integrated PLC, the system requires a firmware with the functional package MLD. The following are possible:

- “ML“ for using the self-contained PFC function, as well as PFC-Lib to implement your own additional functions.
- “MA“ for high functionality (in conjunction with specific technology functions)

The user has to specify the correct firmware package for the required functionality.

☞ In urgent cases, functional packages may be subsequently activated via IndraWorks. After an unlicensed function has been activated, the corresponding license has to be ordered from Bosch so that the function can be rightfully used.

To operate Sytronix 7020 systems, use the drive firmware with the "SYX" expansion package.

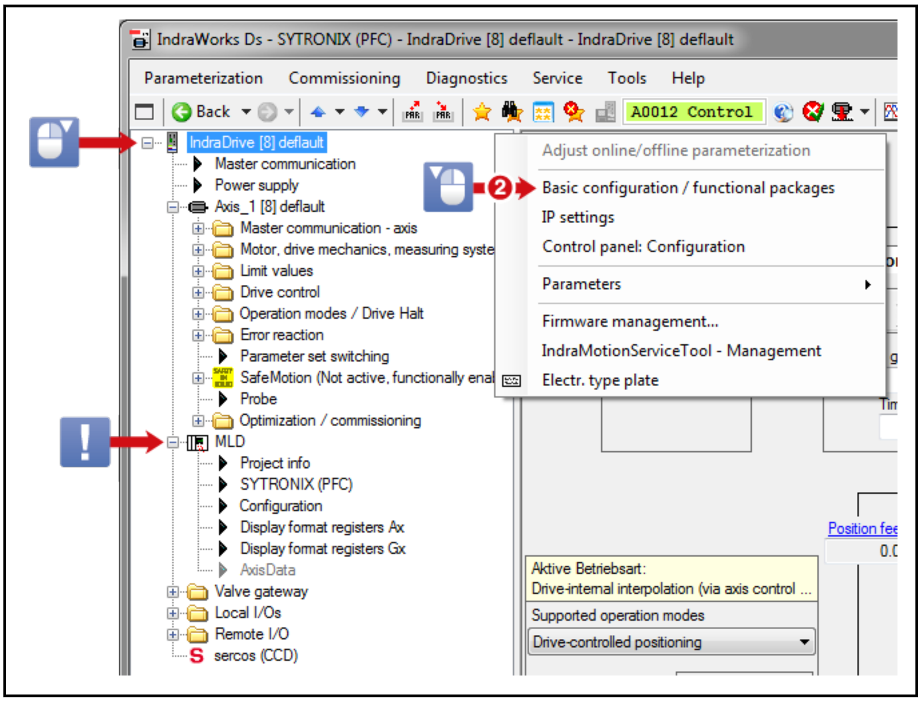


Fig. 5-2: Navigation for setting the functional packages

Using the technology function as a library

The PFC library is available for the user to expand the functionality.

In this case, the PFC function has to be included as a library in the MLD program. The respective functions then have to be called in the corresponding tasks:

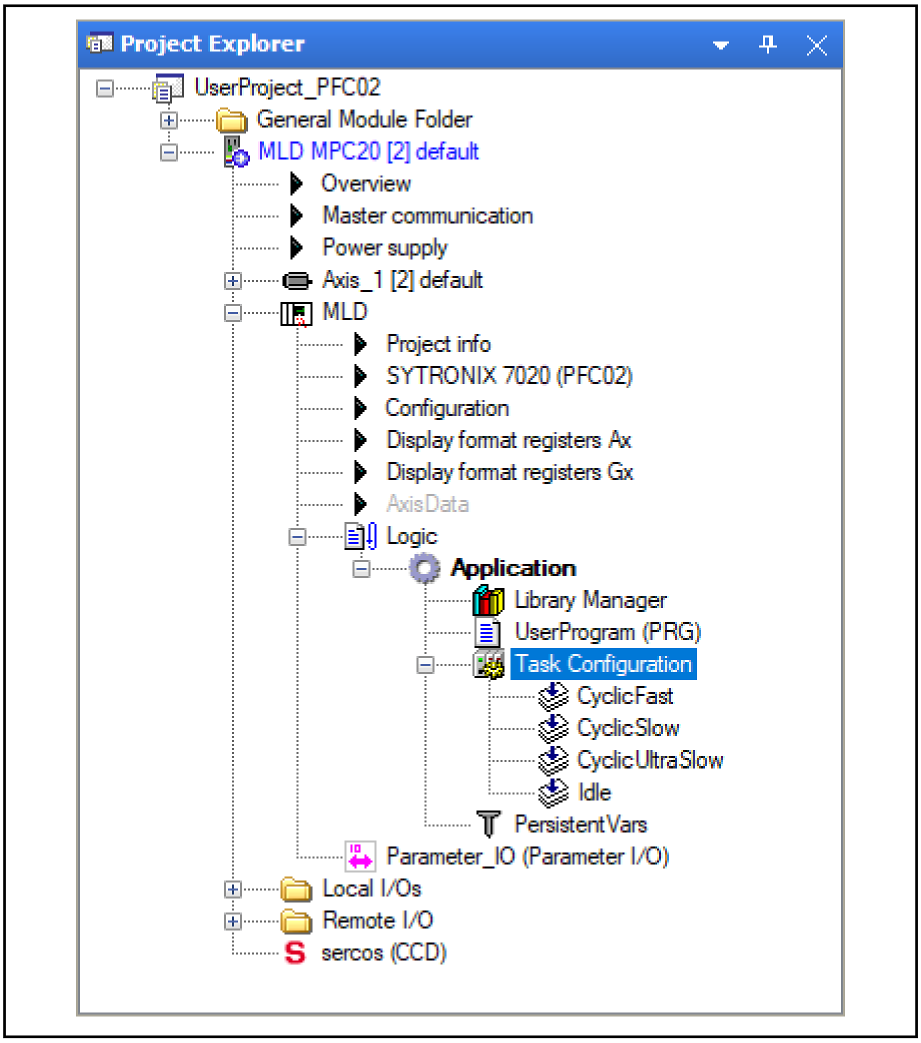


Fig. 5-3: Program calls required when using the library for PFC03VRS

☞ It is recommended that the task configuration, as well as the library manager, are imported from the Application_4UserProject_PFC_03VRS.iwx file.

System function

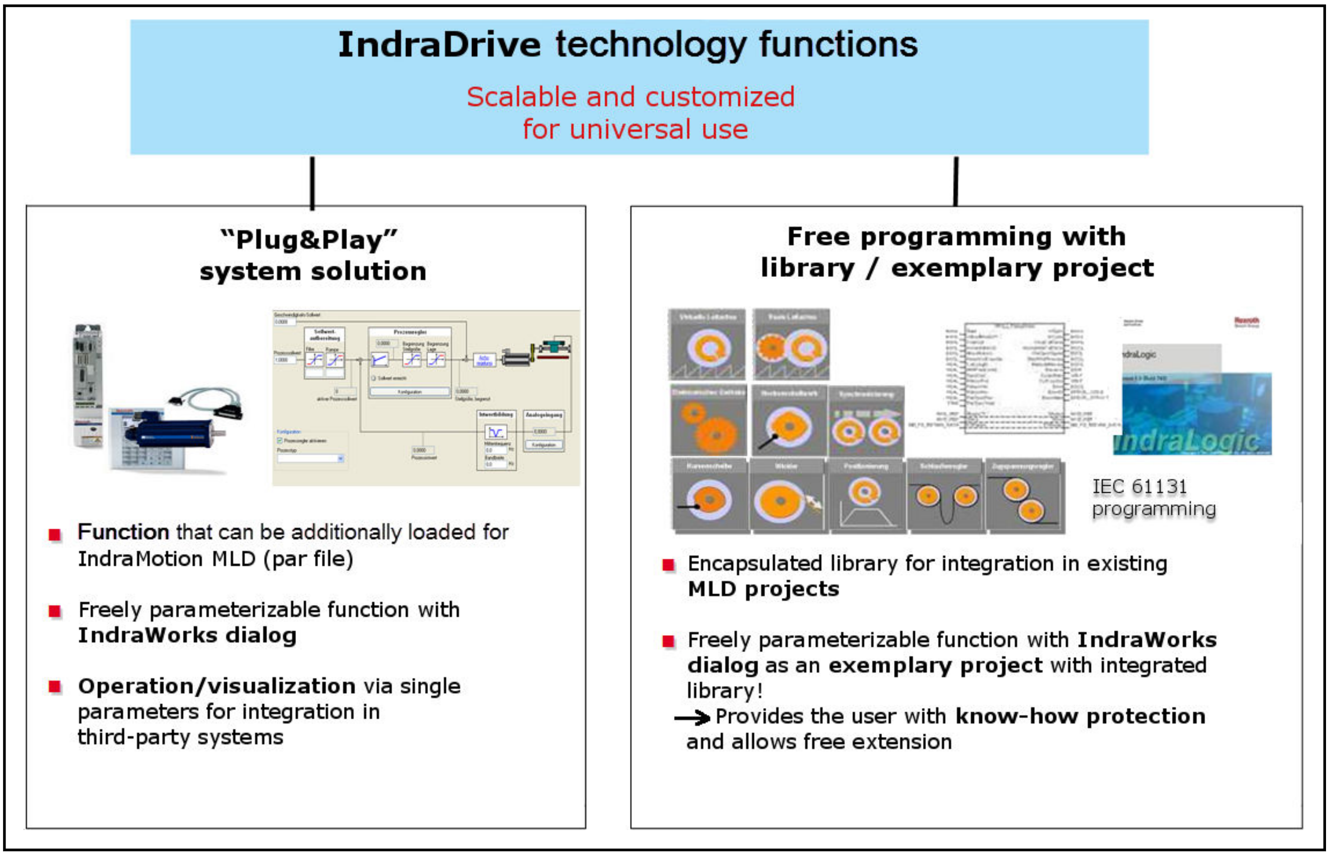


Fig. 5-4: System function

5.3 Electrical system characteristics

Combinations of firmware, control section, master communication

According to the application, the characteristics of control section options and master communication used have an influence on the firmware and the operation modes that can be used. Only Advanced devices are supported. Since the number of optional slots is limited, it is necessary to check whether or not the control section configuration has to be adjusted in accordance with the specification/application.

Requirement

The tables below can help assess the additionally required optional slots that are needed in view of the properties of the hydraulic system, the control quality and the machine integration.

<table>
<tr><th>Category</th><th colspan="2">Function</th><th>Code</th><th>Required
Optional slots</th><th>Note</th></tr>
<tr><td rowspan="2">Encoder</td><td colspan="2">Motor encoder</td><td>EC</td><td>0</td><td>On-board at multi-encoder interface</td></tr>
<tr><td colspan="2">Actuator encoder</td><td>EC</td><td>1</td><td>2nd encoder at free interface</td></tr>
<tr><td rowspan="8">Communication</td><td colspan="2">None (analog/digital)</td><td>NN</td><td>0</td><td></td></tr>
<tr><td colspan="2">Multi-Ethernet slave</td><td>ET</td><td>0</td><td>ET on-board at communication interface</td></tr>
<tr><td colspan="2">PROFIBUS® slave</td><td>PB</td><td>1</td><td rowspan="2">ET (Engineering only) on-board at communication interface
PB/CN at interface 1</td></tr>
<tr><td colspan="2">CANopen® Slave</td><td>CN</td><td>1</td></tr>
<tr><td rowspan="4">Sercos®
Master +</td><td>No slave</td><td>CC</td><td>0</td><td rowspan="4">CC on board at communication interface
ET/PB/CN at interface 1</td></tr>
<tr><td>Multi-Ethernet slave</td><td>CC + ET</td><td>1</td></tr>
<tr><td>PROFIBUS® slave</td><td>CC + PB</td><td>1</td></tr>
<tr><td>CANopen® Slave</td><td>CC + CN</td><td>1</td></tr>
</table>

Tab. 5-1: Optional slots required for communication and encoders

<table>
<tr><th>Control section used</th><th>Required quantity</th><th>Code</th><th>Required optional slots</th><th>Note</th></tr>
<tr><td rowspan="2">Analog inputs with CSH02.1B (IndraDrive C/M)</td><td>0...3</td><td>-</td><td>0</td><td>For interface equipment B;
2x current/voltage, 1x voltage</td></tr>
<tr><td>4...5</td><td>DA</td><td>1</td><td>DA at interface 4;
4x current/voltage, 1x voltage</td></tr>
</table>

Tab. 5-2: Optional slots required for analog sensor inputs

In case of CSx02.1B the total of required optional slots must not be more than 2.

Availability

For the available configuration of a control section, please see the matrix below. Also compare type codes of the respective control sections. Only one option can be selected in each column. A CSx02.1B control section is provided with 2 unassigned optional slots (interfaces 2 and 4) for free use.

If more optional slots are required, see "Remedy" for potentials of cutting down on slots.

	Communication	Interface 1 Encoder only	Interface 2	Interface 3 Safety technology only	Interface 4 For CSx02.1 only
Sercos® master	CC (X24/X25)	–	–	–	–
Multi-Ethernet slave (Sercos®, EtherCAT®, PROFINET®, EtherNet/IP™)	ET (X24/X25)	–	ET (X22/X23)[1)]	–	–
Field bus slave (PROFIBUS®, CANopen®)	–	–	PB (X30) CN (X61)	–	–
Multi-encoder	–	EC (X4)	EC (X8)	–	EC (X10)
I/O extension	–	–	–	–	DA (X37/X38)
Encoder emulation	–	–	EM (X8)	–	EM (X10)[2)]
Safety technology (STO, SBC, SMO, SMOB)	–	–	–	L3 (X49) S4, S5 (...)[3)] SB (-)[4)]	–

1) ET is only possible, if it is not available at the communication interface (X24/X25)
2) EM is only possible, if it is not available at interface 2 (X8)
3) Slot name: X41/X42/X43/X48
4) Separate Safety slot not available for SafeMotion via safety bus

Tab. 5-3: Matrix: possible control section options at corresponding interface

Remedy There are the following potentials for cutting down on optional slots.

- **Master communication:**
  - With MPx20 and above, Advanced control sections without CCD master option are supported. If Multi-Ethernet master communication is used (Sercos®, EtherCAT®, PROFINET®, EtherNet/IP™), it is now employed at the "communication" connection point and interface 2 thus becomes available.
  - The interfaces for PROFIBUS® or CANopen® cannot be operated at the communication interface. Interface 2 has to be used. If it is possible to change over to Multi-Ethernet, only the communication interface is required, and interface 2 becomes free (e.g. PROFINET® instead of PROFIBUS®).
- **Cutting down on encoder interfaces:**
  - With MPx20 and above, encoder signals (encoder status + increments) can also be received via Sercos®. If the encoder of motor or actuator is read in at another Sercos® device and transmitted to the PFC axis, the corresponding optional slot can be used differently. Take Sercos® cycle time (= dead time) into account!
  - If the performance requirements are low, motor control can be operated in the FXC mode. Thus, the actuator encoder can be read in via interface 1 instead of the motor encoder and an optional slot becomes available.

- **Cutting down on the number of analog inputs:**
  - Values to be controlled or to be monitored, such as force, temperature and pressures, can be read in at other devices and transmitted to the PFC axis via the master communication or in the CCD group as the corresponding variable (force, temperature, pressure, ...).
  - With MPx20 and above, there are remote analog inputs available in IndraDrive. The corresponding sensor is not connected to IndraDrive, but to an external I/O device that only captures the signal value as voltage or current. The signal value can be transmitted to the PFC axis via the master communication or in the CCD group and there converted into the corresponding variable (pressure, force, temperature, ...). Thus, an analog input is not required on the hardware side at IndraDrive.
  - An analog voltage input is always available at the control section. If this input is used, it might be possible to do without the DA option. It is necessary to check whether or not a signal can be made available as voltage if 3 current signals, for example, are used with CSH02.1B. Thus, the on-board inputs would be used and the DA option would not be necessary.

Examples

The tables below show the most common control section types that can be used:

IndraDrive C, IndraDrive M

Equipment						Function/application			Operation mode				
Control section						Communication	Motor encoder (motor control)	Actuator encoder	Positioning block mode	Drive-internal interpolation	Position control	Drive-controlled positioning	Velocity control
Multi-Ethernet, 2 encoders, 5 analog inputs (4x current/voltage, 1x voltage)													
CSH02.1B	ET	EC	EC	NN	DA	PROFINET® EtherNet/IP™	✓ (FOC)	✓	✓	✓	– 1)	✓	– 1)
CSH02.1B	ET	EC	EC	NN	DA	EtherCAT® Sercos®	✓ (FOC)	✓	✓	✓	✓	✓	✓
PROFIBUS®/CANopen®, 2 encoders, 3 analog inputs (2x current/voltage, 1x voltage)													
CSH02.1B	ET	EC	PB	NN	EC	PROFIBUS®	✓ (FOC)	✓	✓	✓	– 1)	✓	– 1)
CSH02.1B	ET	EC	CN	NN	EC	CANopen®	✓ (FOC)	✓	✓	✓	✓	✓	✓
PROFIBUS®/CANopen®, 1 encoder, 5 analog inputs (4x current/voltage, 1x voltage)													
CSH02.1B	ET	EC	PB	NN	DA	PROFIBUS®	– (FXC)	✓	✓	✓	– 1)	✓	– 1)
CSH02.1B	ET	EC	CN	NN	DA	CANopen®	– (FXC)	✓	✓	✓	✓	✓	✓
CCD master (decentralized extension, e.g. S20 modules), **2 encoders, 5 analog inputs** (4x current/voltage, 1x voltage)													
CSH02.1B	CC	EC	EC	NN	DA	Self-contained from MLD appli-cation	✓ (FOC)	✓	✓	✓	✓	✓	✓
CSH02.1B	CC	EC	EC	NN	DA	Digital inputs	✓ (FOC)	✓	✓	–	–	–	–
CCD master (decentralized extension, e.g. S20 modules), **Multi-Ethernet, 2 encoders, 3 analog inputs** (2x current/voltage, 1x voltage)													
CSH02.1B	CC	EC	ET	NN	EC	PROFINET® EtherNet/IP™	✓ (FOC)	✓	✓	✓	– 1)	✓	– 1)
CSH02.1B	CC	EC	ET	NN	EC	EtherCAT® Sercos®	✓ (FOC)	✓	✓	✓	✓	✓	✓

[V] Sensor signal as voltage
[mA] Sensor signal as current
1) Master communication is not real-time capable

Tab. 5-4: PFC device configuration (IndraDrive C, IndraDrive M)

5.4 Relevant parameters

See chapter 8 "Parameters and diagnostic messages of Position Force Con-trol (PFC)" on page 261

6 Description of PFC functions

6.1 Overview

The IndraDrive technology function PositionForceControl (PFC) is used for positioning and for controlling the force of a hydraulic or a mechanical cylinder.

With hydraulic systems, the position is controlled on the basis of a position encoder mounted to the cylinder. With purely mechanical systems with linear transmission, the position encoder on the electric motor is sufficient.

The force is controlled using pressure sensors in the cylinder chambers or using a force sensor at the piston/cylinder.

The controller transition is alternating.

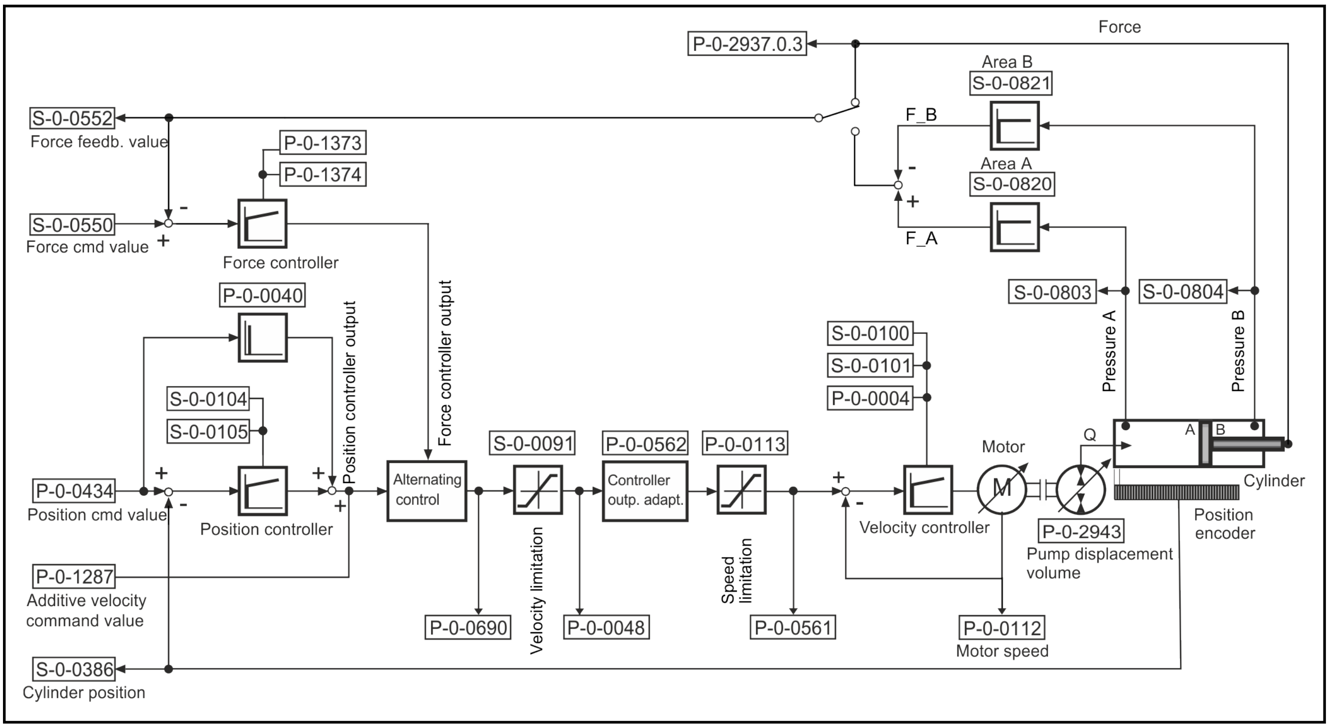


Fig. 6-1: Control structure for hydraulic cylinders in PFC and IndraDrive; force control using differential pressure measurement/force sensor

Mechanical system characteristics

All mechanical system characteristics with linear transmission are supported, e.g.:

- Ball screw assembly
- Belt drive

Hydraulic system characteristics

Cylinder axes with the following system characteristics of the hydraulic components are supported.

1. Hydraulic system:
   - Direction input via pump (usually "closed oil circuit")
   - Direction input via valves ("open oil circuit")
2. Cylinders:
   - Double rod cylinder
   - Single rod cylinder

- Double rod cylinder; cylinder with effective area switching
- Single rod cylinder; cylinder with effective area switching

3. Pump types:
    - 4-quadrant operation; cylinder moved directly via pump
    - 2-quadrant operation; pump with only one direction of displacement, cylinder direction determined via valves
4. Pump volume:
    - Fixed displacement pump
    - Pump system with 2-point control
    - Pump with continuously variable displacement
5. On/off valves:
    - Enable valves for A-side and B-side
    - Rapid mode and press mode valve
    - Directional valves for retracting and extending
    - Decompression valve
        - Double rod cylinders: Decompression with pulling (decompression valve on A-side - from PFC03V04) and pushing (decompression valve on B-side) loads
        - Single rod cylinders: Decompression valves on A-side and B-side
    - Swivel angle control valve (2-point control)
6. Proportional valve:
    - Swivel angle control valve (continuously variable adjustment)
7. Sensors:
    - Encoders for cylinder position
    - Pressure sensors for A-side and B-side of cylinder
    - Pressure sensor for chamber C
    - Force sensor
    - Tank pressure sensor or switch
    - System pressure sensor or switch
    - Pilot oil pressure sensor or switch
    - Oil temperature sensor or switch
    - Swivel angle sensor

The sizing of the components and the hydraulic design are limiting elements of the operating points and the dynamics of the actuator.

Supported functions

The following functions are available:

- Operation modes:
    - Closed-loop position control chapter 6.7 "Closed-loop position control" on page 44
    - Open-loop velocity control chapter 6.8 "Open-loop velocity control" on page 51
    - Position control with alternating force control chapter 6.9 "Pressure/force controller" on page 52 and chapter 6.10 "Alternating control" on page 56

  – Open or closed-loop swivel angle control chapter 6.16 "Swivel angle control" on page 70
- Active vibration damping chapter 6.7 "Closed-loop position control" on page 44
  – Typically up to 15 Hz with 2 ms control clock cycle; depending on motor dynamics and encoder dead times
  – Typically up to 20 Hz with 1 ms control clock cycle; depending on motor dynamics and encoder dead times
- Pulsation compensation chapter 6.17 "Pulsation compensation for axial piston pumps" on page 75
- Output adjustment in the case of hydraulic change of actuator feed chapter 6.11 "Rapid mode/press mode switching, cylinder" on page 58
- Decompression chapter 6.14 "Decompression" on page 62
- Holding functionchapter 6.15 "Holding function" on page 66
- Protective/monitoring functions chapter 6.20 "Protective functions" on page 86
- Parameter set switching chapter 6.7.5 "Parameter set switching" on page 48
- Diagnostics/error handling chapter 6.22 "Diagnostics/error handling" on page 104

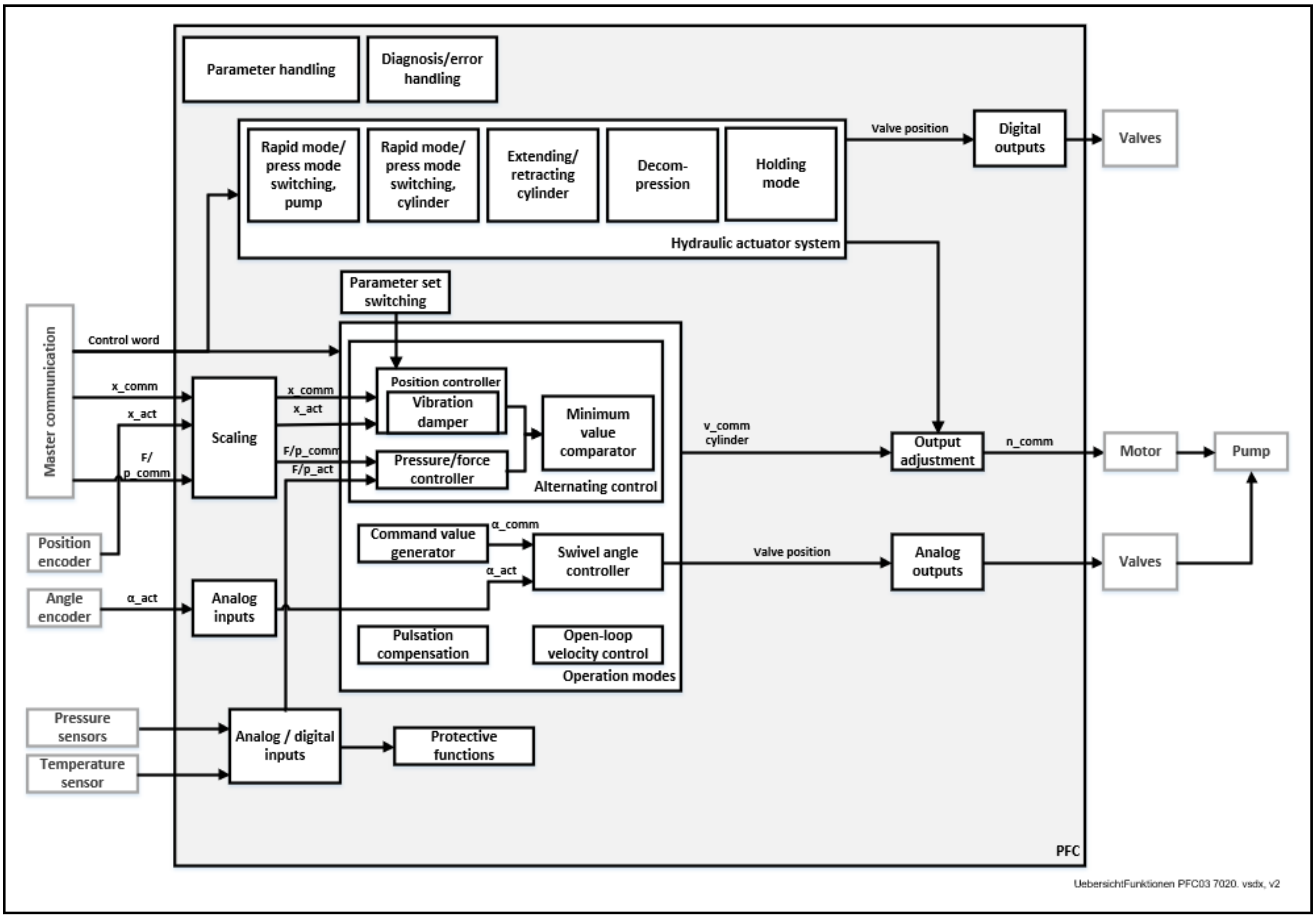


Fig. 6-2: Overview of functions

Functions that are not supported

The following functions are not or not yet available:

- Torque/force control mode
- Position control mode
  - Automatic control or control of area switching with plausibility check is not possible in cyclic position control.
- Hydraulic circuit
  - Rapid mode circuit for single rod cylinder

Requirements/restrictions

There are the following requirements/restrictions:

- Precision of position control depends on:
  - Encoder resolution
  - Encoder precision/jitter
  - Freedom from interference in the encoder signal
- Precision of force control depends on:
  - Type of force acquisition (pressure sensors/force sensor)
  - Sensor resolution
  - Sensor precision/jitter
  - Freedom from interference in the sensor signals
- Accuracy of closed-loop swivel angle control depends on:
  - Encoder resolution
  - Encoder precision/jitter
  - Freedom from interference in the encoder signal
  - Pump leakage
  - Dynamic response the swivel angle adjustment
- Magnetostrictive position encoders:
  - have to be set to synchronization
  - by "BALLUFF®" can be used with measuring rod lengths up to 1100 mm
  - by "MTS SENSORS®" can be used with measuring rod lengths up to 2200 mm
  - by "MTS SENSORS®" with measuring rod lengths of more than 2200 mm can be used with the encoder firmware "396-06-10" and above, if they are reprogrammed to extrapolation and init delay "10". For reprogramming use the proprietary "Temposonics Sensors PC-Programming" programming adapter and the "MTS SSI-Configurator" software tool of version "5.3.7" and above. Otherwise, jumps in the velocity signal can occur due to oversampling (aliasing effects).
- PFC03V02: When the "Drive Halt" (AH) mode is selected, the function valves remain open and the pump is put to standstill with torque. Closed-loop controlled standstill of the cylinder is not possible.

  ab PFC03V04: When the "Drive Halt" (AH) mode is selected the axis is shut down in the current operating mode by zeroing the command value change. The axis remains in the current operating mode in closed-loop control.
- Open/closed-loop velocity control

– The closed-loop velocity control mode regulates the motor speed. The cylinder velocity is only open-loop controlled, taking the hydraulic advance into account.
– During closed-loop velocity control, switching of controllers to force control is not possible.
– During closed-loop velocity control, area switching has to be performed manually or externally via a switching control word, via an automated process or plausibility check of controlling.

6.2 Cycle times

When the PFC boot application is used, the fast PLC task is always called in a 1-ms clock cycle. The cycle time of the controllers in PFC can, however, be set in "P-0-1311[177], PFC cycle time".

Cycle time 1 ms

With a PFC cycle time of 1 ms the controllers are called in every task call. Valve activation and advance calculation as well as monitoring functions and event handling are called alternatingly (2 ms).

☞ Calling the FDA functionality with a PFC cycle time of 1 ms is not possible for performance reasons.

Cycle time 2 ms

With a PFC cycle time of 2 ms the controllers are called in every second task call. Valve activation and feed calculation as well as monitoring functions and event handling are also called alternatingly. The FDA functionality is called in the cycle of monitoring functions and event handling.

Cycle time greater than 2 ms

With a PFC cycle time of more than 2 ms, the first two cycles are identical to that of a cycle time of 2 ms; all further cycles are used exclusively for slower tasks.

Cycle time of user projects

If PFC is used as library in an application, it is also possible to change the cycle time of the fast PLC task ("TaskCyclicFast") to higher cycles times (e.g., 2 ms). This may be useful, if PFC is to be called synchronously with the CCD cycle or master communication. If a PLC cycle time greater than 1 ms is set, the PFC functions are called in every PLC cycle. The assignment to PLC calls is made automatically through the interruption by firmware functions of higher priority. In "P-0-1311[177], Fast task, cycle time" the cycle time of "TaskCyclicFast" has to be entered.

Pertinent parameters

- P-0-1311[177], Fast task, cycle time

Pertinent diagnostic messages

- E2015, B5008: Cycle time not feasible P-0-1311[177]

6.3 Parameter handling

For the input parameters, we generally distinguish process data and machine data:

Process data contain values read in in a rapid task to follow the process; a force command value or a control word, for example. These values are validated in each cycle. If a value is not within its allowed range, a corresponding message is generated and a valid alternative value is used internally for calculations.

Machine data contain values read in in a slow task to internally map the hydraulic system or make control settings; cylinder areas, a controller gain (is cyclically transmitted) or a filter time, for example. These values are checked for content and editability in the slow cycle. If the check is successful, a value is internally applied and takes effect in the next cycle of the rapid task. If the check fails, the last valid value remains internally active and is written to the corresponding parameter again. The fact that the last valid value is written back and an additional message that is generated indicate that the user made the wrong input.

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B503D: Invalid value for data type of ...
- E2015, B5074: Axis conf. must not be changed P-0-1370
- F2017, D5075: Init not completed, check config data

6.4 Hydraulic actuator system

6.4.1 Overview

The type of the actuator system (motor, pump, valves, cylinder etc.) has to be registered in the technology function. For this, actuator type "4" is used; el. motor-pump-hydraulic cylinder (Sytronix) (the actuator is a motor, which is activated by a controller; possibly non-linear behavior of actuator system).

The following features are supported.

Definition

The **A-side** is the side in a hydraulic system at which the chamber of a cylinder is connected that, with sufficient increase in pressure, makes the cylinder move in the direction facing the machine process. For single rod cylinders this is the extending direction.

The **B-side** is the side in a hydraulic system at which the chamber of a cylinder is connected that, with sufficient increase in pressure, makes the cylinder move in the direction away from the machine process. For single rod cylinders this is the retracting direction.

Chamber C is the third cylinder chamber of a multiple-area cylinder. The cylinder chamber can be hydraulically connected to the A-side or the B-side.

Features

- Determination of direction of the actuator
  - Direction of rotation of the pump (closed oil circuit).
  - Directional valves (open oil circuit)
- Single rod/double rod cylinder
- Rapid mode/press mode switching at actuator with different changeover logics
- Displacement of pump (fixed, two-point control, continuously variable)
- Decompression function on A- and B-side
- Valves:
  - Enable valve: A-side
  - Enable valve: B-side
  - Changeover valve: Rapid mode
  - Changeover valve: Creep mode
  - Directional valve: Extending
  - Directional valve: Retracting
  - Decompression valves
  - Swivel angle control valve
    - Two-point control
    - Continuous adjustment
- Sensors:

- Pressure sensor: Chamber A
- Pressure sensor: Chamber B
- Pressure sensor: Chamber C
- Force sensor: Cylinder piston
- Pressure sensor: System pressure
- Pressure sensor: Tank pressure
- Pressure sensor: Pilot oil pressure
- Temperature sensor: Oil temperature
- Swivel angle sensor Actual swivel angle value

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0113, Bipolar velocity limit value of motor
- P-0-0560, Configuration of actuator
- P-0-0562, Active feed/gear factor
- P-0-1275, Effective displacement
- P-0-1280, System status word 1
- P-0-1281, System status word 2
- P-0-1282, Pressure feedback value C
- P-0-1283, Switching control word
- P-0-1284, Oil temperature
- P-0-1288, Pilot oil pressure
- P-0-1289, Swivel angle feedback value
- P-0-1290, Valve control variable for swivel angle control
- P-0-1311[112], Pressure threshold for recognizing the load side when extending
- P-0-1311[137], Process pressure max.
- P-0-1311[138], Cylinder area 3 (press mode, extending)
- P-0-1311[139], Cylinder area 4 (press mode, retracting)
- P-0-1311[192], Pressure difference for load-dependent feed switching
- P-0-1311[193], Debounce time for load-dependent feed switching
- P-0-1311[194], Switch-on threshold for decompression (pressure A)
- P-0-1311[195], Switch-off threshold for decompression (pressure A)
- P-0-1311[196], Debounce time for decompression activation condition
- P-0-1311[206], Pressure differential, inlet valves
- P-0-1311[207], Debounce time of inlet valves
- P-0-1370, Axis structure configuration
- P-0-1371, Minimum pump displacement (Vg) 2
- P-0-1372, Configuration, axis controllers/functions
- P-0-1410, Valve switching word 1
- P-0-1411, Valve switching word 2
- P-0-2943, Pump displacement
- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B

- S-0-0813, System pressure
- S-0-0814, Tank pressure
- S-0-0820, Piston area A
- S-0-0821, Piston area B
- S-0-0880, Swivel angle command value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5000: Cyl. area less or equal zero, check S-0-0820
- E2015, B5001: Cylinder areas fast/slow not feasible P-0-1311[138]
- E2015, B5002: Cyl. area less or equal zero, check S-0-0821
- E2015, B5003: Cyl. areas fast>slow, check that S-0-0821<=S-0-0820
- E2015, B5004: Cylinder areas fast/slow not feasible P-0-1311[139]
- E2015, B500A: Config data exceeds valid range P-0-1371
- E2015, B500B: Config data exceeds valid range P-0-2943
- E2015, B500C: Config data not feasible P-0-1371
- E2015, B500E: Speed limitation NOT feasible: P-0-0113
- E2015, B500F: Config data exceeds valid range P-0-1311[137]
- E2015, B5014: Actual pump displacement volume exceeds valid range
- E2015, B5015: Pump displacement volume can not be modified
- E2015, B5016: Actual cylinder volume <=0
- E2015, B5017: Force control plant compensation <= 0
- E2015. B5019: Swivel angle mode config not feasible P-0-1370.5
- E2015, B5023: Cylinder areas can not be switched
- E2015, B5031: Pos. vel. lim. < neg. vel. lim.: S-0-0038/0039/0113
- E2015, B5045: Config data not feasible P-0-1372.10
- E2015, B505B: Config data not feasible P-0-1311[206]
- E2015, B5069: Automatic not possible in cyclic pos ctrl P-0-1372
- E2015, B506E: Config data not feasible P-0-1311[194]
- E2015, B507A: Config data not feasible P-0-1311[195]
- E2015, B507C: Config data not feasible P-0-1372.3
- E2015, B5081: Config data not feasible P-0-1372.3
- E2015, B5099: Pressure difference controlling not allowed P-0-1370
- E2015, B50B4: Force calculation and cylinder config not feasible
- F2017, D5062: Config err, axis type sel. not feasible P-0-1370.2
- F2017, D5090: Actor cannot be hyd. motor -> change in P-0-0560

6.4.2 Cylinders

The following cylinder types are supported (each with effective area switching):

- Double rod cylinder
- Single rod cylinder

Double rod cylinder

A double rod cylinder has a rod at both sides of the piston. The two resulting annular areas A1 and A2 of the cylinder are equal. Given the same flow rate, the cylinder advance is equal during extending and retracting. Besides, the resulting force pressing and pulling is equal given the same pressure differential.

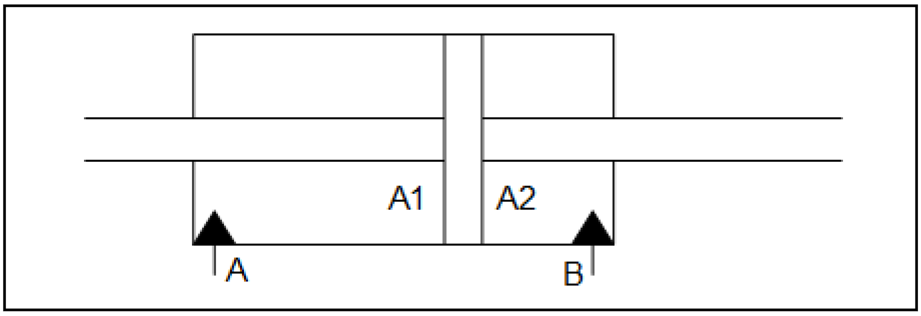


Fig. 6-3: Double rod cylinders with A/B connections and A1/A2 annular areas (here: A1 = A2)

Single rod cylinders

A single rod cylinder has a rod at one side of the piston. The resulting annular area A2 of the cylinder is always smaller than piston area A1. Given the same flow rate, when extending the cylinder advance is by the area ratio A2 / A1 smaller than when retracting. Besides, the resulting force pressing is by the area ratio A1 / A2 greater than pulling given the same pressure differential.

For calculating the controlled system adjustment for retracting and extending you may select from:

- Direction-dependent on the sign of the controller output
- Pressure-dependent on the difference of pressures in chambers A1 and A2 (hydraulically pilot operated check valve)

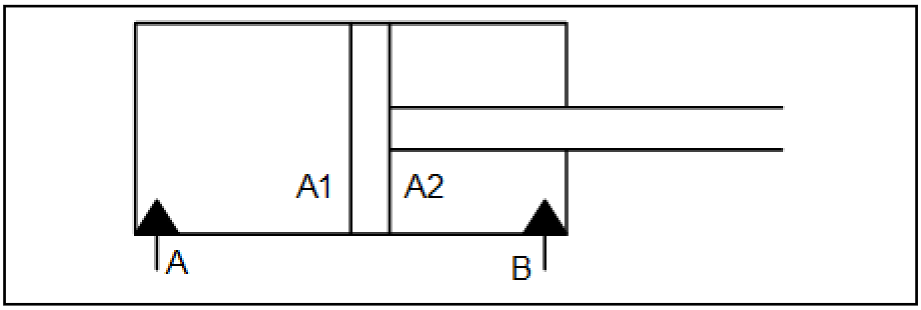


Fig. 6-4: Single rod cylinder with A/B connections, A1 piston area and A2 annular area (A1 > A2)

Effective area switching

Switching the effective area (rapid mode/press mode switching) is usually implemented by a type of regenerative circuit, by connecting a third chamber to chamber A or chamber B. This results in an effective total area for the cylinder advance. If the oil of the two connected chambers flows in the same direction with one cylinder motion, the effective area is the sum of the individual areas. If the oil of the two connected chambers flows in the opposite direction with one cylinder motion, the effective area is the difference between the greater and the smaller area.

There are three different modes for controlling the effective area switching between rapid mode and press mode. They are selected via the configuration of the coordination type (P-0-1372; bits 8/7):

- 00: Direct input via the valve switching control word, P-0-1283 from the higher-level control.
- 01: Automatic mode of the technology function using command values and feedback values of positioning velocity and pressure/force (P-0-1372, bit 6, to be considered).

- **10:** Validation of the selection in the valve control word using the feedback values of speed and pressure.

Example:

Double rod cylinder with effective area switching (A1 = A2 + A3)

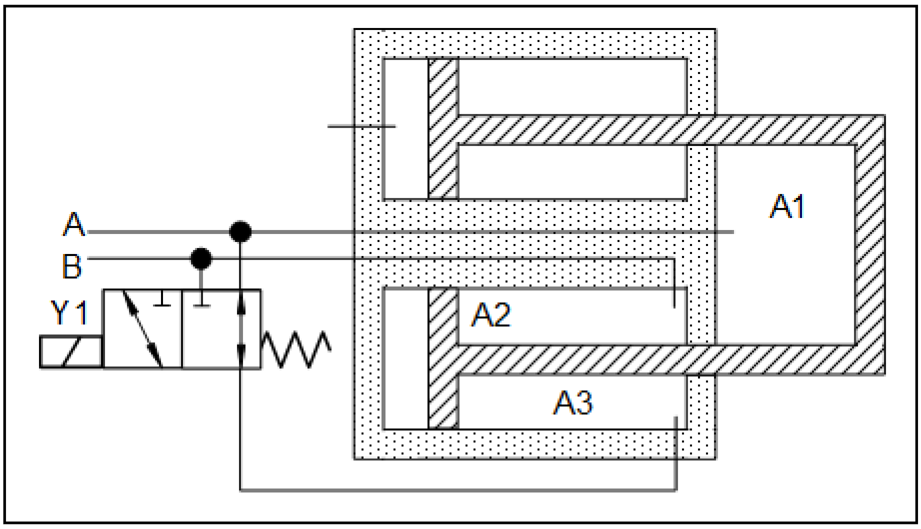


Fig. 6-5: Double rod multiple-chamber cylinder with A/B connections and A1/A2/A3 areas

Effective rapid mode area when extending is A1 minus A3. Y1 is in its basic position.

Effective rapid mode area when retracting is A2. Y1 is in its basic position.

Effective press mode area when extending is A1. Y1 is controlled.

Effective press mode area when retracting is A2 plus A3. Y1 is controlled.

Example:

Single rod cylinder with effective area switching (A1 > A2 > A3)

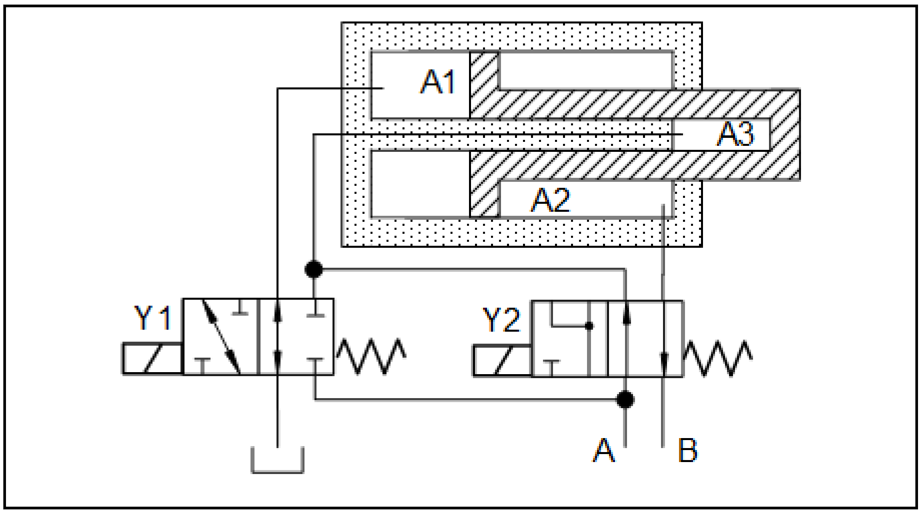


Fig. 6-6: Single rod multi-chamber cylinder with A/B connections and A1/A2/A3 areas

Effective rapid mode area when extending is A3. Valves Y1 and Y2 are in their basic positions.

Effective rapid mode area when retracting is A2 minus A3. Valves Y1 and Y2 are operated.

Effective press mode area when extending is A1 plus A3. Valve Y1 is controlled and Y2 is in its basic position.

Effective press mode area when retracting is A2. Valves Y1 and Y2 are in their basic positions.

6.4.3 Pumps

Pumps have a geometric volume (Vg), also called displacement or simply pump volume. This volume is transported during one pump revolution from the suction side to the pressure side, neglecting leakage.

The following pump types are supported:

- Fixed displacement pump
- Variable displacement pump, continuously variable
- Variable displacement pump, two-point control

The mechanical structure (axial piston, internal/external gear, ...) is not important. The allowed operating regions (2-quadrant, 4-quadrant, ...) are also irrelevant at this point.

Fixed displacement pump

Fixed displacement pumps have a fixed displacement per revolution.

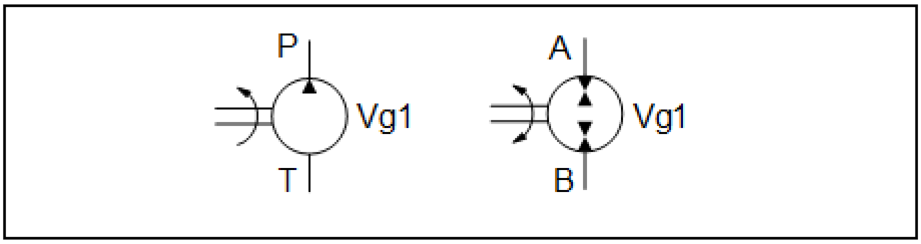


Fig. 6-7: Left: 2-quadrant pump with T/P ports; right: right: 4-quadrant pump with A/B ports; each with a fixed displacement Vg1

Variable displacement pump, continuously variable

In the case of variable displacement pumps the displacement can be continuously adjusted between the minimum value and the maximum value. The minimum value can be greater than or equal to zero. A "negative displacement", with which the pump given the same direction of rotation delivers to the other connection side, is not supported. The swivel angle can be controlled by an external controller or by the internal generation of a swivel angle command value with swivel angle controller.

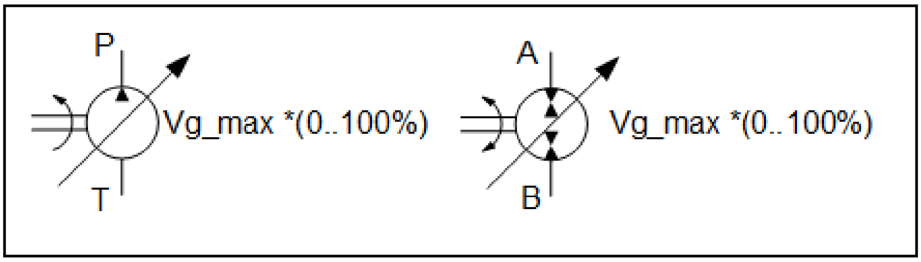


Fig. 6-8: Left: 2-quadrant pump with T/P ports; right: right: 4-quadrant pump with A/B connections; each with a continuously variable displacement of 0 to Vg_max

Variable displacement pump, two-point control

Pumps with two-point control usually are variable displacement pumps with binary selection (on/off valves), or two pumps interconnected via a valve. In the steady state, both pump systems only have two different displacements: the minimum value and the maximum value.

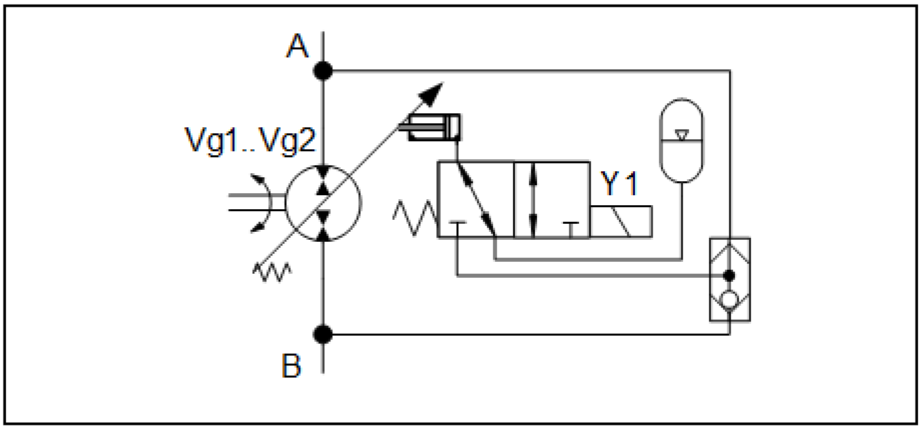


Fig. 6-9: Variable displacement pump, two-point control

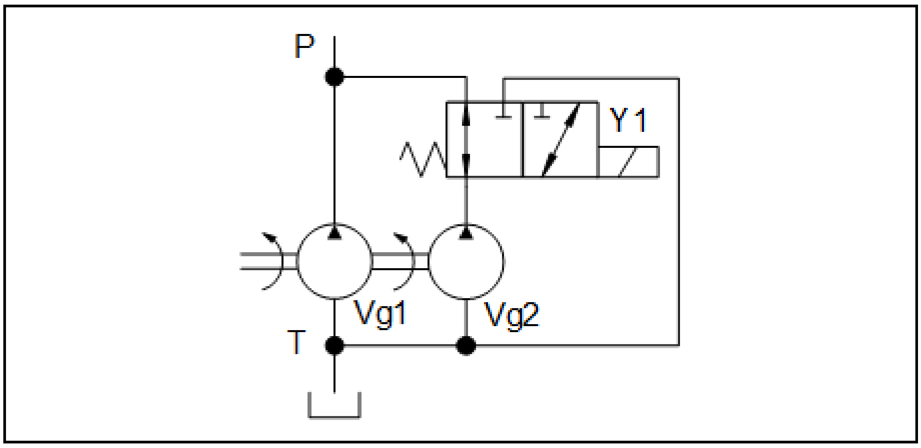


Fig. 6-10: Double pump

Switching between the displacements takes place manually using the switching control word (P-0-1283).

6.4.4 Valve operation

The following valve signals are available in the valve control words. They are switched according to the actuator configuration and operating state:

- Enable valve: A-side
- Enable valve: B-side
- Changeover valve: Rapid mode, cylinder
- Changeover valve: Press mode, cylinder
- Changeover valve: Extending, cylinder
- Changeover valve: Retracting, cylinder
- Changeover valve: Rapid mode, pump
- Changeover valve: Creep mode, pump
- Decompression valve B-side
- Decompression valve A-side (for single rod cylinders only)

To adjust the varying switching behaviors of different valves, a switching sequence can be set for switching to rapid mode and to press mode. In this sequence up to 15 intermediate states with switching durations can be parameterized for the transition to the respective final states of the valves.

User-defined switching sequences can be created and selected via the switching control word. A total of up to 15 valves per switching sequence can be defined.

6.5 Scaling

6.5.1 Overview

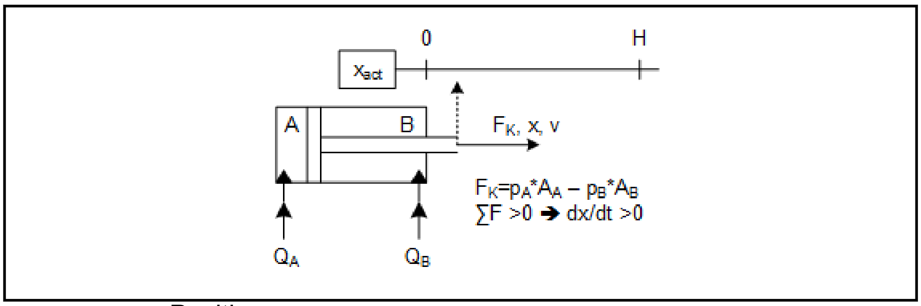
With PFC03, actuator type "4" is used; el. motor-pump-hydraulic cylinder (Sytronix) (the actuator is a motor, which is activated by a controller; possibly non-linear behavior of actuator system).

A reference between the actuator and the controller has to be established (standard axis).

Initial state:

1. Encoder system without negation of position
2. Velocity scaling not negated

The cylinder extends with positive force and the position increments, if position negation has not been set.



x	Position
H	Maximum cylinder stroke
v, dx/dt	Velocity
$p_{A/B}$	Pressure in chamber A/B
$A_{A/B}$	Cylinder area of chamber A/B
$Q_{A/B}$	Flow in chamber A/B
F_K	Piston force

Fig. 6-11: Standard axis

The following aspects are always assumed:

- The technology function does not support the modulo format for position data processing. The absolute format has to be set for position data processing.
- The position data need to have linear scaling.
- The external encoder has to be configured in such a way that without negation of the position data it counts positively when the hydraulic cylinder extends.
- The torque/force data should not be scaled with a percentage factor.

Direction via pump (closed oil circuit)

If the pressure in cylinder chamber B is built up with a positive motor speed (P-0-0112 > 0), the direction of displacement of the pump is inverted and needs to be adjusted using P-0-1370; bit 10 = 1.

Directional valves (open oil circuit)

If the pump delivers oil from the pressure side to the suction side with a positive motor speed (P-0-0112 > 0), the velocity polarities have to be negated (S-0-0043).

The remaining drive scaling can be set as the application requires.

Features

- Standard axis reference
- Direction of displacement of the pump has to be set depending on the hydraulic system
- Scaling settings in the drive can be freely selected
- Advancing (possibly variable) is automatically determined from effective areas and displacement; with the suitable compensation via integrated controller output adjustment

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1370, Axis structure configuration
- S-0-0055, Position polarities
- S-0-0076, Position data scaling type
- S-0-0077, Linear position data scaling factor
- S-0-0077, Linear position data scaling exponent
- S-0-0043, Velocity polarity parameter
- S-0-0044, Velocity data scaling type
- S-0-0045, Velocity data scaling factor
- S-0-0046, Velocity data scaling exponent
- S-0-0160, Acceleration data scaling type
- S-0-0161, Acceleration data scaling factor
- S-0-0162, Acceleration data scaling exponent
- S-0-0085, Torque/force polarity parameter
- S-0-0086, Torque/force data scaling type
- S-0-0093, Torque/force data scaling factor
- S-0-0094, Torque/force data scaling exponent
- S-0-0805, Pressure polarity parameter
- S-0-0806, Pressure data scaling type
- S-0-0807, Pressure data scaling factor
- S-0-0808, Pressure data scaling exponent
- S-0-0601.x.1, Encoder data out configuration
- S-0-0602.1.2, Phys. encoder properties

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5042: S-0-0123 adjusted to set force/torque to scale
- E2015, B505E: Feed constant, S-0-0123 must be >0
- E2015, B509D: Config data exceeds valid range S-0-0077
- E2015, B509E: Config data exceeds valid range S-0-0045
- E2015, B509F: Config data exceeds valid range S-0-0161
- E2015, B50A0: Config data exceeds valid range S-0-0093
- E2015, B50A1: Config data exceeds valid range S-0-0846

- E2015, B50A2: Config data exceeds valid range S-0-0806
- F2017, D5068: Torque/force unit cannot be [%] -> set in S-0-0086
- F2017, D509A: Rot. pos. not supported -> set S-0-0076 bit 2..0=001

6.6 Operation modes

6.6.1 Overview

The actuator can be operated in various modes. These are closed-loop position control, open-loop velocity control and closed-loop pressure/force control. Hydraulic special modes such as rapid mode/press mode switching are additionally available.

☞ The **operation mode** selected in IndraDrive and the **operating mode** of the technology function are two settings that have to be distinguished. They interdepend only to some extent!

Features

- Closed-loop position control:
  - In all operation modes made available by IndraDrive ("drive-controlled positioning", "drive-internal interpolation", "positioning block mode", "cyclic position control"). The actuator encoder is the control encoder; encoder 1 in this case.
  - The special mode “rapid mode/press mode switching with automatism and plausibility check” is supported by the operation modes "drive-controlled positioning", "drive-internal interpolation" and "positioning block mode" that are made available by IndraDrive.
  - The special mode “rapid mode/press mode switching with manual selection” is supported by the operation modes "drive-controlled positioning", "drive-internal interpolation", "cyclic position control" and "positioning block mode" that are made available by IndraDrive.
- Open-loop velocity control:
  - As an operating mode; is activated using the IndraDrive operation mode "velocity control"; the motor encoder is the control encoder in this case
  - As speed addition taking the active feed into account
  - Does not allow switching of controllers in pressure/force control
- Closed-loop pressure/force control:
  - Replaces the operation mode closed-loop position control, as soon as the pressure/force controller output is lower than the output of the position controller (minimum value principle).
  - Thus, it is also used in a positioning mode of IndraDrive, where a position command value has to be commanded that leads to force buildup, so that switching to force control takes place.
  - Closed-loop pressure/force control cannot be explicitly activated.

Parameters involved

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0115, Device control: Status word
- P-0-0116, Device control: Control word
- P-0-0556, Config word of axis controller

- P-0-1281, System status word 2
- S-0-0032, Primary operation mode
- S-0-0033, Secondary operation mode 1
- S-0-0034, Secondary operation mode 2
- S-0-0035, Secondary operation mode 3
- S-0-0284, Secondary operation mode 4
- S-0-0285, Secondary operation mode 5
- S-0-0286, Secondary operation mode 6
- S-0-0287, Secondary operation mode 7
- S-0-0292, List of supported operation modes

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- F2017, D5063: Config error, no pos./vel. operation mode active

6.7 Closed-loop position control

6.7.1 Overview

☞ For correct operation of the position controller in the technology function, the acceleration feedforward of the position controller has to be deactivated in the IndraDrive firmware by writing the value "0" to parameter S-0-0348.

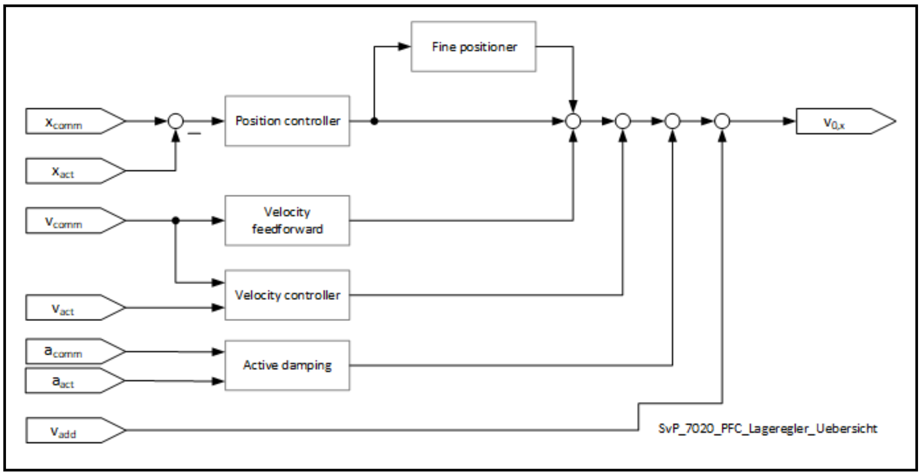


Fig. 6-12: Position controller overview

Closed-loop position control consists of the position controller itself, to which further components can be connected. Fine positioning (integrator), velocity feedforward control, the inner-loop velocity controller, active damping and additive velocity provision.

Features

- Position controller:
  - Proportional gain, Kv
  - Switching integral term, Ti incl. limitation (anti-windup)
  - Percentage-based velocity feedforward
- Velocity state feedback:

- Command value from differentiation of position command value, can be switched off (command value = 0)
- Feedback value from differentiation of position feedback value
- Proportional gain, Kp_vel
- Filtering the controller output from velocity controller

- Acceleration state feedback, active damping:
  - Command value from double differentiation of position command value, can be switched off (command value = 0)
  - Feedback value alternatively from:
    - Double differentiation of position feedback value
    - High-pass filtered actual force scaled weighted with moving mass
    - Acceleration observer; uses actual force, moving mass and actual velocity
    - Acceleration sensor
  - Proportional gain, Kp_acc
  - Filtering the controller output from the acceleration controller

6.7.2 Position controller

The position controller in PFC utilizes the controller parameters of the IndraDrive (S-0-0104, S-0-0105, P-0-0040). Accordingly, the position controller is continuously active in the IndraDrive firmware. The controller output of the position controller in the IndraDrive firmware (P-0-0563) must not be linked to the velocity controller and has to be separated by “opening the position control loop” (P-0-0556 bit 8 =1). This configuration has to be checked in PFC during phase switching PM → OM and, if required, prevent operation (→ "F2017, D5065 Drive loop cannot be enabled in pos. control").

Monitoring functions for S-0-0104 = 0 and P-0-0040 = 0 are cleared. Monitoring for S-0-0346 = 0 remains active; if applicable, "F2017, D5064: Acc. FF not supported → set S-0-0348 =0!" is generated.

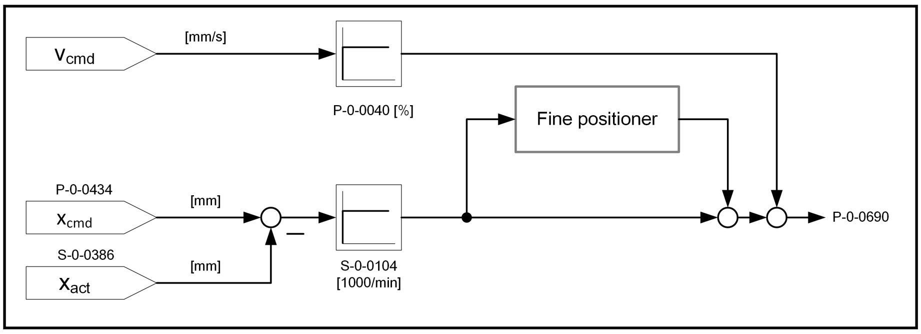


Fig. 6-13: Position controller

Due to the difference between the position command value of the controller (P-0-0434) and the active position feedback value (S-0-0386), the position controller of the technology function provides a controller output as the additive velocity command value, process controller (P-0-0690). The position controller has been implemented as a P-controller with fine positioner (switching I-term) and additional velocity feedforward.

Depending on the controlled system, a permanent control error persists. This can be minimized by means of the fine positioner. While a position control mode is active, a change of the Kv-parameter (S-0-0104) takes place abruptly.

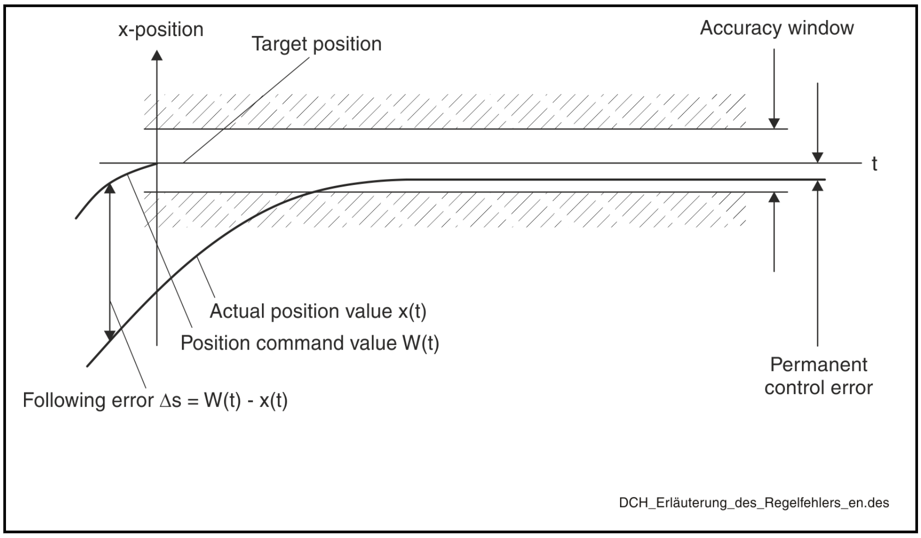


Fig. 6-14: Explanation of the control error

Velocity feedforward

With the help of feedforward control (command value feedforward), the command velocity - scaled with a percentage factor (P-0-0040) - can be processed in parallel to the position controller. In this way, any following distance can be minimized. A change of feedforward control scaling is implemented abruptly.

Integrator for fine positioning

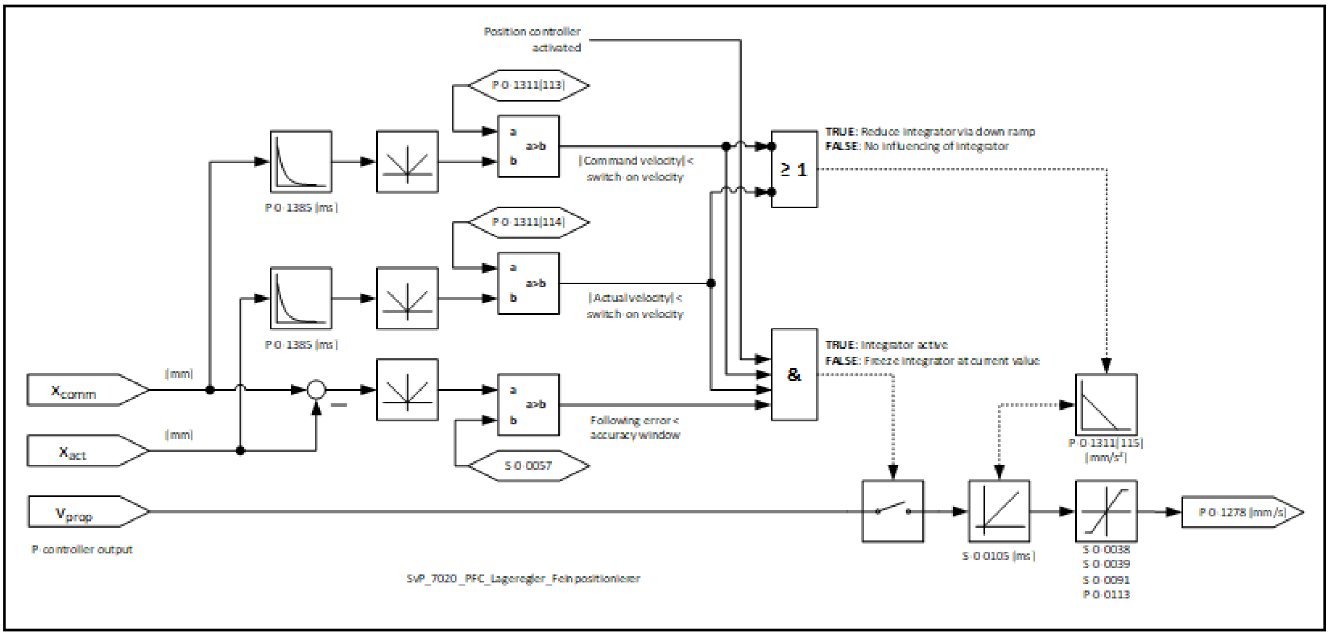


Fig. 6-15: Fine positioner

For exact positioning of a hydraulic axis it may be required to activate a special algorithm for fine positioning. Because at higher travel speeds the integrator has an unfavorable influence on the control behavior, it is only activated at lower travel speeds and close to the target position. The accuracy is specified by the accuracy window (S-0-0057).

The input of the integrator is the controller output of the P position controller. The slope of the I-term is determined by the integration time constant (S-0-0105). Apart from not having reached the accuracy window yet, a switch-on condition for the integrator is a value below that given for the I-term velocity threshold (P-0-1311[113] and P-0-1311[114]).

When fine positioning is switched off, the value is ramped down in the integrator (P-0-1311[115]).

The output of the fine positioning integrator can be limited additionally (MIN <S-0-0038, S-0-0039, S-0-0091, S-0-0113>). This means that the integrator sums up to, but will not exceed the maximum of this limit value.

The current value of the integrator can be read out, e.g. for optimization purposes (P-0-2831.0.3).

In the position operation modes (e.g. cyclic position), the axis is monitored for being able to follow the position command value. See Monitoring functions, chapter 6.20 "Protective functions" on page 86

6.7.3 Velocity controller and active damping

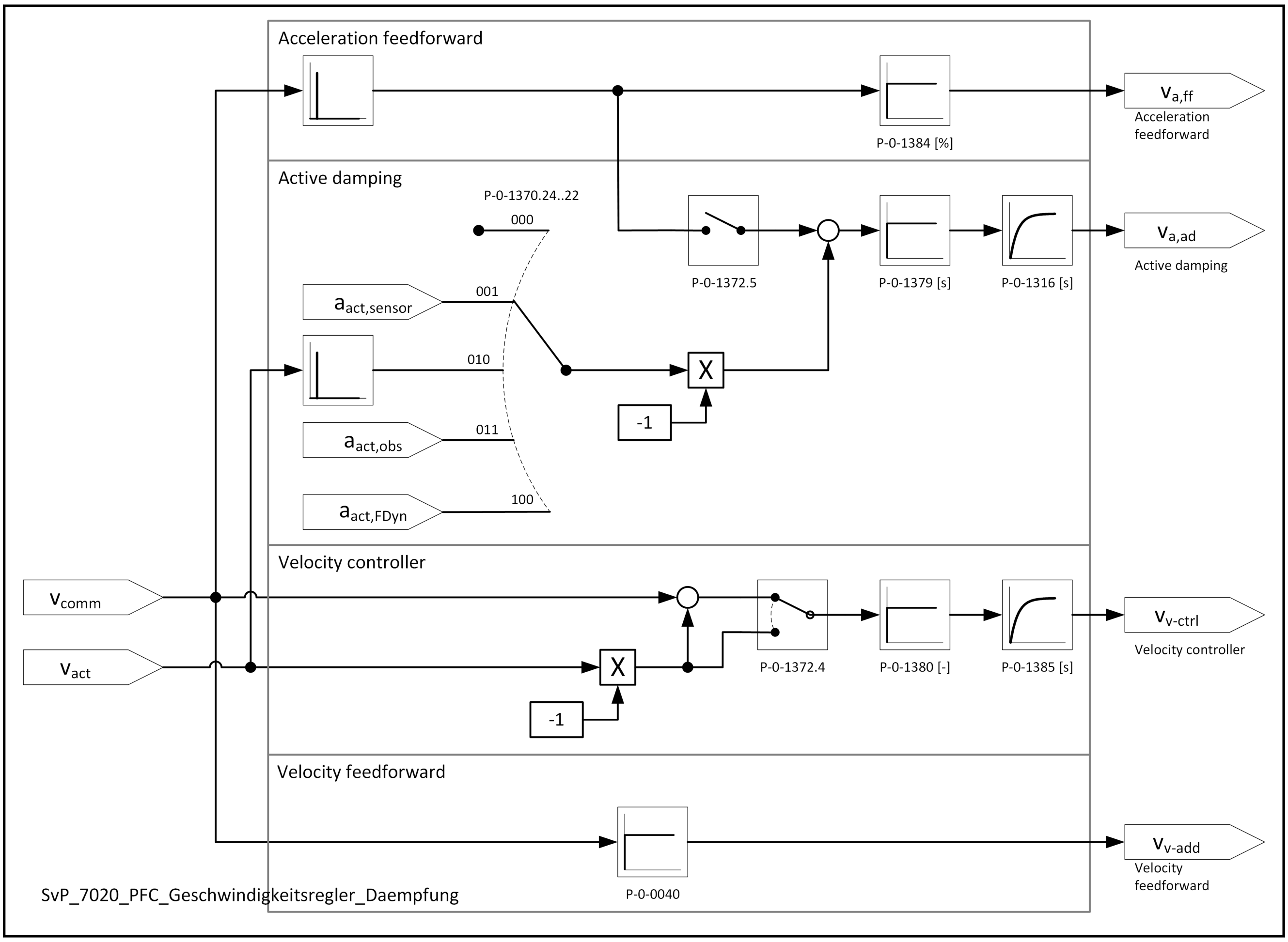


Fig. 6-16: Velocity controller and active damping

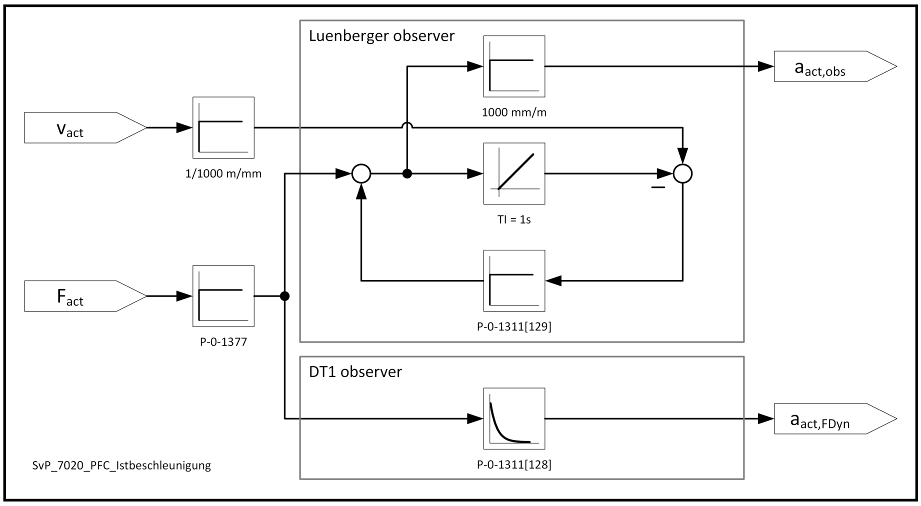


Fig. 6-17: Options for determining the actual acceleration

The actual force for active damping is calculated using the scaled pressures.

The inner-loop velocity control can be used to achieve a constant path velocity. If an operation mode with feedforward control has been selected, a command acceleration can additionally be fed forward to the output with the help of acceleration feedforward. This command velocity is weighted with a mass (S-0-1377) and converted into a velocity via force normalization. If required, the velocity can additionally be filtered.

For axes with a low natural frequency, active damping can be utilized to improve the control quality.

Inner-loop velocity control

The inner-loop velocity controller (see fig. 6-16 "Velocity controller and active damping" on page 47) is a P-controller. It is used to correct the velocity deviation between the command and the actual value. The P-term results from multiplication by the V-controller proportional gain (P-0-1380). The controller output of the velocity controller is fed through a configurable filter and added to the complete controller output of the position controller. The integrator, too, can be limited by means of a parameter (P-0-2832.0.5). The inner-loop velocity control is switched on via a value ! = 0 in P-0-1380.

6.7.4 Additive velocity command value

Via parameter P-0-1287 an additive velocity command value can be provided, which is active at the controller output, but before alternating control (firmware parameter S-0-0037 is active after alternating control).

6.7.5 Parameter set switching

Parameter set switching is available with four different sets. The parameter values can be switched manually or linked to rapid mode/press mode switching.

For each parameter set there is a delay that elapses before the values are switched, and a ramp time with which the old values are subsequently brought to the new values. The structure is as follows:

Parameter	Unit	Active values	Set 1	Set 2	Set 3	Set 4
Set switching delay	ms		P-0-1311[0]	P-0-1311[25]	P-0-1311[50]	P-0-1311[75]
Time in which values are brought to the corresponding set	ms		P-0-1311[1]	P-0-1311[26]	P-0-1311[51]	P-0-1311[76]
Kv, position control loop	1000/min	S-0-0104	P-0-1311[2]	P-0-1311[27]	P-0-1311[52]	P-0-1311[77]
Velocity feedforward weighting	%	P-0-0040	P-0-1311[3]	P-0-1311[28]	P-0-1311[53]	P-0-1311[78]
Ti, position control loop	ms	S-0-0105	P-0-1311[4]	P-0-1311[29]	P-0-1311[54]	P-0-1311[79]
Kp, veloc. control loop	-	P-0-1380	P-0-1311[5]	P-0-1311[30]	P-0-1311[55]	P-0-1311[80]
Kp, veloc. control loop	ms	P-0-1379	P-0-1311[6]	P-0-1311[31]	P-0-1311[56]	P-0-1311[81]

Tab. 6-1: Parameter sets structure

Features

- Manually or linked to rapid mode/press mode switching
- Switchable parameters
  - Kv, position control loop
  - Velocity feedforward
  - Ti, position control loop
  - Kp_v, velocity control loop
  - Kp_a, acceleration control loop
  - Set switching delay
  - Set switching transition time
- Four different parameter sets can be preconfigured
- Currently active set is displayed
- Currently active values are displayed in the respective registers
- Parameterizable delay until switching to the respective set takes place
- Parameterizable transition time for the values of the set to which switching takes place

6.7.6 Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0040, Velocity feedforward
- P-0-0113, Bipolar velocity limit value of motor
- P-0-0434, Position command value of controller
- P-0-0556, Config word of axis controller
- P-0-0562, Active feed/gear factor
- P-0-0563, Velocity command value input for adjustment
- P-0-0690, Additive velocity command value, process loop
- P-0-1276, Actual velocity value
- P-0-1277, Actual acceleration value
- P-0-1280, System status word 1
- P-0-1283, Hydraulic function, switching control word
- P-0-1285, Max. model deviation, position
- P-0-1287, Additive velocity command value

- P-0-1311 [0]+[25]+[50]+[75], Set switching delay time (to set 1...4)
- P-0-1311 [1]+[26]+[51]+[76], Set switching transition time (to set 1...4)
- P-0-1311 [2]+[27]+[52]+[77], Kv, position control loop (set 1...4)
- P-0-1311 [3]+[28]+[53]+[78], Velocity feedforward (set 1...4)
- P-0-1311 [4]+[29]+[54]+[79], Ti, position control loop (set 1...4)
- P-0-1311 [5]+[30]+[55]+[80], Kp, velocity control loop (set 1...4)
- P-0-1311 [6]+[31]+[56]+[81], Kp, accel. control loop (set 1...4)
- P-0-1311[113], Position controller, I-logic, change threshold command values
- P-0-1311[114], Position controller, I-logic, change threshold actual values
- P-0-1311[115], Position controller, I-term down ramp
- P-0-1311[116], Lag error monitoring: Reference velocity
- P-0-1311[118], Lag error monitoring: Max. lag error at reference velocity
- P-0-1311[119], Lag error monitoring: Max. lag error in standstill
- P-0-1311[120], Lag error monitoring: Warning threshold
- P-0-1311[121], Lag error monitoring: Debounce time
- P-0-1311[122], Lag error model monitoring window
- P-0-1311[128], Acceleration feedback value generation: Filter time
- P-0-1311[129], Acceleration observer: P-gain
- P-0-1311[130], Acceleration observer: Mounting angle
- P-0-1316, Acceleration controller smoothing time constant
- P-0-1370, Axis structure configuration
- P-0-1372, Configuration, axis controllers/functions
- P-0-1377, Moving mass
- P-0-1379, Acceleration controller load, Kp
- P-0-1380, Velocity controller load, Kp
- P-0-1384, Acceleration feedforward
- P-0-1385, Velocity control load, smoothing time constant
- P-0-2831.0.1, Output position controller Kv-part
- P-0-2831.0.3, Output position controller I-part
- P-0-2831.0.4, Output of position controller
- P-0-2831.0.5, Correction value: velocity feedforward control
- S-0-0038, Positive velocity limit value
- S-0-0039, Negative velocity limit value
- S-0-0057, Position window
- S-0-0091, Bipolar velocity limit value
- S-0-0104, Position loop Kv-factor
- S-0-0105, Position controller integral action time
- S-0-0189, Following distance
- S-0-0346, Positioning control word
- S-0-0348, Acceleration feedforward gain
- S-0-0386, Active position feedback value

6.7.7 Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B501A: Config data exceeds valid range P-0-1385
- E2015, B501B: Config data exceeds valid range P-0-1311[113]
- E2015, B501C: Config data exceeds valid range P-0-1311[114]
- E2015, B501D: Config data exceeds valid range S-0-0057
- E2015, B502E: Config data exceeds valid range S-0-0104
- E2015, B502F: Config data exceeds valid range S-0-0105
- E2015, B5033: Control command for integral part not feasible
- E2015, B5044: Config data exceeds valid range P-0-1311[130]
- E2015, B5046: Config data exceeds valid range P-0-1311[129]
- E2015, B5047: Config data exceeds valid range P-0-1377
- E2015, B5082: Config data exceeds valid range P-0-1385
- E2015, B5086: Config data exceeds valid range P-0-1316
- E2015, B5089: Config data exceeds valid range P-0-1311[115]
- E2015, B508C: Config data exceeds valid range P-0-1377
- E2015, B508D: Config data exceeds valid range P-0-1311[128]
- E2015, B5093: Parameter set no. 1 invalid, P1311.0...6
- E2015, B5094: Parameter set no. 2 invalid, P1311.25...31
- E2015, B5095: Parameter set no. 3 invalid, P1311.50...56
- E2015, B5096: Parameter set no. 4 invalid, P1311.75...81
- F2017, D502C: Position lag exceeds alarm level
- F2017, D5064: Acc. FF not supported -> set S-0-0348 =0!
- F2017, D5065: Drive loop cannot be enabled in pos. control

6.8 Open-loop velocity control

6.8.1 Overview

Open-loop velocity control has been implemented as speed control of the pump. It determines the velocity at the actuator.

If the velocity command values are to be accepted within the position controller clock cycle of the IndraDrive firmware (500 µs), the position control loop of the firmware may be closed (P-0-0556, bit 8 = "0”) and the position/force control loop of PFC opened (P-0-1370, bit 31 = "1"). Switching to closed-loop position control is not possible in this state.

☞ It is not the actuator velocity that is controlled!

Features

- Open-loop velocity control as speed command value addition.
- This operating mode is activated via the IndraDrive operation mode "velocity control". The motor encoder is the control encoder in this case.
- The active advance, which results from the displaced volume and areas, is taken into account and compensated by the controller output adjustment.
- Automatic changeover (e.g., rapid mode/press mode) is not possible.

- Transition to pressure/force control is not possible.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0535, Active velocity feedback value
- P-0-0556, Config word of axis controller
- P-0-0561, Effective velocity controller command value
- P-0-0562, Active feed/gear factor
- P-0-0563, Velocity command value input for adjustment
- P-0-0690, Additive velocity command value, process loop
- P-0-1283, Hydraulic function, switching control word
- P-0-1311[105], Ramp time for controller outputs when changing oper. modes
- S-0-0036, Velocity command value
- S-0-0037, Additive velocity command value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- F2017, D500D: Pos. loops of PFC and drive cannot both be enabled

6.9 Pressure/force controller

6.9.1 Overview

The pressure/force controller is called when alternating control has been activated. Alternating control can be activated by means of P-0-2853 bit 0 = 1. When the pressure/force controller is active (for conditions, see chapter 6 "Description of PFC functions" on page 29), bit 0 of parameter P-0-1280 is set to “1”. Then, the pressure/force controller corrects the actual force value on the basis of the set active force command value.

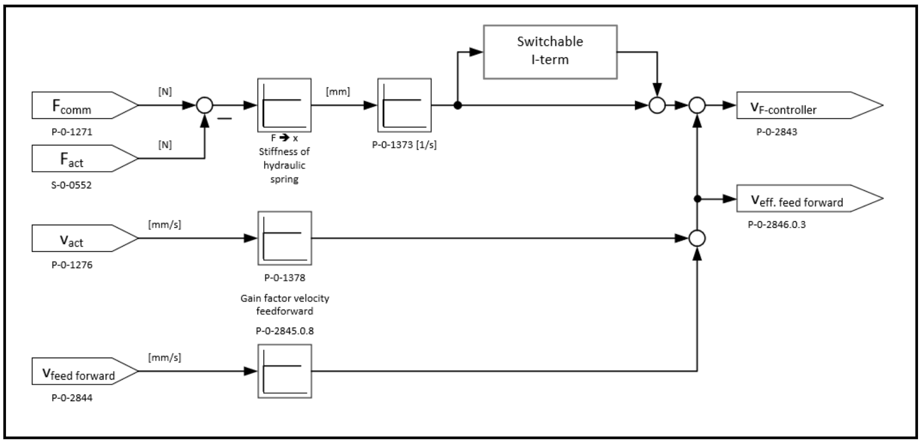


Fig. 6-18: Controller structure using the example of force

Normalization of force by velocity

The force control deviation is converted into a position using the stiffness of the hydraulic spring. This conversion factor is calculated from the cylinder geometry data entered and results in the fact that with a P-gain of 1 of the force controller (P-0-1373), overshoot-free controlling can theoretically be realized. This provides a good starting value for further optimization.

P-gain

Parameter P-0-1373 is used for setting the proportional control action of the controller.

Integrator

Despite optimization of the P-gain, a permanent control deviation due to disturbances or offsets may be present. This can be corrected by means of the integrated integrator.

The integrator can be set with the following parameters:

- P-0-1311[107], Pressure/force controller, I-logic, filter time
- P-0-1311[108], Pressure/force controller, I-logic, change threshold command values and P-0-1311[109], Pressure/force controller, I-logic, change threshold actual values
- P-0-1311[110], Pressure/force controller, I-logic, accuracy window
- P-0-1374, Pressure/force loop integral action time

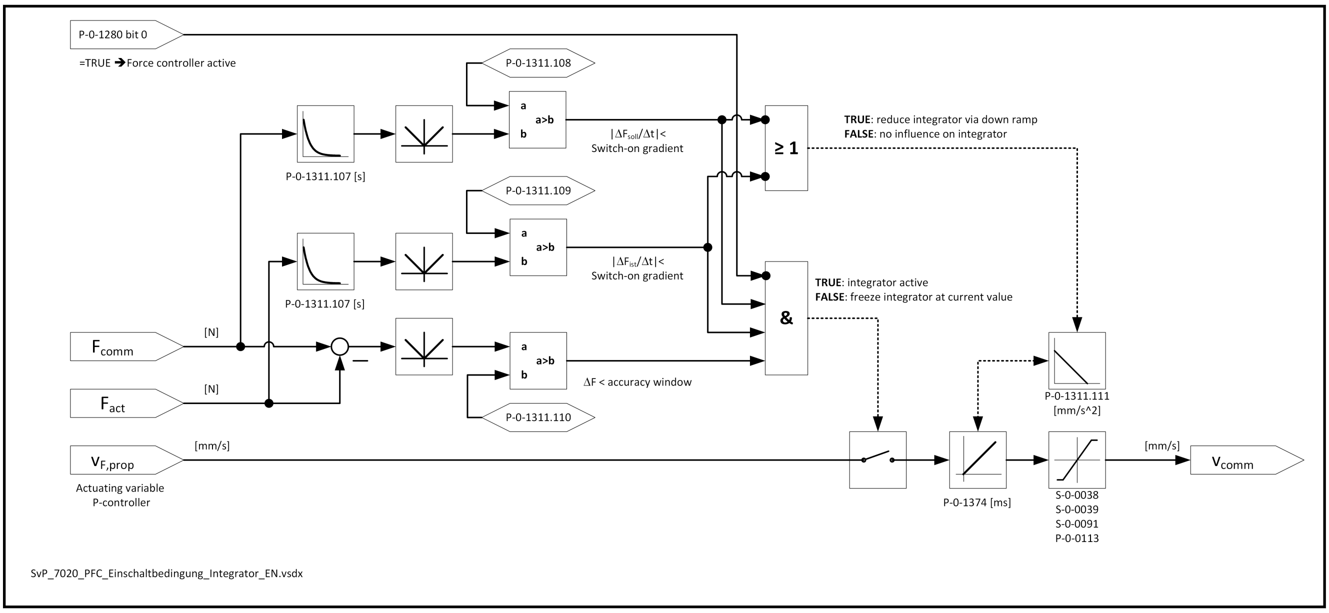


Fig. 6-19: Switch-on condition for integrator

By specifying the “force controller integrator force change threshold” and “force controller integrator accuracy window” you can define the enable condition for the integrator. The integrator is only activated when the change of the actual force value and the force command value is smaller than the specified change threshold, and the force control deviation is still greater than the force controller integrator accuracy window. When the control deviation is within the envisaged accuracy window, the I-term is stopped to prevent the drive from oscillating at values around the command value.

Velocity feedforward

The following variants of velocity feedforward control are provided:

- The actual velocity value is multiplied by “P-0-1378, Gain factor for pressure/force controller velocity feedback”, and added to the controller output.
- The writable parameter P-0-2844, Force controller velocity feedforward control is multiplied by P-0-2845.0.8 and added to the controller output.

☞ This function is available as of PFC03V04.

The active velocity feedforward control is displayed in P-0-2846.0.3.

Status of pressure/force

☞ The status of pressure/force is provided as of PFC03V04.

"Pressure/force command value has reached target value" is displayed. Depending on the configuration of pressure/force control, alternating control and, if applicable, on the current operating state, the target value for the pressure/force command values takes one of the following three command values:

- S-0-0550, Torque/force command value, positive 2
- S-0-0551, Torque/force command value, negative 2
- S-0-0800, Pressure command value

The relevant target value is limited and ramped. "P-0-1280, System status word 1", bit 1 = 1 indicates that the active pressure/force command value P-0-1271 has reached the limited target value.

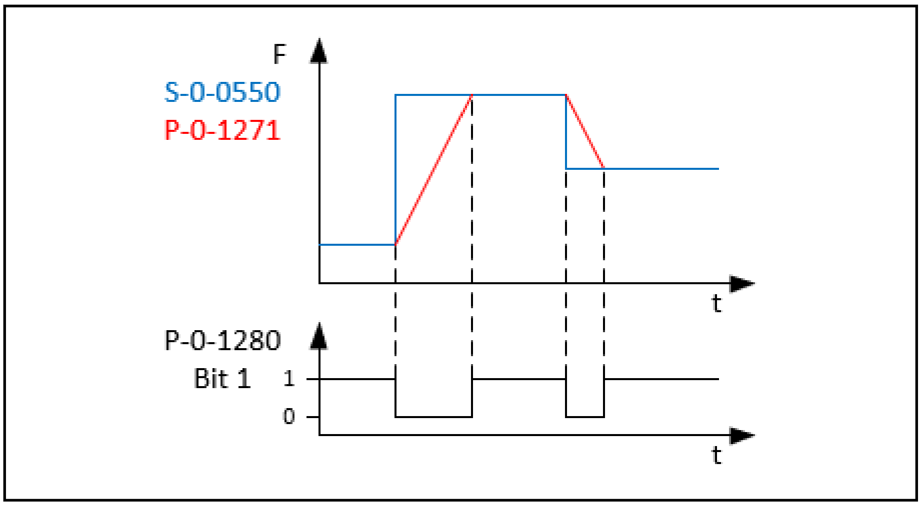


Fig. 6-20: Behavior of "pressure/force command value has reached target value" using the example of "force command value positive"

"Actual pressure/force command value is within the accuracy window" is displayed. For both the actual pressure value and the actual force value a separate accuracy window can be configured. "P-0-1280, System status word 1", bit 2 indicates that the actual value is within the accuracy window. The bit takes value 1, if the conditions for the active command value are fulfilled:

- Positive force command value active: |S-0-0550 - S-0-0552| < P-0-1311[104]
- Negative force command value active: |S-0-0551 - S-0-0552| < P-0-1311[104]
- Pressure command value active: |S-0-0800 - S-0-0809| < P-0-1311[105]

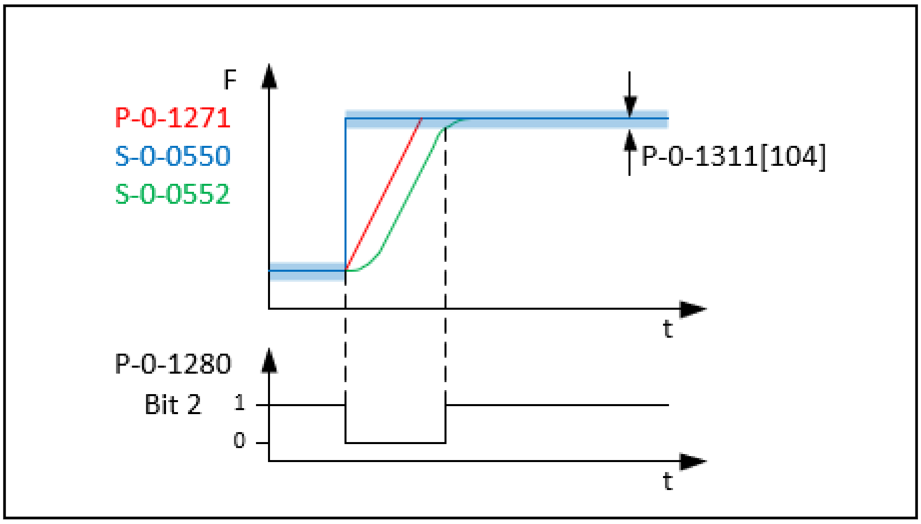


Fig. 6-21: Behavior of “actual pressure/force value is within the accuracy window” using the example of “force command value, positive”

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0113, Bipolar velocity limit value of motor
- P-0-1271, Effective pressure/force command value
- P-0-1276, Actual velocity value
- P-0-1280, System status word 1
- P-0-1311[101], Minimum pressure command value
- P-0-1311[102], Maximum force command value
- P-0-1311[103], Minimum force command value
- P-0-1311[104], Accuracy window of actual force value
- P-0-1311[106], Accuracy window of actual pressure value
- P-0-1311[107], Pressure/force controller, I-logic, filter time
- P-0-1311[108], Pressure/force controller, I-logic, change threshold command values
- P-0-1311[109], Pressure/force controller, I-logic, change threshold actual values
- P-0-1311[110], Pressure/force controller, I-logic, accuracy window
- P-0-1311[111], Pressure/force controller, I-term down ramp
- P-0-1311[141], Elastic modulus
- P-0-1311[198], Stiffness of mechanical system (for force build-up with electromechanical system)
- P-0-1373, Pressure/force controller, proportional gain
- P-0-1374, Pressure/force loop integral action time
- P-0-1376, Cylinder volume in force control
- P-0-1378, Pressure/force controller, velocity feedforward ratio
- P-0-2842, Force control deviation
- P-0-2843, Force controller output
- P-0-2844, Velocity feedforward control
- P-0-2845.0.8, Force controller scaling of velocity feedforward control

- P-0-2846.0.1, Term of force controller P-gain
- P-0-2846.0.2, Term of force controller integrator
- P-0-2846.0.3, Term of force controller velocity feedforward
- S-0-0038, Positive velocity limit value
- S-0-0039, Negative velocity limit value
- S-0-0091, Bipolar velocity limit value
- S-0-0550, Torque/force command value, positive
- S-0-0551, Torque/force command value, negative
- S-0-0552, Torque/force feedback value 2
- S-0-0800, Pressure command value
- S-0-0809, Pressure feedback value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5006: Force command value exceeds valid range
- E2015, B5007: Pressure command value exceeds valid range
- E2015, B5016: Actual cylinder volume <= 0
- E2015, B5017: Actual bulk modulus <= 0
- E2015, B5018: Config data not feasible P-0-1311[104]
- E2015, B501E: Config data not feasible P-0-1311[106]
- E2015, B501F: Config data exceeds valid range P-0-1311[107]
- E2015, B5020: Config data exceeds valid range P-0-1311[108]
- E2015, B5021: Config data exceeds valid range P-0-1311[109]
- E2015, B5022: Config data exceeds valid range P-0-1311[110]
- E2015, B5039: Config data exceeds valid range P-0-1373
- E2015, B503A: Config data exceeds valid range P-0-1374
- E2015, B503B: Config data exceeds valid range P-0-1375
- E2015, B503E: Control command for integral part not feasible
- E2015, B5041: Controller configuration is out of range P-0-1378
- E2015, B505F: Mechanical stiffness, P-0-1311[198] must be >0
- E2015, B5061: Force sensor is needed -> set P-0-2937.0.1.1..0 = 11
- E2015, B506F: Config data exceeds valid range P-0-1311[101]
- E2015, B5070: Config error: max cmd pressure <= min cmd pressure
- E2015, B5071: Config data exceeds valid range P-0-1311[102]
- E2015, B5072: Config data exceeds valid range P-0-1311[103]
- E2015, B5079: Controller config. is out of range P-0-2845.0.8
- E2015, B508A: Config data exceeds valid range P-0-1311[111]
- E2015, B5099: Pressure difference controlling not allowed P-0-1370

6.10 Alternating control

6.10.1 Overview

Alternating control uses a minimum value generator that compares the controller outputs of the position controller and the pressure/force controller weighted as velocities and transmits the smaller one to IndraDrive as the velocity command value. This is implemented by a minimum value/maximum value principle depending on the direction of motion.

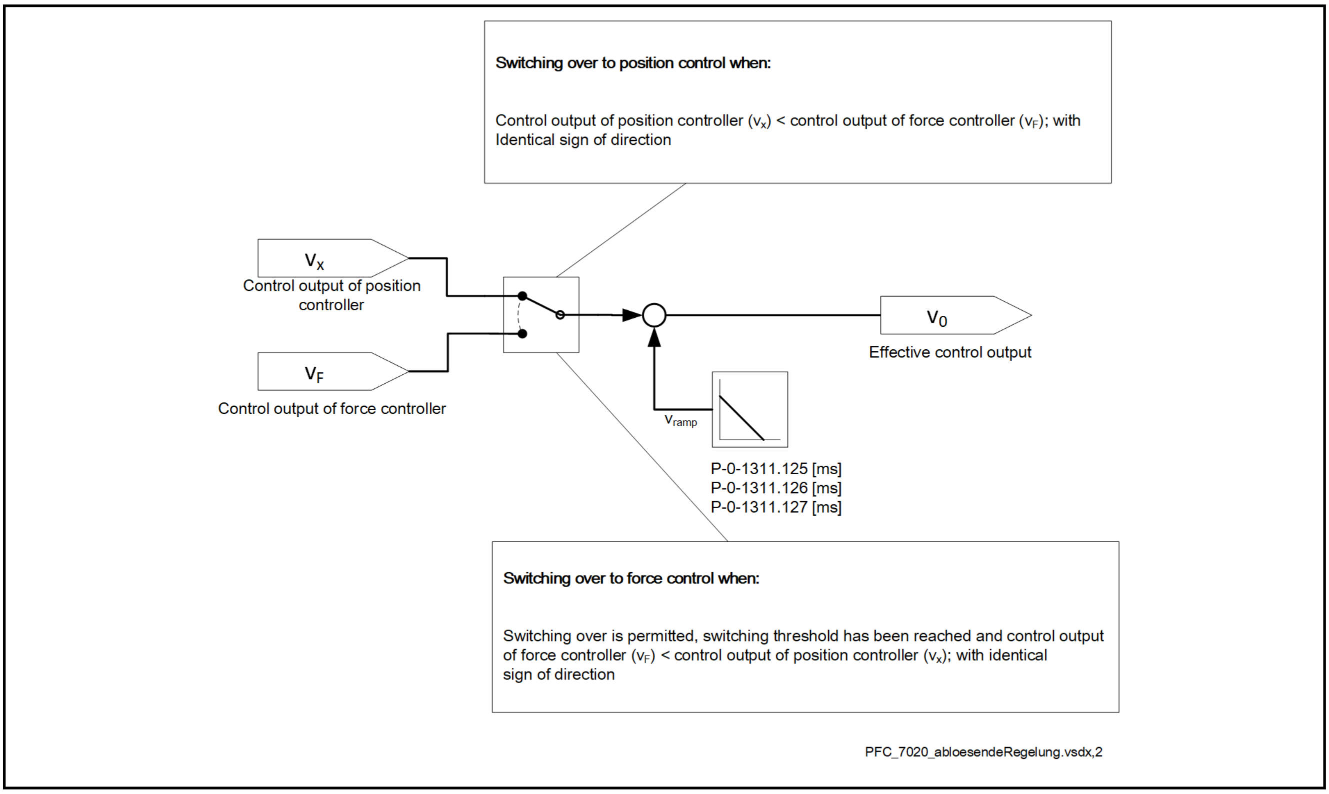


Fig. 6-22: Alternating control

Features

- Switching of controllers activated via Configuration, axis controllers/ functions; otherwise, position control only.
- Adjustable threshold for pressure/force feedback value, from which on switching to pressure/force control is permitted.
- Switching condition can be selected, either relative window (in percent of pressure/force command value) or absolute threshold.
- Debounce time can be set for switching between the operation modes.
- Adjustable ramp time for transferring the controller outputs with the transition from position control to pressure/force control.
- Change back lock can be set for the transition from pressure/force control to position control.
- Alternating control in positive direction (with torque/force command value, positive 2) and in negative direction (with torque/force command value, negative 2) can be activated separately.
- Active operation mode is displayed in system status word 1.
- Depending on the setting in “Configuration, axis controllers/functions”, either the positive or the negative pressure/force command value is used for alternating control. If both directions have been activated, either the positive or the negative pressure/force command value is used depending on the sign of the position controller output. Switching occurs only if pressure/force control is not active.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1280, System status word 1

- P-0-1311[123], Alternating control: Absolute switching threshold
- P-0-1311[124], Alternating control: Relative switching window
- P-0-1311[125], Alternating control: Debounce time for switching condition
- P-0-1311[126], Alternating control: Transition ramp time, pressure/force control
- P-0-1372, Configuration, axis controllers/functions
- P-0-2831.0.4, Position controller output
- P-0-2843, Force controller output
- P-0-2853, Alternating control, control word 1
- P-0-2855, Alternating control, status word

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5032: Config not feasible: P-0-2937.0.1 P-0-1372.15
- E2015, B5036: Config not feasible: P-0-2937.0.1 P-0-1372.14
- E2015, B5037: Config not feasible: P-0-2937.0.1 P-0-2853.0
- E2015, B5048: Config data exceeds valid range P-0-1311[124]
- E2015, B5049: Config data exceeds valid range P-0-1311[125]
- E2015, B504B: Config data exceeds valid range P-0-1311[126]
- E2015, B504C: Velocity limit not feasible: S-0-0038/0039/0091
- E2015, B5078: IPO impact not possible P-0-2853

6.11 Rapid mode/press mode switching, cylinder

6.11.1 Overview

Cylinders with effective area switching or regenerative circuit can be operated in rapid mode (flow on small area) or in press mode (flow on large area). See "Controlling the effective area switching" on page 176. The valves used for hydraulic switching can be controlled from the technology function manually, automatically or manually with plausibility check.

Features

- Configurable switching control (manually, automatically or manually with validation).
- Control of rapid mode valve and press mode valve
- Controller output is adapted to the new feed rate
- Delay for changing the controller output adjustment can be set.
- Transition time for changing the controller output adjustment can be set.
- Linking to parameter set switching (for Kv, feedforward control, etc.) is possible.

Automatic switching between rapid mode and press mode takes place when force and velocity exceed or fall below the threshold value. The threshold values for force and velocity result from the configured maximum pressure (P-0-1311[137]) and the configured maximum speed (P-0-0113) and the relevant cylinder area. The thresholds for the actual values may be reduced additionally by applying a factor (P-0-1311[131]) in order not to put the system to the extreme.

Rapid mode thresholds:

- Small force (actual value) ≤ maximum pressure * rapid mode area * reserve factor
- When P-0-1372 bit 6 = 1: Small force (command value) ≤ maximum pressure * rapid mode area
- High velocity (command value) ≥ maximum speed * active displacement / press mode area

Press mode thresholds:

- Small velocity (actual value) ≤ maximum speed * active displacement / press mode area * reserve factor
- Small velocity (command value) ≤ maximum speed * active displacement / press mode area
- When P-0-1372 bit 6 = 1: Large force (command value) ≥ maximum pressure * rapid mode area

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0113, Bipolar velocity limit value of motor
- P-0-0562, Active feed/gear factor
- P-0-1275, Effective displacement
- P-0-1280, System status word 1
- P-0-1281, System status word 2
- P-0-1283, Hydraulic function, switching control word
- P-0-1311[131], Switching factor for rapid mode/press mode
- P-0-1311[132], Debounce time for area switching rapid mode/press mode
- P-0-1311[137], Process pressure max.
- P-0-1311[142], Controller output switching delay (rapid to press mode)
- P-0-1311[143], Controller output switching transition time (rapid to press mode)
- P-0-1311[144], Controller output switching delay (press to rapid mode)
- P-0-1311[145], Controller output switching transition time (press to rapid mode)
- P-0-1370, Axis structure configuration
- P-0-1372, Configuration, axis controllers/functions
- P-0-1390, Input valve switching word 1
- P-0-1410, Valve switching word 1
- S-0-0820, Piston area A
- S-0-0821, Piston area B

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5005: Config data exceeds valid range P-0-1311[131]
- E2015, B5009: Areas switch coordination not feasible P1372.7
- E2015, B500F: Config data exceeds valid range P-0-1311[137]
- E2015, B5023: Cylinder areas can not be switched

6.12 Direction input via valve

6.12.1 Overview

The direction of motion of a cylinder can be given by valve positions instead of by the pump's direction of rotation. These valves are controlled in the technology function based on the position controller output. To protect the components, switching only takes place if the process pressure has dropped below a configurable threshold.

Features

- Configurable switching control (manually or automatically)
- Activation of valve for extending and valve for retracting
- Automatic control based on position controller output
- Switching only in the case of allowed pressure conditions

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0562, Active feed/gear factor
- P-0-1280, System status word 1
- P-0-1283, Hydraulic function, switching control word
- P-0-1311[133], Direction input via valve: Switching time
- P-0-1311[134], Direction input via valve: Allowed differential pressure when switching
- P-0-1370, Axis structure configuration
- P-0-1391, Input valve switching word 2
- P-0-1411, Valve switching word 2

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5010: Config data exceeds valid range P-0-1311[134]
- E2015, B5011: Directional valve coord. not feasible P1370.8
- E2015, B5013: Actuation of directional valve not possible
- E2015, B507C: Config data not feasible P-0-1372.3

6.13 Rapid mode/press mode switching, pump

6.13.1 Overview

Pumps with a **two-point control** of their displacement can be operated in rapid mode (large displacement) or in press mode (small displacement). A detailed description can be found in "Controlling the effective area switching" on page 176. The valves used for hydraulic switching can be controlled manually, from the automatic mode or with plausibility check.

Pumps with a **continuously variable displacement** can also be operated with swivel angles between the minimum and maximum displacement. The swivel angle is usually controlled using a proportional valve that cannot be activated from the technology function. In order to correctly adapt the controller output, the feed rate has to be cyclically transmitted.

Features

- Continuously variable with external input (between Vg_min and Vg_max)
- Two-point control between Vg_min and Vg_max with manual switching activation, can be configured for automatic mode or with plausibility check.

- Control of rapid mode valve and press mode valve
- Controller output is adapted to the new feed rate
- Switching time for mapping the switching behavior can be set

Automatic switching between rapid mode and press mode takes place when the force and velocity exceed or fall below the threshold value. The threshold values for pressure and flow result from the configured maximum motor torque (P-0-0444) or the configured maximum speed (P-0-0113) and the relevant displacement. The thresholds for the actual values may be reduced additionally by applying a factor (P-0-1311[135]) in order not to put the system to the extreme. The actual values for pressure and flow are calculated from the actual force or from the actual velocity, respectively, and the active cylinder area.

Rapid mode thresholds:

- Pressure differential across the pump (actual value) ≤ maximum torque* 2 Pi / rapid mode volume * reserve factor
- When P-0-1372 bit 6 = 1: Small force (command value) ≤ maximum torque * cylinder area / rapid mode volume
- High velocity (command value) ≥ maximum speed * press mode volume / cylinder area

Press mode thresholds:

- Small velocity (actual value) ≤ (maximum speed * press mode volume / cylinder area) * reserve factor
- Small velocity (command value) ≤ maximum speed * press mode volume / cylinder area
- When P-0-1372 bit 6 = 1: Large force (command value) ≥ maximum torque * cylinder area / rapid mode volume

The corresponding bits for activating the valves are generated in the valve control word (P-0-1410 and P-0-1411).

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0113, Bipolar velocity limit value of motor
- P-0-0444, Actual value peak torque limit
- P-0-0562, Active feed/gear factor
- P-0-1275, Effective displacement
- P-0-1280, System status word 1
- P-0-1283, Hydraulic function, switching control word
- P-0-1311[127], Debounce time for pump switching rapid mode/press mode
- P-0-1311[135], Factor for pump switching rapid mode/press mode
- P-0-1311[136], Two-point displacement, pump volume: Switching time
- P-0-1311[137], Process pressure max.
- P-0-1370, Axis structure configuration
- P-0-1371, Minimum pump displacement (Vg) 2
- P-0-1391, Input valve switching word 2
- P-0-1411, Valve switching word 2
- P-0-2943, Pump displacement

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B500F: Config data exceeds valid range P-0-1311[137]
- E2015, B5012: Swivel angle actuat. coord. not feasible P-0-1370.13
- E2015, B5014: Actual pump displacement volume exceeds valid range
- E2015, B5015: Pump displacement volume can not be modified
- E2015, B503C: Config data exceeds valid range P-0-1311[135]

6.14 Decompression

6.14.1 Overview

In the case of tandem or double-rod cylinders

The decompression function ensures that the compression volume of a force build-up phase can be fed back to the accumulator. This helps to avoid that pressure in the chambers increasingly goes up, components suffer damage and the performance of the axis cannot be utilized to its full extent, if a pressure differential that may be required cannot be built up via the cylinder chambers.

In the case of **pushing load** the cylinder A-side is decompressed by/via the pump. Fluid from the chamber on the A-side is displaced to the B-side path, from where it is fed via the decompression valve on the cylinder B-side to the accumulator.

To switch on decompression (P-0-1280, System status word 1; bit 16 = 1), the pressure on the A-side (S-0-0803) must have exceeded the switch-on threshold (P-0-1311[194]) after debouncing (P-0-1311[196]), and refilling must have been recognized on the B-side (P-0-1280; bit 18 = 1). Refilling of cylinder chamber B is recognized when the difference between the chamber pressure (S-0-0804) and low pressure (tank pressure S-0-0814) or system pressure (S-0-0813)) is less than the pressure differential entered in P-0-1311[206]. This recognition is debounced by P-0-1311[207]. The activation of the B-side decompression valve is no longer active (P-0-1280; bit 16 = 0), if the pressure on the A-side (S-0-0803) is below the switch-off threshold (P-0-1311[195]) after debouncing.

In the case of **pulling load** the cylinder B-side is decompressed by/via the pump. Fluid from the chamber on the B-side is displaced to the A-side path, from where it is fed via the decompression valve on the cylinder A-side to the accumulator.

☞ Decompression in conjunction with pulling load is made available as of PFC03V04.

To switch on decompression on the cylinder B-side (P-0-1280, System status word 1; bit 15 = 1), the pressure on the B-side (S-0-0804) must have exceeded the switch-on threshold (P-0-1311[194]) after debouncing (P-0-1311[196]), and refilling must have been recognized on the B-side (P-0-1280; bit 17 = 1). Refilling of cylinder chamber A is recognized when the difference between the chamber pressure (S-0-0803) and low pressure (tank pressure S-0-0814) or system pressure (S-0-0813)) is less than the pressure differential entered in P-0-1311[206]. This recognition is debounced by P-0-1311[207]. The activation of the A-side decompression valve is no longer active (P-0-1280; bit 15 = 0), if the pressure on the B-side (S-0-0804) is below the switch-off threshold (P-0-1311[196]) after debouncing.

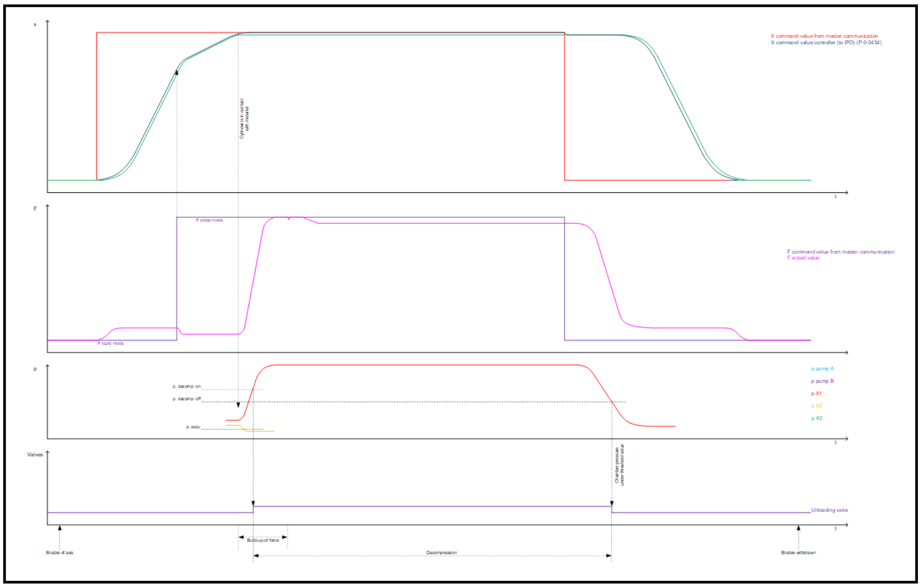


Fig. 6-23: Sequence of decompression using as an example decompression on the cylinder A-side with pushing load

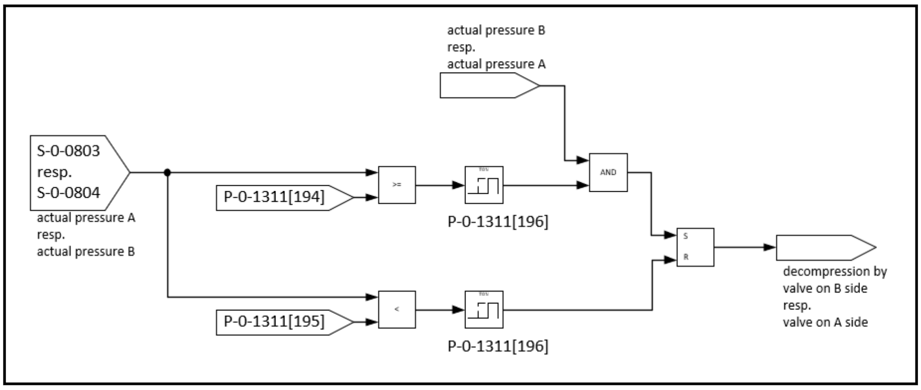


Fig. 6-24: Switch-on/off logic of decompression

The hydraulic functions of “decompression” and “rapid mode” must not be active together. They are therefore interlocked. If rapid mode is selected or active, decompression is deselected. If decompression is selected or active, rapid mode is not selected via the automatic mode or validation. Rapid mode can always be selected via the control word.

In the case of single rod cylinders

The function ensures that during retracting excessive oil (differential volume between piston chamber and annular chamber) is fed to the accumulator. Electrically controllable decompression valves on the piston side (cylinder A-side) and annular side (cylinder B-side) of a single rod cylinder are activated.

Determining the state of extending/retracting:

With the help of the controller output in the additive velocity command value, pressure loop (P-0-0690), and the velocity window (P-0-1311[221]), it can be determined whether the axis extends or retracts.

- Controller output > velocity window → axis is in the “extending” state (volume on the A-side of the cylinder is increasing)
- Controller output < velocity window → axis is in the “retracting” state (volume on the B-side of the cylinder is increasing)

Determining the load situation for the actuator feed

The load situation is determined on the basis of the pressure on the A-side of the cylinder, p_A (S-0-0803), the pressure on the B-side of the cylinder, p_B

(S-0-0804), the cylinder area on the A-side, A_A (S-0-0820), the cylinder area on the B-side A_B (S-0-0821), and the threshold value p_{Thres} (P-0-1311[220]). For an enhanced recognition, the pressure thresholds must have been exceeded in the retracting direction $p_{ThresIn}$ P-0-1311[220] or in the extending direction $p_{ThresOut}$ P-0-1311[112] after scaling. Switching from pulling to pushing load is debounced (P-0-1311[219]).

Direction	Cylinder area A active	Cylinder area B active
Retracting $v_{cmd} < -\|P-0-1311[221]\|$	Pushing load: $p_A \bullet \frac{A_A}{A_B} > p_B + p_{ThresIn}$ (debounced by P-0-1311[219])	Pulling load: $p_A \bullet \frac{A_A}{A_B} < p_B + p_{ThresIn}$ (debounced by P-0-1311[219])
Extending $v_{cmd} > \|P-0-1311[221]\|$	Pushing load: $p_A \bullet \frac{A_A}{A_B} > p_B + p_{ThresOut}$ (debounced by P-0-1311[219])	Pulling load: $p_A \bullet \frac{A_A}{A_B} < p_B + p_{ThresOut}$ (debounced by P-0-1311[219])

Fig. 6-25: Load situation

☞ The actuator feed is switched over in dependence on the load situation and hence on the effective area.

Activation of decompression valves

Decompression is activated via decompression valves A and B on the basis of the data described above as well as low pressure p_{Low} (system pressure (S-0-0813) or tank pressure (S-0-0814)), switch-on threshold $p_{ThresDecoOn}$ (P-0-1311[194]) and switch-off threshold $p_{ThresDecoOff}$ (P-0-1311[195]) of decompression and the pressure differential for recognizing refilling $p_{DiffSuc}$ (P-0-1311[206]). Switching from pulling to pushing load while retracting is debounced (P-0-1311[219]). Switching from pulling to pushing load while extending is debounced (P-0-1311[196]). Moreover, changing a load situation is subject to hysteresis. The detection of refilling is debounced (P-0-1311[207]).

Direction	Cylinder area A active	Cylinder area B active
Retracting $v_{cmd} < -\|P-0-1311[221]\|$	Pushing load: $p_A \bullet \frac{A_A}{A_B} > p_B + p_{ThresIn}$ (debouncing by P-0-1311[219])	Pulling load: $p_A \bullet \frac{A_A}{A_B} < p_B + p_{ThresIn}$ (debouncing by P-0-1311[219])
Extending $v_{cmd} > \|P-0-1311[221]\|$	Pushing load: $p_A > p_{ThresDecoOn}$ (debouncing by P-0-1311[196]) + B-side in suction $p_B - p_{Low} < p_{DiffSuc}$ (debouncing by P-0-1311[207])	Pulling load: $p_B > p_{ThresDecoOn}$ (debouncing by P-0-1311[196]) + A-side in suction $p_A - p_{Low} < p_{DiffSuc}$ (debouncing by P-0-1311[207])
	No pushing load: $p_A < p_{ThresDecoOff}$	No pulling load: $p_B < p_{ThresDecoOff}$

Fig. 6-26: Activation of decompression valves

If the cylinder is retracting, the decompression valve on the non-active cylinder side is opened to discharge oil.

When activated the decompression valves connect the low-pressure side of the pump to the system pressure or the tank. The switching thresholds refer to the high-pressure side.

Low pressure is provided by the system pressure (S-0-0813) or tank pressure (S-0-0814) depending on the availability. If a system pressure (S-0-0813) is present for functional reasons (P-0-1370, bit 17/16 <> 00), it is used as low-pressure level. Otherwise, tank pressure (S-0-0814) is used as low pressure.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0690, Additive velocity command value, process loop
- P-0-1280, System status word 1
- P-0-1311[112], Pressure threshold for recognizing the load side when extending
- P-0-1311[194], Switch-on threshold for decompression
- P-0-1311[195], Switch-off threshold for decompression
- P-0-1311[196], Debounce time for decompression activation condition
- P-0-1311[206], Pressure difference to low pressure for refilling
- P-0-1311[207], Debounce time for refilling
- P-0-1311[219], Debounce time for recognizing the load side
- P-0-1311[220], Pressure threshold for recognizing the load side when retracting
- P-0-1311[221], Velocity window for recognizing the direction of movement
- P-0-1370, Axis structure configuration
- P-0-1372, Configuration, axis controllers/functions
- P-0-1391, Input valve switching word 2
- P-0-1411, Valve switching word 2
- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- S-0-0820, Piston area A
- S-0-0821, Piston area B

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B505B: Config data not feasible P-0-1311[206]
- E2015, B506E: Config data not feasible P-0-1311[194]
- E2015, B507A: Config data not feasible P-0-1311[195]
- E2015, B507C: Config data not feasible P-0-1372.3
- E2015, B5081: Config data not feasible P-0-1372.3

6.15 Holding function

6.15.1 Overview

☞ The holding function is provided as of PFC03V04.

The holding function contributes to reducing the thermal load of a hydraulic unit. To this end, after operation in force control, the pressure is isolated in the cylinder chamber by means of a valve. When completing of force control is detected, the cylinder chamber is decompressed in an automated way and then switching back to closed-loop control operation takes place. The holding function is activated/deactivated by means of P-0-1370, bit = 1/0.

If the function is deactivated while the chamber is isolated, a reactivation is carried out.

A precondition for the holding function is that one or several electrically controllable valves are provided in the action path between pump and cylinder which can be used to isolate the hydraulic volume of the active/loaded cylinder chamber.

The status word P-0-1280 bit 3 = 0/1 shows whether or not the axis follows the command value input, that is, whether it is in closed-loop control or not.

Features

- Isolation of one or more cylinder chambers.
- Consequently, holding of the cylinder force without power requirement from the motor (torque = 0).
- Implemented by controlled pressure reduction on the pump side.
- Controlled pressure build-up on the pump side before the cylinder chambers are reactivated and closed-loop controlling is resumed.
- Automatic recognition and control of the holding function or manual commanding via control word.

6.15.2 Automatic mode

The configuration word P-0-1372 bit 11 = 0 is used to switch the holding function to the automatic mode. Automatic mode means that isolating and reactivating are linked to the criteria for process data.

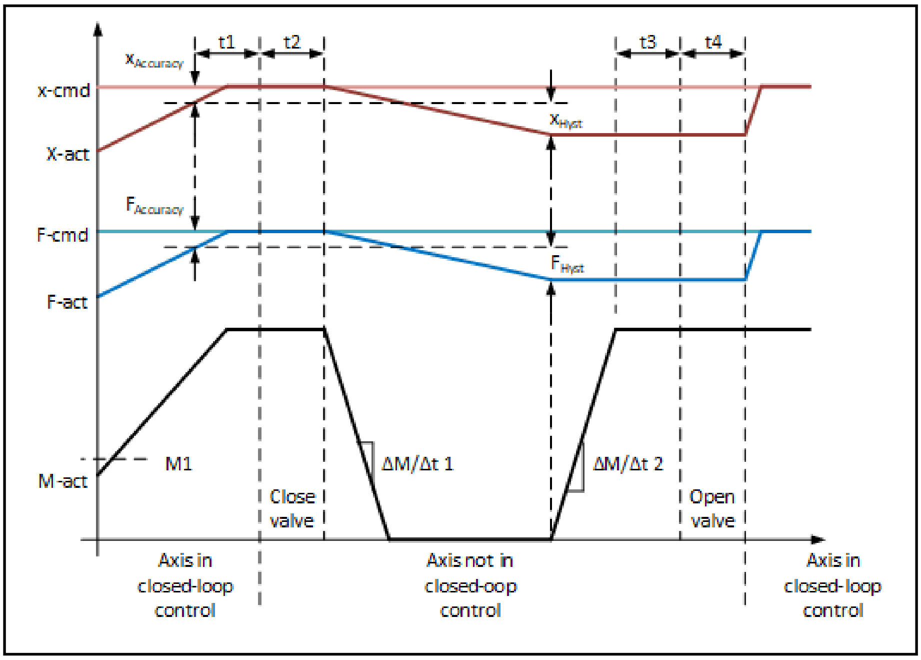


Fig. 6-27: Automatic mode of the holding function

Isolating is carried out, if, for the duration t1 (P-0-1311[433]),

- the force control difference (P-0-1271 - S-0-0552) ≤ $F_{Accuracy}$ (P-0-1311[430]) and
- the position control difference (P-0-0434 - S-0-0386) ≤ $x_{Accuracy}$ (P-0-1311[441]) and
- the actual torque value (S-0-0084) ≥ torque threshold M1 (P-0-1311[432]).

If a condition for isolating is fulfilled, the current actual torque value (S-0-0084) is saved and the valve/s is/are activated according to the valve switching sequence for the isolating procedure (P-0-1311[900..929]). Due to the fact that the valve switching sequence "isolation" is applied, the hydraulic switching function, which corresponds to the isolated state, can be carried out individually. As the functional valves between the pump and the loaded cylinder chamber are closed, the hydraulic connection between the pump and the cylinder is interrupted. The axis is therefore no longer in closed-loop control. The valve switching time for closing has to be entered in P-0-1311[434] (t2). When this time has elapsed, the torque is ramped to zero via slope P-0-1311[437] ($\Delta M/\Delta t_1$).

Reactivating is recognized when

- the force control difference (P-0-1271 - S-0-0552) > $F_{Accuracy}$ (P-0-1311[430]) + F_{Hyst} (P-0-1311[431]),
- or the position control difference (P-0-0434 - S-0-0386) > $x_{Accuracy}$ (P-0-1311[441])

  + x_{Hyst} (P-0-1311[442]),
- or a change in the active target position (S-0-0430) is recognized.

If the condition for reactivating is fulfilled, the torque is ramped via slope P-0-1311[438] ($\Delta M/\Delta t_2$) to the actual torque value at the time of isolating. After ramping up a delay P-0-1311[435] (t3) has to elapse. After t3 elapsed, the mode active/selected before isolating is reactivated and the valves are switched accordingly. This process is not carried out according to the valve switching sequence, but the final state at the end of the valve switching sequence is activated directly. In this context, P-0-1311[436] (t4) provides the valve switching time for opening the valve. After t4 elapsed, the axis is again in closed-loop control (P-0-1280.3 = 0).

☞ In the case of cylinder types with area switching, which use the automatic mode or plausibility check for rapid/press mode switching, isolating is carried out only from the press mode. Accordingly, the mode is switched back to the press mode when reactivating is carried out. In the case of cylinder types without area switching or manual activation of rapid/press mode switching, isolating can be carried out from any block function. Upon reactivating, the mode is switched to the currently commanded block function (see P-0-1283 bit 7..4). Reactivating and hence switching back to a block function does not follow the order of the corresponding valve switching function. The final state of the valves is commanded directly.

6.15.3 Manual commanding

The configuration word P-0-1372 bit 11 = 1 is used to switch the holding function to the manual mode. In this case, reactivating/isolating is commanded manually (e.g. via master communication) using control word P-0-1283 bit 13 = 0/1.

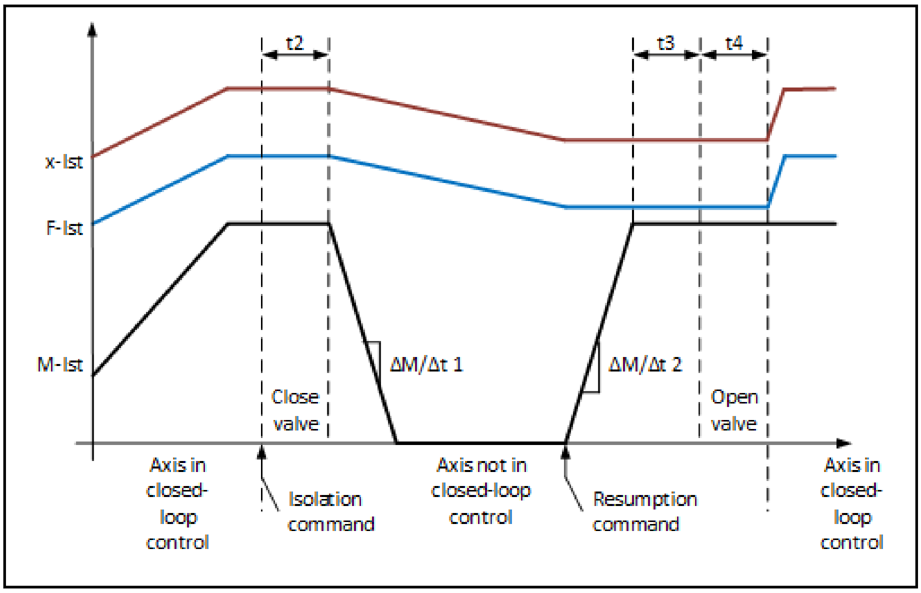


Fig. 6-28: Manual commanding of the holding function

Isolating is carried out when commanding of isolating takes place with P-0-1283 bit 13 = 1.

☞ The axis is isolated without plausibility check of current process data. It has to be ensured in the application that the axis is isolated in this situation and, when the command is withdrawn, can be reactivated.

If isolating is commanded, the current actual torque value (S-0-0084) is saved and the valve/s is/are activated according to the valve switching sequence for isolating (P-0-1311[900..929]). Due to the fact that the valve switching sequence "isolation" is applied, the hydraulic switching function, which corresponds to the isolated state, can be carried out individually. As the valve closed, the hydraulic connection between the pump and the cylinder is interrupted. The axis is therefore no longer in closed-loop control. The valve switching time for closing has to be entered in P-0-1311[434] (t2). When this time has elapsed, the torque is ramped to zero applying slope P-0-1311[437] (ΔM/Δt1).

Reactivating is carried out when commanded with P-0-1283 bit 13 = 1.

When the condition for reactivating is fulfilled, reactivating is carried out as with automatic recognition (see chapter 6.15.2 "Automatic mode" on page 66).

6.15.4 Motor control and restarting behavior

Motor control

During isolating, the motor torque is ramped to zero in order to minimize loading of the motor. This process follows the profile illustrated above (see chapter 6.15.2 "Automatic mode" on page 66/chapter 6.15.3 "Manual commanding" on page 68). During this time, the motor is in closed-loop torque control. For both closed-loop torque control and threshold detection, the torque feedback value (S-0-0084) is preprocessed using a moving average filter. The filter time can be set in P-0-1311[439]. The torque controller is a P-controller. The gain can be set in P-0-1311[440].

Restarting behavior

If reactivating is triggered due to a change in the active target position (S-0-0430), a major control error may develop over the time that the function takes for reactivating. This may result in a large control variable, which becomes effective when reactivating is completed. This can be reduced by commanding a small command value change of the position via master communication. Alternatively, the function for automatic freezing of position command values may be used. This function overwrites the feedrate override (S-0-0108) and hence freezes the position command value for the duration of reactivating until the axis is again in closed-loop control. The function can be activated by means of P-0-1370, bit 1 = 1.

> The function for automatic freezing is only available in the case of position-controlled operation modes with interpolator:
>
> - Drive-controlled positioning
> - Drive-internal interpolation
> - Positioning block mode

6.15.5 Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0084, Torque/force feedback value
- S-0-0108, Feedrate override
- S-0-0386, Active position feedback value
- S-0-0430, Active target position
- S-0-0552, Torque/force feedback value
- P-0-0434, Position command value of controller
- P-0-1271, Effective pressure/force command value
- P-0-1280, System status word 1
- P-0-1283, Hydraulic function, switching control word
- P-0-1370, Axis structure configuration
- P-0-1372, Configuration, axis controllers/functions
- P-0-1311[430], Holding function: Force accuracy window

- P-0-1311[431], Holding function: Force hysteresis
- P-0-1311[432], Holding function: Torque threshold
- P-0-1311[433], Debounce time for detecting isolation
- P-0-1311[434], Closing time of shut-off valve
- P-0-1311[435], Delay time
- P-0-1311[436], Opening time of shut-off valve
- P-0-1311[437], Descending torque slope
- P-0-1311[438], Ascending torque slope
- P-0-1311[439], Holding function: Filter time for determining actual torque value
- P-0-1311[440], Holding function: Gain (Kp) of torque controller
- P-0-1311[441], Holding function: Position accuracy window
- P-0-1311[442], Holding function: Position hysteresis

6.15.6 Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5008: Cycle time not feasible P-0-1311[177]
- E2015, B5038: Block mode not feasible
- E2015, B5118: Config data exceeds valid range P-0-1311[439]
- E2015, B5119: Config data exceeds valid range P-0-1311[430]
- E2015, B511A: Config data exceeds valid range P-0-1311[431]
- E2015, B511B: Config data exceeds valid range P-0-1311[432]
- E2015, B511C: Config data exceeds valid range P-0-1311[440]
- E2015, B511D: Config data exceeds valid range P-0-1311[437]
- E2015, B511E: Config data exceeds valid range P-0-1311[438]
- E2015, B511F: Config data exceeds valid range P-0-1311[441]
- E2015, B5120: Config data exceeds valid range P-0-1311[442]

6.16 Swivel angle control

6.16.1 Overview

The function of swivel angle adjustment is available. For this purpose, the swivel angle is continuously controlled. The adjustment can be subdivided into the two functions of command value generator and controller.

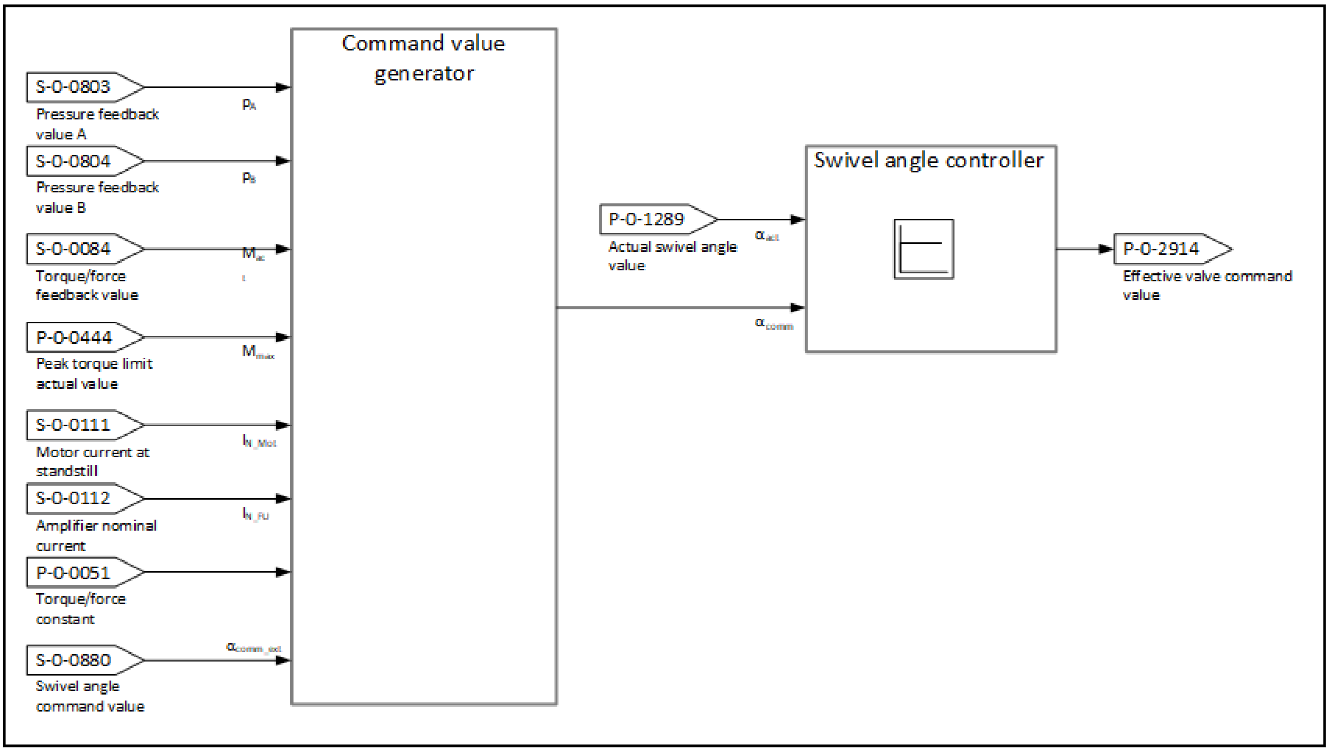


Fig. 6-29: Overview of swivel angle control

Features

- Swivel angle command value generator:
  - Continuous generation of a swivel angle command value
  - Swivel angle command value depending on the motor/pump load
  - High force build-up rates
  - Relief of the motor/pump group in steady-state case
  - Alternative provision of an optional swivel angle command value
- Swivel angle controller:
  - Proportional gain, Kv
  - Controlled system adjustment for proportional valve
  - When deactivated, output of a controller output substitute value
  - Controller output limitation

6.16.2 Swivel angle command value generator

For variable-speed pumps with continuously adjustable swivel angle, a swivel angle command value is generated for the swivel angle controller depending on the load. The load and hence the command value for the swivel angle is calculated according to two criteria:

1. T0-criterion: The command value is provided so that the drive torque is less than or equal to the nominal torque (T0) of motor and converter.
2. Tmax criterion: The command value is provided so that the load moment of the pump due to load pressure is less than the dynamic peak torque (Tmax) of motor and converter.

In addition, an optional command value (S-0-0880) can be provided, which does not follow the above criteria. P-0-1311[291] can be used to select how the active command value is to be generated. Nominal torque T0 is the product of the minimum nominal current of the motor (S-0-0111) and the converter (S-0-0112) and the torque/force constant (P-0-0051). The torque in the steady state can be input by means of P-0-1311[140] with reference to the nominal torque.

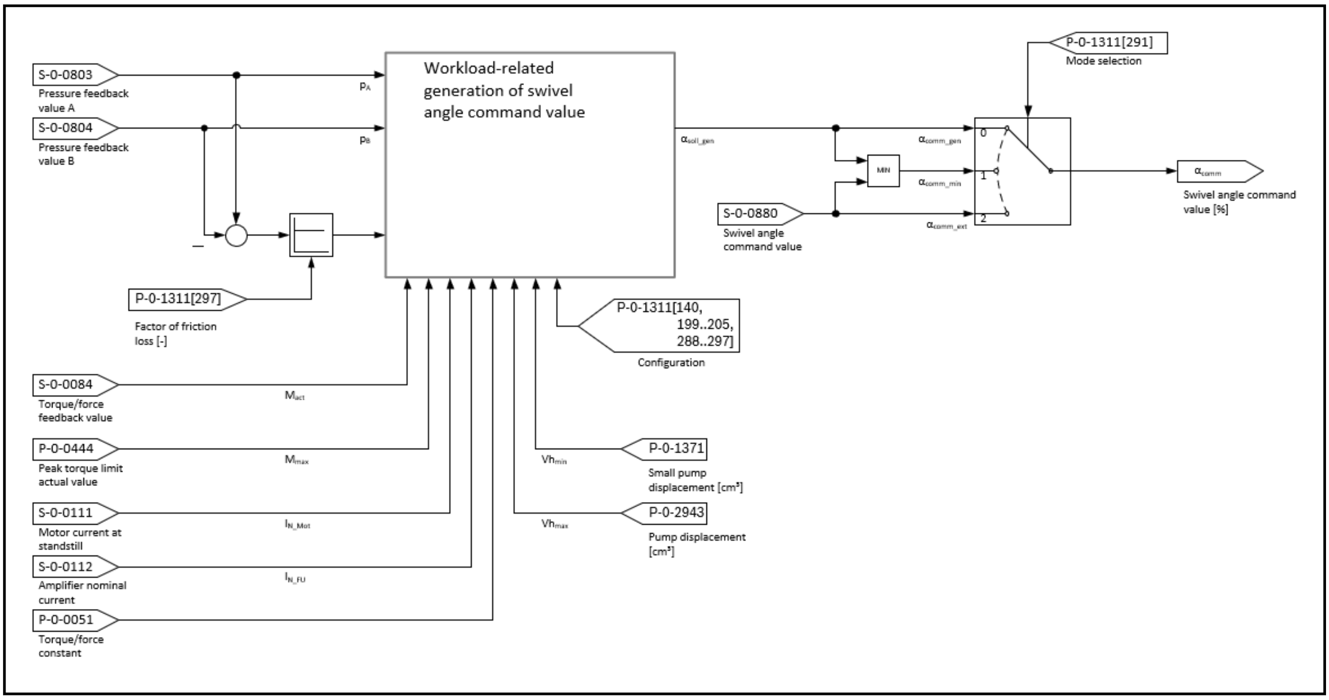


Fig. 6-30: Swivel angle command value generator

6.16.3 Swivel angle controller

The swivel angle controller receives a swivel angle command value from the swivel angle command value generator and generates the actuating variable for a proportional valve for adjusting the swivel angle. The controller consists of a P-controller, which weights the control deviation from the swivel angle command value and the actual swivel angle value (P-0-1289) with the proportional gain (P-0-1311[292]).

After this, processing functions for controlled system adjustment to a real valve are made available. They consist of:

- the valve standard velocity P-0-1311[293], at which the actuating speed is transformed into the actuating variable for valve opening
- control variable inversion P-0-2873.0.3 for setting the direction of action
- the valve offset P-0-1311[295] for setting a unidirectional offset of the controller output
- the positive (S-0-0865) and negative (S-0-0866) limitation of the valve control variable

P-0-1283 bit 3 can be used to switch dynamically at runtime from the output value of the swivel angle controller and a valve substitute value P-0-1311[296] to the active valve command value P-0-2914.

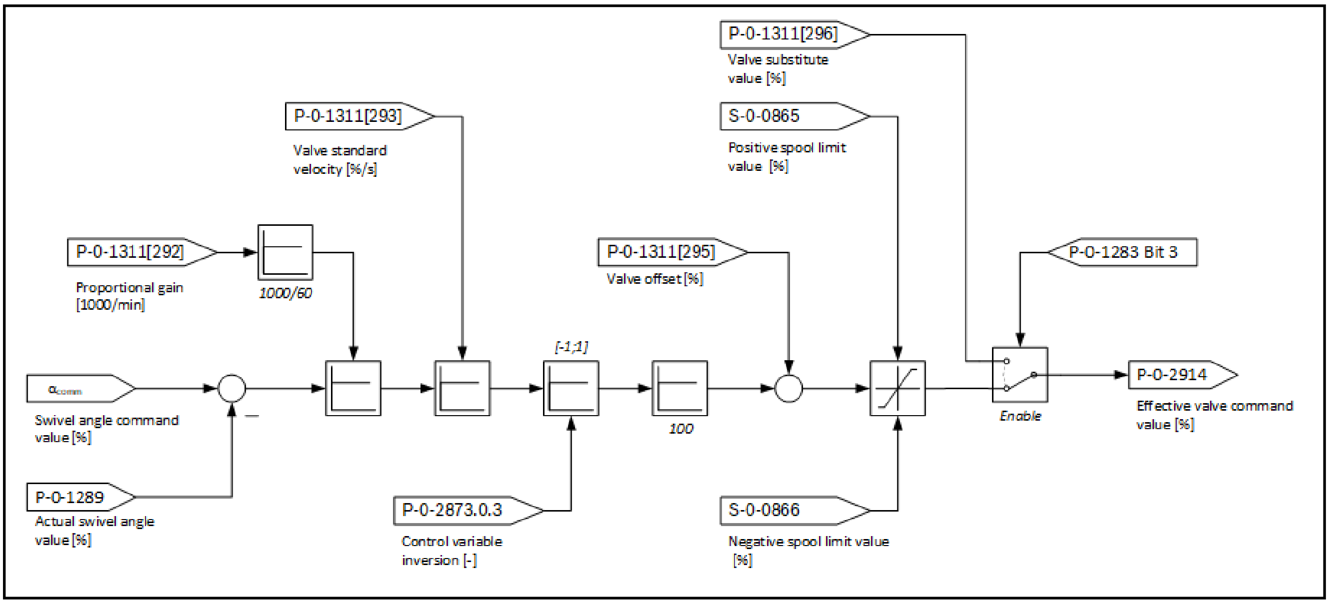


Fig. 6-31: Swivel angle controller

6.16.4 Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1311[117], Tolerance window for warning when active Vg is limited
- P-0-1311[140], Swivel angle generator: Maximum torque in steady state
- P-0-1311[199], Swivel angle generator: Gain D-term
- P-0-1311[200], Swivel angle generator: Time constant D-term
- P-0-1311[201], Swivel angle generator: Time constant I-term
- P-0-1311[202], Swivel angle generator: Swivel angle generator: Target dynamics to compensate dynamics of swivel angle control
- P-0-1311[203], Swivel angle generator: Time constant of swivel angle control
- P-0-1311[204], Swivel angle generator: Maximum controller output correction
- P-0-1311[205], Swivel angle generator: Delay for integrator activation
- P-0-1311[288], Swivel angle generator: Filter time of current motor torque
- P-0-1311[289], Swivel angle generator: Reduction factor [0..1] for static torque
- P-0-1311[290], Swivel angle generator: Reduction factor [0..1] for peak torque
- P-0-1311[291], Swivel angle generator: Mode selection of swivel angle generation
- P-0-1311[292], Swivel angle controller: Proportional gain
- P-0-1311[293], Swivel angle controller: Valve standard velocity
- P-0-1311[295], Swivel angle controller: Valve offset
- P-0-1311[296], Swivel angle controller: Valve substitute value while function is deactivated

- P-0-1311[297], Swivel angle controller: Factor for pressure differential-related friction losses in the pump
- P-0-0444, Actual value peak torque limit
- P-0-1275, Effective displacement
- P-0-1283, Hydraulic function, switching control word
- P-0-1289, Actual swivel angle value
- P-0-1370, Axis structure configuration
- P-0-1371, Small pump displacement
- P-0-2873.0.3, Control variable inversion
- P-0-2914, Effective valve command value
- P-0-2943, Pump displacement
- S-0-0084, Torque/force feedback value
- S-0-0092, Bipolar torque/force limit value
- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- S-0-0865, Positive spool limit value
- S-0-0866, Negative spool limit value
- S-0-0880, Swivel angle command value

6.16.5 Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B500B: Config data exceeds valid range P-0-2943
- E2015, B500C: Config data not feasible P-0-1371
- E2015, B5014: Actual pump displacement volume exceeds valid range
- E2015, B5019: Swivel angle mode config not feasible P-0-1370.5
- E2015, B50E6: Config data not feasible P-0-1311[200]
- E2015, B50E7: Config data not feasible P-0-1311[288]
- E2015, B50E8: Config data not feasible P-0-1311[202]
- E2015, B50E9: Config data not feasible P-0-1311[203]
- E2015, B50EA: Config data not feasible P-0-1311[289]
- E2015, B50EB: Config data not feasible P-0-1311[290]
- E2015, B50EC: Config data not feasible P-0-2873.0.3
- E2015, B50ED: Config data not feasible P-0-1311[295]
- E2015, B50EE: Config data not feasible P-0-1311[296]
- E2015, B50EF: Config data not feasible S-0-0865
- E2015, B50F0: Config data not feasible S-0-0866
- E2015, B50F1: Config data not feasible P-0-1311[291]
- E2015, B50F2: Config data not feasible P-0-1311[201]
- E2015, B50F3: Config data not feasible P-0-1311[293]
- E2015, B50F4: Config data not feasible P-0-1311[204]

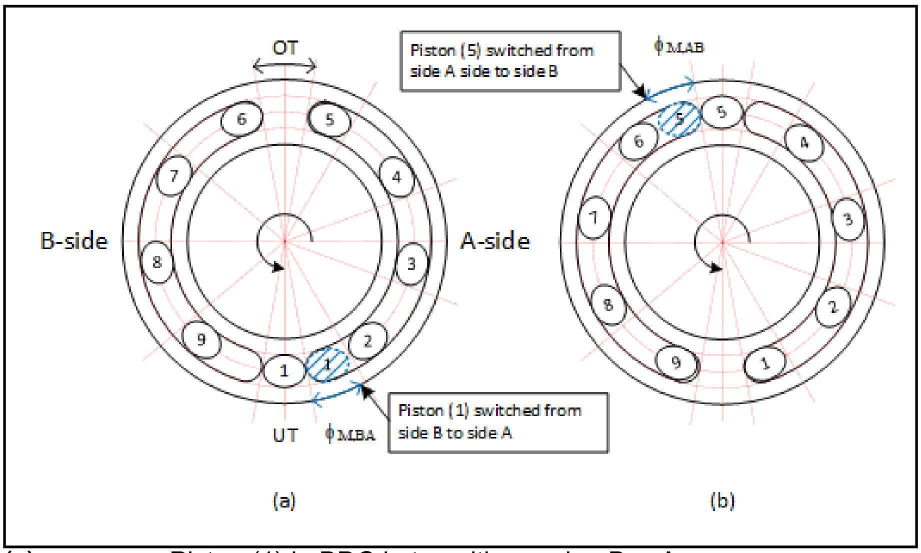
6.17 Pulsation compensation for axial piston pumps

6.17.1 Overview

Pulsation compensation of axial piston pumps is available. Pulsation results from the fact that the high pressure side and the low pressure side of the pump are short-circuited via the pump pistons. To compensate for this, an additive motor speed is fed forward while the short-circuit is present.

Transition regions of axial piston pumps

Axial piston pumps are provided with a cylinder drum with pump pistons, which rotates on a fixed swashplate. The swashplate establishes the connection to the A-side and to the B-side of the pump. The swashplate has a so-called transition region in the bottom dead center (BDC) and the tope dead center (TDC). If one of the rotating pump pistons is within the transition regions, it short-circuits the high and the low pressure side, which results in pressure pulsation. Due to the symmetry of the swashplate and the odd number of pump pistons, there is never more than one piston in the transition region.



(a) Piston (1) in BDC in transition region B ⇒ A
(b) Cylinder drum rotated further by 20°: Piston (5) in TDC in transition region A ⇒ B

Fig. 6-32: Swashplate and pistons (1..9) of an axial piston pump with 9 pistons; (a); (b)

Configuration of compensation signals

To compensate for pressure pulsation, an additive speed is fed forward when a pump piston is within the transition region. The additive speed can be firmly configured or provided cyclically. The input mode can be configured in P-0-1370 bit 29..28.

P-0-1370 bit 29..28	Description
00	Deactivated
01	Compensation with fixed configuration Additive motor speed B ⇒ A: P-0-1311[343] Additive motor speed A ⇒ B: P-0-1311[344]

P-0-1370 bit 29..28	Description
10	Compensation with cyclic input Additive motor speed B ⇒ A: P-0-1292 Additive motor speed A ⇒ B: P-0-1293
11	Reserved

Tab. 6-2: Configuration of pulsation compensation

For the configuration of the transition regions, the rotary angle of the motor is to be subdivided into pump piston segments. For this purpose, the number of pump pistons has to be configured (P-0-1311[334]). Compensating takes place in every pump piston segment of 360° / P-0-1311[334]. The transition regions therefore only have to be configured for one pump piston segment.

Transition region B ⇒ A is configured via the motor angle, at which the first pump piston enters the transition region (P-0-1311[335]), as well as via the overlap angle B ⇒ A (P-0-1311[339]). For optimization, the angle displacement offset (P-0-1311[337]) and the percentage-based factor for the overlap angle are provided (P-0-1311[341]).

Transition region A ⇒ B is configured via the motor angle, at which the first pump piston enters the transition region (P-0-1311[336], as well as via the overlap angle B ⇒ A (P-0-1311[340]). For optimization, the angle displacement offset (P-0-1311[338]) and the percentage-based factor for the overlap angle (P-0-1311[342]) are provided.

Thus, the additive motor speed B ⇒ A is fed forward in each pump piston segment at an angle between

- P-0-1311[335] + P-0-1311[337] and
- P-0-1311[335] + P-0-1311[337] + (P-0-1311[339] * P-0-1311[341] / 100 %)

Thus, the additive motor speed A ⇒ B is fed forward in each pump piston segment at an angle between

- P-0-1311[336] + P-0-1311[338] and
- P-0-1311[336] + P-0-1311[338] + (P-0-1311[340] * P-0-1311[342] / 100 %)

Configuration of working range

Since this compensation is not possible at high speeds and, in particular, the additive motor speed depends on the load, you have to define the working range, in which pulsation compensation is to be active. This is possible via the following restrictions:

- Maximum speed, up to which pulsation compensation is active, in P-0-1311[330]
- Optional: Relative force threshold referred to the force command value (P-0-1271), from which on pulsation compensation is active, in P-0-1311[331]
- Optional: Absolute force threshold, from which on pulsation compensation is active, in P-0-1311[332]
- External blocking of pulsation compensation via P-0-1283 bit 11 = 1

To suppress peaks, a debounce time can be set in P-0-1311[333].

P-0-1372 bit 17..16	Description
00	No consideration of the force threshold
01	Activated with use of the relative force threshold in P-0-1311[331]
10	Activated with use of the absolute force threshold in P-0-1311[332]
11	Reserved

Tab. 6-3: Configuration of the force threshold

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0111, Actual position value of motor
- P-0-0112, Actual velocity value of motor
- P-0-1281, System status word 2
- P-0-1283, Hydraulic function switching control word
- P-0-1292, Pulsation compensation: Additive motor speed B ⇒ A (cyclic input)
- P-0-1293, Pulsation compensation: Additive motor speed A ⇒ B (cyclic input)
- P-0-1311[330], Pulsation compensation: Activation of velocity threshold
- P-0-1311[331], Pulsation compensation: Activation of relative force threshold value
- P-0-1311[332], Pulsation compensation: Activation of absolute force threshold value
- P-0-1311[333], Pulsation compensation: Activation of debounce time
- P-0-1311[334], Pulsation compensation: Number of pump pistons
- P-0-1311[335], Pulsation compensation: Angular displacement of motor to transition region B -> A
- P-0-1311[336], Pulsation compensation: Angular displacement of motor to transition region A -> B
- P-0-1311[337], Pulsation compensation: Angular displacement offset of transition region B -> A
- P-0-1311[338], Pulsation compensation: Angular displacement offset of transition region A -> B
- P-0-1311[339], Pulsation compensation: Angle of transition region B -> A
- P-0-1311[340], Pulsation compensation: Angle of transition region A -> B
- P-0-1311[341], Pulsation compensation: Factor of angle of transition region B -> A
- P-0-1311[342], Pulsation compensation: Factor of angle of transition region A -> B
- P-0-1311[343], Pulsation compensation: Additive motor speed B -> A (fixed configuration)
- P-0-1311[344], Pulsation compensation: Additive motor speed A -> B (fixed configuration)

- P-0-1370, Axis structure configuration
- P-0-1372, Configuration, axis controllers/functions
- S-0-0550, Torque/force command value, positive
- S-0-0551, Torque/force command value, negative
- S-0-0552, Torque/force feedback value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B50FB: Config data exceeds valid range P-0-1311[330]
- E2015, B50FC: Config data exceeds valid range P-0-1311[331]
- E2015, B50FD: Config data not feasible P-0-1311[332]
- E2015, B50FE: Config data not feasible P-0-1311[334]
- E2015, B50FF: Config data exceeds valid range P-0-1311[335]
- E2015, B5100: Config data exceeds valid range P-0-1311[336]
- E2015, B5101: Config data exceeds valid range P-0-1311[337]
- E2015, B5102: Config data exceeds valid range P-0-1311[338]
- E2015, B5103: Config data exceeds valid range P-0-1311[339]
- E2015, B5104: Config data exceeds valid range P-0-1311[340]
- E2015, B5105: Config data exceeds valid range P-0-1311[341]
- E2015, B5106: Config data exceeds valid range P-0-1311[342]
- E2015, B510B: Config data not feasible P-0-1370.28
- E2015, B510C: Config data not feasible P-0-1372.16

6.18 Digital/analog interfaces

6.18.1 Overview

IndraDrive provides up to five analog inputs for reading in pressure, temperature and force actual values. To monitor or use the values as a basis for controlling, they have to be made available to the technology function by assigning the analog inputs. The following signals are available:

Parameter	Description	Parameter for signal selection	PLC variable analog value	Parameter for digital signals	PLC structure for digital signals
S-0-0803	Pressure feedback value A	P-0-1311[253]	iPressureFeedbackValueA	-	-
S-0-0804	Pressure feedback value B	P-0-1311[261]	iPressureFeedbackValueB	-	-
S-0-0813	System pressure	P-0-1311[225]	iSystemPressure	P-0-1392 bits 5..2	stSystemPressure
S-0-0814	Tank pressure	P-0-1311[277]	iTankPressure	-	-
S-0-0880	Swivel angle command value	P-0-1311[42]	iManualSwivelAngle_cmd	-	-
P-0-1282	Pressure feedback value C	P-0-1311[269]	iPressureFeedbackValueC	-	-
P-0-1284	Oil temperature	P-0-1311[162]	iOilTemperature	P-0-1392 bits 13..10	stOilTemperature
P-0-1288	Pilot oil pressure	P-0-1311[239]	iControlPressure	P-0-1392 bits 9..6	stControlPressure

Parameter	Description	Parameter for signal selection	PLC variable analog value	Parameter for digital signals	PLC structure for digital signals
P-0-1289	Actual swivel angle value	P-0-1311[17]	iSwivelAngle_act	-	-
P-0-2937.0.3	Input of force feedback value	P-0-1311[67]	iInputForceFeedback-Value	-	-

Tab. 6-4: Overview of available input signals

For all signals a parameter is provided for the selection of the signal source which can be used to select the relevant type of assignment.

- 0: **External writing** to the parameter via master communication or assignment of the analog inputs from the IndraDrive firmware. IndraDrive can process three analog inputs in the form of scaling and assignment, and monitor them for wire break. Make sure that assignment A is made in the position controller cycle of the IndraDrive firmware, and assignments B and C with a cycle time of 2 ms.
- 1 - 5: Assignment from **analog inputs** and input processing via PFC. The acceptance is made in the cycle of relevant signal processing in PFC.
- 6: Assignment via a **PLC variable**. If Sercos IOs are used, the variable can be assigned via the IO configurator in an applicative extension. The acceptance is made in the cycle of relevant signal processing in PFC.

Signals that are merely used for monitoring purposes may alternatively be read in digitally via pressure or temperature switches.

- 7: Reading of the digital signals from a **PLC input word** (P-0-1392). The bits of the input word can be assigned to the digital inputs of the IndraDrive.
- 8: Reading of the digital signals from a **PLC structure**. If Sercos IOs are used, the structure variable can be assigned via the IO configurator in an applicative extension.

Digital outputs are available at IndraDrive for controlling on/off valves. The valve control word generated in the technology function has to be assigned to the digital outputs that are wired to the hydraulic valves. For using Sercos IOs the valve control word is also available as PLC variable. This can be assigned via the IO configurator in an applicative extension.

6.18.2 Analog input variables

Reading of the parameter

If the associated parameter is selected as signal source (value "0" in the signal selection parameter), it is read by PFC taking account of weighting. The parameter can be written via the assignments of the analog inputs of the Drive firmware, for example. Scaling and filtering have to be handled externally, via the assignments of the IndraDrive firmware, for example.

Reading of analog inputs 1-5

When one of the analog inputs is selected (value "1" to "5" in the signal selection parameter), it is read as voltage (V) or current (mA) and scaled. Scaling can be configured separately for each signal (see Parameter description). The weighting of the associated parameter is expected to be scaled. The scaled value is written to the associated parameter. This allows diagnostics, e.g. with the help of the oscilloscope. Filtering can be accomplished via input processing of the analog input.

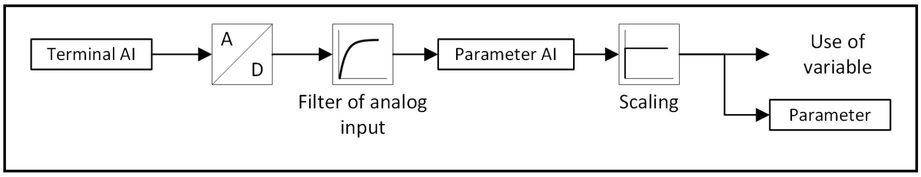


Fig. 6-33: Processing of analog inputs

Reading of the PLC variable

If reading of the PLC variable is selected (value "6" in the signal selection parameter), the PLC variable is read, limited, scaled and filtered. The limitation, scaling and filtering can be configured separately for each signal (see Parameter description). Since invalid values may be defined for analog terminals (e.g., S20-AI-4) to indicate when ranges are exceeded, they are monitored and in the event of violations, a warning is issued. The weighting of the associated parameter is expected to be scaled. Moreover, the filter time of a PT1 filter may be configured for smoothing an analog value. The limited, scaled and filtered value is written to the associated parameter. This allows diagnostics, e.g. with the help of the oscilloscope.

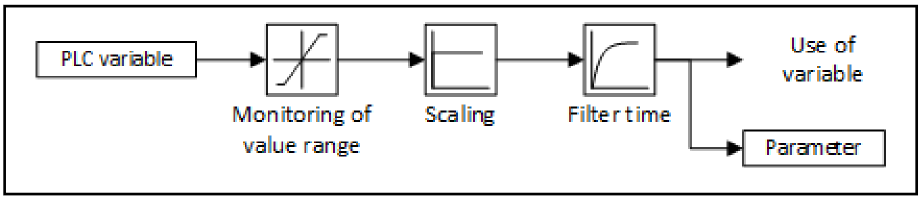


Fig. 6-34: Processing of PLC variables

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

Designation	Parameter	Signal selection P-0-1311[x]	Signal range limitation, min. P-0-1311[x]	Signal range limitation, max. P-0-1311[x]	Scaling value range, min. P-0-1311[x]	Scaling value range, max. P-0-1311[x]	Scaling signal range, min. P-0-1311[x]	Scaling signal range, max. P-0-1311[x]	Filter time P-0-1311[x]
Pressure feedback value A	S-0-0803	253	254	255	256	257	258	259	260
Pressure feedback value B	S-0-0804	261	262	263	264	265	266	267	268
System pressure	S-0-0813	225	226	227	228	229	230	231	232
Tank pressure	S-0-0814	277	278	279	280	281	282	283	284
Swivel angle command value	S-0-0880	42	43	44	45	46	47	48	49
Pressure feedback value C	P-0-1282	269	270	271	272	273	274	275	276

Designation	Parameter	Signal selection P-0-1311[x]	Signal range limitation, min. P-0-1311[x]	Signal range limitation, max. P-0-1311[x]	Scaling value range, min. P-0-1311[x]	Scaling value range, max. P-0-1311[x]	Scaling signal range, min. P-0-1311[x]	Scaling signal range, max. P-0-1311[x]	Filter time P-0-1311[x]
Oil temperature	P-0-1284	162	155	156	157	158	159	160	161
Pilot oil pressure	P-0-1288	239	240	241	242	243	244	245	246
Actual swivel angle value	P-0-1289	17	18	19	20	21	22	23	24
Input of force feedback value	P-0-2937.0.3	67	68	69	70	71	72	73	74

Tab. 6-5: Overview of parameters for configuring analog input variables

- P-0-0208, DA: Analog input 2
- P-0-0210, Analog input 1
- P-0-0211, Analog input 2
- P-0-0217, Analog input 1, time constant input filter
- P-0-0228, Analog input 3
- P-0-0229, DA: Analog input 1
- P-0-0231, Analog input 2, time constant input filter
- P-0-0232, Analog input 3, time constant input filter
- P-0-0233, DA: Analog input 1, time constant input filter
- P-0-0234, DA: Analog input 2, time constant input filter

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B505C: Config data exceeds valid range P1311[157]
- E2015, B505D: Config data exceeds valid range P1311[159]
- E2015, B50B8: Config data not feasible P1311[225]
- E2015, B50B9: Config data not feasible P1311[226]
- E2015, B50BA: System pressure: analog value exceeds range limit
- E2015, B50BB: Config data not feasible P1311[228]
- E2015, B50BC: Config data not feasible P1311[230]
- E2015, B50BD: Config data not feasible P1311[232]
- E2015, B50BE: Config data not feasible P1311[239]
- E2015, B50BF: Config data not feasible P1311[240]
- E2015, B50C0: Pilot oil pressure: analog value exceeds range limit
- E2015, B50C1: Config data not feasible P1311[242]
- E2015, B50C2: Config data not feasible P1311[244]

- E2015, B50C3: Config data not feasible P1311[246]
- E2015, B50C4: Config data not feasible P1311[162]
- E2015, B50C5: Config data not feasible P1311[155]
- E2015, B50C6: Oil temperature: analog value exceeds range limit
- E2015, B50C7: Config data not feasible P1311[161]
- E2015, B50C8: Config data not feasible P1311[253]
- E2015, B50C9: Config data not feasible P1311[254]
- E2015, B50CA: Pressure A: analog value exceeds range limit
- E2015, B50CB: Config data not feasible P1311[256]
- E2015, B50CC: Config data not feasible P1311[258]
- E2015, B50CD: Config data not feasible P1311[260]
- E2015, B50CE: Config data not feasible P1311[261]
- E2015, B50CF: Config data not feasible P1311[262]
- E2015, B50D0: Pressure B: analog value exceeds range limit
- E2015, B50D1: Config data not feasible P1311[264]
- E2015, B50D2: Config data not feasible P1311[266]
- E2015, B50D3: Config data not feasible P1311[268]
- E2015, B50D4: Config data not feasible P1311[269]
- E2015, B50D5: Config data not feasible P1311[270]
- E2015, B50D6: Pressure C: analog value exceeds range limit
- E2015, B50D7: Config data not feasible P1311[272]
- E2015, B50D8: Config data not feasible P1311[274]
- E2015, B50D9: Config data not feasible P1311[276]
- E2015, B50DA: Config data not feasible P1311[277]
- E2015, B50DB: Config data not feasible P1311[278]
- E2015, B50DC: Tank pressure: analog value exceeds range limit
- E2015, B50DD: Config data not feasible P1311[280]
- E2015, B50DE: Config data not feasible P1311[282]
- E2015, B50DF: Config data not feasible P1311[284]
- E2015, B50E0: Config data not feasible P1311[17]
- E2015, B50E1: Config data not feasible P1311[18]
- E2015, B50E2: Swivel angle act: analog value exceeds range limit
- E2015, B50E3: Config data not feasible P1311[20]
- E2015, B50E4: Config data not feasible P1311[22]
- E2015, B50E5: Config data not feasible P1311[24]
- E2015, B50F5: Config data not feasible P1311[42]
- E2015, B50F6: Config data not feasible P1311[43]
- E2015, B50F7: Manual swivel cmd: analog value exceeds range limit
- E2015, B50F8: Config data not feasible P1311[45]
- E2015, B50F9: Config data not feasible P1311[47]
- E2015, B50FA: Config data not feasible P1311[49]
- E2015, B510D: Config data not feasible P1311[67]

- E2015, B510E: Config data not feasible P1311[68]
- E2015, B510F: Force feedback: analog value exceeds range limit
- E2015, B5110: Config data not feasible P1311[70]
- E2015, B5111: Config data not feasible P1311[72]
- E2015, B5112: Config data not feasible P1311[74]

6.18.3 Digital input variables

Reading the digital signals from the PLC input word

If reading of the digital signals from the PLC input word is selected for an input signal (value 7 in the signal selection parameter), the bits belonging to the signal are read from parameter P-0-1392 and made available to the monitoring function. The state of the digital signals is output in P-0-1413 for checking purposes.

Reading the digital signals from the PLC structure

If reading of the digital signals from the PLC structure is selected for an input signal (value 8 in the signal selection parameter), the structure of type IL_MONITORING_SIGNALS belonging to the signal is read and made available to the monitoring function. The parameter is not written. The state of the digital signals is output in P-0-1413 for checking purposes.

Element	Data type	Default value	Description
bAlarmTooHigh	BOOL	FALSE	The error threshold “signal value too high” has been exceeded
bWarningTooHigh	BOOL	FALSE	Value has exceeded the warning threshold “signal value too high”
bAlarmTooLow	BOOL	FALSE	Value has fallen below the error threshold “signal value too high”
bWarningTooLow	BOOL	FALSE	Value has fallen below the warning threshold “signal value too low”

Tab. 6-6: Setup of structure IL_MONITORING_SIGNALS

Digital input variables

The available digital input variables are listed in the table below:

Designation	Parameter for signal selection	Parameter for digital signals	PLC structure for digital signals
System pressure	P-0-1311[225]	P-0-1392 bits 5..2	stSystemPressure
Oil temperature	P-0-1311[162]	P-0-1392 bits 13..10	stOilTemperature
Pilot oil pressure	P-0-1311[239]	P-0-1392 bits 9..6	stControlPressure

Tab. 6-7: Overview of digital input variables

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1392, Input word for digital signals
- P-0-1413, Feedback of digital input signals

6.18.4 Digital output signals

The digital valve control word is available as digital output variable. It can be assigned via parameters P-0-1410 and P-0-1411 in the onboard IO of the

IndraDrive. For using Sercos IOs the valve control word is also available as UNION unValveControlWord_1 and unValveControlWord_2 in the PLC. This UNION contains an element "w" for access as WORD and an element "b" for accessing individual bits.

Name	Type	Description
w	WORD	Element for use as WORD
b	WORD_BIT_ACCESS_BITS	Element for access to bits

Tab. 6-8: UNION WORD_BIT_ACCESS

In the setup of the structure WORD_BIT_ACCESS_BITS the byte order of the processor (Little Endian) is taken into account.

Name	Type	Description
btBIT_08	BIT	Bit 8 of the variable
btBIT_09	BIT	Bit 9 of the variable
btBIT_10	BIT	Bit 10 of the variable
btBIT_11	BIT	Bit 11 of the variable
btBIT_12	BIT	Bit 12 of the variable
btBIT_13	BIT	Bit 13 of the variable
btBIT_14	BIT	Bit 14 of the variable
btBIT_15	BIT	Bit 15 of the variable
btBIT_00	BIT	Bit 0 of the variable
btBIT_01	BIT	Bit 1 of the variable
btBIT_02	BIT	Bit 2 of the variable
btBIT_03	BIT	Bit 3 of the variable
btBIT_04	BIT	Bit 4 of the variable
btBIT_05	BIT	Bit 5 of the variable
btBIT_06	BIT	Bit 6 of the variable
btBIT_07	BIT	Bit 7 of the variable

Tab. 6-9: Structure of WORD_BIT_ACCESS_BITS

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1410, Valve switching word 1
- P-0-1411, Valve switching word 2

6.19 System pressure increase

6.19.1 Overview

System pressure increase is available as of PFC03V04.

The system pressure increase can be made available by an external power unit or an internally activated second motor-pump group (secondary axis).

The provision of the system pressure by an external power unit has to be configured so that system pressure S-0-0813 - and not tank pressure S-0-0814 - is used for detecting the refilling process.

If the system pressure is to be provided via a secondary axis, commanding is effected from PFC. The system pressure is controlled via a two-point controller. A precondition for this is a CCD master interface in the control section of the master axis (PFC) as well as an IndraDrive with master communication as secondary axis.

The system pressure increase can be configured via the configuration word P-0-1370 bit 17/16.

P-0-1370 bit 17/16	Description
00	Deactivated
01	External provision of the system pressure
10	Provision of system pressure via secondary axis
11	Deactivated (reserved)

Tab. 6-10: Configuration of the system pressure increase

6.19.2 Provision of system pressure via secondary axis

Activation of secondary axis

When a secondary axis is used, it can be enabled automatically in OM or via control word P-0-1283 bit 12. For configuration, use P-0-1370, bit 18.

P-0-1370 bit 18	Description
0	Automatic activation of secondary axis in OM
1	External enable via control word P-0-1283 bit 12

Tab. 6-11: Configuration of the enable for system pressure increase

When enabled automatically from PFC, the secondary axis is enabled when the following criteria are fulfilled:

- PFC axis in OM
- Check of machine data by PFC completed
- Secondary axis in OM
- Secondary axis error-free

When an error message of the secondary axis is successfully acknowledged, the axis is automatically re-enabled.

If enabled externally, the secondary axis can be enabled via a 0 → 1 change of control word P-0-1283 bit 12.

If the enable is granted from PFC or externally and if the axis is not ready (error-free in state Ab), a warning is generated after the delay defined in P-0-1311[390]. Causes are:

- Enable from PFC, secondary axis is in bb, because no power was switched on
- External enable, secondary axis is in PM or bb

Closed-loop control of system pressure

If the system pressure increase has been enabled, the system pressure (S-0-0813) is monitored for its level and regulated with a two-point control.

If the system pressure has fallen below the switch-on threshold P-0-1311[385] for debounce time P-0-1389[384], the pressure is increased at a fixed speed of P-0-1389[387] (in rpm). If the switch-off threshold

P-0-1311[386] has been exceeded for debounce time P-0-1389[384], the secondary axis is stopped.

The target acceleration (P-0-1311[388] in rad/s²) and the target deceleration (P-0-1311[389] in rad/s²) of the secondary axis can be configured separately.

If, following the enable, switch-on threshold P-0-1389[385] has been exceeded for debounce time P-0-1389[384], status word P-0-1281 bit 3 indicates when the system pressure is reached.

Scaling configuration of secondary axis

To ensure correct commanding of the secondary axis, a defined scaling of the secondary axis has to be set:

- Velocity scaling in [rpm]
- Acceleration scaling in [rad/s²]

Scalings have to be applied in the preferred scaling with reference to the motor shaft. In the case of differing configuration, warning B506D is generated.

6.19.3 Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1281, System status word 2
- P-0-1283, Hydraulic function, switching control word
- P-0-1311[384], System pressure increase - debounce time
- P-0-1311[385], System pressure increase - switch-on threshold
- P-0-1311[386], System pressure increase - switch-off threshold
- P-0-1311[387], System pressure increase - speed command value
- P-0-1311[388], System pressure increase - acceleration
- P-0-1311[389], System pressure increase - deceleration
- P-0-1311[390], Delay for drive ready for enable
- P-0-1806.2.10, CCD: Resource status (S-0-0135, Drive status of secondary axis)
- P-0-1808.2.1, CCD: Diagnostic message number (S-0-0390, Diagnostic message number of secondary axis)
- P-0-1808.2.11, CCD: S-0-0040, Velocity feedback value (S-0-0040, Velocity feedback value of encoder 1 of secondary axis)

6.19.4 Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B506D: Scaling of slave axis is invalid
- E2015, B507D: Config data not feasible P-0-1311[384]
- E2015, B507E: Slave not ready for control
- E2015, B50A3: Config of system pressure rising invalid P-0-1370.16

6.20 Protective functions

6.20.1 Overview

Protective functions for pressures and temperatures have been implemented with warning and alarm thresholds. They serve to protect the hydraulic components. Other monitoring functions for lag error, wire break and power supply of digital outputs monitor the correct operation of the machine.

Features

- Monitoring functions:
  – Chamber pressure A & chamber pressure B too high
  – Chamber pressure C too high
  – Tank pressure too high
  – Tank pressure too low
  – Oil temperature too high
  – Oil temperature too low
  – System pressure too high
  – System pressure too low
  – Pilot oil pressure too high
  – Pilot oil pressure too low
  – Inadmissible encoder jumps
  – Impermissible drift rate
  – Restraint valves
  – Oil filter clogging
  – Summated pressure too high
  – Operating range of A10 pump
  – Lag error (model-based or velocity-dependent)
  – Wire break, analog current inputs (<4 mA) during processing in firmware
  – Power supply, digital outputs (X37)
- Minimum duration of threshold value violation can be set for monitoring (warning and alarm thresholds have the same debounce time).
- Alarm threshold violations under drive enable will cause error reaction in IndraDrive.
- Monitoring functions can be deactivated to some extent via Configuration, axis controllers/functions.

6.20.2 Monitoring of pressure feedback value A and pressure feedback value B

"S-0-0803, Pressure feedback value A" and "S-0-0804, Pressure feedback value B" can be monitored for excessive values.

In P-0-1372, bit 28, monitoring of pressure feedback value A and pressure feedback value B for excessive values is activated (= 0) / deactivated (= 1). You can configure a warning threshold (P-0-1311[170]) and an error threshold (P-0-1311[171]). To suppress peaks, a debounce time (P-0-1311[169]) can be set.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- P-0-1311[169], Monitoring for process pressure too high: Debounce time
- P-0-1311[170], Monitoring for process pressure too high: Warning threshold

- P-0-1311[171], Monitoring for process pressure too high: Alarm threshold
- P-0-1372, Configuration, axis controllers/functions

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5056: Config data not feasible P-0-1311[170]
- E2015, B5058: Pressure chamber A exceeds warning level
- E2015, B505A: Pressure chamber B exceeds warning level
- F2017, D5057: Pressure chamber A exceeds alarm level
- F2017, D5059: Pressure chamber B exceeds alarm level

6.20.3 Monitoring of pressure feedback value C

"S-0-1282, Pressure feedback value C" can be monitored for excessive values.

Monitoring of pressure feedback value C is activated (= 0) / deactivated (= 1) in P-0-1372, bit 18. You can configure a warning threshold (P-0-1311[286]) and an error threshold (P-0-1311[287]). To suppress peaks, a debounce time (P-0-1311[285]) can be set.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1282, Pressure feedback value C
- P-0-1311[285], Monitoring pressure feedback value C too high: Debounce time
- P-0-1311[286], Monitoring pressure feedback value C too high: Warning threshold
- P-0-1311[287], Monitoring pressure feedback value C too high: Alarm threshold
- P-0-1372, Configuration, axis controllers/functions

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B50B1: Config data not feasible P-0-1311[286]
- E2015, B50B3: Pressure chamber C exceeds warning level
- F2017, D50B2: Pressure chamber C exceeds alarm level

6.20.4 Monitoring of tank pressure

"S-0-0814, Tank pressure" can be monitored for too high or too low values. The monitoring functions for too high and too low values can be activated/ deactivated together. The functions generate a warning or an error, respectively, when the tank pressure exceeds or falls below the warning/error threshold for the duration of a monitoring interval.

Monitoring of the tank pressure is activated (= 0) / deactivated (= 1) in P-0-1372, bit 25. You can configure a warning threshold (P-0-1311[167]) and an error threshold (P-0-1311[168]) for monitoring for too high values. To suppress peaks, a debounce time (P-0-1311[163]) can be set.

For monitoring for too low values you can also configure a warning threshold (P-0-1311[165]) and an error threshold (P-0-1311[166]). To suppress peaks, a debounce time (P-0-1311[164]) can be set.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0814, Tank pressure
- P-0-1281, System status word 2
- P-0-1311[163], Monitoring tank pressure too high: Debounce time
- P-0-1311[164], Monitoring tank pressure too low: Debounce time
- P-0-1311[165], Monitoring tank pressure too low: Warning threshold
- P-0-1311[166], Monitoring for tank pressure too low: Alarm threshold
- P-0-1311[167], Monitoring tank pressure too high: Warning threshold
- P-0-1311[168], Monitoring tank pressure too high: Alarm threshold
- P-0-1372, Configuration, axis controllers/functions

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5050: Config data not feasible P-0-1311[167]
- E2015, B5052: Tank pressure exceeds upper warning level
- E2015, B5053: Config data not feasible P-0-1311[165]
- E2015, B5054: Tank pressure exceeds lower warning level
- F2017, D5051: Tank pressure exceeds upper alarm level
- F2017, D5055: Tank pressure exceeds lower alarm level

6.20.5 Monitoring of the oil temperature

The oil temperature can be monitored for too high or too low values. Monitoring for too low values is only active when the drive is in the state AF. The monitoring functions for too high and too low values can be activated/deactivated separately. Moreover, you can select between monitoring of the analog value "P-0-1284, Oil temperature" and the evaluation of digital signals from temperature switches. The function generates a warning or an error when the oil temperature exceeds or falls below the warning/error thresholds for the duration of a monitoring interval.

Monitoring of the analog value

For monitoring the oil temperature as analog value, an analog signal source (0 – 6) has to be selected in P-0-1311[162].

Monitoring of the oil temperature for too high values is activated (= 0) / deactivated (= 1) in P-0-1372, bit 23. You can configure a warning threshold (P-0-1311[173]) and an error threshold (P-0-1311[174]). To suppress peaks, a debounce time (P-0-1311[172]) can be set.

Monitoring of the oil temperature for too low values is activated (= 0) / deactivated (= 1) in P-0-1383, bit 13. Monitoring for too low values is only active when the drive is in the state AF. You can configure a warning threshold (P-0-1311[153]) and an error threshold (P-0-1311[154]). To suppress peaks, a debounce time (P-0-1311[152]) can be set.

Evaluation of temperature switch signals

For monitoring the oil temperature via temperature switches, a digital signal source (7 – 8) has to be selected in P-0-1311[162].

Monitoring of the oil temperature for too high values is activated (= 0) / deactivated (= 1) in P-0-1372, bit 23. To suppress peaks, a debounce time (P-0-1311[172]) can be set. Monitoring of the oil temperature for too low values is activated (= 0) / deactivated (= 1) in P-0-1383, bit 13.

Monitoring for too low values is only active when the drive is in the state AF. To suppress peaks, a debounce time (P-0-1311[152]) can be set. The characteristic of the inputs (NO or NC contacts) can be configured via P-0-1383 bit 17..14.

For checking purposes, the temperature switch signals are output to P-0-1413 bit 13..10.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1284, Oil temperature
- P-0-1311[152], Monitoring oil temperature too low: Debounce time
- P-0-1311[153], Monitoring oil temperature too low: Warning threshold
- P-0-1311[154], Monitoring oil temperature too low: Alarm threshold
- P-0-1311[162], Oil temperature signal selection
- P-0-1311[172], Monitoring oil temperature too high: Debounce time
- P-0-1311[173], Monitoring oil temperature too high: Warning threshold
- P-0-1311[174], Monitoring oil temperature too high: Alarm threshold
- P-0-1372, Configuration, axis controllers/functions
- P-0-1383, Monitoring configuration
- P-0-1392, Digital signals for use of temperature switches
- P-0-1413, Feedback of digital input signals

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B504D: Config data not feasible P-0-1311[173]
- E2015, B504F: Oil temperature exceeds warning level
- E2015, B50B5: Config data not feasible P-0-1311[153]
- E2015, B50B7: Oil temperature exceeds warning level
- F2017, D504E: Oil temperature exceeds alarm level
- F2017, D50B6: Oil temperature exceeds alarm level

6.20.6 Monitoring of system pressure

The system pressure (also often referred to as low pressure) can be monitored for too high and too low values. Monitoring for too low values is only active when the drive is in the state AF. The monitoring functions for too high and too low values can be activated/deactivated separately. Moreover, you can select between monitoring of the analog value "P-0-0813, System pressure" and the evaluation of digital signals from pressure switches. The function generates a warning or an error when the system pressure exceeds or falls below the warning/error thresholds for the duration of a monitoring interval.

Monitoring of the analog value

For monitoring the system pressure as analog value, an analog signal source (0 – 6) has to be selected in P-0-1311[225].

Monitoring of the system pressure for too high values is activated (= 0) / deactivated (= 1) in P-0-1383, bit 0. You can configure a warning threshold (P-0-1311[234]) and an error threshold (P-0-1311[235]). To suppress peaks, a debounce time (P-0-1311[233]) can be set.

Monitoring of the system pressure for too low values is activated (= 0) / deactivated (= 1) in P-1-1383, bit 1. Monitoring for too low values is only active when the drive is in the state AF to allow system pressure supply via a slave axis in bb/Ab. You can configure a warning threshold (P-0-1311[237]) and an error threshold (P-0-1311[238]). To suppress peaks, a debounce time (P-0-1311[236]) can be set.

Evaluation of pressure switch signals

For monitoring the system pressure via pressure switches, a digital signal source (7 – 8) has to be selected in P-0-1311[225].

Monitoring of the system pressure for too high values is activated (= 0) / deactivated (= 1) in P-0-1383, bit 0. To suppress peaks, a debounce time (P-0-1311[233]) can be set.

Monitoring of the system pressure for too low values is activated (= 0) / deactivated (= 1) in P-1-1383, bit 1. To suppress peaks, a debounce time (P-0-1311[236]) can be set. The characteristic of the inputs (NO or NC contacts) can be configured via P-0-1383 bit 5..2.

For checking purposes, the raw values of the temperature switch signals are output to P-0-1413 bit 5..2.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0813, System pressure
- P-0-1311[225], System pressure signal selection
- P-0-1311[233], Monitoring system pressure too high: Debounce time
- P-0-1311[234], Monitoring system pressure too high: Warning threshold
- P-0-1311[235], Monitoring system pressure too high: Alarm threshold
- P-0-1311[236], Monitoring system pressure too low: Debounce time
- P-0-1311[237], Monitoring system pressure too low: Warning threshold
- P-0-1311[238], Monitoring system pressure too low: Alarm threshold
- P-0-1383, Monitoring configuration
- P-0-1392, Digital signals for use of pressure switches
- P-0-1413, Feedback of digital input signals

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B50A5: Config data not feasible P-0-1311[234]
- E2015, B50A7: System pressure exceeds upper warning level
- E2015, B50A8: Config data not feasible P-0-1311[237]
- E2015, B50AA: System pressure falls below lower warning level
- F2017, D50A6: System pressure exceeds upper alarm level
- F2017, D50A9: System pressure falls below lower alarm level

6.20.7 Monitoring of pilot oil pressure

The pilot oil pressure (also often referred to as high pressure) can be monitored for too high and too low values. Monitoring for too low values is only active when the drive is in the state AF. The monitoring functions for too high and too low values can be activated/deactivated separately. Moreover, you can select between monitoring of the analog pilot pressure value (P-0-1288) and the evaluation of digital signals from pressure switches. The function generates a warning or an error when the pilot oil pressure exceeds or falls below the warning/error thresholds for the duration of a monitoring interval.

Monitoring of the analog value

For monitoring the pilot oil pressure as analog value, an analog signal source (0 – 6) has to be selected in P-0-1311[239].

Monitoring of the pilot oil pressure for too high values is activated (= 0) / deactivated (= 1) in P-6-1383, bit 6. You can configure a warning threshold (P-0-1311[248]) and an error threshold (P-0-1311[249]). To suppress peaks, a debounce time (P-0-1311[247]) can be set.

Monitoring of the pilot oil pressure for too low values is activated (= 0) / deactivated (= 1) in P-7-1383, bit 7. Monitoring for too low values is only active when the drive is in the state AF to allow a pilot oil pressure supply via a slave axis in bb/Ab. You can configure a warning threshold (P-0-1311[251]) and an error threshold (P-0-1311[252]). To suppress peaks, a debounce time (P-0-1311[250]) can be set.

Evaluation of pressure switch signals

For monitoring the system pressure via pressure switches, a digital signal source (7 – 8) has to be selected in P-0-1311[239].

Monitoring of the pilot oil pressure for too high values is activated (= 0) / deactivated (= 1) in P-6-1383, bit 6. To suppress peaks, a debounce time (P-0-1311[247]) can be set.

Monitoring of the pilot oil pressure for too low values is activated (= 0) / deactivated (= 1) in P-7-1383, bit 7. To suppress peaks, a debounce time (P-0-1311[250]) can be set. The characteristic of the inputs (NO or NC contacts) can be configured via P-0-1383 bit 11..8.

For checking purposes, the raw values of the pressure switch signals are output to P-0-1413 bit 9..6.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1288, Pilot oil pressure
- P-0-1311[239], Pilot oil pressure signal selection
- P-0-1311[247], Monitoring pilot oil pressure too high: Debounce time
- P-0-1311[248], Monitoring pilot oil pressure too high: Warning threshold
- P-0-1311[249], Monitoring pilot oil pressure too high: Alarm threshold
- P-0-1311[250], Monitoring pilot oil pressure too low: Debounce time
- P-0-1311[251], Monitoring pilot oil pressure too low: Warning threshold
- P-0-1311[252], Monitoring pilot oil pressure too low: Alarm threshold
- P-0-1383, Monitoring configuration
- P-0-1392, Digital signals for use of pressure switches
- P-0-1413, Feedback of digital input signals

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B50AB: Config data not feasible P-0-1311[248]
- E2015, B50AD: Pilot oil pressure exceeds upper warning level
- E2015, B50AE: Config data not feasible P-0-1311[251]
- E2015, B50B0: Pilot oil pressure falls below lower warning level
- F2017, D50AC: Pilot oil pressure exceeds upper alarm level
- F2017, D50AF: Pilot oil pressure falls below lower alarm level

6.20.8 Monitoring for impermissible encoder jumps

Encoder jump monitoring can ignore implausible jumps in the encoder signal (S-0-0386) and keep extrapolating the internal actual position with the last valid velocity.

Monitoring can be deactivated (P-0-1372; bit 24). P-0-1311[176] is used to evaluate the maximum allowed velocity (cf. velocity limit values) to determine the threshold for the plausibility check of the changes in position per clock cycle. P-0-1311[175] is used to set the desired number of cycles (in 2-ms clock cycle) for which encoder jump monitoring is to ignore implausible encoder signals. If the velocity continues to be too high after these cycles, "D502, actual velocity exceeds valid range" is issued.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1311[175], Encoder jump monitoring: Number of suppression cycles
- P-0-1311[176], Encoder jump monitoring: Maximum velocity factor
- P-0-1372, Configuration, axis controllers/functions
- S-0-0386, Active position feedback value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

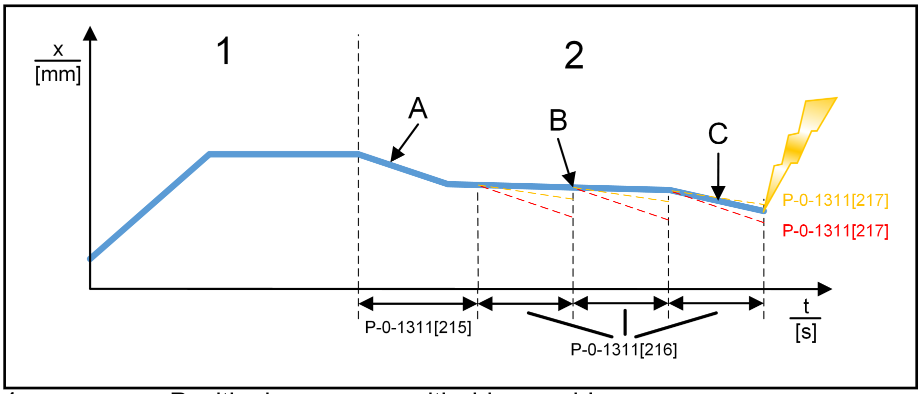
- E2015, B5024: Change rate pos./neg. not feasible
- E2015, B509B: Config data exceeds valid range P-0-1311[176]
- F2017, D5025: Actual velocity exceeds valid range

6.20.9 Monitoring for impermissible drift rate

The monitoring function offered captures an impermissible drift rate of an axis when no drive enable has been granted. The function issues a warning or an error, if the related threshold values have been exceeded at the end of a monitoring interval. By means of configuration bit 29 of “P-0-1372, Configuration, axis controllers/functions”, monitoring can be activated (= 0, default) and deactivated (= 1).

Features of the monitoring function:

- Stopping of the axis is recognized via disabling of the drive. The switching time of the shut-off valves can be parameterized using a delay.
- The drift rate is compared with parameterizable threshold values (warning/error) and rated at two levels with clear diagnostic messages.
- The absolute value of velocity is evaluated in order to be able to detect an undesirable change in position - irrespective of the mounting position and pulling or pushing loads.
- The monitoring function can only evaluate changes in position while the drive is supplied with control voltage. After booting, monitoring cannot be carried out since the time reference is missing. For monitoring the absolute change in position after booting the absolute encoder monitoring window (P-0-0095) can be used with the corresponding firmware function.



1 Positioning process with drive enable
2 None drive enable
A “Sag”
B Minor drift
C Strong drift

Fig. 6-35: Schematic course of the actual position value when the drive is disabled

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0115, Device control: Status word
- P-0-1311[215], Drift monitoring: Switching time of shut-off valve
- P-0-1311[216], Drift monitoring: Cycle time of monitoring interval
- P-0-1311[217], Drift monitoring: Warning threshold for lowering speed
- P-0-1311[218], Drift monitoring: Alarm threshold for drift rates
- P-0-1372, Configuration, axis controllers/functions
- S-0-0386, Active position feedback value

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B57DD: Position drift exceeds warning level
- E2015, B57DE: Position drift exceeds alarm level
- E2015, B57DF: Config data not feasible P-0-1311[217]
- E2015, B57E0: Config data not feasible P-0-1311[218]

6.20.10 Monitoring of restraint valves

The configuration of restraint valve monitoring can be locked and unlocked using parameter P-0-1382. The locking mechanism serves to prevent unintentional overwriting of the parameters while a parameter file is loaded. Locking/unlocking is only possible, while the drive in the operating mode (e.g. OM, Ab, AF), because the configuration and hence the locking status can only be checked in this mode.

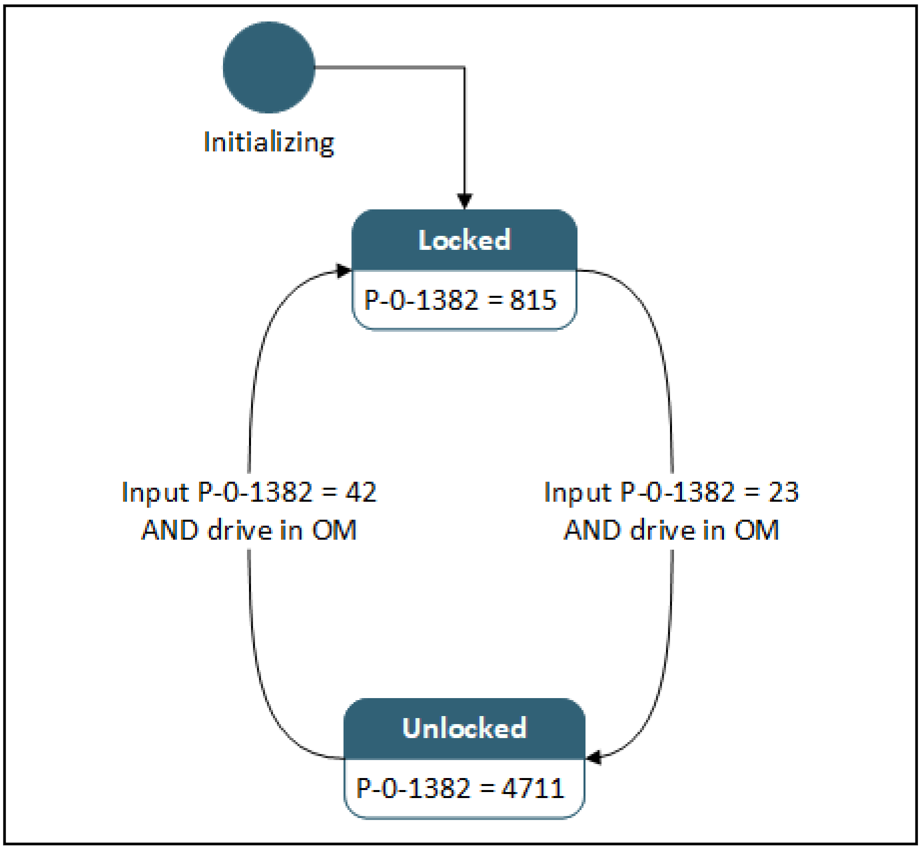


Fig. 6-36: State machine of the locking parameter

Monitoring of the feedback signals of restraint valves is activated (= 0, default) or deactivated (= 1) via bit 0 of P-0-1311[208]. When the monitoring function is used, feedback signals of the valves in response to parameter P-0-1393 are expected according to the following representation:

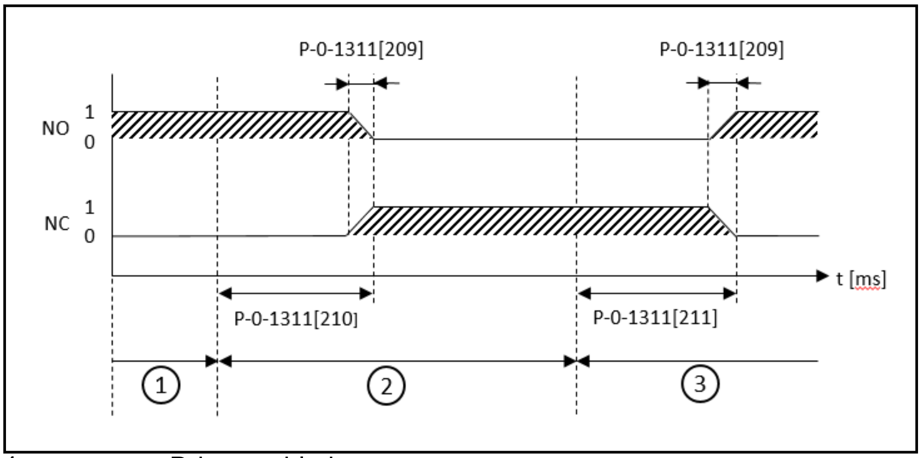
P-0-1393 PLC input WORD AT %IB6:

Bit	Description
0	NC contact valve 1
1	NO contact valve 1
2	NC contact valve 2
3	NO contact valve 2

Tab. 6-12: Feedback of valves

The following settings have to be made, on the basis of which feedback signals are monitored:

- Maximum overlap [ms] of the feedback signals of safety valves NO (normally open) and NC (normally closed) in P-0-1311[209]
- Permissible maximum time [ms] until a safety valve has to be closed in P-0-1311[210]
- Permissible maximum time [ms] until a safety valve has to be opened in P-0-1311[211]
- Pilot oil pressure [bar], from which on safety valves remain open, if they are to be opened, in P-0-1311[212]



1 Drive enabled
2 Drive not enabled
3 Drive enabled and pilot oil pressure present

Fig. 6-37: Parameterization of restraint valve monitoring

To ensure regular monitoring of switching level changes, the maximum time intervals between two valve tests can be parameterized with the help of the warning threshold (P-0-1311[213]) and the error threshold (P-0-1311[214]).

After having entered the parameters, lock the setting using parameter P-0-1382.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1311[208], Monitoring of restraint valves: Deactivation
- P-0-1311[209], Monitoring of restraint valves: Max. time overlap of NO and NC contacts
- P-0-1311[210], Monitoring of restraint valves: Max. time for closing the valves
- P-0-1311[211], Monitoring of restraint valves: Max. time for opening the valves
- P-0-1311[212], Monitoring of restraint valves: Pilot oil pressure for opening the safety valves
- P-0-1311[213], Monitoring of restraint valves: Permissible time interval between 2 tests (warning)
- P-0-1311[214], Monitoring of restraint valves: Permissible time interval between 2 tests (error)
- P-0-1382, Locking of safety configuration
- P-0-1393, Valve feedback status word
- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B57D2: Safety vlv mon: Test time Vlv1
- E2015, B57D3: Safety vlv mon: Test time Vlv2
- E2015, B57DC: Safety config is locked
- F2017, D57D4: Safety vlv mon: Antivalence check Vlv1 failed
- F2017, D57D5: Safety vlv mon: Antivalence check Vlv2 failed

- F2017, D57D6: Safety vlv mon: Opening Vlv1 failed
- F2017, D57D7: Safety vlv mon: Opening Vlv2 failed
- F2017, D57D8: Safety vlv mon: Closing Vlv1 failed
- F2017, D57D9: Safety vlv mon: Closing Vlv2 failed
- F2017, D57DA: Safety vlv mon: Test time Vlv1
- F2017, D57DB: Safety vlv mon: Test time Vlv2

6.20.11 Oil filter clogging monitoring

Oil filter monitoring is provided. This function supports filters with two feedback contacts for 75 % and 100 % clogging indicators.

☞ The functional extension for emergency stop is available only as of PFC02V08.

Indication and evaluation of oil filter monitoring

The function can be deactivated by means of P-0-1372 bit 22 (see parameter). While the function is deactivated, the warnings are reset. Moreover, the function only becomes active, if the oil temperature has exceeded the threshold P-0-1311[178]. The feedback contacts of the filter are read via digital inputs in P-0-1281. The feedback signals can be inverted by means of the configuration word P-0-1372. The evaluation of the feedback contacts is debounced using P-0-1311[179]. For 75 % filter clogging, B5076 is issued and for 100 % clogging, B5077.

The warnings for filter clogging are reset with a rising edge of the enable (P-0-0115).

For checking purposes, the raw values of the feedback contacts are output to P-0-1413 bit 1..0.

In the case of an emergency stop, filter clogging is not signaled. The reason for this is that in the event of an emergency stop, pressure peaks occur in the system that could cause the filter monitor to respond by mistake. If 100 % filter clogging is detected within the framework of an emergency stop, event B5091 is reported. It indicates that filter clogging was signaled by mistake and that the visual indicator on the filter may be reset.

An emergency stop is present when P-0-0115 bit 6/3 has the status according to the following table:

Bit 6	Bit 3	State	Description
0	0	Drive carries out internal deceleration	Fault: Safety technology: Drive-controlled transition
0	1	Drive follows command value of external control unit in active operation mode	Normal operating state
1	0	Internal PLC controls drive via an MC function block	
1	1		Not possible

Tab. 6-13: P-0-0115, Device control: Status word

The evaluation as emergency stop may only take place when the internal drive enable is present. This then represents the starting point of the emergency stop. The emergency stop is regarded as completed when the internal enable is withdrawn (see the following excerpt from the firmware documentation):

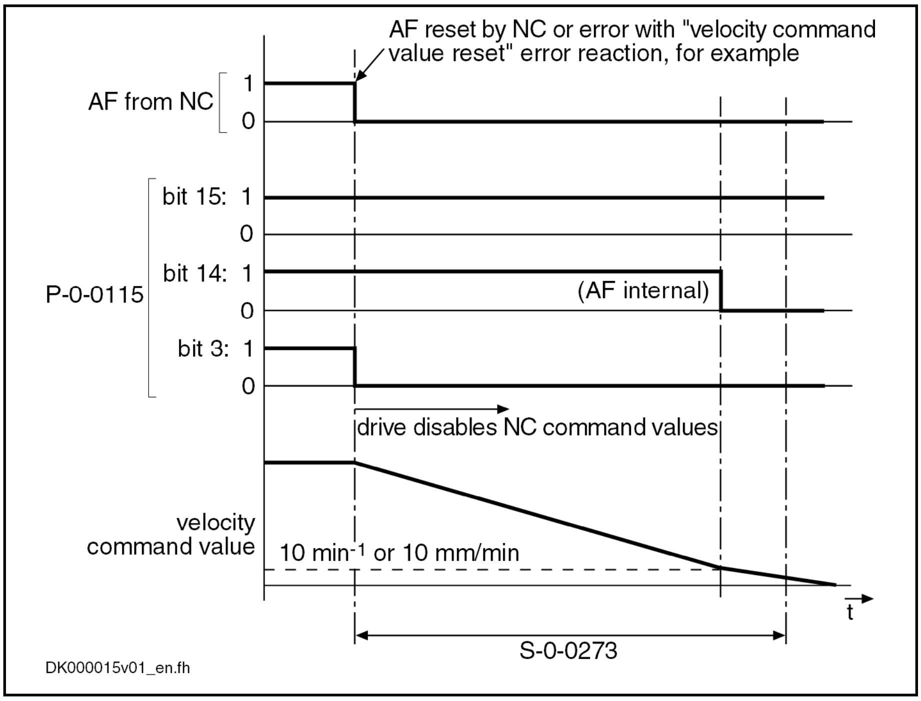


Fig. 6-38: Excerpt emergency stop

The recognition of an emergency stop is additionally provided with a time buffer for the duration given in P-0-1311[197].

Logging of the operating time with set filter warning.

If the filter function is activated, the operating time of the filter in the states ok, 75-% clogging and 100-% clogging is cumulated and shown in the parameters P-0-1312[100ff].

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0115, Device control: Status word 2
- P-0-1281, System status word 2
- P-0-1284, Oil temperature
- P-0-1311[178], Oil temperature threshold, filter monitoring
- P-0-1311[179], Debounce time, filter monitoring
- P-0-1311[197], Debounce time emergency stop
- P-0-1312[100], Filter ok time stamp
- P-0-1312[101], Filter warning time stamp
- P-0-1312[102], Filter alarm time stamp
- P-0-1312[103], Filter ok operating time
- P-0-1312[104], Filter warning operating time
- P-0-1312[105], Filter alarm operating time
- P-0-1372, Configuration, axis controllers/functions
- P-0-1392, Input word for digital signals
- P-0-1413, Feedback of digital input signals

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5076: Oil filter clogging >75%
- E2015, B5077: Oil filter clogging 100%

- E2015, B5091: Oil filter feedback fail, reset feedback signal

6.20.12 Monitoring of summated pressure

Monitoring of the summated pressure is provided to protect the displacer. The function generates a warning or an error when the sum of the chamber pressures "S-0-0803, Pressure feedback value A" and "S-0-0804, Pressure feedback value B" exceeds a threshold value for the duration of a monitoring interval. Since the pressures are mostly measured at the cylinder and not at the pump, this message may also be generated when, for example, a chamber is isolated by enable valves or safety valves.

Bit 19 of P-0-1372 serves to activate (= 0)/deactivate (= 1) this function. A warning threshold (P-0-1311[223]) and an error threshold (P-0-1311[224]) can be set. To suppress peaks, a debounce time (P-0-1311[222]) can be set.

☞ In the case of a fault, the decompression valves can be opened in order to reduce the summated pressure at the pump as quickly as possible. To tis end, bit 4 (decompression valve on B-side of the pump) and bit 5 (decompression valve on the A-side of the pump) are set in "P-0-1411, Valve switching word 2", until the drive error has been successfully acknowledged.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- P-0-1311[222], Monitoring summated pressure too high: Debounce time
- P-0-1311[223], Monitoring summated pressure too high: Warning threshold
- P-0-1311[224], Monitoring summated pressure too high: Alarm threshold
- P-0-1372, Configuration, axis controllers/functions
- P-0-1411, Valve switching word 2

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- B5083: Config data not feasible P-0-1311[223]
- D4084: Sum pressure of pump exceeds alarm level
- B5085: Sum pressure of pump exceeds warning level

6.20.13 Monitoring of operating points of an A10 pump

Overview

Monitoring of the operating points of a pump of the A10 series is provided for protecting the displacer. For displacers of the A10 series, defined operating points are permitted for a defined period of time only. If impermissible operating points are active for too long, swiveling back to a lower Vg is commanded for pumps with adjustable swivel angle. Should this be impossible for design reasons, a systemic reaction is initiated.

Monitoring for the operating point of an A10 can be used for the following technical variants of the displacer:

- Displacer with fixed Vg
- Displacer with switchable Vg (two-point control)
- Displacer with continuously variable Vg

Inadmissible operating ranges: Bit 31 of P-0-1372 serves to activate (= 0)/deactivate (= 1) this function. Monitoring the operating point of the pump is based on the differential pressure (S-0-0803 – S-0-0804) and the active velocity controller command value (P-0-0561) as well as the current relative displacement of the pump (P-0-1275). The operating ranges, which are limited in time, are shown in the following:

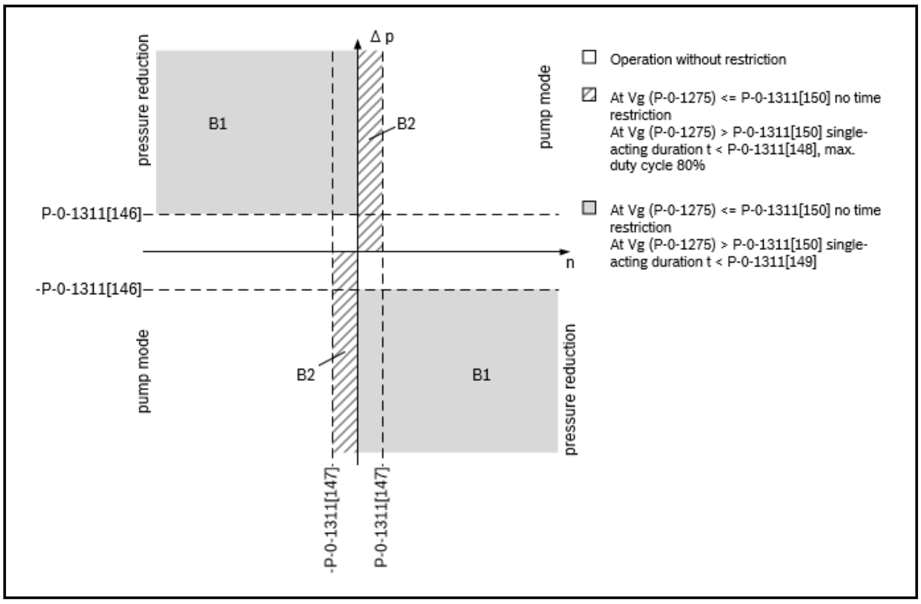


Fig. 6-39: Operating ranges of the A10 displacer

In pressure reduction operation B1, limited by the pressure differential for recognizing high load (P-0-1311[146]), when active Vg (P-0-1275) > critical Vg (P-0-1311[150] / 100 * P-0-2943) the pump may only be operated for the maximum time set (P-0-1311[149]). In the case of an excessively long dwell time in the impermissible operating range B1, the displacer is commanded to set a Vg less than the critical Vg.

In pump operation, the operating range B2, limited by the speed limit value for recognizing low speed (P-0-1311[147]), is only admissible for the maximum time set (P-0-1311[148]) when Vg (P-0-1275) > critical Vg (P-0-1311[150] / 100 * P-0-2943). In the case of an excessively long dwell time in operating range B2 (maximum 80 % duty cycle) the displacer is commanded to set a Vg less than the critical Vg for a 20 % duty cycle (as far as possible for design reasons).

The commanded Vg for reducing the load can by specified by means of factor P-0-1311[151] in relation to the critical Vg in order to command a Vg that is certainly below the critical Vg.

When the permissible maximum duration is exceeded in operating point B1 or B2, a warning is generated. In addition, a systemic reaction is carried out depending on the design of the displacer as listed below:

	Displacer design with regard to Vg		
Reaction in the case of excessively long dwell time in B1/B2	**Fixed Vg**	**Switchable Vg (two-point control)**	**Continuously adjustable Vg**
Warning	X	X	X
Error	-	-	-

	Displacer design with regard to Vg		
Reaction in the case of excessively long dwell time in B1/B2	Fixed Vg	Switchable Vg (two-point control)	Continuously adjustable Vg
Swiveling to minimum Vg	-	X	-
Swiveling to Vg ≤ P-0-1311[150]	-	-	X

X is carried out
- is not carried out

Tab. 6-14: Reaction in the case of inadmissible operating point

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- P-0-1275, Effective displacement
- P-0-2943, Pump displacement
- P-0-1311[146], Critical pressure differential of the pump for detecting high load
- P-0-1311[147], Speed limit value for detecting low speed
- P-0-1311[148], Time limit for operation in B2
- P-0-1311[149], Time limit for operation in B1
- P-0-1311[150], Critical Vg for detecting high load of the pump
- P-0-1311[151], Factor for reducing the commanded Vg in relation to the critical Vg
- P-0-1372, Configuration, axis controllers/functions

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B504A: Config data exceeds valid range P-0-1311[151]
- E2015, B5115: Pump runs on low speed at high Vg
- E2015, B5116: Pump is reversing at high Vg and high load

6.20.14 Model monitoring/following distance monitoring

It is possible to choose between model-based and velocity-dependent lag error monitoring. To deactivate lag error monitoring, “not active” can be selected (P-0-1372; bits 27/26 = 00).

Model monitoring

In the model monitoring mode (“P-0-1372, Configuration, axis controllers/functions“ bits 27/26 = 01), an actual position value model is computed and compared to the real actual position value. If this deviation exceeds the value entered in "P-0-1311[122], Lag error model monitoring window”, the axis cannot follow the given command value and the error “F2017, D502C: position lag exceeds alarm level“ is generated.

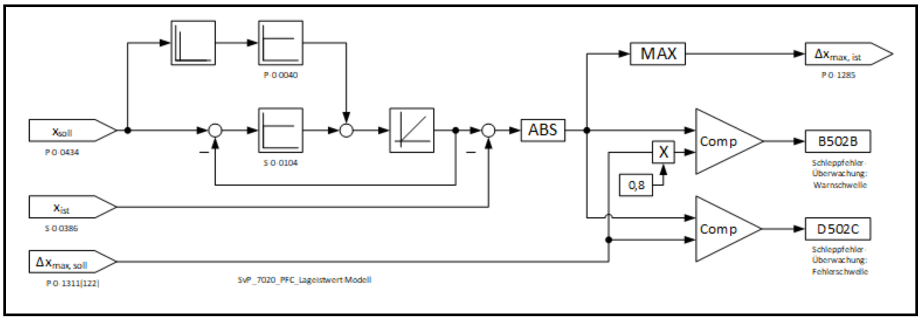


Fig. 6-40: Actual position value model with monitor

Position lag error monitoring

In the position lag error monitoring mode ("P-0-1372, Configuration, axis controllers/functions" bits 27/26 = 10), the error "F2017, D502C: position lag exceeds alarm level" is generated, when "S-0-0189, Following distance" exceeds a velocity-related threshold value. This function monitors the absolute value of the lag error with dynamic thresholds depending on the command velocity in the form of a line through origin with a minimum section in standstill. The slope of the straight line is given by the reference velocity (P-0-1311[116]) and the maximum lag error at this velocity (P-0-1311[118]). The minimum section is given by the maximum lag error at standstill (P-0-1311[119]). Standstill is detected if the command velocity is smaller than the standstill window (S-0-0124). For each dynamic alarm threshold value for the lag error there is a warning threshold value that is preset in percentage-based form using the warning threshold (P-0-1311[120]). In addition, a debounce time (P-0-1311[121]) can be set to suppress peaks.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1311[116], Lag error monitoring: Reference velocity
- P-0-1311[118], Lag error monitoring: Max. lag error at reference velocity
- P-0-1311[119], Lag error monitoring: Max. lag error in standstill
- P-0-1311[120], Lag error monitoring: Warning threshold
- P-0-1311[121], Lag error monitoring: Debounce time
- P-0-1311[122], Lag error model monitoring window
- P-0-1372, Configuration, axis controllers/functions
- S-0-0124, Standstill window
- S-0-0189, Following distance

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5026: Config data exceeds valid range P-0-1311[116]
- E2015, B5027: Config data exceeds valid range P-0-1311[116]
- E2015, B5028: Config data exceeds valid range P-0-1311[118]
- E2015, B5029: Config data exceeds valid range P-0-1311[119]
- E2015, B502A: Config data exceeds valid range P-0-1311[120]
- E2015, B502B: Position lag exceeds warning level
- E2015, B507B: Config data exceeds valid range P-0-1311[122]
- F2017, D502C: Position lag exceeds alarm level

6.21 Patch function for internal variables of PFC

The patch function serves to display the content of internal PFC variables in parameters. These parameters may then, amongst others, be recorded via the oscilloscope in IndraWorks Ds. The internal variables can be selected via parameters P-0-1311[380] – P-0-1311[383]. The instance path of the individual variables is entered in the associated data source parameters and then the value of the variable is shown in the display parameter.

☞ If a PLC variable is to be recorded via the patch function using the oscilloscope, the function has to be configured before the oscilloscope is started in order that the display parameter is shown in the correct format.

Number of symbol-based patch function	Selection of internal variable	Symbol-based patch function, data source	Symbol-based patch function, display
1	P-0-1311[380]	P-0-0492	P-0-0493
2	P-0-1311[381]	P-0-0494	P-0-0495
3	P-0-1311[382]	P-0-0496	P-0-0497
4	P-0-1311[383]	P-0-0498	P-0-0499

Tab. 6-15: Assignment of the selection of symbol variables, the data source and the display parameter of the symbol-based patch function

The following internal variables from the global variable list "Application.Position_Force_Control.Symbol_Variables" can be recorded:

Number of internal variable	Name of symbol variable	Description
1	stPositionController_gb.rVelFeedForward	Controller output from velocity feedforward [mm/s]
2	stPositionController_gb.rAccFeedForward	Controller output from acceleration feedforward [mm/s]
3	stPositionController_gb.rVelControl	Controller output from velocity feedback [mm/s]
4	stPositionController_gb.rAccControl	Controller output from acceleration feedback [mm/s]
5	stPressureForceController_gb.rFeedFactor_PnF	Stiffness [mm/N]
6	stSystemStatus_gb.rActiveAreaA	Active area on A-side of the pump [cm²]
7	stSystemStatus_gb.rActiveAreaB	Active area on B-side of the pump [cm²]
8	stSwivelAngleController_gb.rSwivelAngle_SetValue	Swivel angle command value [%] for controller
9	stSwivelAngleController_gb.rSwivelAngle_SetValue_s_T0	Static swivel angle command value [%], T0 criterion
10	stSwivelAngleController_gb.rSwivelAngle_SetValue_d_T0	Dynamic swivel angle command value [%], T0 criterion
11	stSwivelAngleController_gb.rSwivelAngle_SetValue_adj_T0	Correction of swivel angle command value (T0 criterion) via I-controller [%]

Number of internal variable	Name of symbol variable	Description
12	stSwivelAngleController_gb.rSwivelAngle_SetValue_s_Tmax	Static swivel angle command value [%], Tmax criterion
13	stSwivelAngleController_gb.rSwivelAngle_SetValue_d_Tmax	Dynamic swivel angle command value [%], Tmax criterion
14	stPulsationCompensation_gb.rAdditionalSpeed	Actual value of additive speed for pulsation compensation [rpm]
15	stPulsationCompensation_gb.rActAnglePump	Angle of rotation of the pump in relation to the transition region from the B-side to the A-side [°]
16	stPulsationCompensation_gb.rActAnglePistonSegment	Rotary angle of the pump segment referred to the transition region from the B-side to the A-side [°]

Tab. 6-16: Internal variables of the PFC, which can be selected via the patch function

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-0492, PLC patch function 1, data source
- P-0-0493, PLC patch function 1, display
- P-0-0494, PLC patch function 2, data source
- P-0-0495, PLC patch function 2, display
- P-0-0496, PLC patch function 3, data source
- P-0-0497, PLC patch function 3, display
- P-0-0498, PLC patch function 4, data source
- P-0-0499, PLC patch function 4, display
- P-0-1311[380], Selection of variable for symbol-based patch function 1
- P-0-1311[381], Selection of variable for symbol-based patch function 2
- P-0-1311[382], Selection of variable for symbol-based patch function 3
- P-0-1311[383], Selection of variable for symbol-based patch function 4

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- E2015, B5107: Config data not feasible P-0-1311[380]
- E2015, B5108: Config data not feasible P-0-1311[381]
- E2015, B5109: Config data not feasible P-0-1311[382]
- E2015, B510A: Config data not feasible P-0-1311[383]

6.22 Diagnostics/error handling

6.22.1 Overview

Events like operating states, activities and reactions of the technology function are recorded by the integrated generation of diagnostic messages and displayed via various output channels. We distinguish the following categories of events:

- **Stop_0** (event of highest severity), diagnostic code: D5xxx, diagnostic message number: F2017
- **Stop_1**, diagnostic code: D4xxx, diagnostic message number: F2016

- **Warning**, diagnostic code: B5xxx, diagnostic message number: E2015
- **Message** (event of lowest severity), diagnostic code: B4xxx, no diagnostic message number

The event of the highest severity is displayed both in the diagnostic code and diagnostic text of the technology function, and in the diagnostic message of the IndraDrive firmware (S-0-0095). Thus, it is shown on the display of the device. To this end, Stop_0, Stop_1 and warning events in IndraDrive output corresponding error and warning messages. In addition, a diagnostic logbook is available. It records the last 50 events including time stamps in chronological order. Furthermore, what is appended to the diagnostic text is the corresponding parameter or list element, the entered value of which is the cause of the event, if it can be definitely determined.

Some important diagnostics (e.g., pressure monitoring) is additionally recorded bit by bit in system status word 2.

See also description of diagnostic messages chapter 8.3 "Error and warning messages for position/force control x/F control (PFC) " on page 483.

Features

- Four categories of events according to their severities
- Unequivocal diagnostic message number with diagnostic text
- PLC errors/warning messages generated at IndraDrive for the events: Stop_0, Stop_1 and warning
- Errors and warning messages that are present are displayed in system status word 1
- Last 50 events recorded with time stamps in diagnostic logbook
- States of the most important diagnostics displayed in system status word 2

Visualization of diagnostics

To visualize the operating state of the axis, a signal lamp can be activated. An RGB LED (red, green, blue) is activated via P-0-1412 Bit 0..2.

Operating state	Color	P-0-1412 bit 2..0
No error or warning	Cyan	110
Warning present	Yellow	011
Error present	Red	001

Tab. 6-17: Color scheme of operating state

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1280, System status word 1
- P-0-1281, System status word 2
- P-0-1300, TF diagnostic code
- P-0-1312, TF diagnostic logbook
- P-0-1387, TF diagnostic text
- S-0-0095, Diagnostic message
- S-0-0390, Diagnostic message number
- P-0-1412, Activation of special functions

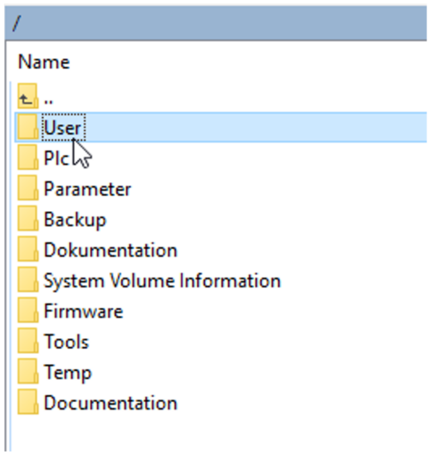
6.23 Field data acquisition

6.23.1 Overview

The program package FDA (Field Data Acquisition) allows process data of an electrohydraulic linear drive (SHA) in the field to be recorded. The acquired data describe the load of the axis components in the field and simplify diagnostics and fault detection if servicing or repairs have to be carried out. The data are stored on the local storage medium of the control system.

☞ The FDA program package FDA requires a free space of 310 Mbytes on the microSD card. It has to be ensured that the required memory is available on the microSD card. If the microSD card is full or if there is no sufficient free space, an F9005 may be generated on the control section.

For evaluating the data the generated files have to be copied from the storage medium of the control system and made available to Bosch Rexroth Service for evaluation. In the case of an IndraDrive the data are stored in the "User" folder (see figure below) on the microSD card that is inserted in the slot of the control panel.



Ordnerstruktur_Speichermedium_IndraDrive

Fig. 6-41: Fig.: Folder structure on the storage medium of IndraDrive

6.23.2 Activating/deactivating the FDA package

Activating calculation of data for PFC

P-0-1312[702] bit 0

→ 0 = calculation of field data for PFC not enabled

→ 1 = calculation of field data for PFC enabled

Activating the FDA functionality

P-0-1372; bit 30

→ 0 = function active

→ 1 = function not active

☞ Field data acquisition can only be activated with a cycle time (and consequently P-0-1311[177], PFC cycle time) greater than or equal to 2 ms. With a cycle time of 1 ms this would be impossible due to the required performance.

Pertinent parameters

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- P-0-1311[177], Fast task, cycle time
- P-0-1312[702], Activation of field data acquisition
- P-0-1372, Configuration, axis controllers/functions

Pertinent diagnostic messages

See also: chapter 8 "Parameters and diagnostic messages of Position Force Control (PFC)" on page 261

- F2017, B5073: FDA with cycle time of 1 ms not possible P-0-1372.30

7 Commissioning

7.1 Establishing the connection to the drive controller

7.1.1 General information

Use the IndraWorks software to commission and diagnose IndraDrive devices. It is possible to use IndraWorks Ds and IndraWorks D/MLD.

☞ The following paragraphs show the drive commissioning steps, exemplified by IndraWorks Ds. The dialogs can look different if IndraWorks D/MLD is used.

7.1.2 Requirements

The following components and requirements are needed for Ethernet communication with the drive controller:

- IndraDrive device
- Suitable firmware
- Standard Ethernet cable
- Unassigned Ethernet interface at PC or notebook
- IndraWorks Ds or IndraWorks D/MLD

7.1.3 Establishing the connection

To configure the drive in IndraWorks, establish a connection. It can be established via an Ethernet connection using an unassigned Ethernet interface at the drive. The connection can be directly selected when starting IndraWorks Ds or using the **Tools ▸ Connection selection ▸ Connection selection...** menu.

The IP address can be changed using the control panel of the drive controller, or via IndraWorks.

☞ If the control is connected to the company network, observe your network administrator's instructions.

Ethernet connection

After IndraWorks was started, the connection selection dialog opens. Using the **Network search** tab, all devices that are in the same network will be found, independent of their IP and computer configuration. Devices with an IP configuration outside of the subnet used will also be found.

☞ It is not possible to search across network boundaries (router).

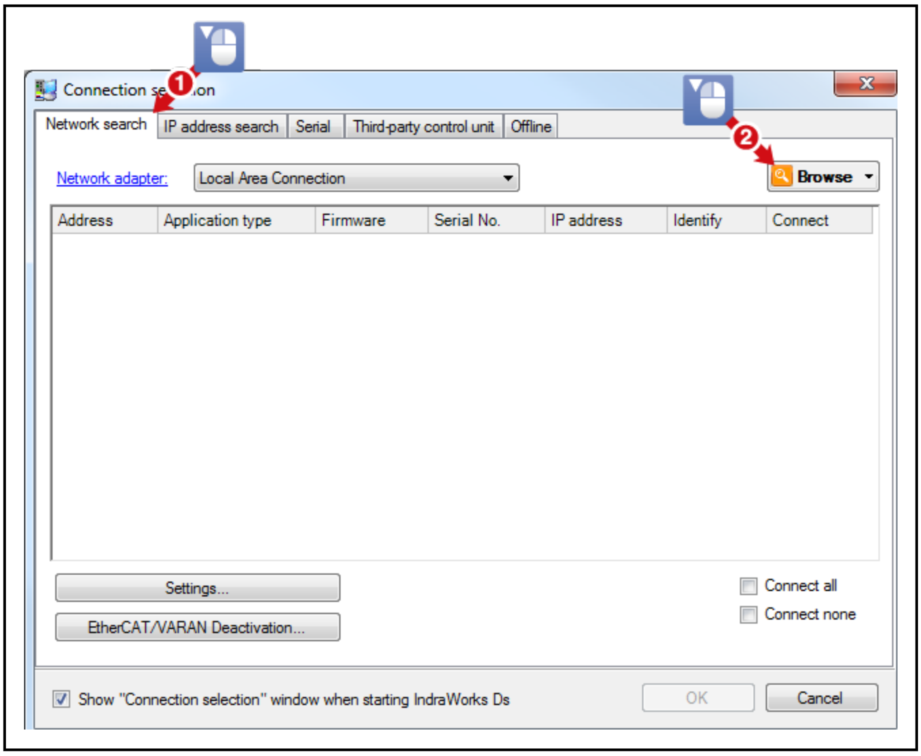


Fig. 7-1: Network search

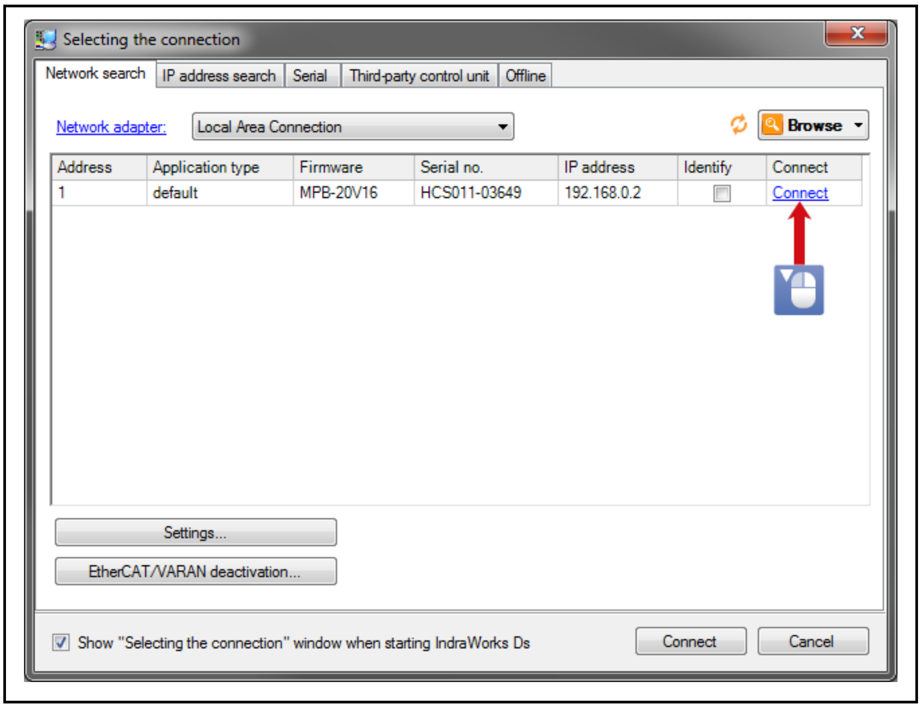


Fig. 7-2: Establishing the connection in the network search

☞ If the "Identify" column is ticked, the display of the selected drive flashes.

If the network search was successful, but the IP address does not match, it is impossible to establish communication. IndraWorks then displays the device in red.

In this case, there are two options after having clicked on "Connect"

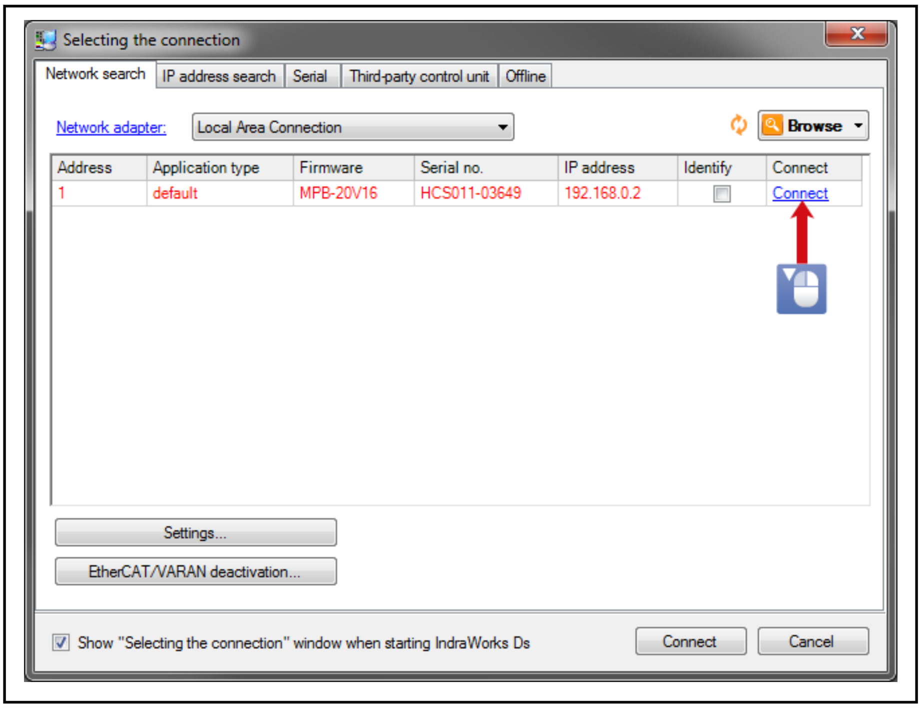


Fig. 7-3: IP address does not match

1. **Extending the computer IP address** (e.g., in case servicing is required). IndraWorks automatically adds a matching IP address in the computer to facilitate communication with the devices. The address will be automatically deleted, if the check box for "Restore old settings" has been activated and IndraWorks is closed, or after a system restart

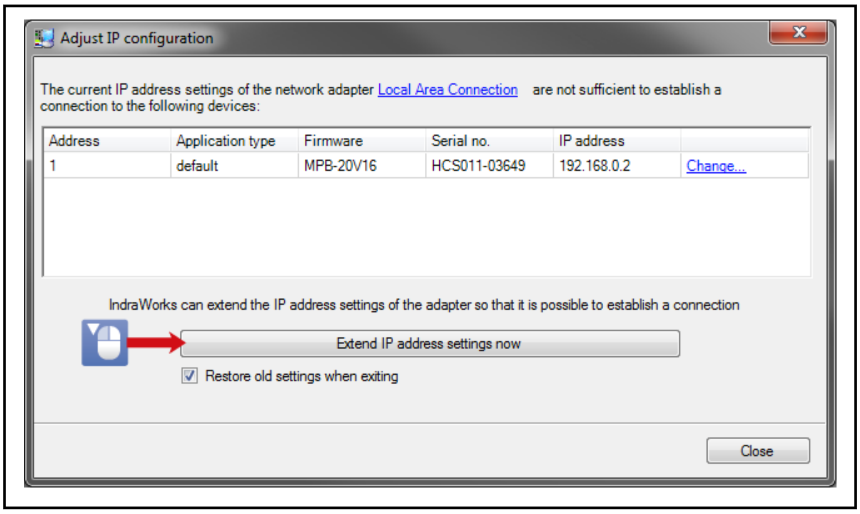


Fig. 7-4: Extend IP address settings

2. **Changing the drive address** (e.g., initial commissioning). Using the "SetIP" SIP service, the IP address can be changed in the drive remotely. IndraWorks suggests an IP address suitable for communication with the computer. Alternatively, a specific IP address can be assigned.

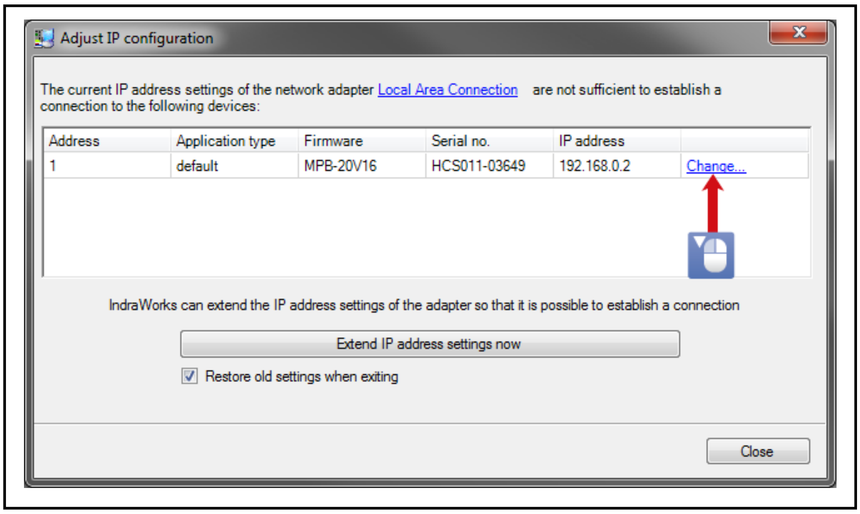


Fig. 7-5: Changing the IP configuration

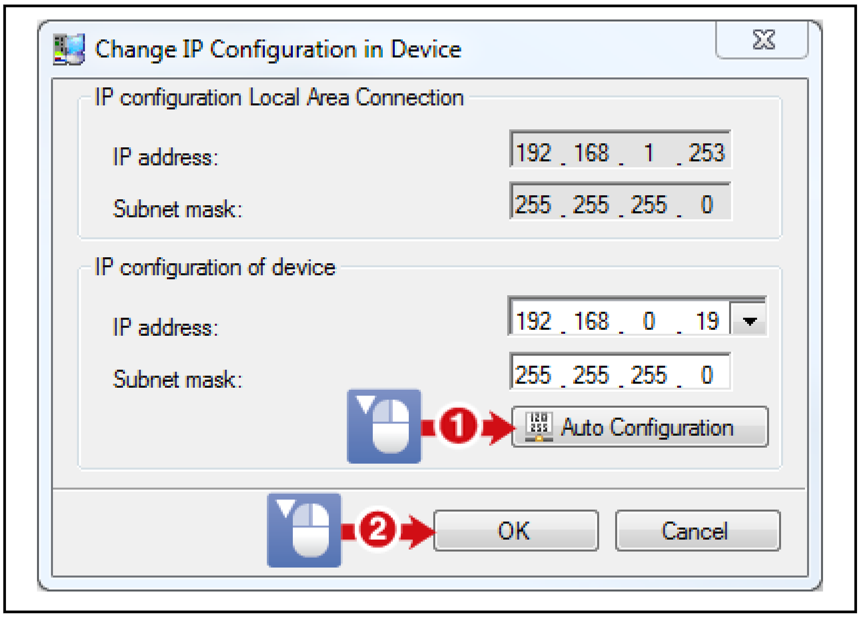
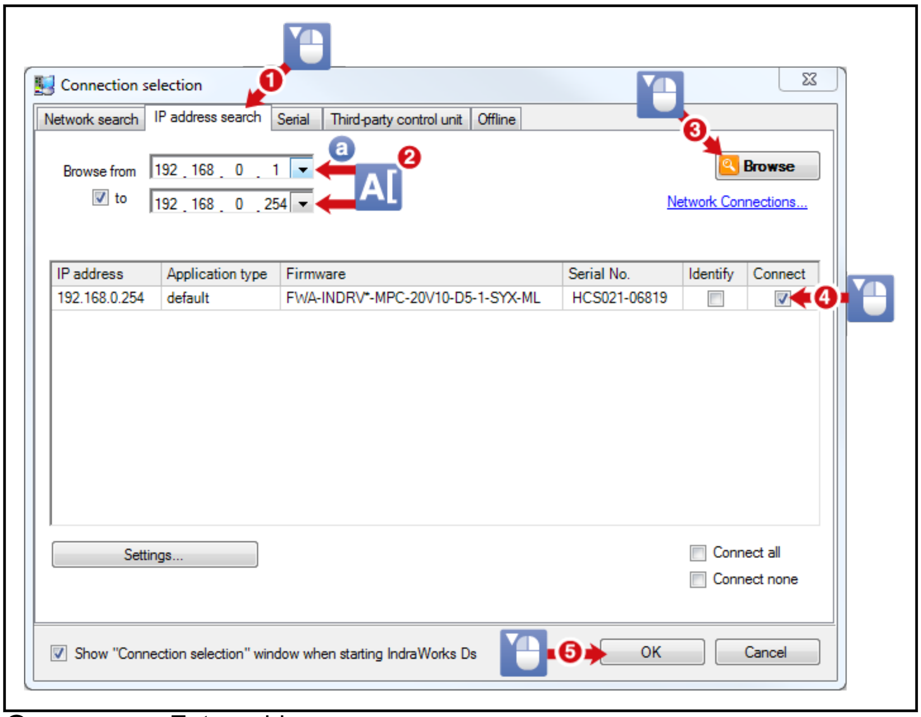


Fig. 7-6: Changing the IP configuration in the device

Another option for establishing a TCP/IP connection is to set the address range to be browsed in the connection selection dialog on the **IP address search** tab.



ⓐ Enter address or range

Fig. 7-7: IndraWorks Ds - establishing connection to drive (TCP/IP connection using an Ethernet interface)

The current IP settings of the drive can be read using the control panel.

IP address range

For local networks, IP addresses can be assigned in the following address ranges:

- 10.0.0.0 to 10.255.255.255,
- 172.16.0.0 to 172.31.255.255 and
- 192.168.0.0 to 192.168.255.255

Example:

IP address: 192.168.0.19

Network mask: 255.255.255.0

Default gateway: 0.0.0.0

☞ The desired IP address, network mask and default gateway can only be parameterized in the parameter mode. See below for the description of how to switch to the parameter mode using the control panel.

Setting the IP address using the control panel

To set the IP address using the control panel, proceed as follows:

1. Switch on the control voltage of the drive controller.
2. Press the Enter key on the control panel.
3. Select "Ethernet" with the ▽/△ keys and confirm your selection with the Enter key.
4. With the ▽/△ keys, select the connected interface you would like to configure (e.g., X22)
5. Select the address you would like to configure or verify
    - IP address

- MAC address
- Gateway address
- Network mask (subnet mask)

The individual octets are applied by pressing the Enter key. You can always get back using the Esc key.

6. Switch the control voltage of the drive controller off and back on so that the parameterization of the desired IP address, network mask and default gateway takes effect. From firmware MPx18 and above, the parameterization is directly applied without restart.

7.2 Configuring IndraDrive

7.2.1 Master communication

All field buses available for IndraDrive are supported - with the known dependencies of the operation modes:

Master communication\OM	Cyclic position control	Drive-internal interpolation	Drive-controlled positioning	Positioning block mode	Velocity control[1)]
Sercos®	✓	✓	✓	✓	✓
EtherNet/IP™	–	✓	✓	✓	✓**
EtherCAT®	✓	✓	✓	✓	✓
PROFINET®	–	✓	✓	✓	✓**
PROFIBUS®	–	✓	✓	✓	✓**
CANopen®	✓*	✓	✓	✓	✓

1) This is an open-loop velocity control, not a closed-loop control, see chapter chapter 6.8 "Open-loop velocity control" on page 51
* Possible, but not recommended
** No synchronous command value acceptance

Tab. 7-1: Supported operation modes per master communication

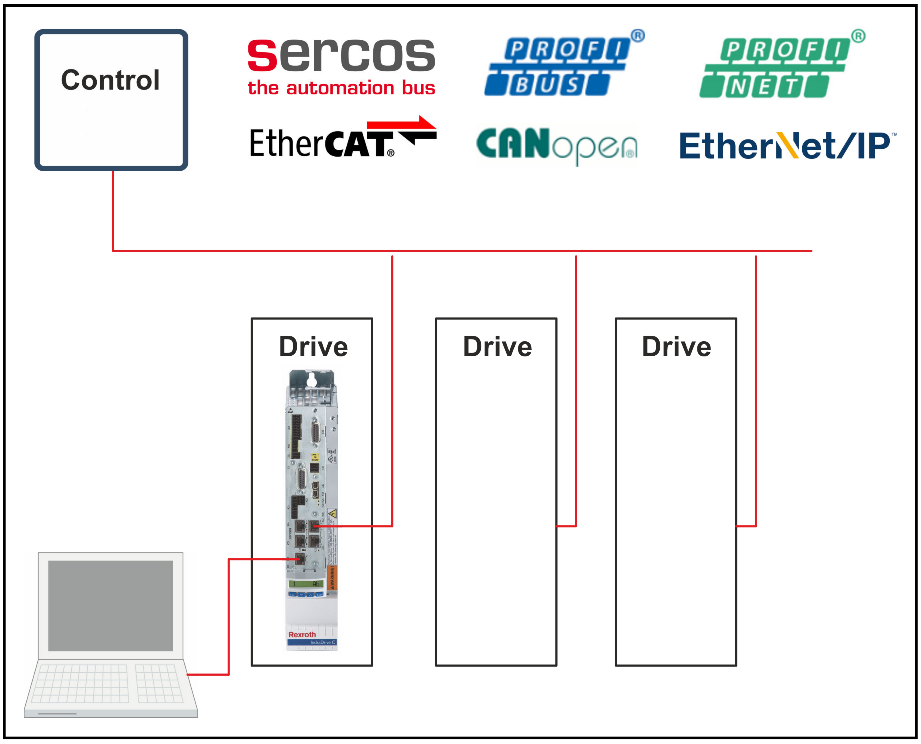


Fig. 7-8: Connection to the control

It is recommended that the master communication be activated only after the IndraDrive and the technology function was configured. Repeatedly switching the phases of the drive state machine, which is required for commissioning, causes the machine commissioning under an active field bus to be delayed.

The master communication settings differ depending on the selected field bus. For field buses with the greatest relevance for the technology function, parameterization examples are given in the following for a standard positioning and press application with the operation mode "Drive-internal interpolation".

Cyclically transmitted feedback values can be very noisy, like the velocity feedback value (S-0-0040) due to the encoder signal. To provide a usable signal to the higher-level control, the display of two selectable feedback values (velocities, accelerations, torques...) can be smoothed in IndraDrive using the average value filter for display. Internally, IndraDrive continues computing with the non-filtered values.

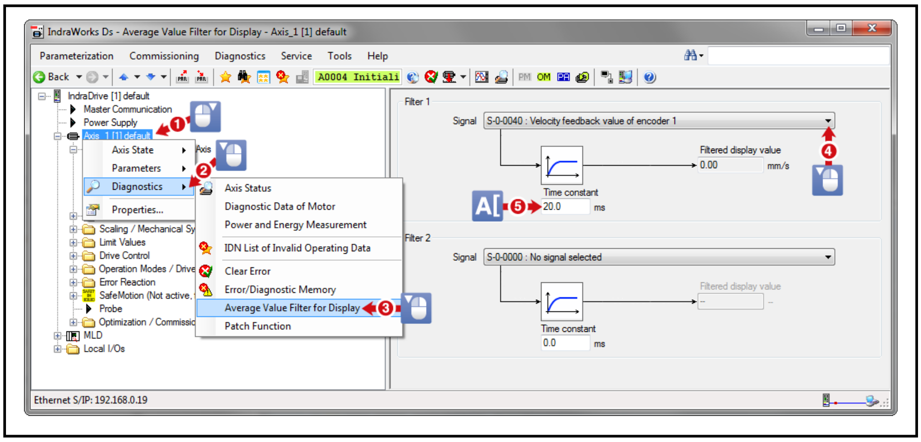


Fig. 7-9: Average value filter display

PROFIBUS® The paragraphs below describe the most important steps on the IndraDrive side for proper operation of the PFC software.

1. Activate field bus, if necessary (P-0-4089.0.1 = 16)

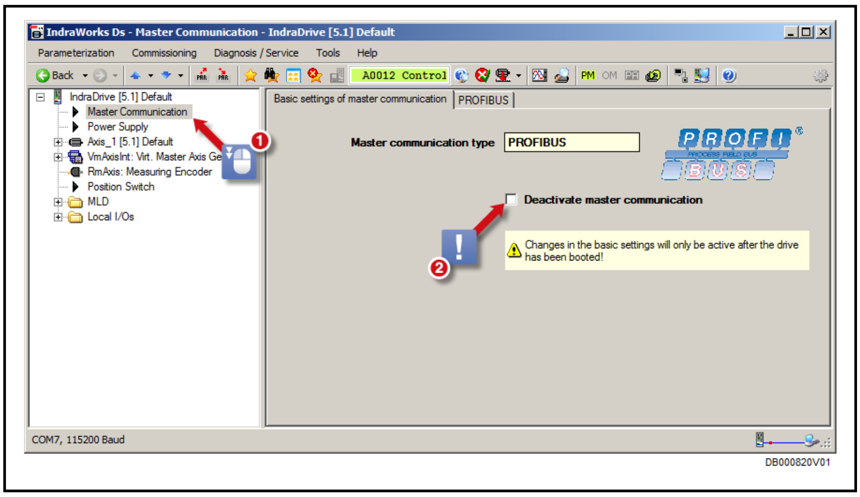


Fig. 7-10: Activating the field bus

Restart (C6400) required!

2. Set drive address (P-0-4025)

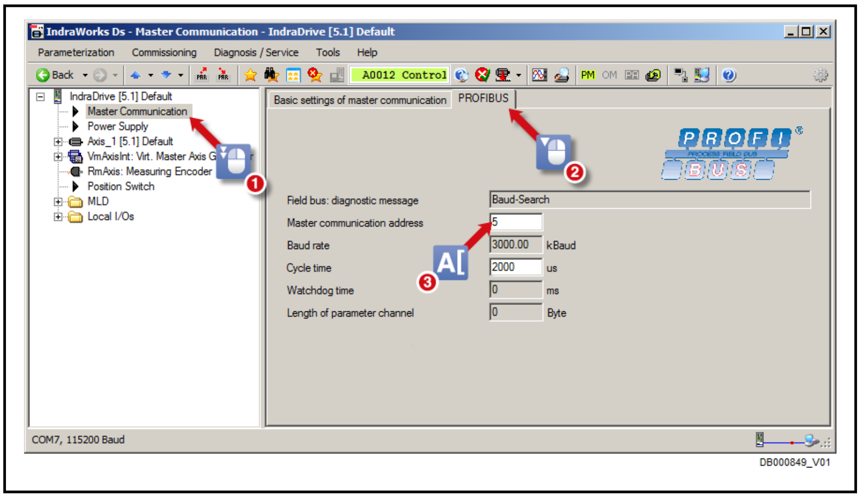


Fig. 7-11: Setting the drive address

3. Activate profile type "freely configurable mode" (P-0-4084 = 0xFFFE)

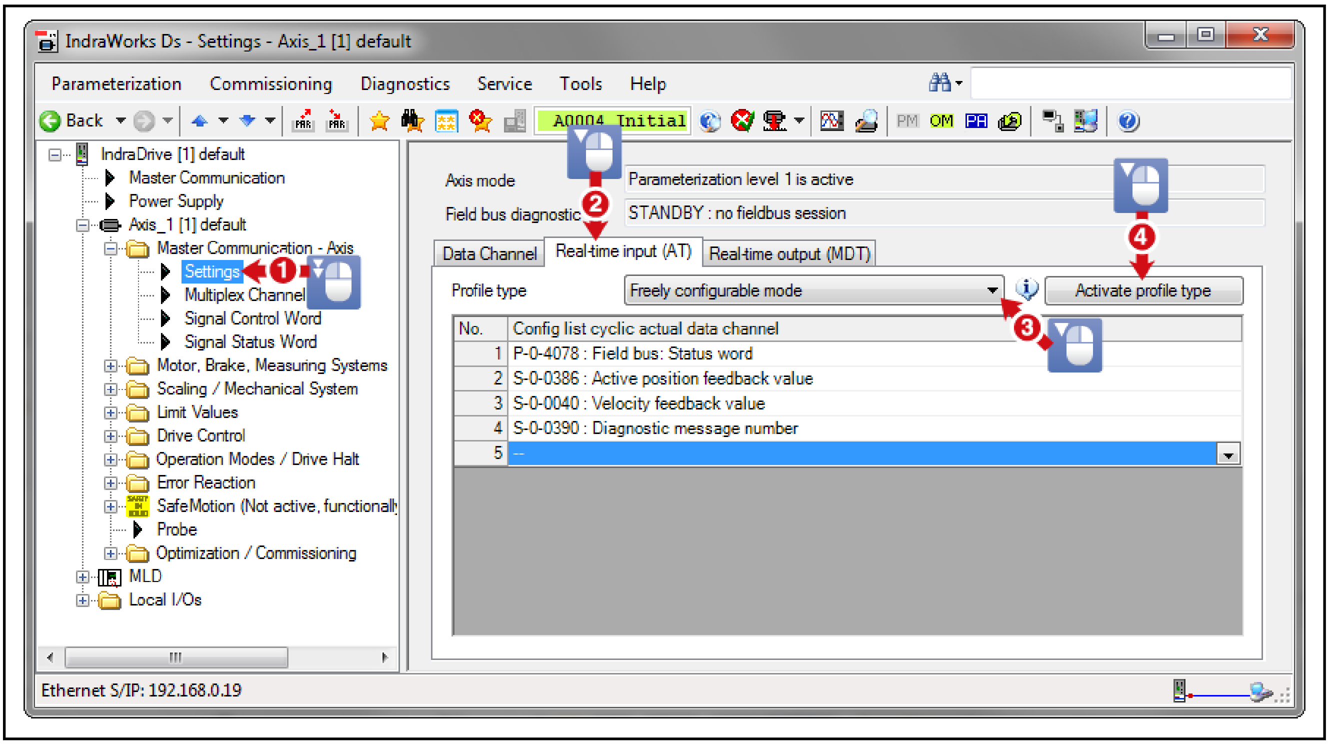


Fig. 7-12: Activating the freely configurable mode

Operation modes and cyclic data are preconfigured by activating the profile type. Afterwards they need to be adjusted.

4. Configure cyclic feedback values (AT)

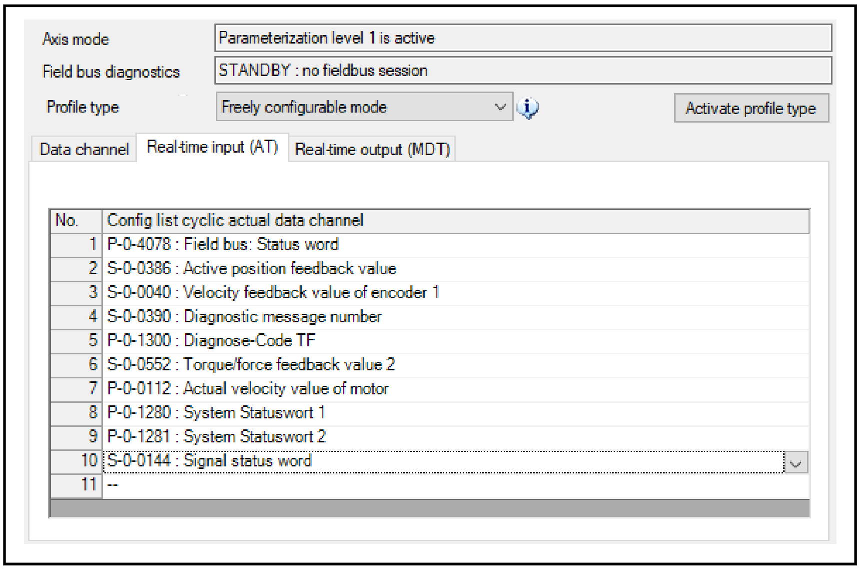


Fig. 7-13: Real-time input (AT)

- P-0-4078 (Field bus: Status word); length: 2 bytes; decimal places: 0; unit: -
- S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
- Velocity feedback value (S-0-0040); length: 4 bytes; decimal places: typically 3; unit: typically mm/s

- S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
- Add P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
- Add S-0-0552 (torque/force feedback value 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0809 (pressure feedback value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- If necessary, add P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
- If necessary, add P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -

The sum of actual value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic actual value data channel" (P-0-4082). For an operable bus communication, the same length has to be set on the control side.

5. Configuring cyclic command values (MDT)

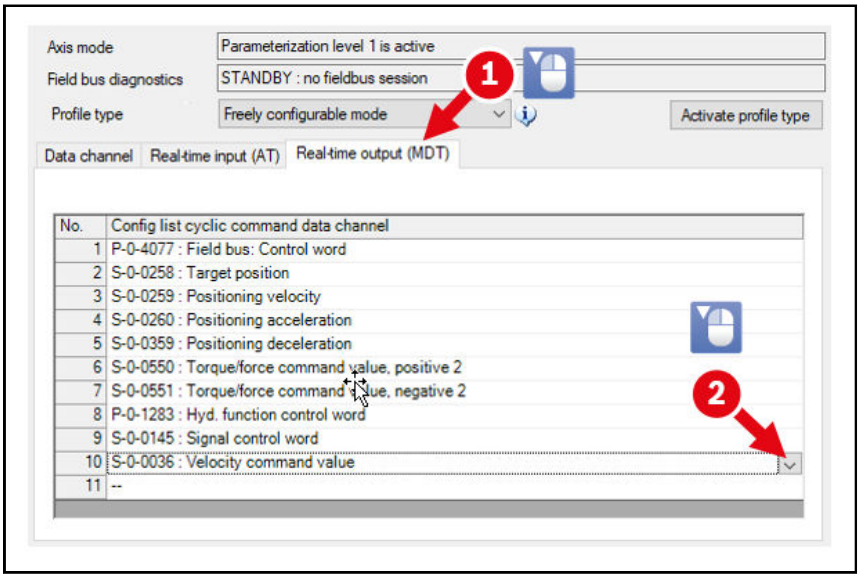


Fig. 7-14: Real-time output (MDT)

- P-0-4077 (field bus: control word); length: 2 bytes; decimal places: 0; unit: -
- S-0-0258 (target position); length: 4 bytes; decimal places: typically 4; unit: typically mm
- S-0-0259 (positioning velocity); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
- Add S-0-0260 (positioning acceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
- Add S-0-0359 (positioning deceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²

- Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s

The sum of command value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic command value data channel" (P-0-4071). For an operable bus communication, the same length has to be set on the control side.

6. Configuring operation modes
   - Primary operation mode: Drive-internal interpolation (via axis controller control word S-0-0520); S-0-0032 = 0x0315
   - Secondary operation mode 1 if necessary: Velocity control; S-0-0033 = 0x0002

PROFINET®

The paragraphs below describe the most important steps on the IndraDrive side for proper operation of the PFC software.

1. Activate field bus (P-0-4089.0.1 = 4)

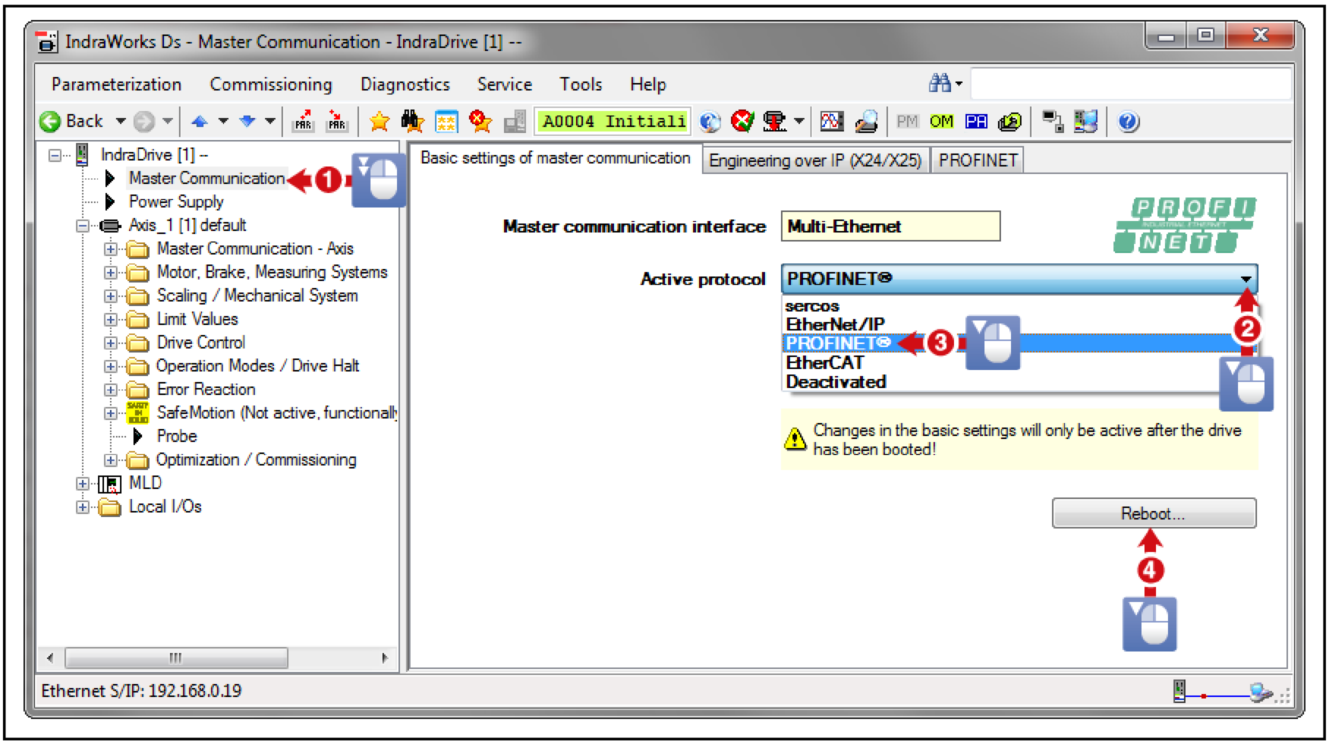


Fig. 7-15: Field bus start dialog

Restart (C6400) required!

2. The slave address (P-0-4025) can be set optionally. The communication is IP-based and configured with the "device naming" on the higher-level control
3. Activate profile type "freely configurable mode" (P-0-4084 = 0xFFFE)

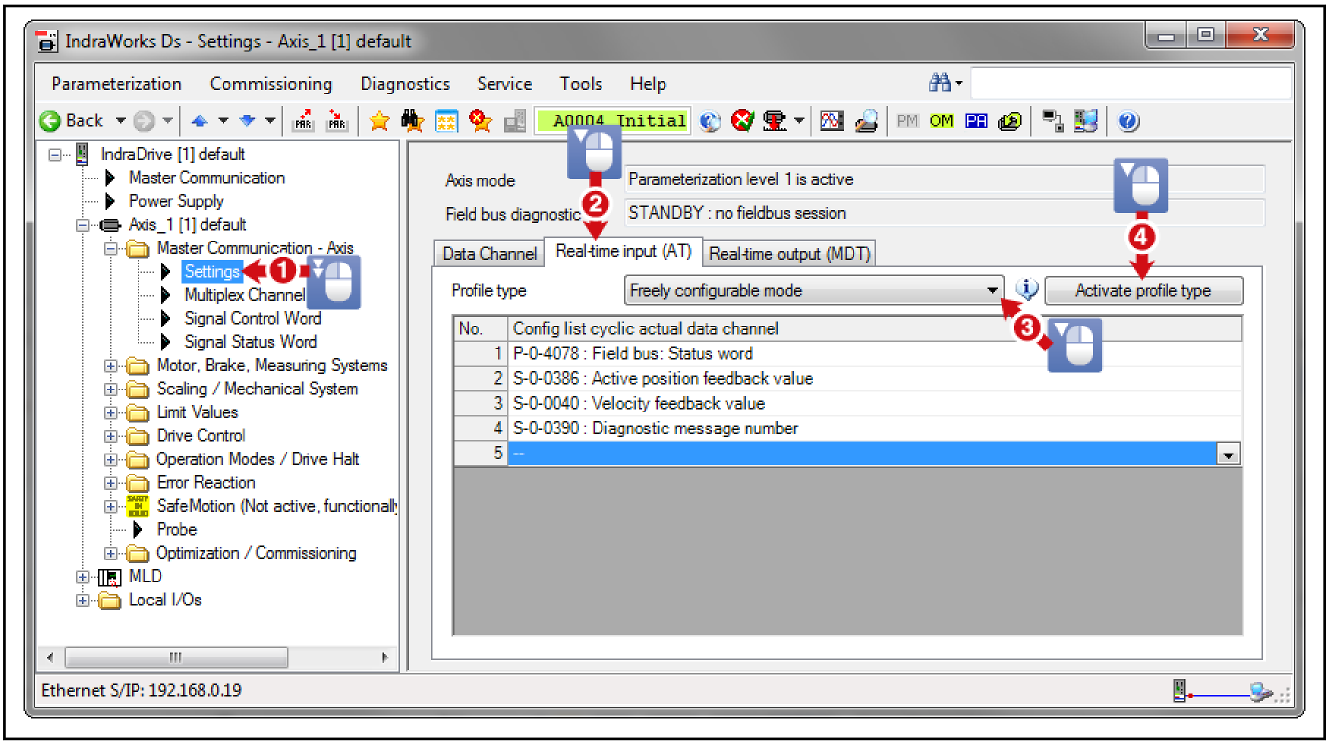


Fig. 7-16: Activating the freely configurable mode

Operation modes and cyclic data are preconfigured by activating the profile type. Afterwards they need to be adjusted.

4. Configure cyclic feedback values (AT)

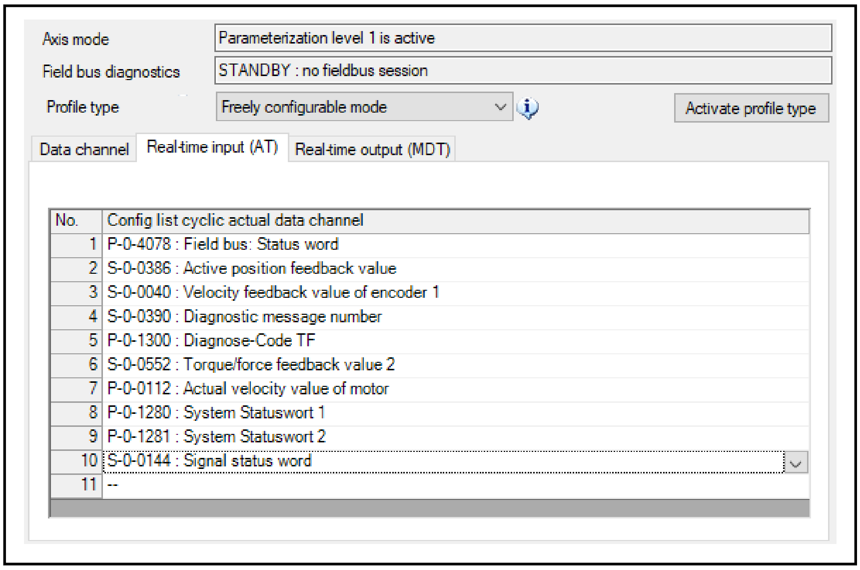


Fig. 7-17: Configure cyclic feedback values (AT)

- P-0-4078, (Field bus: Status word); length: 2 bytes; decimal places: 0; unit: -

- S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
- Velocity feedback value (S-0-0040); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
- S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
- Add P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
- Add S-0-0552 (torque/force feedback value 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0809 (pressure feedback value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- If necessary, add P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
- If necessary, add P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -

The sum of actual value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic actual value data channel" (P-0-4082). For an operable bus communication, the same length has to be set on the control side.

5. Configuring cyclic command values (MDT)

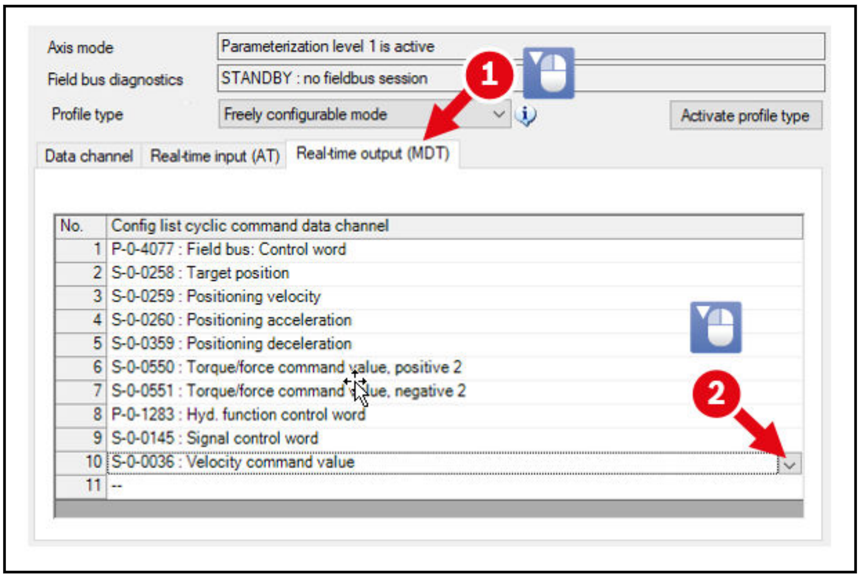


Fig. 7-18: Configuring cyclic command values (MDT)

- P-0-4077 (field bus: control word); length: 2 bytes; decimal places: 0; unit: -
- S-0-0258 (target position); length: 4 bytes; decimal places: typically 4; unit: typically mm
- S-0-0259 (positioning velocity); length: 4 bytes; decimal places: typically 3; unit: typically mm/s

- Add S-0-0260 (positioning acceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
- Add S-0-0359 (positioning deceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
- Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s

The sum of command value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic command value data channel" (P-0-4071). For an operable bus communication, the same length has to be set on the control side.

6. Configuring operation modes
   - Primary operation mode: Drive-internal interpolation (via axis controller control word S-0-0520); S-0-0032 = 0x0315
   - Secondary operation mode 1 possibly velocity control; S-0-0033 = 0x0002

Activate Ethernet/IP

The paragraphs below describe the most important steps on the IndraDrive side for proper operation of the PFC software.

1. Activate field bus (P-0-4089.0.1 = 3)

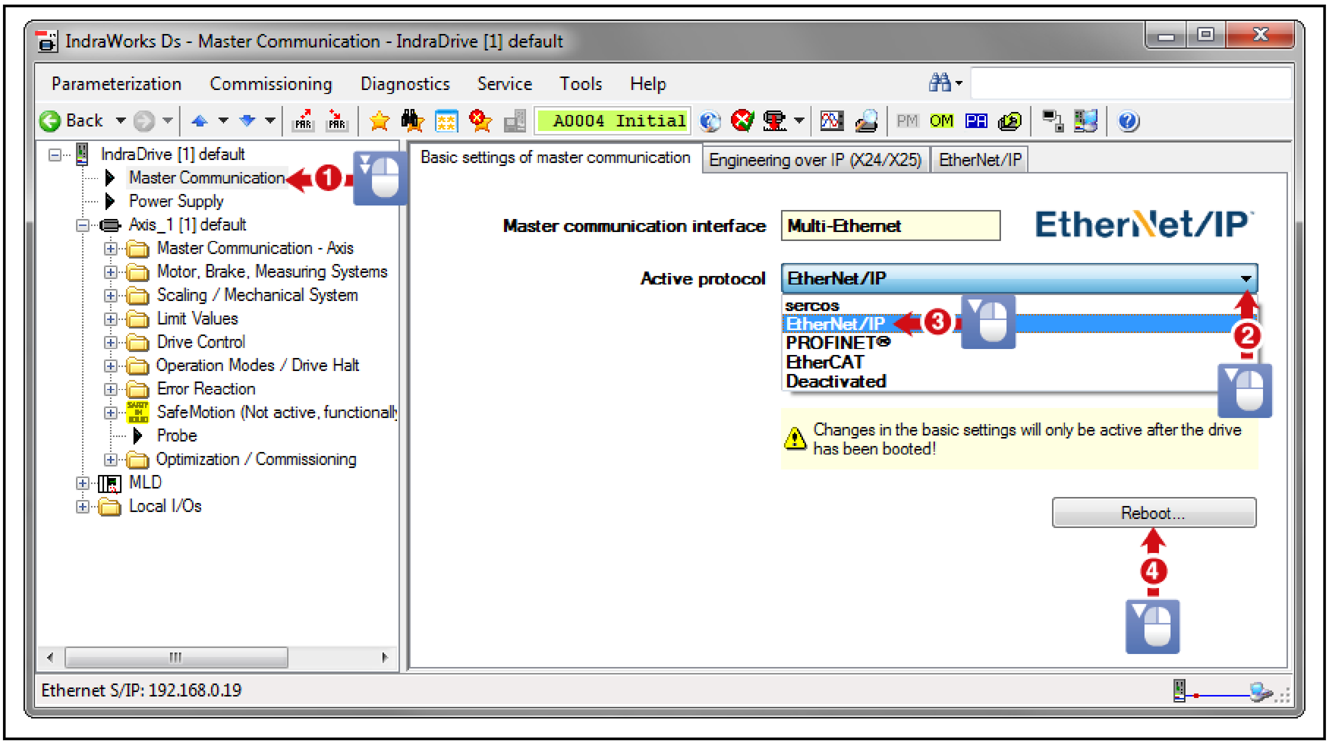


Fig. 7-19: Activating EtherNet/IP

Restart (C6400) required!

2. The slave address (P-0-4025) can be set optionally. The communication is IP-based and configured on the higher-level control

3. Activate profile type "freely configurable mode" (P-0-4084 = 0xFFFE)

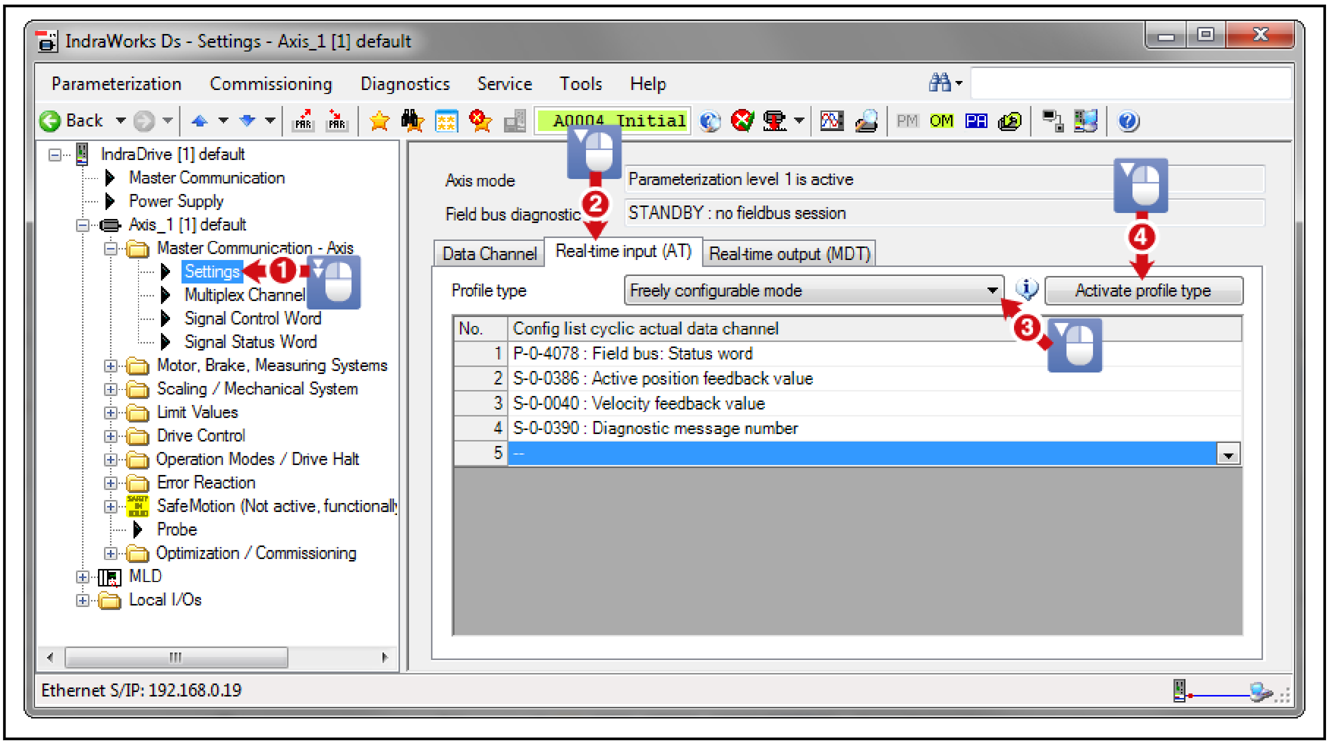


Fig. 7-20: Freely configurable mode

Operation modes and cyclic data are preconfigured by activating the profile type. Afterwards they need to be adjusted.

4. Configure cyclic feedback values (AT)

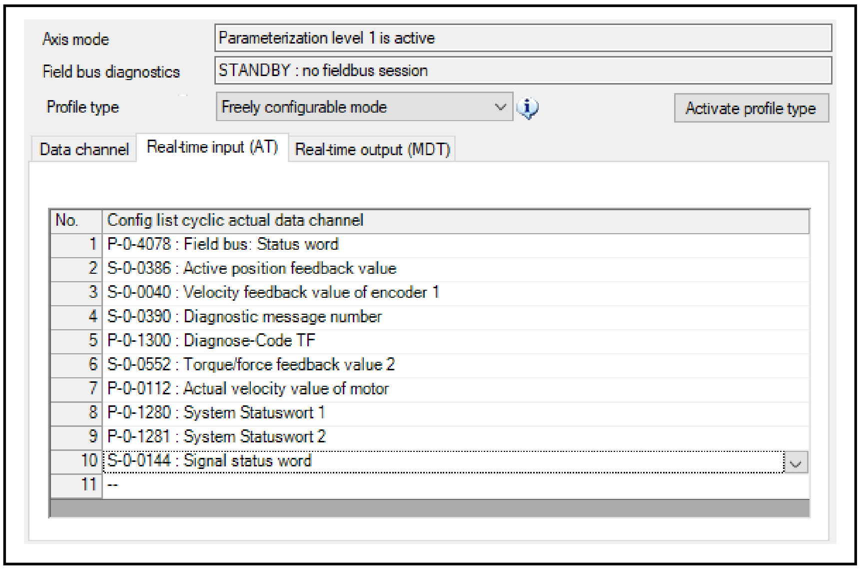


Fig. 7-21: Real-time input (AT)

- P-0-4078 (Field bus: Status word); length: 2 bytes; decimal places: 0; unit: -
- S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
- Velocity feedback value (S-0-0040); length: 4 bytes; decimal pla-ces: typically 3; unit: typically mm/s

- S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
- Add P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
- Add S-0-0552 (torque/force feedback value 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0809 (pressure feedback value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- If necessary, add P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
- If necessary, add P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -

The sum of actual value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic actual value data channel" (P-0-4082). For an operable bus communication, the same length has to be set on the control side.

5. Configuring cyclic command values (MDT)

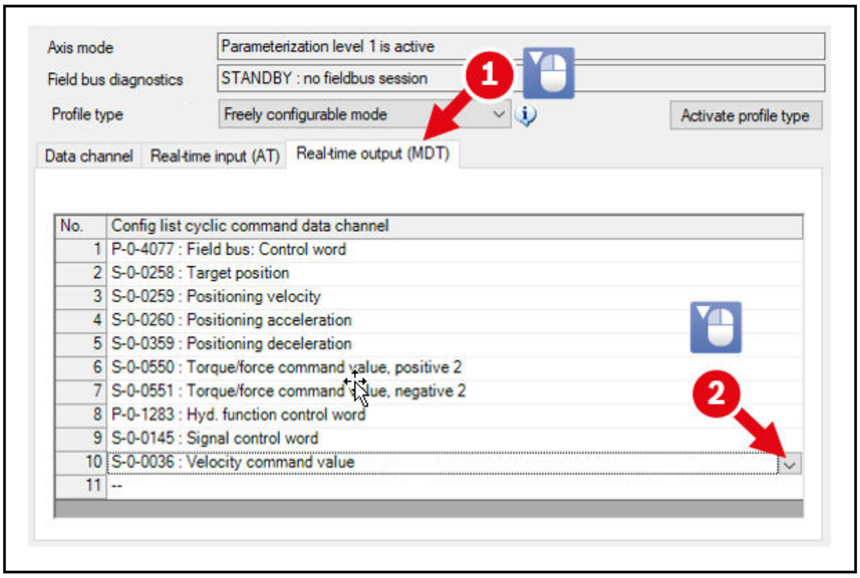


Fig. 7-22: Real-time output (MDT)

- P-0-4077 (field bus: control word); length: 2 bytes; decimal places: 0; unit: -
- S-0-0258 (target position); length: 4 bytes; decimal places: typically 4; unit: typically mm
- S-0-0259 (positioning velocity); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
- Add S-0-0260 (positioning acceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
- Add S-0-0359 (positioning deceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²

- Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -
- If necessary, add S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s

The sum of command value bytes to be cyclically transmitted is displayed in "Field bus: Length of cyclic command value data channel" (P-0-4071). For an operable bus communication, the same length has to be set on the control side.

6. Configure operation modes
   - Primary operation mode: Drive-internal interpolation (via axis controller control word S-0-0520); S-0-0032 = 0x0315
   - Secondary operation mode 1 if necessary: Velocity control; S-0-0033 = 0x0002

Activate EtherCAT® (SoE)

The Commissioning Manual "IndraDrive with EtherCAT® - Example with Beckhoff TwinCAT®" (R911341345) describes in detail how to configure the control and IndraDrive. Since the configuration is carried out almost exclusively on the control side, only master communication needs to be activated in IndraDrive.

1. Activate field bus (P-0-4089.0.1 = 5)

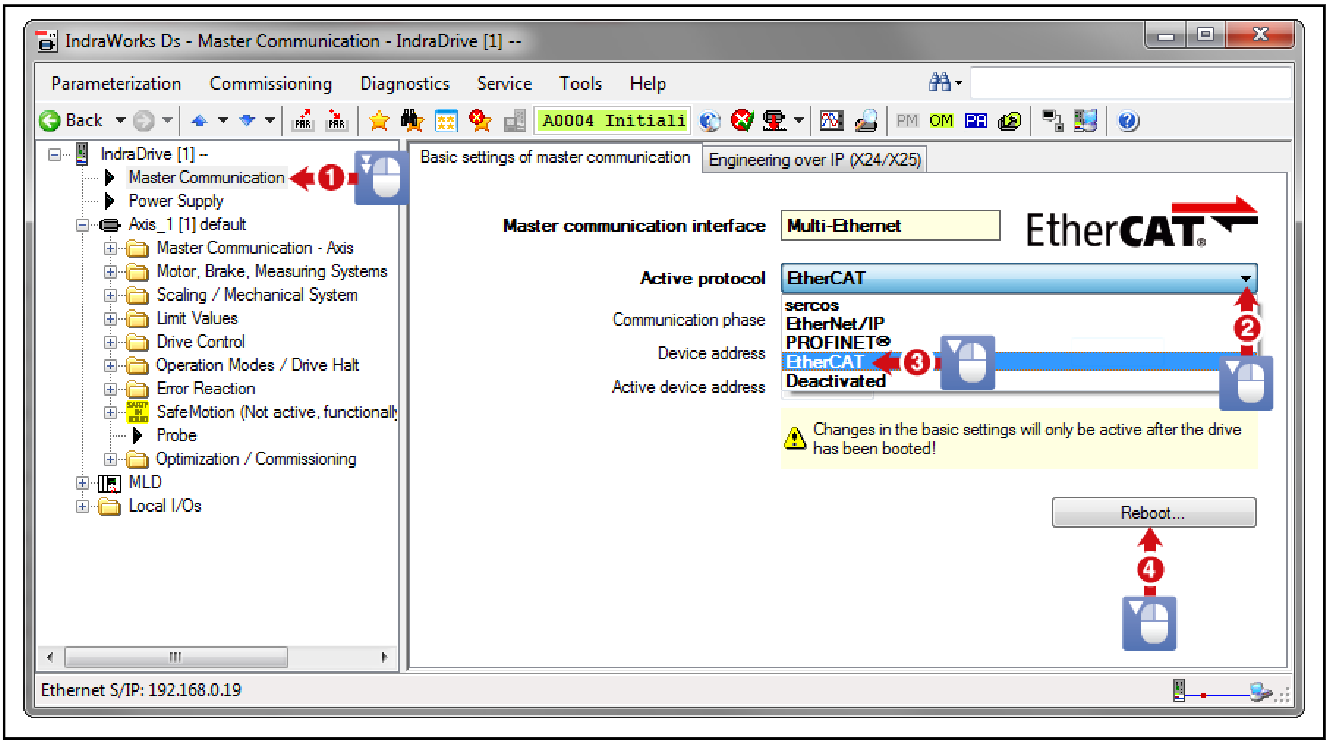


Fig. 7-23: Activating EtherCAT®

Restart (C6400) required!

2. Profile type "Servo drive profile" (P-0-4084 = 0x0002)
3. Configure cyclic feedback values (AT) (on control side)
   - S-0-0135 (drive status word); length: 2 bytes; decimal places: 0; unit: -
   - S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
   - S-0-0040 (velocity feedback value); length 4 bytes; decimal places: typically 3; unit: typically mm/s
   - S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
   - P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
   - Add S-0-0552 (torque/force feedback value 2); length: 4 bytes; decimal places: typically 1; unit: typically N
   - Alternatively, add S-0-0809 (pressure feedback value); length: 4 bytes; decimal places: typically 3; unit: typically bar
   - If necessary, P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
   - If necessary, P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -

4. Configure cyclic command values (MDT) (on control side)
   - S-0-0134 (master control word); length 2 bytes; decimal places: 0; unit: -
   - S-0-0258 (target position); length: 4 bytes; decimal places: typically 4; unit: typically mm
   - S-0-0259 (positioning velocity); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
   - S-0-0260 (positioning acceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
   - S-0-0359 (positioning deceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
   - Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
   - If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
   - Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
   - Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -
   - If necessary, S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
5. Configuring operation modes
   - Primary operation mode: Drive-internal interpolation (via axis controller control word S-0-0520); S-0-0032 = 0x0315
   - Secondary operation mode 1 if necessary: Velocity control; S-0-0033 = 0x0002

Activate Sercos® (CCD)

Since the configuration is carried out almost exclusively on the control side, only the master communication needs to be activated at the IndraDrive slave.

1. Activate field bus (P-0-4089.0.1 = 6)

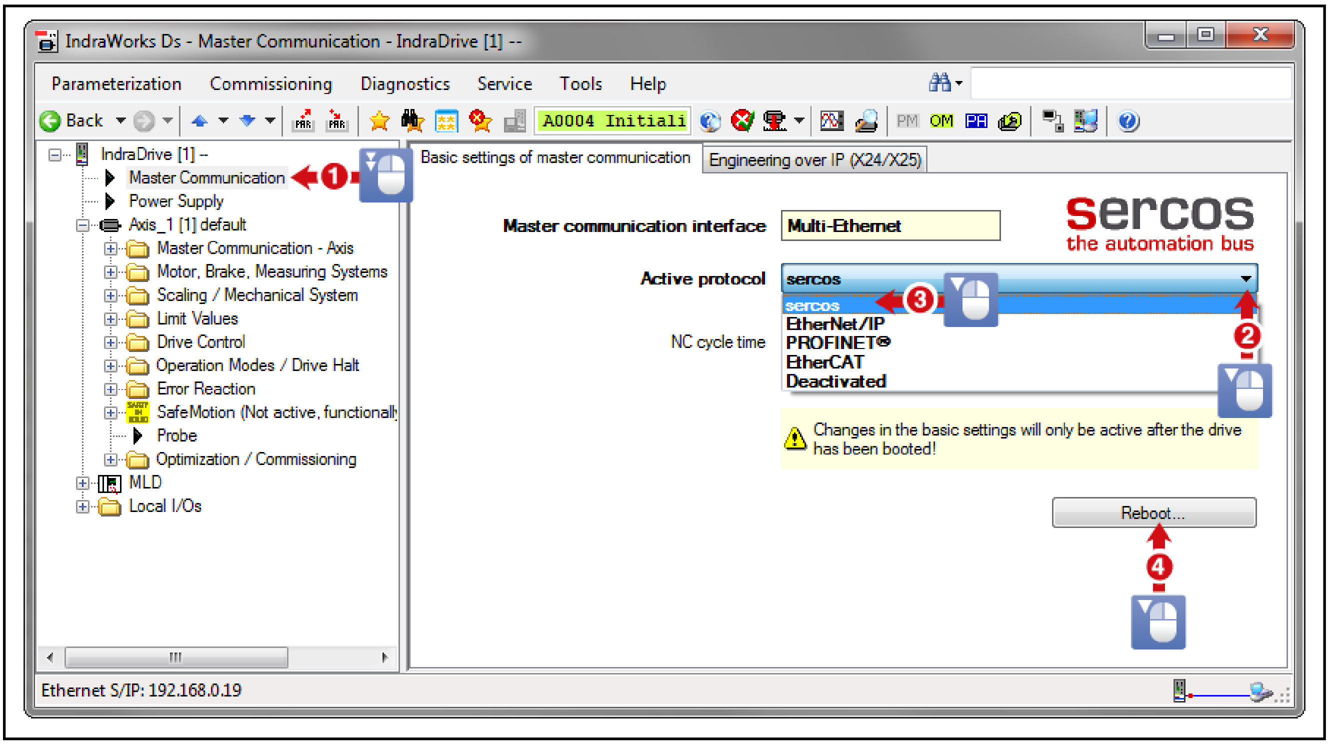


Fig. 7-24: Activating Sercos® (CCD)

Restart (C6400) required!

2. Profile type "FSP Drive (Sercos® profile)" (P-0-4084 = 0x0102)
3. Configure cyclic feedback values (AT) (on control side)
   - S-0-0135 (drive status word); length: 2 bytes; decimal places: 0; unit: -
   - S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
   - S-0-0040 (velocity feedback value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
   - S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
   - P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
   - Add S-0-0552 (torque/force feedback value 2); length: 4 bytes; decimal places: typically 1; unit: typically N
   - Alternatively, add S-0-0809 (pressure feedback value); length: 4 bytes; decimal places: typically 3; unit: typically bar
   - If necessary, P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
   - If necessary, P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -

4. Configure cyclic command values (MDT) (on control side)
    - S-0-0134 (master control word); length 2 bytes; decimal places: 0; unit: -
    - S-0-0258 (target position); length: 4 bytes; decimal places: typically 4; unit: typically mm
    - S-0-0259 (positioning velocity); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
    - S-0-0260 (positioning acceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
    - S-0-0359 (positioning deceleration); length: 4 bytes; decimal places: typically 3; unit: typically mm/s²
    - Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
    - If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
    - Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
    - Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
    - If necessary, S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -
    - If necessary, S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
5. Configuring operation modes
    - Primary operation mode: Drive-internal interpolation (via axis controller control word S-0-0520); S-0-0032 = 0x0315
    - Secondary operation mode 1 if necessary: Velocity control; S-0-0033 = 0x0002

Activating Sercos® (MLC)

The IndraDrive slave will be created as a "real axis" in MotionLogicControl (MLC). The operation modes are determined on this basis so that in IPO control and in IndraDrive "position control drive-controlled (via axis control word S-0-0520)" is used. This operation mode is controlled with the standard motion function blocks "MC_MoveAbsolute" or "MC_MoveRelative" on MLC.

☞ If the IndraDrive is to be entered as IO device, in conjunction with MLC13VRS, see to it that for MDT and AT each at least one parameter is provided in the cyclic data (e.g. control word and status word). Otherwise, the MLC13VRS cannot be switched to P4.

Since the configuration is carried out almost exclusively on the control side, only the master communication needs to be activated at the IndraDrive slave.

1. Activate field bus (P-0-4089.0.1 = 6)

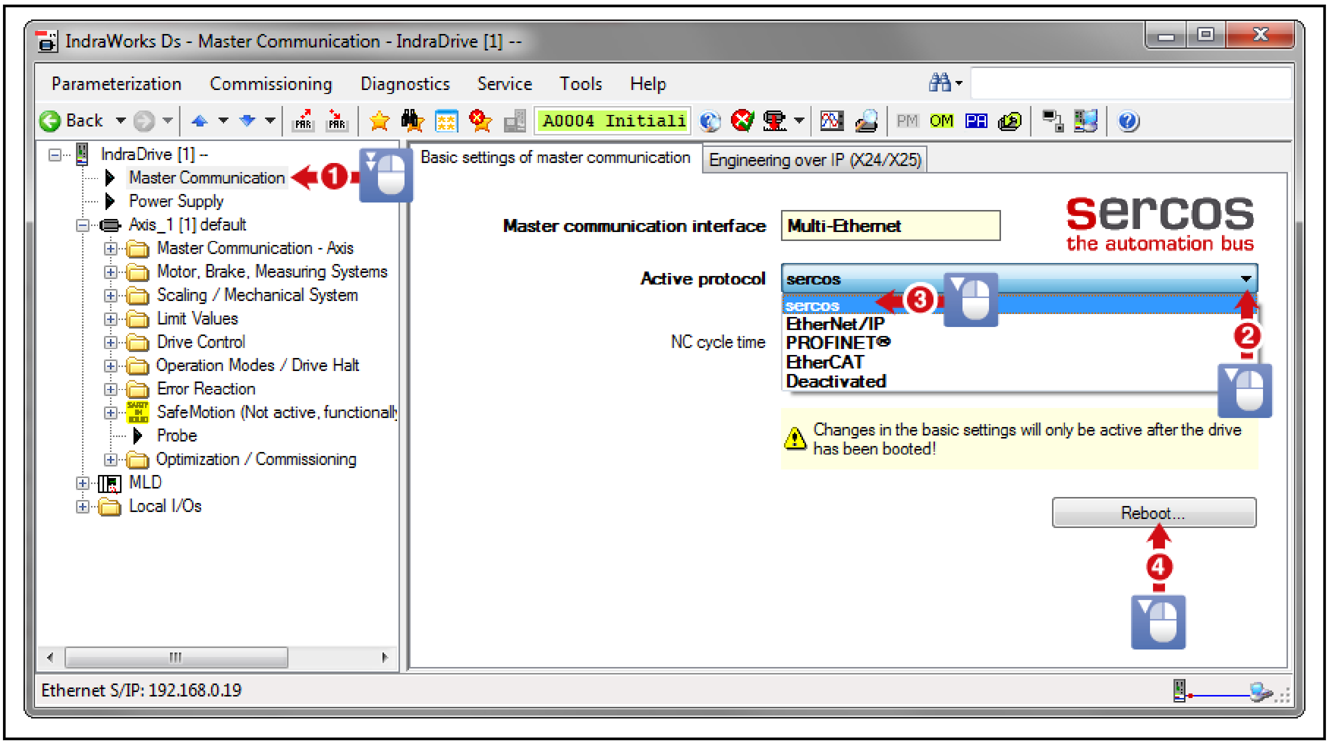


Fig. 7-25: Activate Sercos® (MLC)

Restart (C6400) required!

2. Profile type "FSP Drive (Sercos® profile)" (P-0-4084 = 0x0102)
3. Configure cyclic feedback values (AT) (on control side)
   - S-0-0135 (drive status word); length: 2 bytes; decimal places: 0; unit: -
   - S-0-0386 (active position feedback value); length: 4 bytes; decimal places: typically 4; unit: typically mm
   - S-0-0040 (velocity feedback value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
   - S-0-0390 (diagnostic message number); length: 4 bytes; decimal places: 0; unit: -
   - P-0-1300 (diagnostic code of technology function); length: 4 bytes; decimal places: 0; unit: -
   - S-0-0809, Pressure feedback value
   - S-0-0552, Torque/force feedback value 2
   - P-0-0112 (pump speed); length: 4 bytes; decimal places: 2; unit: rpm
   - P-0-1280 (system status word 1); length: 4 bytes; decimal places: 0; unit: -
   - P-0-1281 (system status word 2); length: 4 bytes; decimal places: 0; unit: -
   - If necessary, P-0-0144 (signal status word); length: 2 bytes; decimal places: 0; unit: -
4. Configure cyclic command values (MDT) (on control side)

- S-0-0134 (master control word); length 2 bytes; decimal places: 0; unit: -
- S-0-0036 (velocity command value); length: 4 bytes; decimal places: typically 3; unit: typically mm/s
- S-0-0047 (position command value); length: 4 bytes; decimal places: typically 4; unit: typically mm
- Add S-0-0550 (torque/force command value, positive 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- If necessary, add S-0-0551 (torque/force command value, negative 2); length: 4 bytes; decimal places: typically 1; unit: typically N
- Alternatively, add S-0-0800 (pressure command value); length: 4 bytes; decimal places: typically 3; unit: typically bar
- Add P-0-1283 (hydraulic function, switching control word); length: 4 bytes; decimal places: 0; unit: -
- If necessary, S-0-0145 (signal control word); length: 2 bytes; decimal places: 0; unit: -

5. Operation modes
   - Primary operation mode: Velocity control; S-0-0032 = 0x0002
   - Secondary operation mode 1: Torque control; S-0-0033 = 0x0001
   - Secondary operation mode 2: Position control drive-controlled (using axis control word S-0-0520); S-0-0034 = 0x0305

7.2.2 Actuator

Hydraulic actuator

With the functional package Sytronix, IndraDrive can be configured as a controller for a complex actuator with motor, pump and hydraulic cylinder. This setting is required for servohydraulic cylinder axes, because it allows a continuously variable advance (e.g., by switching cylinder areas or pump displacements) to be compensated in the output adjustment.

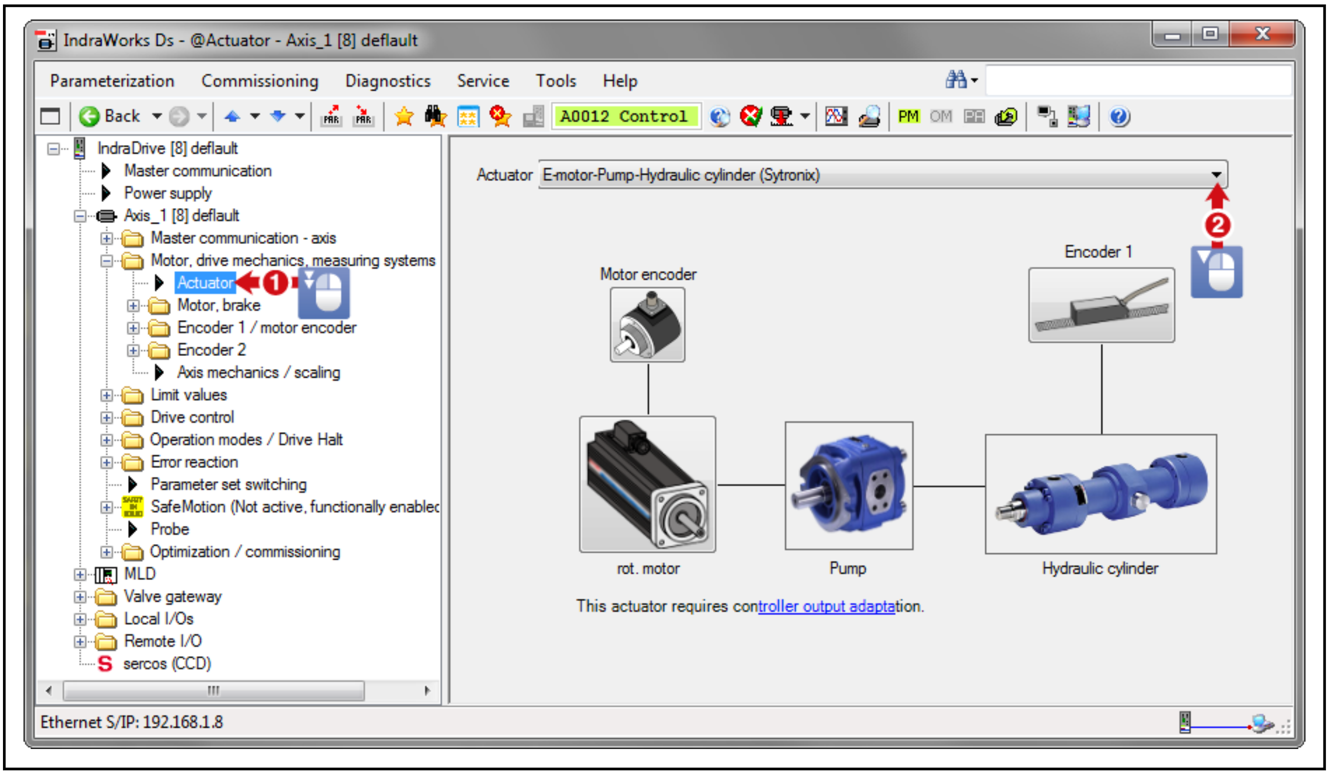


Fig. 7-26: Actuator, configuration for servohydraulic cylinder axes

The output adjustment is written from the technology function and needs not to be configured.

With the complex actuator, encoder 1 becomes the control encoder of the hydraulic cylinder (actuator encoder) like in the HDx firmware. The motor encoder is separated from encoder 1 and with "P-0-0111, Actual position value of motor" and "P-0-0112, Actual velocity value of motor" has its own reference system. In IndraDrive, the controller output in the actuator reference (linear velocity) is converted into a command value in the motor reference (rotary speed) with the factor "P-0-0562, Actuator infeed/gear ratio compensation" in the output adjustment.

Encoder 2 is not required.

Mechanical actuator

For electromechanical axes with linear transmission, the simple, rotary actuator (el. motor) remains configured.

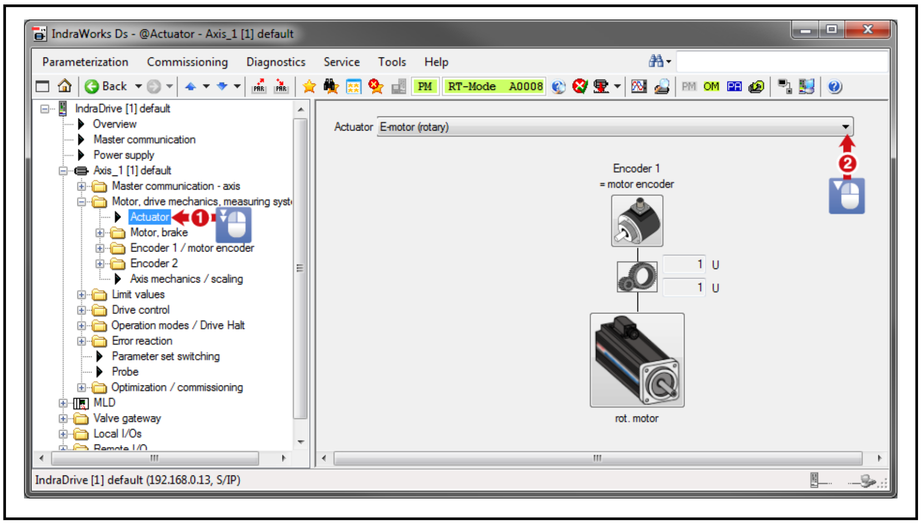


Fig. 7-27: Rotary actuator (el. motor)

In this case, the feed does not change. Nevertheless, the Sytronix function package is required also here to enable the parameter interface for alternating control, among others.

7.2.3 Actuator encoder

Supported encoders

Basically all encoder types supported with the multi-encoder interface of IndraDrive (EC option) can be used to determine the cylinder position. In addition, encoder signals can be transmitted via Sercos® to IndraDrive with MPx20 and above. Among others, these are:

Designation	Assignment encoder 1 → interface (P-0-0077)	Physical encoder type (S-0-0602.x.1)
Encoders with sine signals (1 Vpp, 5 V or 12 V supply)	x	2
Encoders with sine signals and HIPERFACE® interface (1 Vpp, 12 V supply)	x	4
Encoders with square-wave signals (TTL, 5 V or 12 V supply)	x	5
Encoders with sine signals and EnDat® 2.1 interface (1 Vpp, 5 V or 12 V supply)	x	6

Designation		Assignment encoder 1 → interface (P-0-0077)	Physical encoder type (S-0-0602.x.1)
Digital encoders (Sercos® encoder profile)	Encoders with sine signals and SSI interface	x	26
	Encoders with EnDat® 2.2 interface	x	106
	Encoders with SSI interface	x	107
	Via master communication (Sercos®)	20	-
	Via CCD (Sercos®)	21	-

x Optional slot of encoder interface used: X4 = 1; X8 = 2, X10 = 4

Tab. 7-2: Supported encoders

☞ The multi-encoder interface of IndraDrive provides a power supply of 5 V or 12 V. Encoders operated with other voltages (e.g., 24 V) have to be supplied separately. Make sure that the supply is buffered long enough when switching off, so that IndraDrive can save the last position correctly.

Using DC-DC converters (12 V to 24 V) has proven effective in increasing the supply voltage buffered in IndraDrive for the encoder (encoder interface output, EC) from 12 V to 24 V.

Typically, linear encoders with SSI interface or linear encoders with sine signals and SSI interface (e.g., for SafeMotion) are used.

Encoders with SSI interface (digital)

☞ Magnetostrictive encoders have to be set to **synchronous** in their evaluation electronics so that beat effects do not occur in the velocity signal.

Magnetostrictive encoders with relatively long measuring rods cannot provide the current values in the required clock cycle (1 kHz) (value in data sheet) and thus are oversampled. This causes jumps in the velocity signal. If these encoders can be set to **extrapolation**, an estimated value is output in the required clock cycle and the encoder can be operated.

The actuator encoder is configured as encoder 1 at the connected interface.

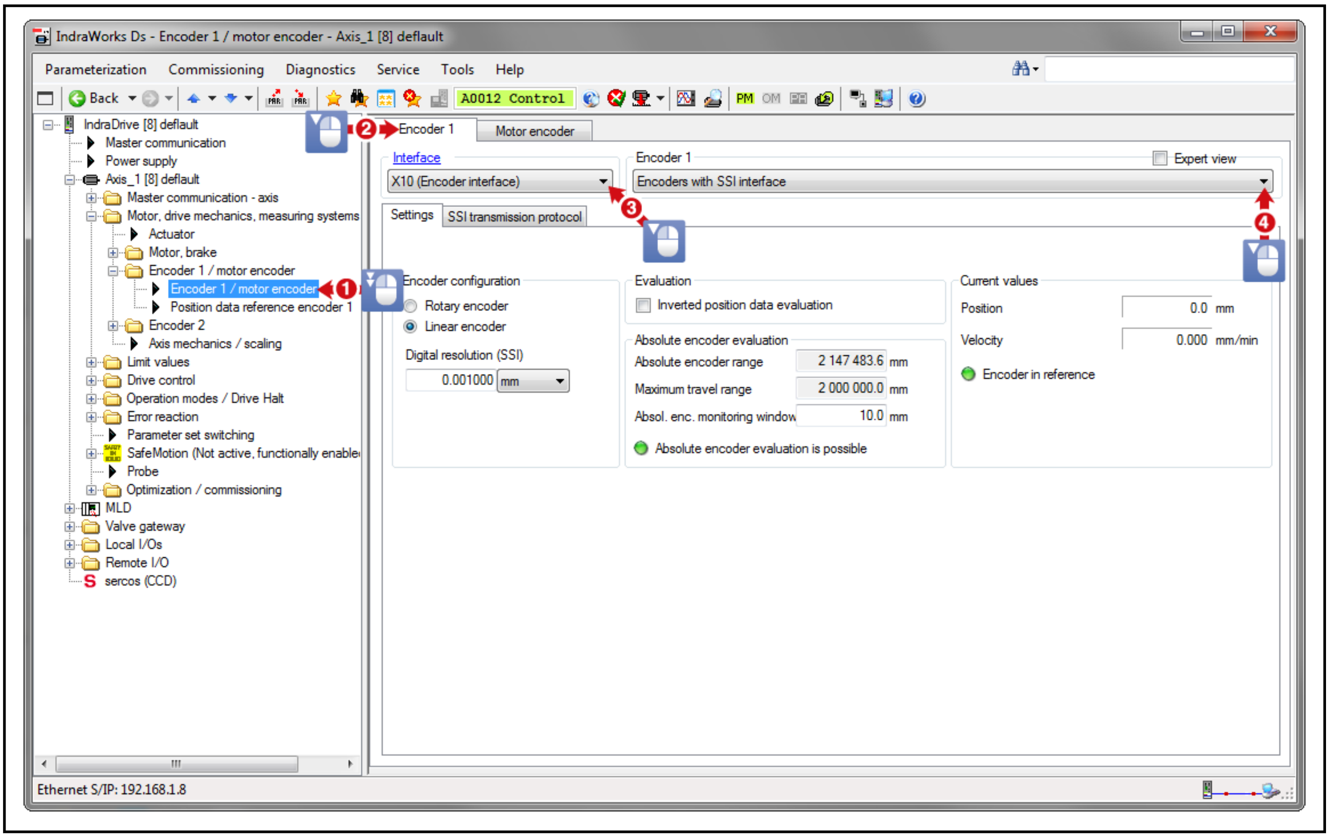


Fig. 7-28: Encoder 1, configuration

The digital resolution of the encoder is contained on its data sheet and usually also inscribed on the evaluation electronics. For inputting the encoder resolution it is possible to switch between millimeters per increment and increments per millimeters to directly apply the manufacturer's specification.

Whether or not an inversion has to be set is explained in the "scaling" chapter.

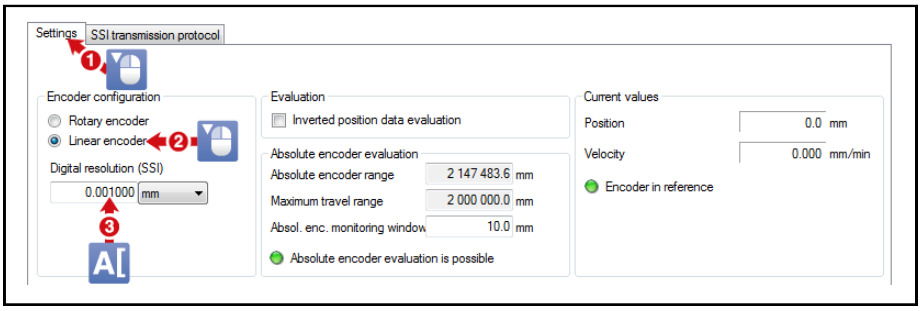


Fig. 7-29: Encoder 1, settings

The structure of the digital signal is set on the "SSI transmission protocol" tab. The structure is not standardized and can differ according to the manufacturer and order. The coding (Gray/binary) and the number of position bits are contained in the data sheet and usually also inscribed on the evaluation electronics.

The baud rate that can be set depends on the encoder cable length and is contained in the encoder data sheet.

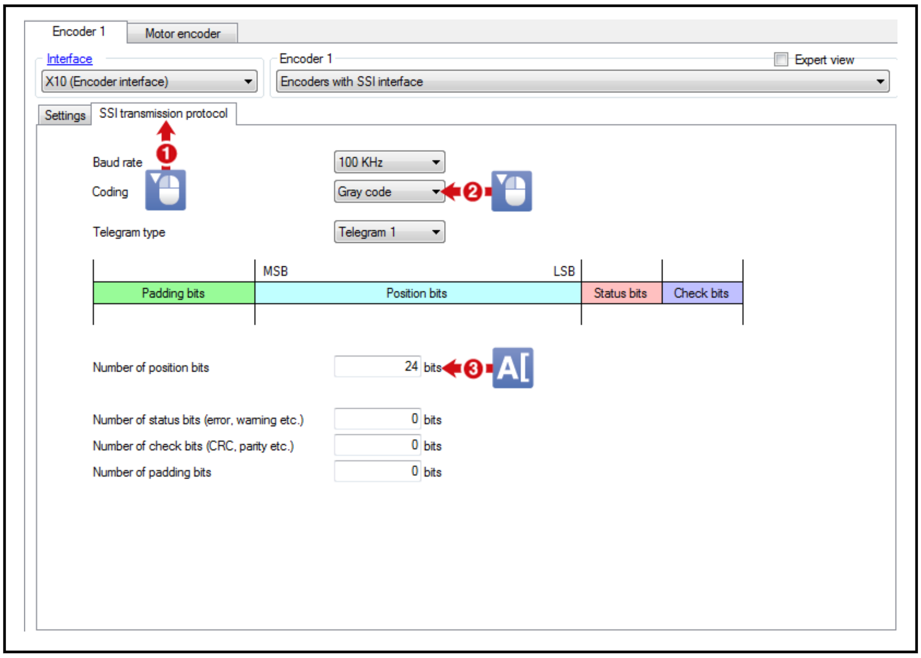


Fig. 7-30: Encoder 1, SSI transmission protocol

The structure of the digital telegram illustrated in the dialog. The order of padding bits, position bits, status bits and check bits is not standardized and differs according to the manufacturer. Usually, the telegram type 1 is used, rarely the telegram type 2.

Status bits and check bits are not evaluated in the IndraDrive firmware, since they are not used by all manufacturers and faulty diagnoses might occur otherwise.

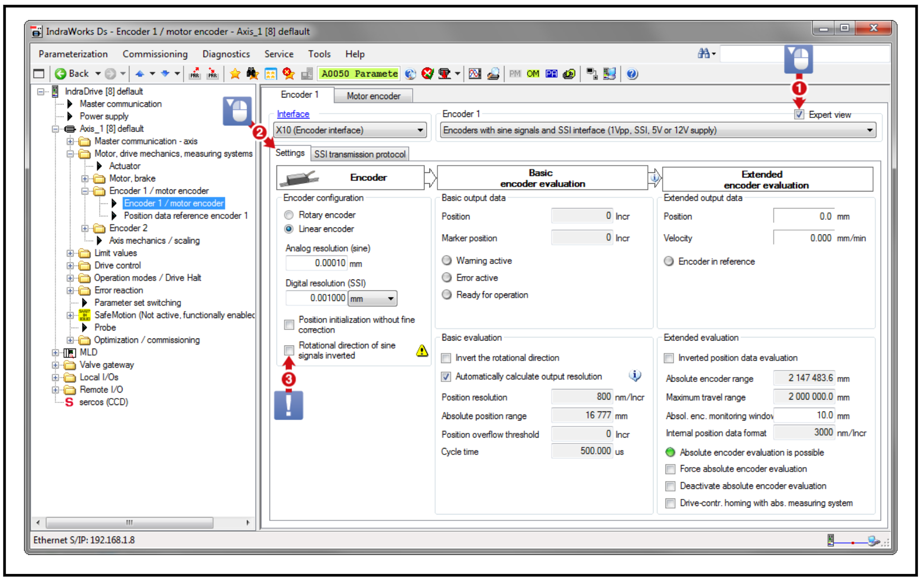


Fig. 7-31: Encoder 1, SSI telegram type 2

For rotary SSI encoders that are used in linear form (e.g., wire-actuated encoders), the sum of multi-turn bits and single-turn bits is specified as the number of position bits.

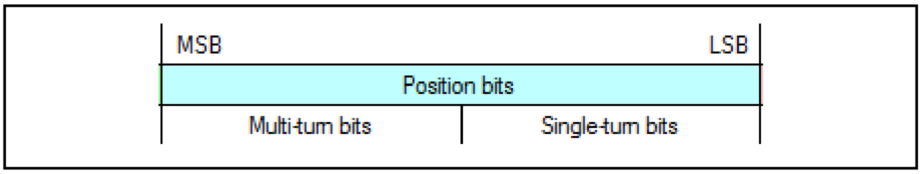


Fig. 7-32: Encoder 1, SSI position bits

The resolution results from the single-turn bits and the infeed.

$$resolution\,[mm] = \frac{Infeed\left[\frac{mm}{rev}\right]}{2^{\text{single-turn bits}}\left[\frac{\text{incr}}{\text{rev}}\right]}$$

Fig. 7-33: Formula for calculating the resolution in mm/incr

$$resolution\left[\frac{incr}{mm}\right] = \frac{2^{\text{single-turn bits}}\left[\frac{\text{incr}}{\text{rev}}\right]}{Infeed\left[\frac{mm}{rev}\right]}$$

Fig. 7-34: Formula for calculating the resolution in incr/mm

Example of wire-actuated encoder: rot. resolution: 12 single-turn bits = 4096 [incr/rev], winch: 100 [mm/rev]

$$Linear\ resolution\ per\ increment = \frac{100\left[\frac{mm}{rev}\right]}{4096\left[\frac{\text{incr}}{\text{rev}}\right]} = 0.024414\ [\text{mm}]$$

Fig. 7-35: Example of calculating the resolution

Encoders with sine signals and SSI interface (combined encoders)

Combined encoders for SSI provide their absolute position using the digital track during phase switching from "PM" to "OM". Thereafter, the position is determined using the more accurate, analog signals.

In the case of encoders with sine signals and SSI interface, make sure that the digital and the analog track are counting in the same direction. Check this by comparing the position feedback values at two clearly different axis positions, after a phase switch from "PM" to "OM" took place for each position. If the position feedback values do not reflect the change in the axis position in a verisimilar way, invert the rotational direction of the sine signals (S-0-0602.x.2; bit 3) and repeat the check. In the dialog, the setting is only provided in the expert view.

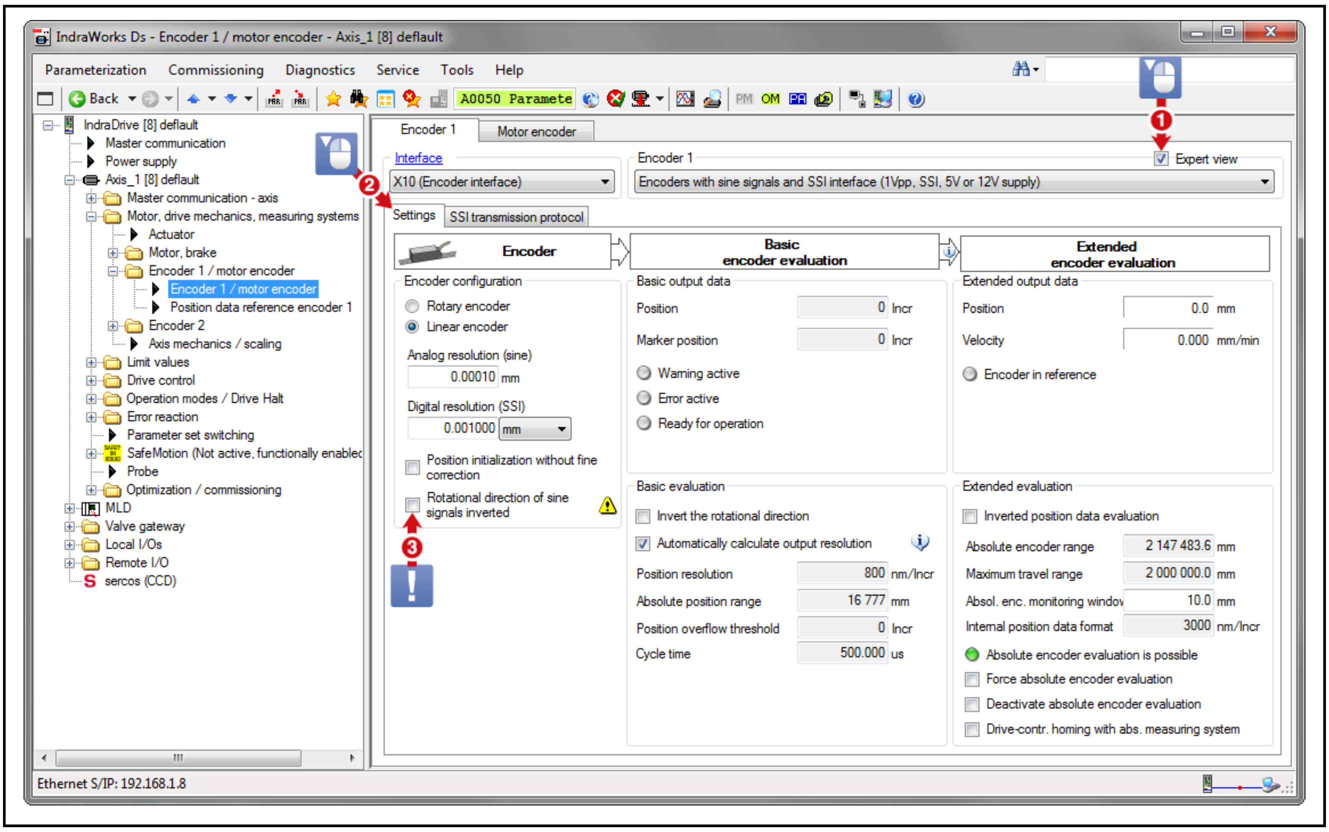


Fig. 7-36: Setting for encoders with sine signals and SSI interface

Homing procedure

Since positioning and position control are implemented via the actuator encoder, this encoder has to be homed as encoder 1.

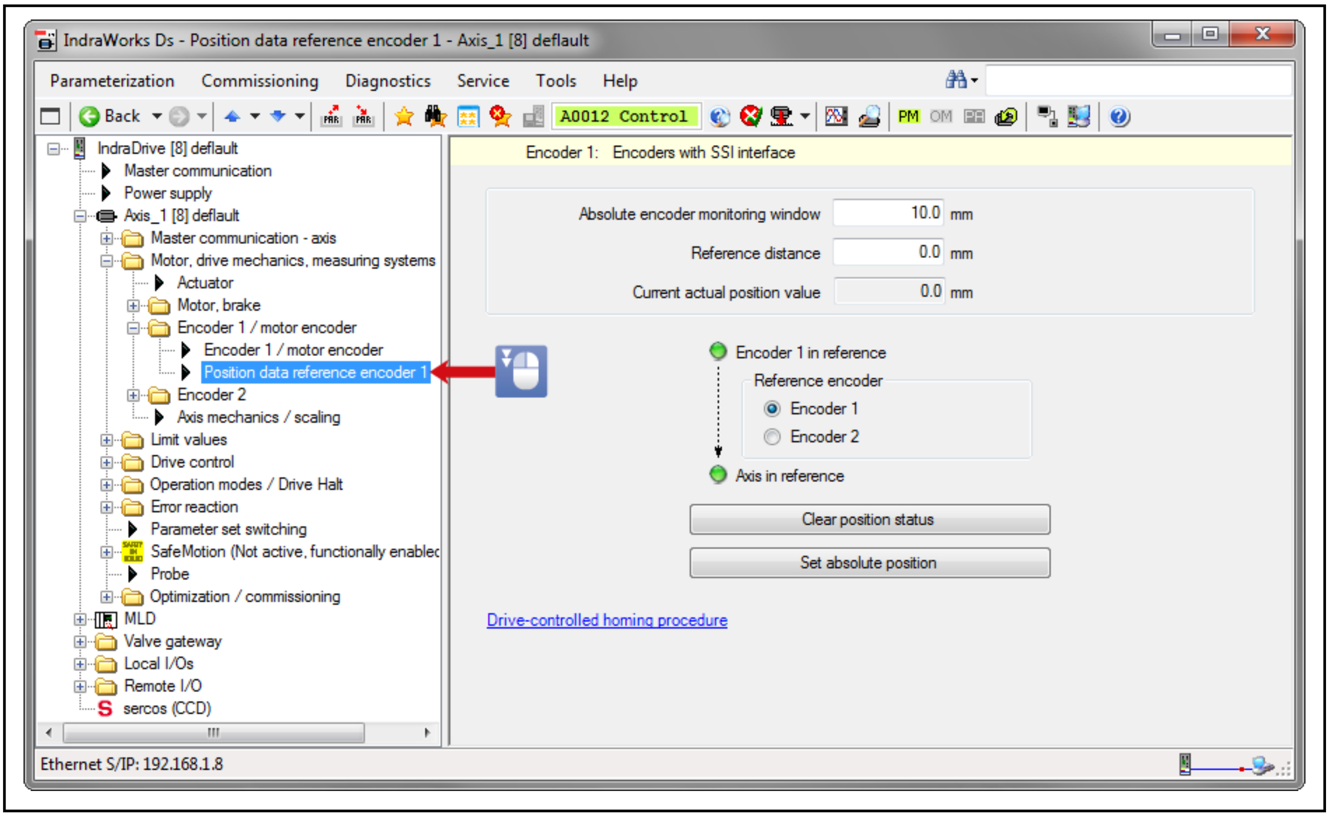


Fig. 7-37: Position data reference, encoder 1

Command C0300 (set absolute measuring) can only be started in OM.

7.2.4 Holding brake

The function behind the “holding brake” is the activation of an inductive load with the objective of preventing a movement. This brake may be a rotational brake or a valve in a hydraulic system. The function of the holding brake has to be activated in the dialog “Brake" (1) via the checkbox "Holding brake available" (2) (P-0-0525 bit 2 = 1).

Without this activation, no valves are activated. If the function of the holding brake is not activated and if PFC is used with a complex actuator, error D509C is issued.

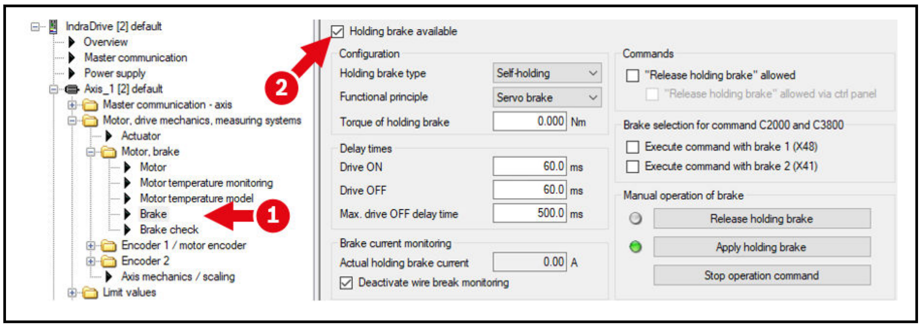


Fig. 7-38: Holding brake dialog

The activation of the inductive loads can be delayed with a “drive ON” delay (S-0-0206) for enabling the control. For deactivating the inductive loads, the drive can be disabled with a “drive OFF” delay (S-0-0207). Thus, an overlap between the activated inductive load and a motor with torque at zero speed can be provided.

☞ The function of a brake test is not supported when valves are used.

7.2.5 Scaling

Standard axis

A reference between the actuator and the controller has to be established; the reference to the "standard axis". The following aspects are always assumed:

☞
- The technology function does not support the modulo format for position data processing. The absolute format has to be set for position data processing.
- The position data need to have linear scaling.
- The external encoder has to be configured in such a way that without negation of the position data it counts positively when the hydraulic cylinder extends.
- The torque/force data should not be scaled with a percentage factor.

☞ To be able to set scaling correctly, the sensors for pressure or force have to be correctly configured. The information required for this is stored in chapter 7.4.4 "Sensor data" on page 191.

The flowcharts below describe the analysis of the systemic interaction and how it is represented in the scaling configuration.

Closed hydraulic circuit - flowchart

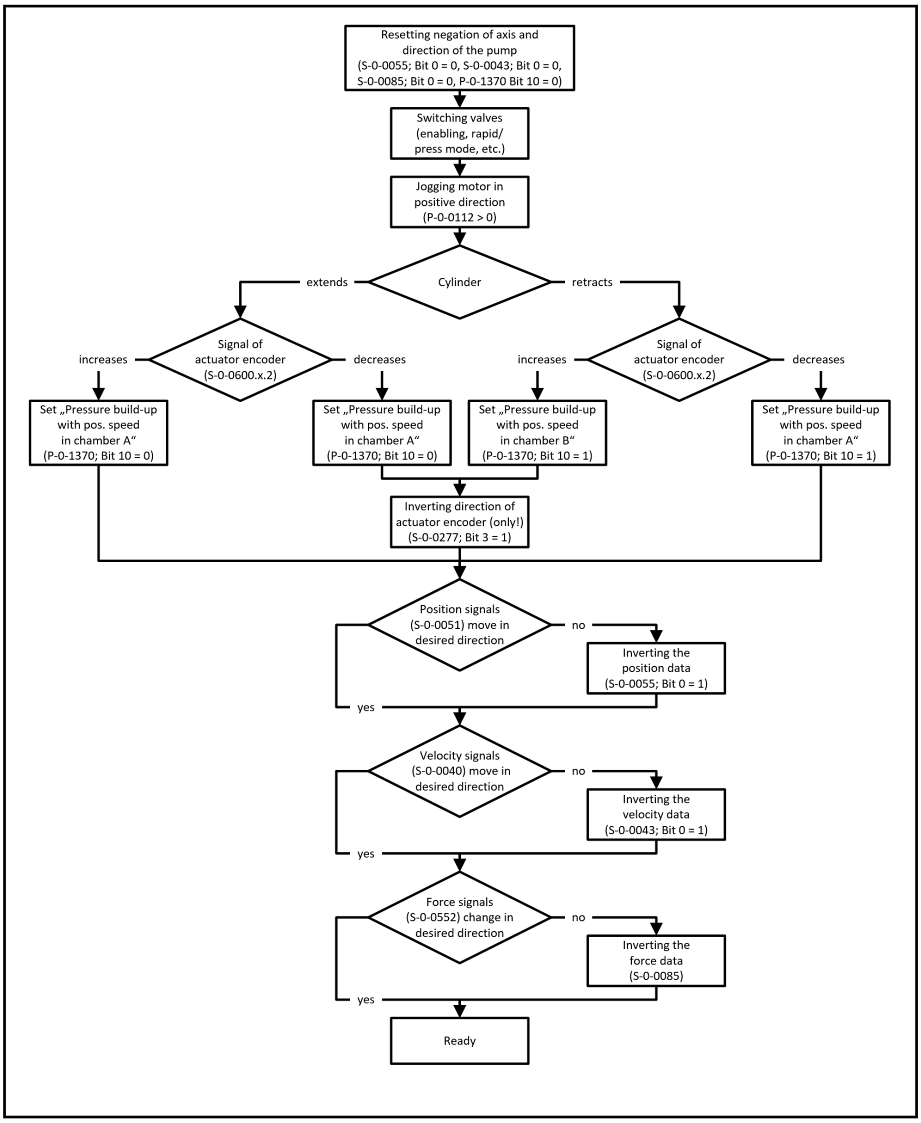


Fig. 7-39: Scaling configuration if cylinder direction is determined via the rotational direction of the pump

☞ If the pressure in cylinder chamber B is built up with a positive motor speed (P-0-0112 > 0), the direction of displacement of the pump is inverted and requires to be adjusted using P-0-1370; bit 10.

Other scaling settings (such as unit, negation, decimal places) can be set for position, velocity, acceleration and torque/force data according to the requirements of the application at hand.

Closed hydraulic circuit - flowchart

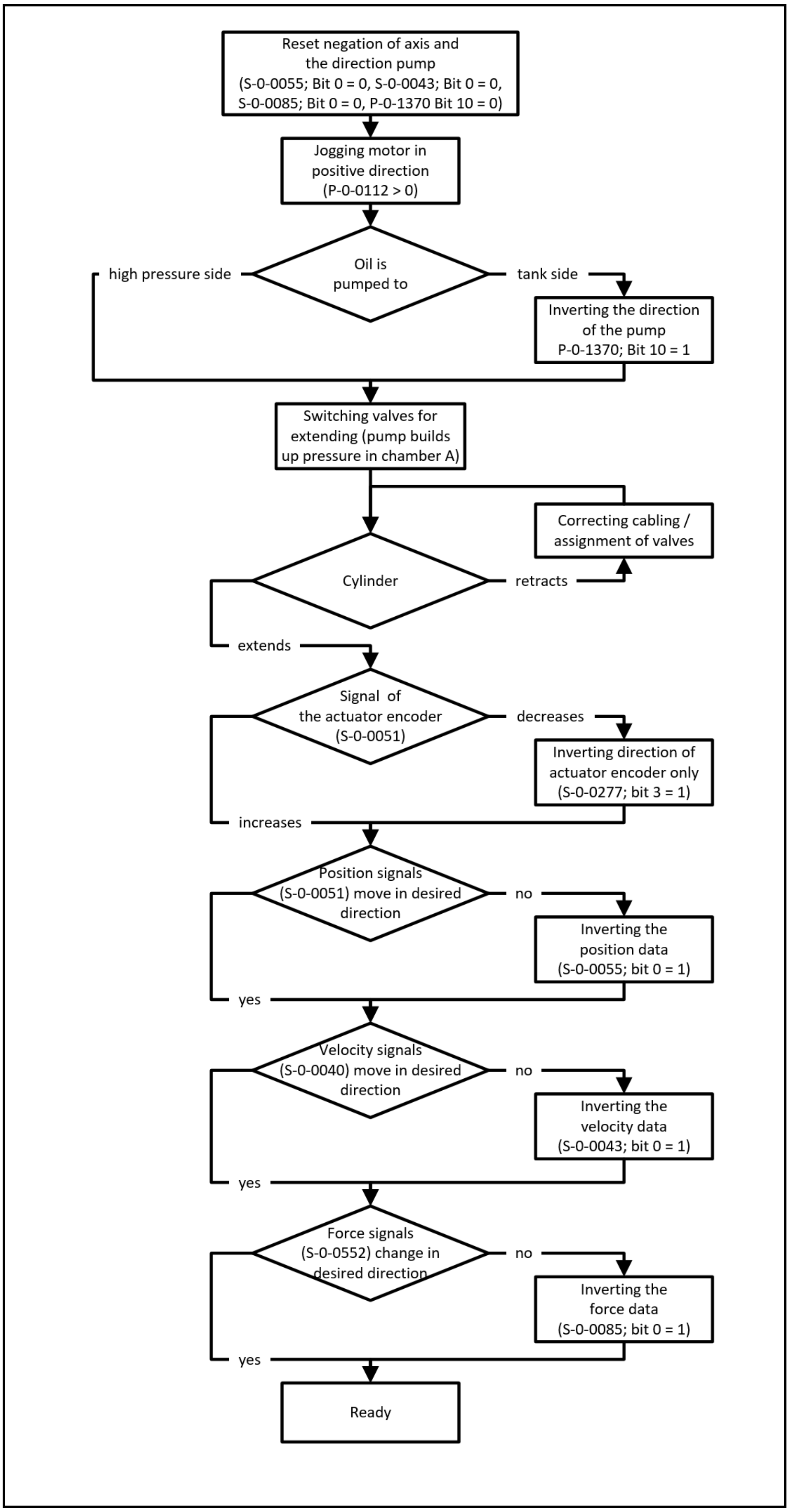


Fig. 7-40: Scaling configuration if direction is input via valves

☞ If the pump displaces fluid with positive motor speed (P-0-0112 > 0) from the pressure side to the suction side, the velocity polarities have to be inverted (S-0-0043).

Other scaling settings (such as unit, negation, decimal places) can be set for position, velocity, acceleration and torque/force data according to the requirements of the application at hand. Unit and decimal places can be freely set for velocity data. The negation has to be parameterized as stipulated above.

Mechanical system - flowchart

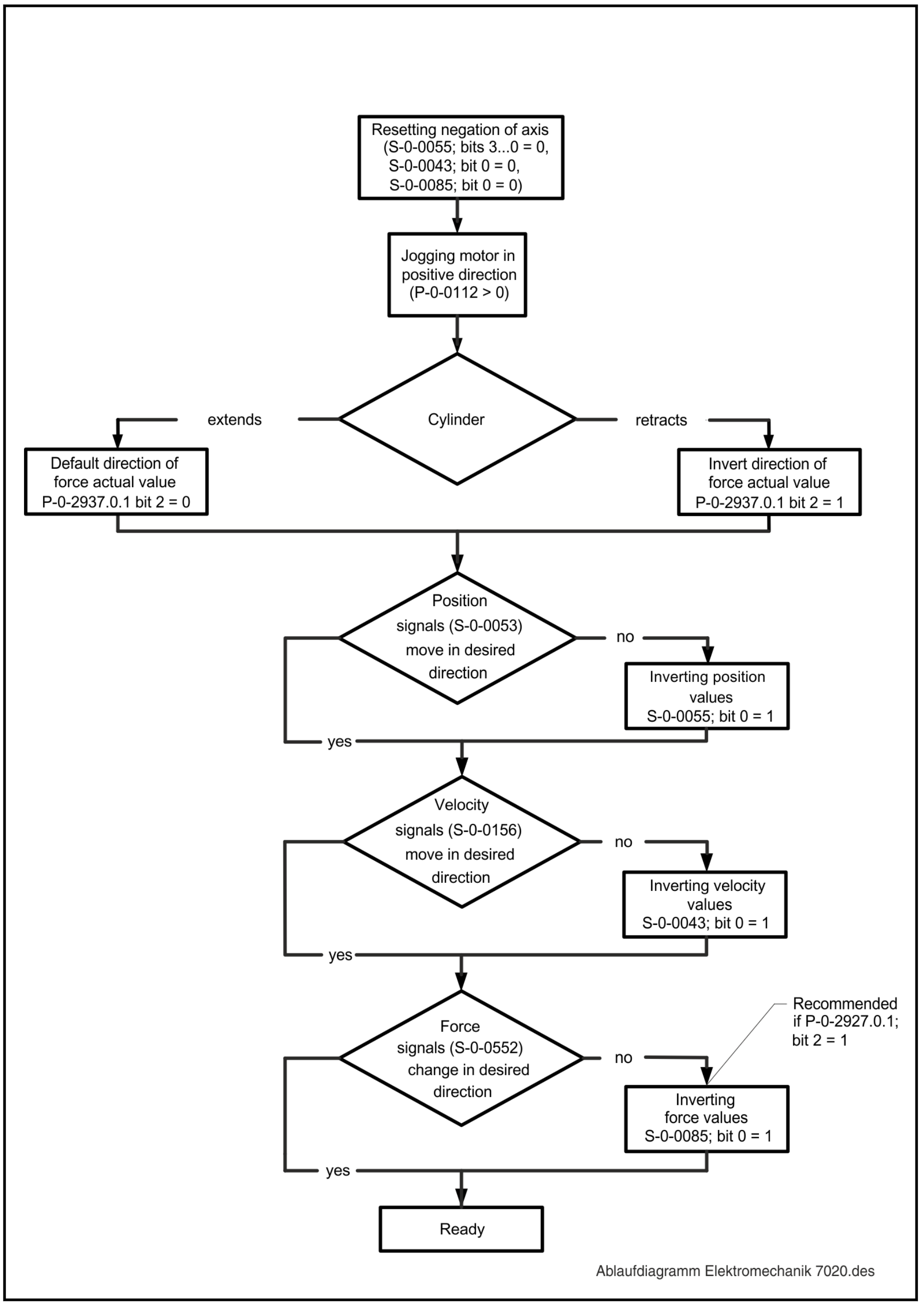


Fig. 7-41: Flow diagram for scaling configuration with electromechanical system

☞ If the axis retracts with positive motor speed (P-0-0112 > 0), the actual force value has to be inverted via P-0-2937.0.1 bit 2 in order to adapt the direction of force of the internal standard axis.

The counting direction of the encoder determines the orientation of the internal standard axis. For motor encoders with data memory the counting direction cannot be inverted so that the internal standard axis may move in the opposite direction to the real axis and requires the actual force value to be inverted. This can be adjusted via the scaling settings (such as unit, negation, decimal places) for position, velocity, acceleration and torque/force data.

7.2.6 Limit values

It is possible to set limitations for the actuator with regard to position, velocity and acceleration. Moreover, limit values for speed and angular acceleration can be set on the motor side. They are used to protect the pump.

The values act as limitations for command values, interpolation and controller outputs, as well as monitors for actual values.

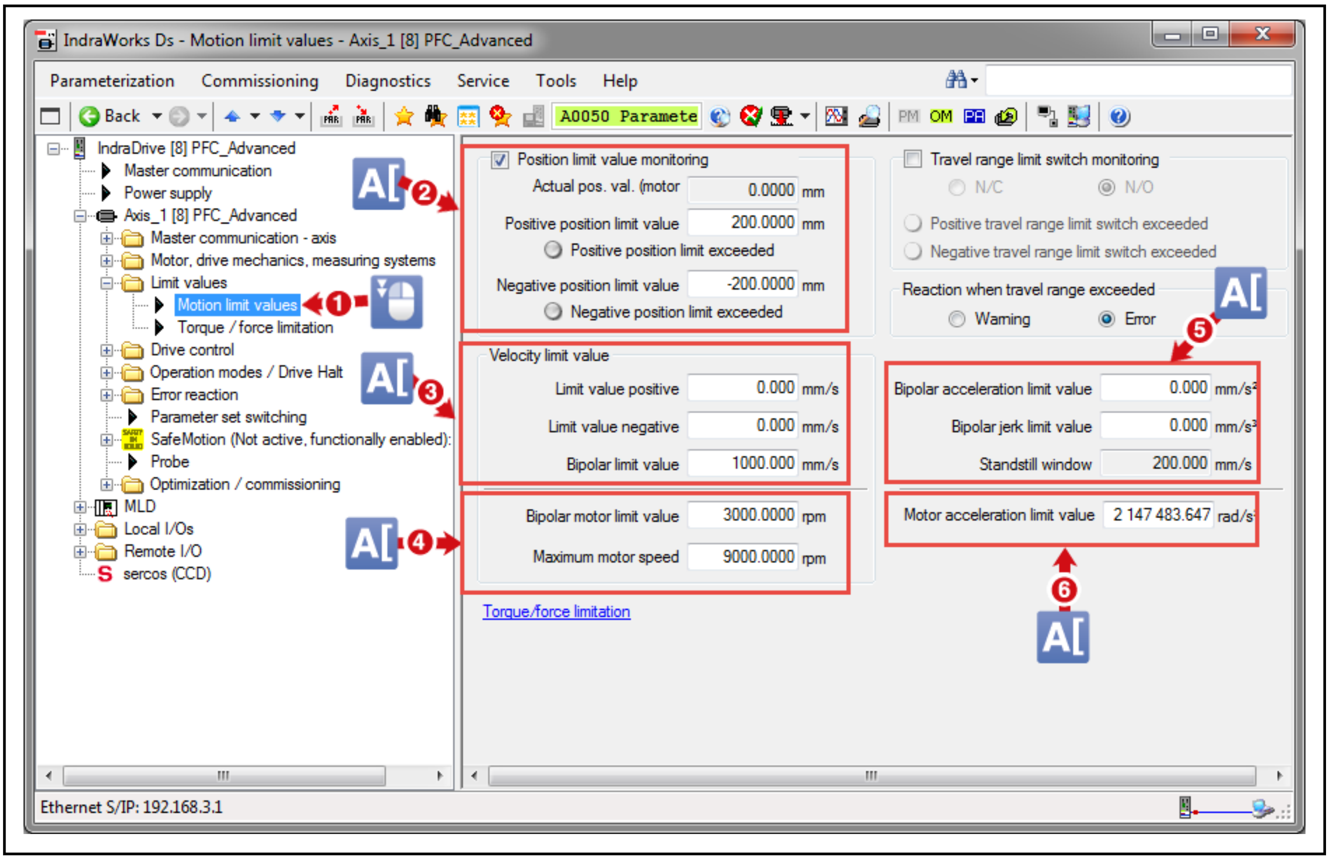


Fig. 7-42: Motion limit values

1. **Motion limit values**
2. Position limit value monitoring

   Enter and activate limit values that are not to be exceeded during the process. Position command values will not be interpolated beyond these thresholds, and the actual value will be monitored for exceeding the threshold. For axes that are to be monitored with regard to one limit value only, the non-critical limit value can be parameterized outside the corresponding limit stop. This might be necessary for axes that in the process move to the limit stop at one end, or when powered off lower beyond the limit stop due to leakage.

3. Velocity limitation

   In the bipolar velocity limit value (S-0-0091) enter the maximum, **linear** velocity at which the actuator is allowed to move. This protects the cylinder seals and the attached mechanical systems and tools!

   Optionally, positive and negative **linear** velocity limit values (S-0-0038, S-0-0039) can be entered differently. The lower values of direction-dependent and bipolar limitation will take effect.

   The velocity feedback value is monitored with regard to 112.5 % of the smallest limit value.

4. Speed limitation

   In the bipolar velocity limit value of the motor (P-0-0113) enter the maximum, **rotary** velocity (speed) at which the motor and thus the connected pump are allowed to rotate. This protects the pump!

   The maximum motor speed (S-0-0113) is read from the encoder data memory (if available) during the phase switch from "PM" to "OM". This rotary velocity limit value (speed) usually is far higher than the allowed maximum speed of the pump and normally does not restrict the process.

5. Linear acceleration limitation

   In the bipolar acceleration limit value (S-0-0138) enter the maximum, **linear** acceleration at which the axis is allowed to move on the load side. This protects the cylinder seals and the attached mechanical systems and tools!

6. Rotary acceleration limitation

   In the motor acceleration limit value (P-0-0564) enter the maximum, **rotary** acceleration at which the motor and thus the connected pump are allowed to spin. This protects the pump, e.g. against cavitation!

   If this limitation is not required, the maximum value of the parameter can be input.

7.2.7 Motor control

"Field-oriented current control with encoder" and "flux-controlled motor operation (FXC) without encoder" are supported, because only these types of motor operation enable position control in IndraDrive.

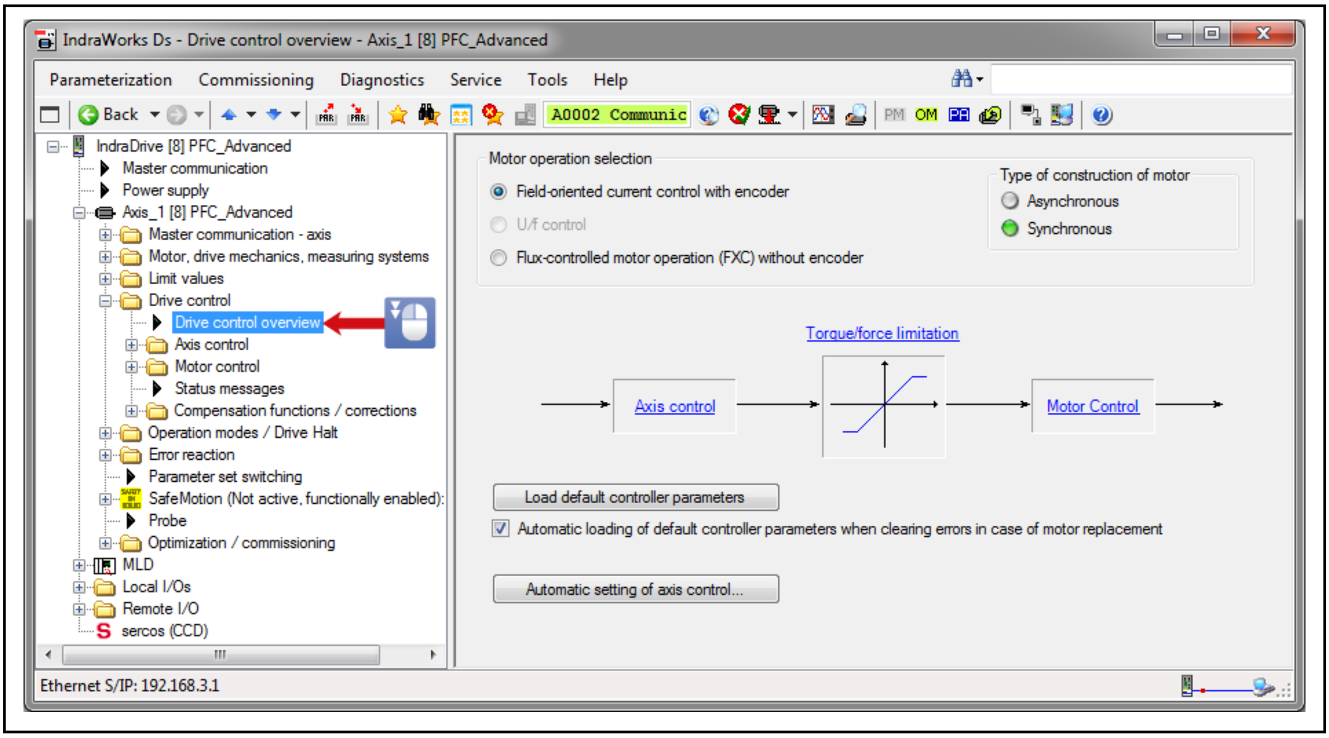


Fig. 7-43: Drive control overview

Field-oriented current control with encoder

Synchronous motors are typically used with integrated Bosch Rexroth encoders. The motor and encoder data are stored in the encoder memory so that they are read and applied during phase switch from "PM" to "OM". Consequently, separate data input is not required.

Flux-controlled motor operation (FXC) without encoder

It is also possible to use asynchronous (induction) motors without motor encoder. In this case, the motor data have to be input manually from the manufacturer's data sheet into the IndraDrive. In addition, it is recommended that an automatic motor data identification be carried out (see also Technical Note "Rexroth IndraDrive Third-Party Motor, Commissioning Instructions").

Compared to field-oriented current control, the flux-controlled motor operation is basically restricted in its control quality and speed accuracy.

☞ The FXC method is not suitable for pressure holding operation with little leakage, since at low speeds it is only possible to move in an open-loop controlled manner and a very high motor current draw occurs when doing so.

7.2.8 Operation modes (IndraDrive)

Supported operation modes

All positioning modes and the velocity control mode are supported.

- Cyclic position control
- Drive-internal interpolation
- Drive-controlled positioning
- Positioning block mode
- Velocity control

☞ The **operation mode** selected in IndraDrive and the **operating mode** of the technology function are two settings that have to be distinguished. They interdepend only to some extent!

The settings for the primary operation mode and the secondary operation modes 1 to 7 are made in the operation modes dialog in IndraWorks. The axis control word is set in such a way that the operation modes take effect on the external encoder at the actuator (S-0-0520; bits 1/0 = 01).

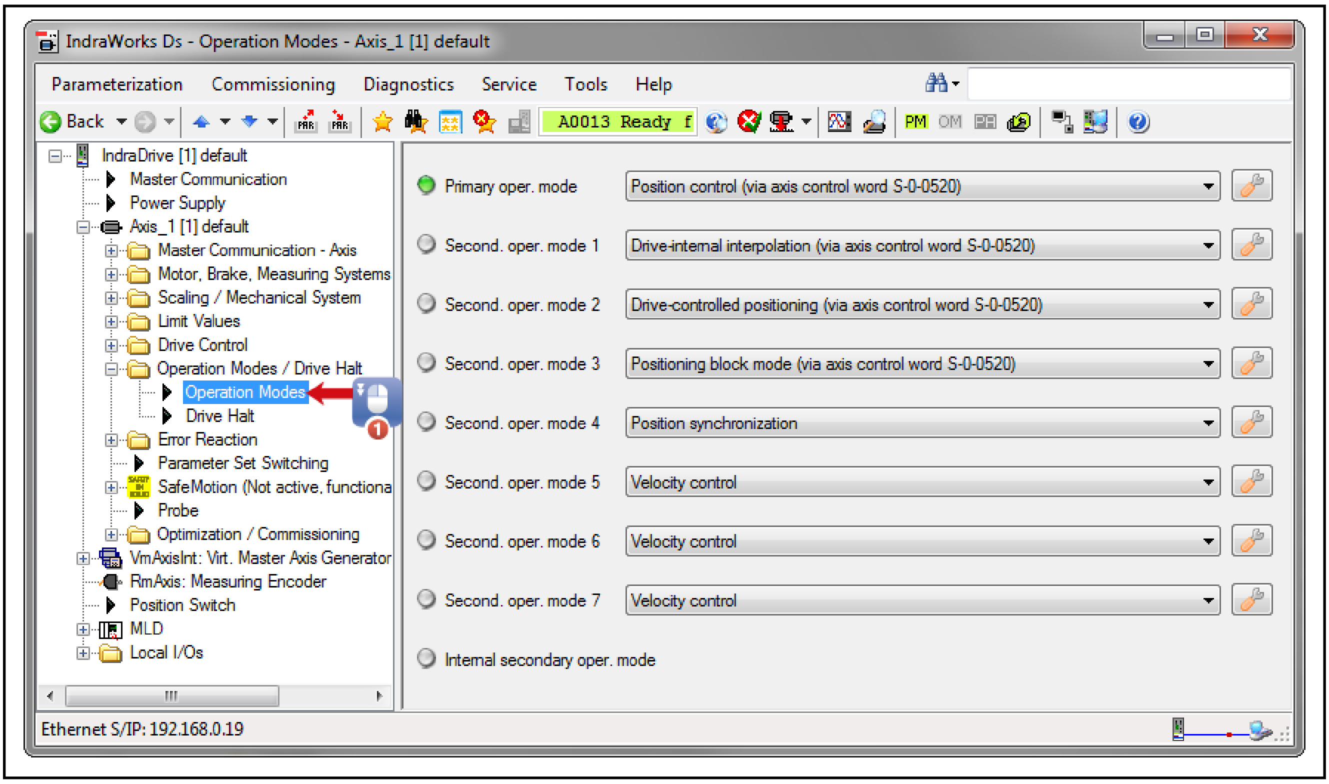


Fig. 7-44: Operation modes

Cyclic position control

In the "closed-loop position control" mode, a cyclic position command value is made available to the drive within the NC clock cycle. This command value is fine-interpolated in the drive and, if necessary, jerk-limited via filters before being transmitted to the actual position controller.

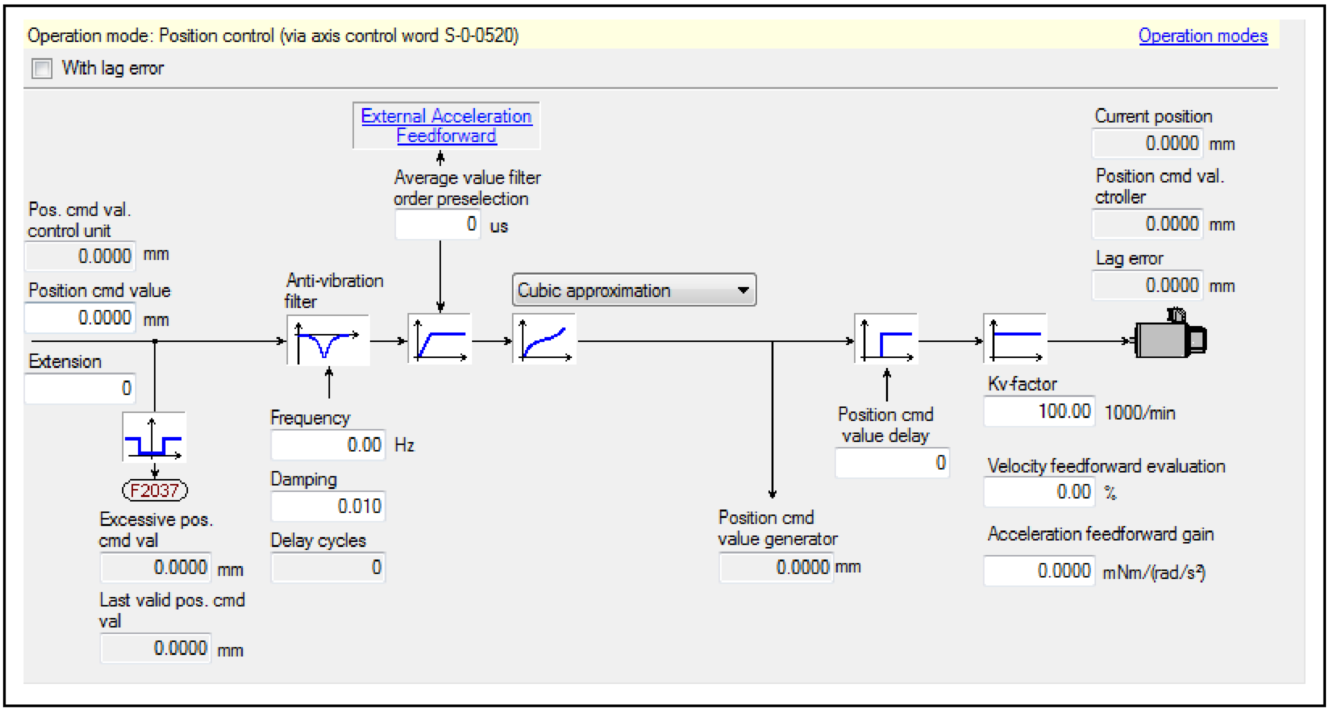


Fig. 7-45: Position control mode

Drive-internal interpolation

In the "drive-internal interpolation" mode, a target position is directly preset for the drive. In the internal positioning generator, a position command value characteristic is generated (interpolated) as the input value for the position controller from the preset value for the target position taking account of preset positioning data (velocity, acceleration and jerk).

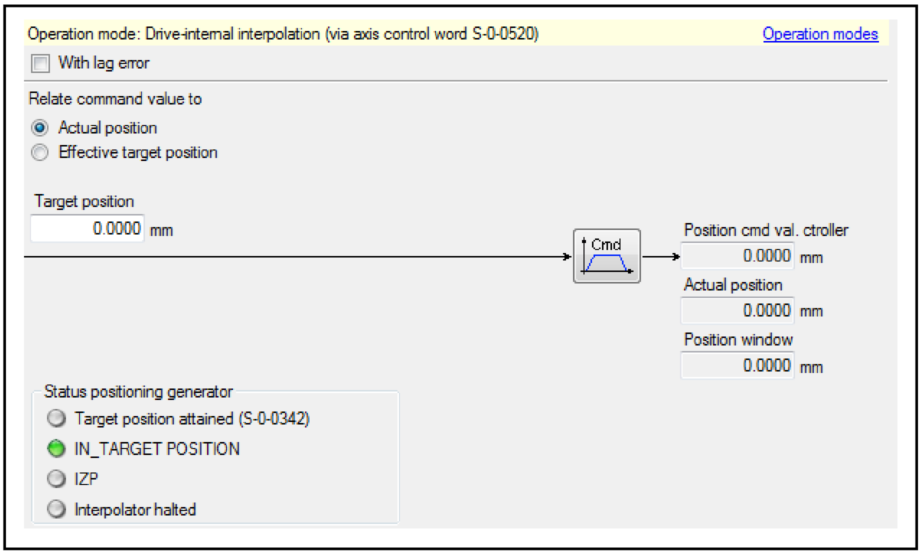


Fig. 7-46: Drive-internal interpolation mode

Drive-controlled positioning

In the "drive-controlled positioning" mode, a positioning command value is preset for the drive. The drive can continue processing this value internally in absolute (position target) or relative (travel distance) form. In the internal interpolator, a position command value characteristic is generated as the input value for the position controller from the preset positioning data (effective target position, velocity, acceleration and jerk).

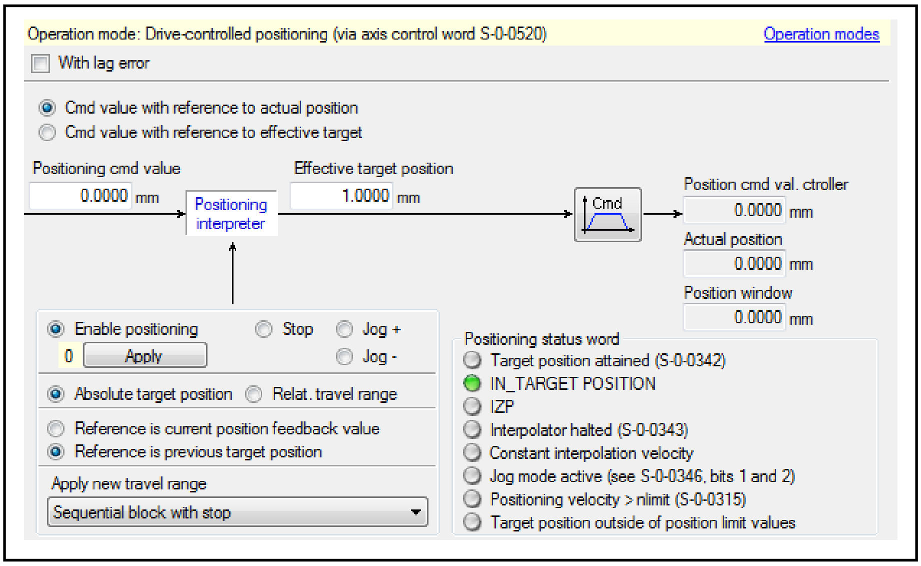


Fig. 7-47: Drive-controlled positioning mode

Positioning block mode

In the "positioning block mode" it is possible to run up to 64 programmed positioning blocks. The drive moves to the target position in position control, while maintaining velocity, acceleration, deceleration and jerk limits as defined in the respective positioning block.

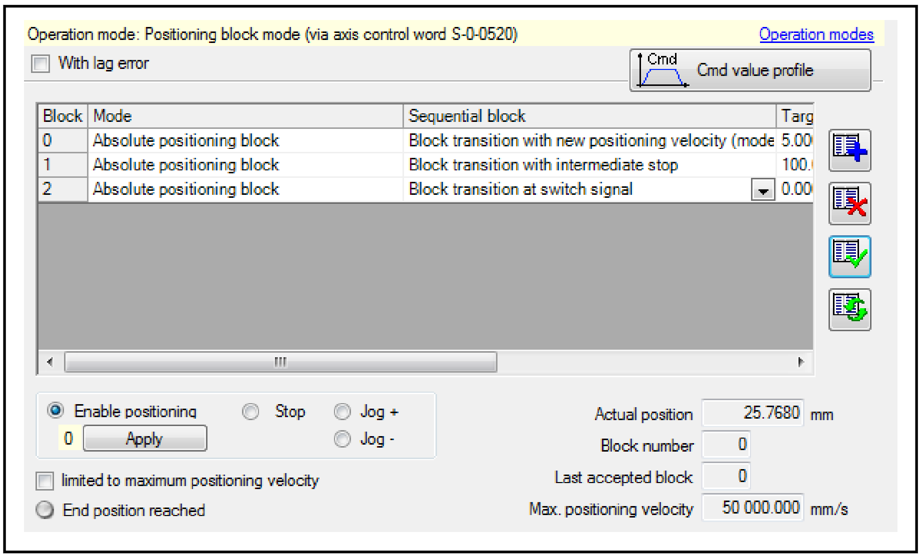


Fig. 7-48: Positioning block mode

Velocity control

In the "velocity control" mode a velocity command value is provided for the drive. The velocity command value is limited by ramps and filters.

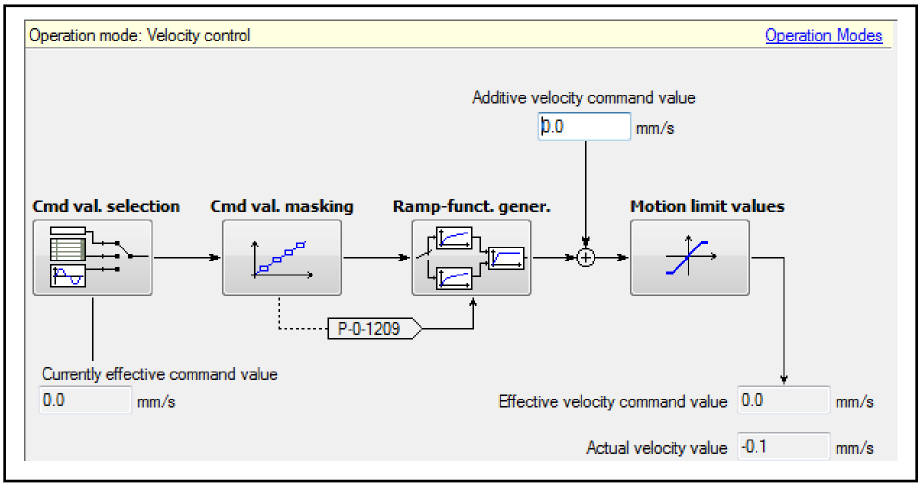


Fig. 7-49: Velocity control mode

7.2.9 Safety technology

Both Safe Torque Off/Safe Brake Control (L3) and Safe Motion (S4/S5) can be used.

For Safe Motion (e.g., safely reduced velocity), the actuator encoder needs to be monitored as safety technology encoder. By itself, Safe Motion monitoring of the motor encoder is not suitable for hydraulic systems.

For Safe Torque Off, the cylinder additionally needs to be supported or isolated using a safe, redundant valve circuit in accordance with the hazard assessment.

7.2.10 Analog interfaces

There are various analog input signals available, which can be read from different signal sources. For each analog input signal, a signal selection parameter is available, which can be used for configuring the signal source (see also chapter 7.4.4 "Sensor data" on page 191).

Signal selection parameter

If an analog input is to be written from the master communication or via the assignment of an analog input in the IndraDrive firmware, the value "0" has to be entered in the associated signal selection parameter. The parameter is read and used by the technology function taking account of the associated weighting settings.

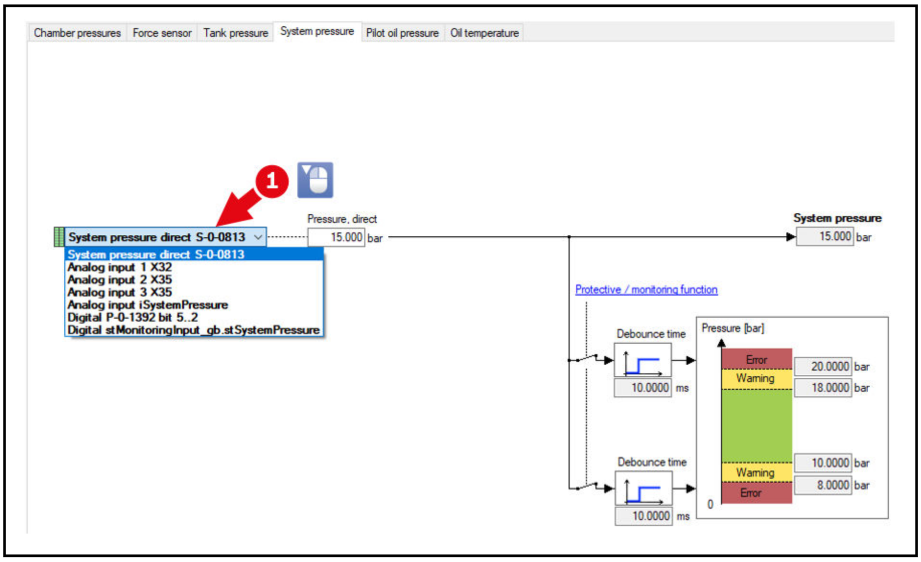


Fig. 7-50: Signal selection parameter using the example of system pressure

If the parameter is written via the master communication, signal processing must be handled completely externally (scaling, filtering, wire break monitoring, ...). How to configure the master communication is described in chapter chapter 7.2.1 "Master communication" on page 114.

If an assignment of the analog inputs of the IndraDrive firmware is used, the signals are processed in the IndraDrive firmware. For configuration, follow the steps below:

1. Select the analog input (analog input 1 can only be used for voltage signals)
2. Select the assignment

☞ Assignment A has a cycle time of 0.5 ms, assignments B and C have a cycle time of 2 ms.

---

3. Select the parameters of the signal
4. Select the signal type of the sensor
5. Configure scaling of the signal (support by automatic calibration possible)
6. Configure filtration of the signal (excessive filtration of the signals can reduce the control dynamics)
7. For current sensors with a measuring range of 4 - 20 mA, wire break monitoring can be activated

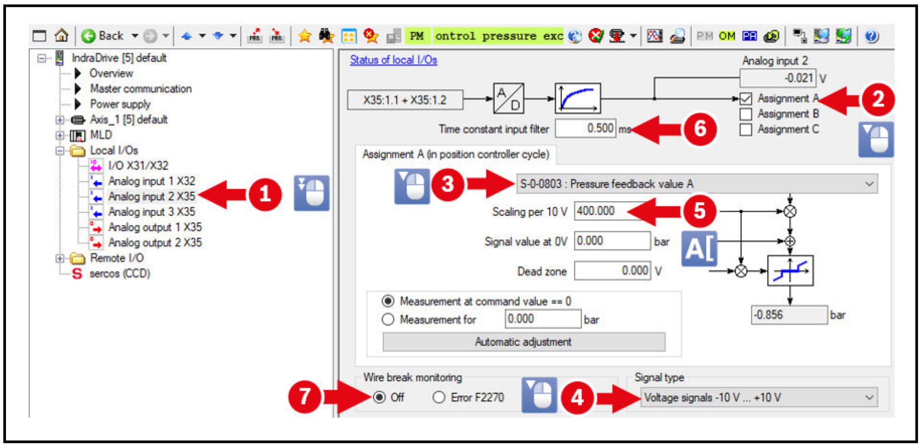


Fig. 7-51: Assignment of analog inputs at analog input 2 with assignment A

Signal selection for analog input

Since only three assignments are available for up to five analog inputs and the cycle time of assignments B and C may be too long, the analog inputs can also be read via the technology function. The current or voltage value of the selected analog input is read and scaled within the required cycle time. For diagnostic purposes, the scaled value is output via the parameter of the signal.

For assigning the analog inputs via the technology function, the number of the analog input, 1 - 5, has to be entered in the relevant signal selection parameter.

For configuration, follow the steps below:

1. Select the analog input via signal selection
2. Select the signal type of the sensor
3. Configure scaling of the signal (if applicable, select a preconfigured sensor)
4. Configure filtration of the signal (excessive filtration of the signals can reduce the control dynamics)
5. For current sensors with a measuring range of 4 - 20 mA, wire break monitoring can be activated

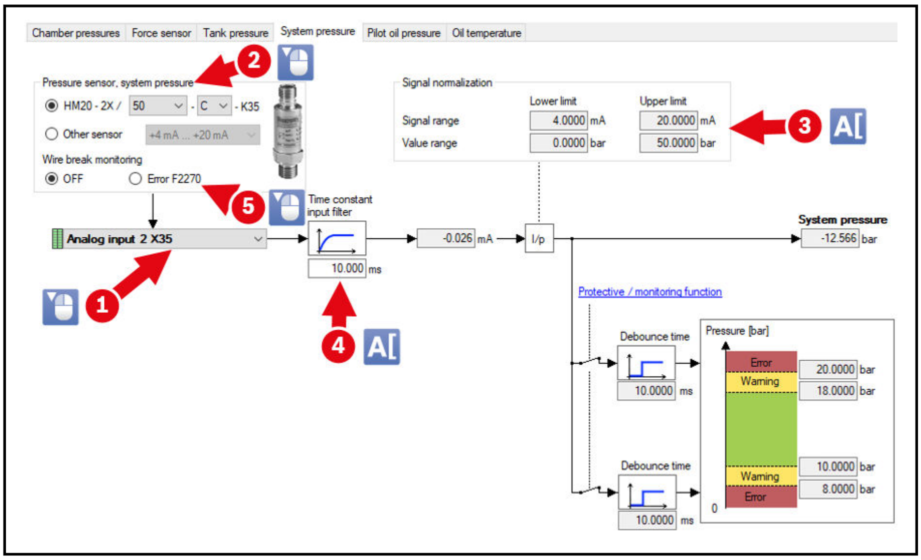


Fig. 7-52: Signal selection of the analog input using the system pressure as an example

Signal selection for PLC variable

In addition to the analog inputs of the IndraDrive, external IOs can be read via a CCD master (see also chapter 5.3 "Electrical system characteristics" on page 24). For this purpose, a PLC variable (16 bits integer), which can also be used for a user project, is available for each analog input signal (see also chapter 7.3.3 "User project (*.xiwp + *.compiled-library)" on page 164).

The PLC variables can be assigned to the analog inputs in the configurator.

> If the analog terminals have another data format, an adjustment is required in the PLC program.

> The PLC variables are read by the technology function within the cycle of individual signal processing. The refresh time of signals is, however, limited by the CCD cycle time and the refresh rate of the IO terminals.

The assignment is made in the configuration of the IO terminal in the following steps:

1. Select the dialog “I/O mapping”.
2. Open the Input Assistant for the analog input
3. Select the variable from the library "Position_Force_Control" in the folder "FWS-MLDSYx-PFC", global variable list "Global_Interface".

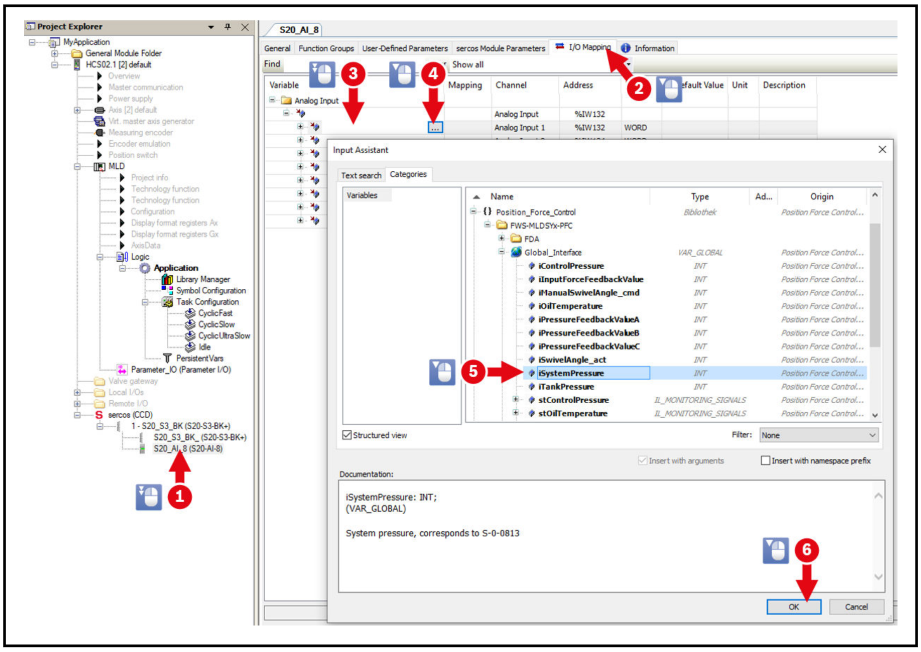


Fig. 7-53: Selection of a PLC variable using the example of system pressure and S20 bus coupler

For using the PLC variables, the value "6" has to be entered in the signal selection parameter. The value of the PLC variables is read, monitored for limit values, scaled and filtered within the required cycle time. For diagnostic purposes, the scaled value is output via the parameter of the signal.

For configuration, follow the steps below:

1. Select the PLC variable via the signal selection
2. Configure the signal limitation (usually, invalid signal ranges are specified for analog terminals in order to display wire breaks, for example)

3. Configure scaling of the signal (in this case, the signal range has to be configured in the process data format of the analog terminal)
4. Configure filtration of the signal (excessive filtration of the signals can reduce the control dynamics)

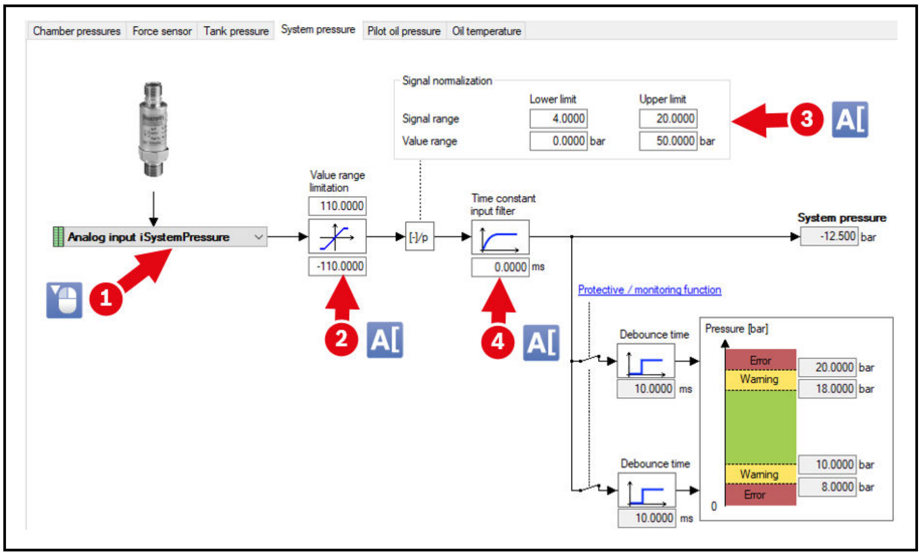


Fig. 7-54: Signal selection of PLC variable using the example of system pressure

7.2.11 Digital interfaces

Digital outputs are required to activate and control valves. Monitoring signals can be read as digital signals.

Valve activation

The valves are activated using the parameters P-0-1410 and P-0-1411.

Bit	Name/function
0	Chamber A enable
1	Chamber B enable
2	Rapid mode, cylinder
3	Press mode, cylinder

Tab. 7-3: Structure of valve switching word 1 (P-0-1410)

Bit	Name/function
0	**Extending** cylinder
1	**Retracting** cylinder
2	**Rapid mode**, pump (swiveling out to V_max)
3	**Press mode**, pump (swiveling in to V_min)
4	**Decompression** valve on cylinder B-side
5	**Decompression** valve on cylinder A-side

Tab. 7-4: Structure of valve switching word 2 (P-0-1411)

Activation of LED

LEDs for displaying the current operating states can be activated via parameter P-0-1412.

Bit	Name/function
0	LED activation: Red
1	LED activation: Green
2	LED activation: Blue

Tab. 7-5: Structure of the activation of special functions (P-0-1412)

Reading of digital monitoring signals

The digital monitoring signals can be read via parameter P-0-1392. For system pressure, pilot oil pressure and oil temperature, the digital monitoring systems can be read alternatively to the analog input variables. To be able to use the monitoring signals from parameter P-0-1392, the value "7" has to be entered in the signal selection parameter of the relevant signal. See also chapter 7.4.4 "Sensor data" on page 191

Bit	Name/function
0	Filter clogging ≥ 75 %
1	Filter clogging ≥ 100 %
2	Monitoring for system pressure too high, warning signal
3	Monitoring for system pressure too high, alarm signal
4	Monitoring for system pressure too low, warning signal
5	Monitoring for system pressure too low, alarm signal
6	Monitoring for pilot oil pressure too high, warning signal
7	Monitoring for pilot oil pressure too high, alarm signal
8	Monitoring for pilot oil pressure too low, warning signal
9	Monitoring for pilot oil pressure too low, alarm signal
10	Monitoring for oil temperature too high, warning signal
11	Monitoring for oil temperature too high, alarm signal
12	Monitoring for oil temperature too low, warning signal
13	Monitoring for oil temperature too low, alarm signal
15/14	Unassigned

Tab. 7-6: Structure of the activation of special functions (P-0-1412)

For various monitoring functions, PLC structures are available as an interface. To be able to use the monitoring signals from the PLC structures, the value "8" has to be entered in the signal selection parameter of the relevant signal. The following structures of type IL_MONITORING_SIGNALS are available in the global variable list "Application.Position_Force_Control.Global_Interface":

Signal	Structure instance	Structure elements	Meaning
System pressure	stSystemPressure	bWarningTooHigh	Warning signal, system pressure too high
		bAlarmTooHigh	Alarm signal, system pressure too high
		bWarningTooLow	Warning signal, system pressure too low
		bAlarmTooLow	Alarm signal, system pressure too low
Pilot oil pressure	stControlPressure	bWarningTooHigh	Warning signal, pilot oil pressure too high
		bAlarmTooHigh	Alarm signal, pilot oil pressure too high
		bWarningTooLow	Warning signal, pilot oil pressure too low
		bAlarmTooLow	Alarm signal, pilot oil pressure too low
Oil temperature	stOilTemperature	bWarningTooHigh	Warning signal, oil temperature too high
		bAlarmTooHigh	Alarm signal, oil temperature too high
		bWarningTooLow	Warning signal, oil temperature too low
		bAlarmTooLow	Alarm signal, oil temperature too low

Tab. 7-7: PLC structures for digital monitoring signals

The current state of the signals is output via parameter P-0-1413 for diagnostic purposes, in particular in order to indicate the state of the PLC structures via IndraWorks Ds or record it in the oscilloscope.

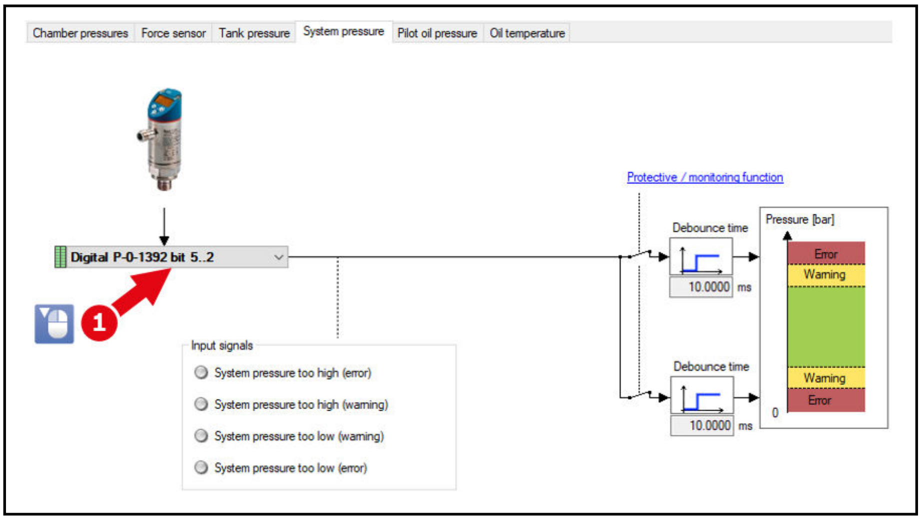


Fig. 7-55: Signal selection of PLC variable using the example of system pressure

Configuring the digital inputs/outputs in IndraWorks

The logical states of the required bits have to be assigned to the digital outputs of IndraDrive. For this purpose, select connectors with pin (2), parameter (3) and bit number (4). If outputs are to be utilized, they have to be activated (5).

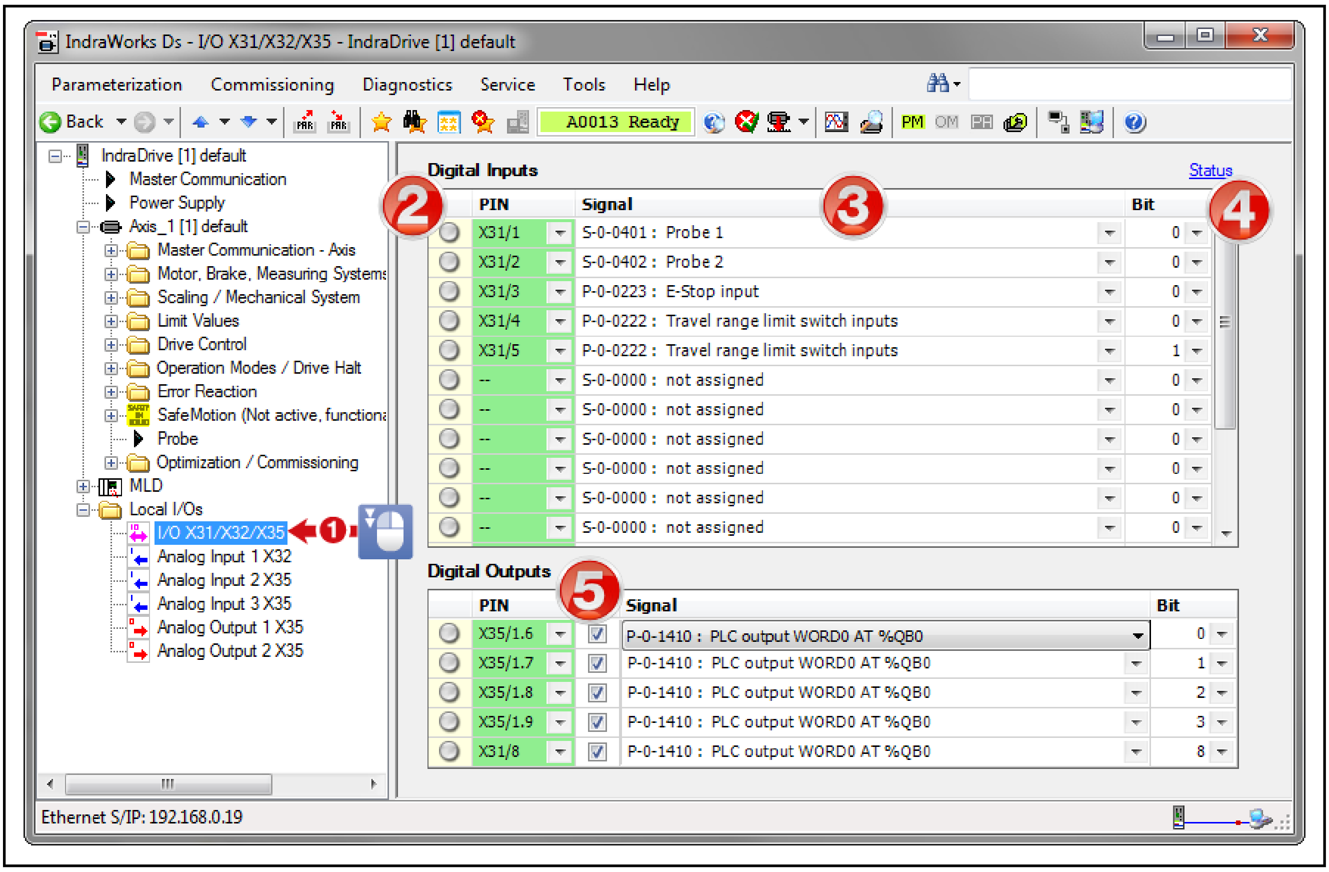


Fig. 7-56: Assignment of digital inputs/outputs

Configuring the digital inputs/outputs of external IO terminals

In the configurator you can assign the elements of the PLC structures of the relevant signal to the input of the terminal. The assignment is made in the configurator of the IO terminal in the following steps:

1. Select the dialog “I/O mapping”.
2. Open the Input Assistant for the analog input
3. Select the structure element from the library "Position_Force_Control" in folder "FWS-MLDSYx-PFC" in the global variable list "Global_Interface".

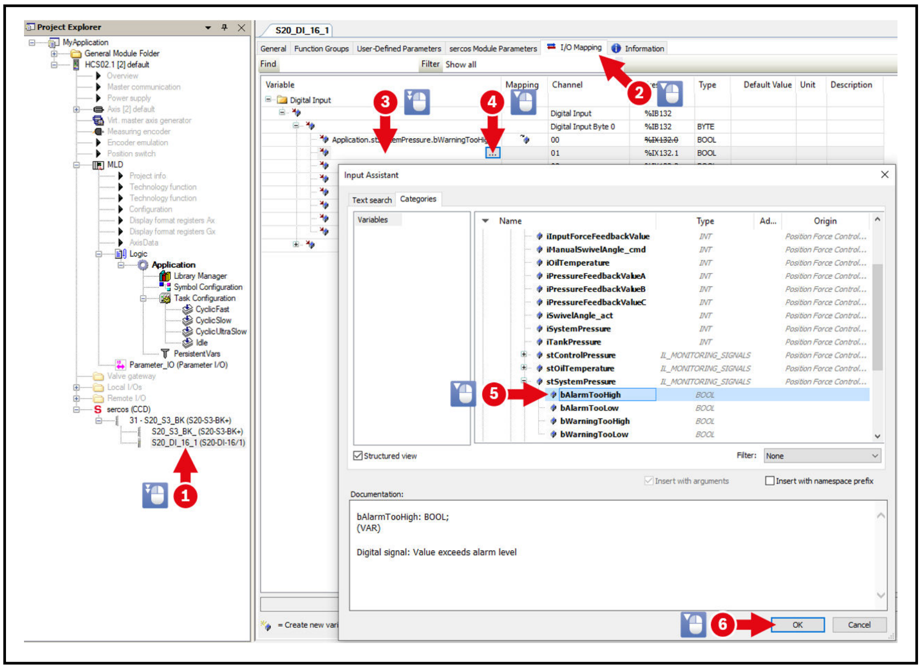


Fig. 7-57: *Signal selection of a PLC structure element when digital signals are used is explained using the example of system pressure and an S20 bus coupler*

The PLC variables are read by the technology function within the cycle of individual signal processing. The refresh time of signals is, however, limited by the CCD cycle time and the refresh rate of the IO terminals.

7.3 Loading the PFC project

7.3.1 General

To access the PFC dialog, the software/parameter file has to be loaded first. This is the case in the condition as supplied. For updating, the software/parameter file can be reloaded and is available as a ready-made solution (loadable compiled MLD project). No PLC programming knowledge is required, because the complete PFC function can be accessed via the dialogs in IndraWorks. In addition, it is possible to add your specific code to a user project. Depending on the application, different files have to be loaded.

Application	File	Storage location	Comment
Boot application	Application.app + Application.crc	microSD card	Memory card is always included in the scope of supply
User project	FWS_MLDSYx_PFC_03*.compiled-library + Application_4UserProject_PFC_03*.iwx	microSD card	Memory card has to be ordered separately

Tab. 7-8: *PFC applications and boot project formats*

The individual handling is described in the following chapters.

When the firmware function "Load basic parameters" is used, the boot application is deleted on the microSD card. If it is necessary to utilize the function "Load basic parameters" first remove the MicroSD card from the control section or make otherwise sure that the data are not lost. One suitable option may be the "Backup/restore function" of the firmware.

The "Backup/restore function" of the firmware can be used to save the boot application and the configuration of the axis. When "Load basic parameters" is being executed these data are archived separately on the microSD card and can be restored, if necessary.

For more detailed information, see chapter 9 "Annex" on page 505.

7.3.2 Boot application (*.app + *.crc)

The boot application is stored on the microSD card.

Fig. 7-58: ADVANCED control panel HAP01.1A

The files “Application.app” and “Application.crc” have to be stored in the folder "PLC” on the memory card. For this purpose, a card reader or an FTP connection to the IndraDrive may be used. In the condition as supplied the files are already stored on the memory card.

Using the memory card as storage location of the boot project has to be set in the MLD configuration. To activate the stored project the device has to be restarted.

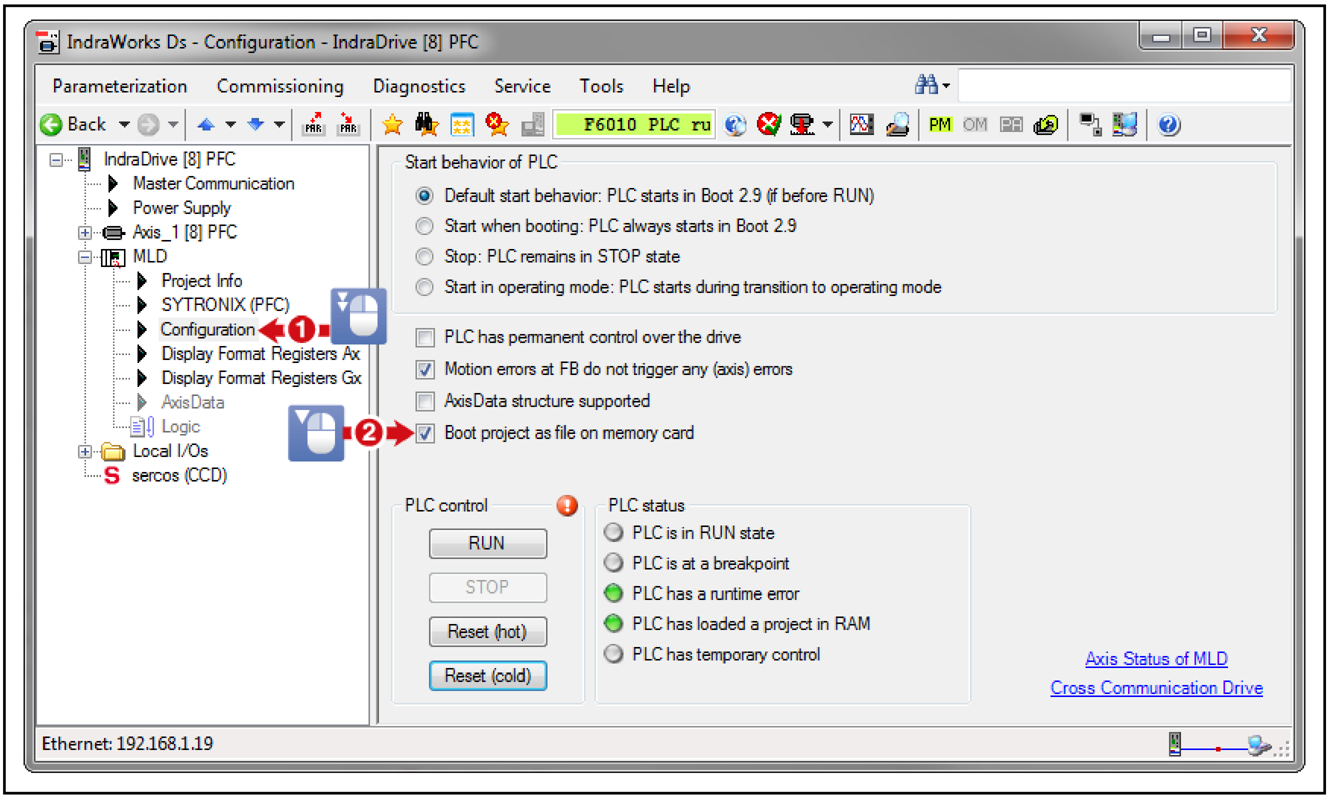


Fig. 7-59: Configuration for using the memory card as storage location of the boot project

☞ The technology function uses retain data. The retain data are overwritten when the program is loaded. This causes a runtime error of the drive-integrated PLC (F6010).

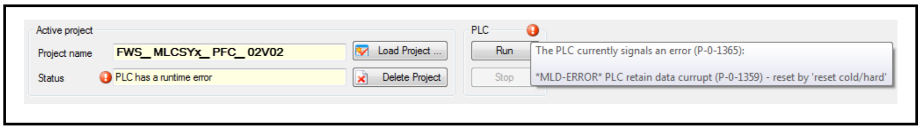


Fig. 7-60: Error F6010 when loading the program

Remedy:

1. Call MLD configuration
2. Execute "RESET (cold)"
3. Set MLD to "RUN"

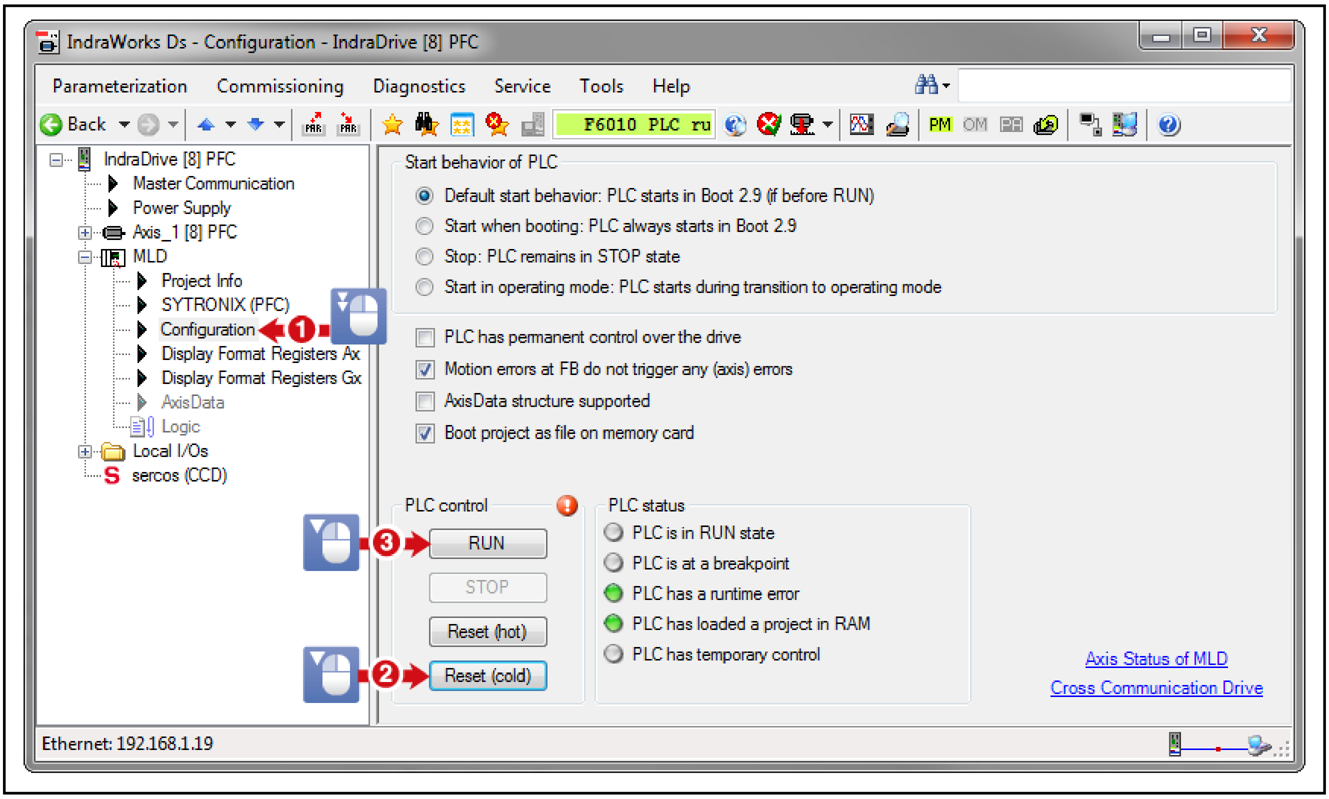


Fig. 7-61: Remedy for error F6010 when loading the program

Checking the loaded MLD program:

1. To have the active MLD program and its status displayed, click "Project info" under the MLD branch in IndraWorks.
2. Here, the loaded software/parameter file can be verified and it can be made sure that the program is running ("RUN" status).
3. When the identifier of the technology function "PFC03V..." is displayed (cf. P-0-1381), the "SYTRONIX (PFC)" dialog appears in the project tree.

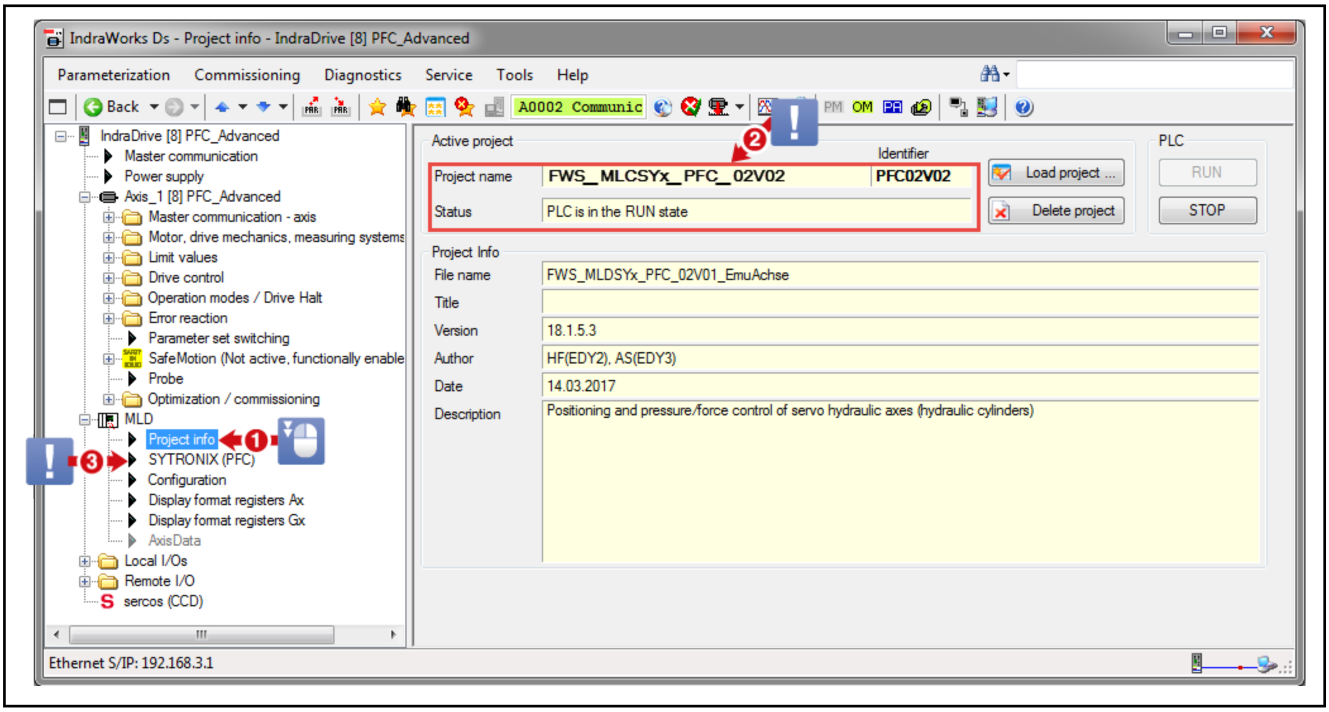


Fig. 7-62: Project info EXTENDED

When the boot application is used, the button “Load project ..." must not be selected.

7.3.3 User project (*.xiwp + *.compiled-library)

A user project allows an application-related PLC code to be implemented that runs in parallel with the technology function. To be able to store the technology function and the extended application on the IndraDrive, a microSD card is required in the relevant slot of the control panel.

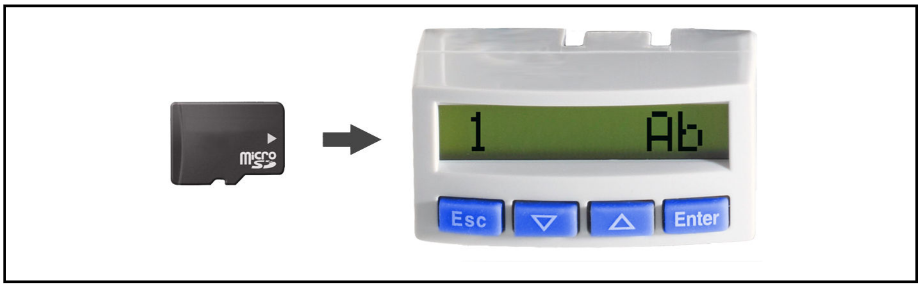


Fig. 7-63: ADVANCED control panel HAP01.1A

Using the memory card as storage location of the boot project has to be set in the MLD configuration. For activating, the device has to be restarted.

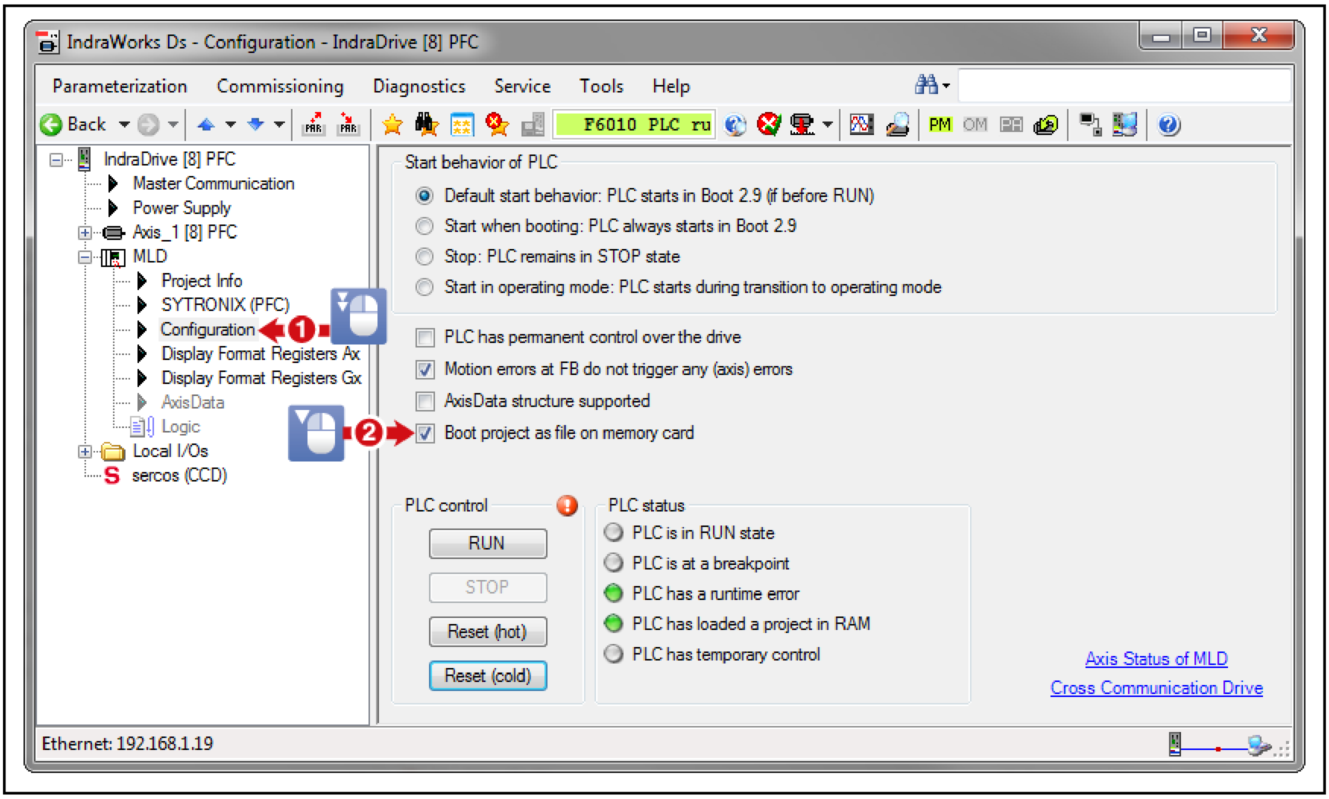


Fig. 7-64: Configuration for using the memory card as storage location of the boot project

To have a freely available interface to IndraDrive, some MLD registers as well as inputs and outputs have been reserved for application-related purposes. These registers are not overwritten by the technology function.

Free, volatile MLD registers:

- A25...A29 (P-0-1295...P-0-1299)

Free, non-volatile MLD registers:

- G25...G30 (P-0-1325...P-0-1329)

Free MLD inputs (volatile):

- %IB30...%IB38 (P-0-1405...P-0-1409)
- %IB104...%IB120 (P-0-1441...P-0-1445)

Free MLD outputs (volatile):

- %QB30...%QB38 (P-0-1425...P-0-1429)

The structure of the user program is described in the following steps. For this, the IndraWorks MLD commissioning software (at least version 15V14) is required.

To begin with, the "Logic" branch has to be created.

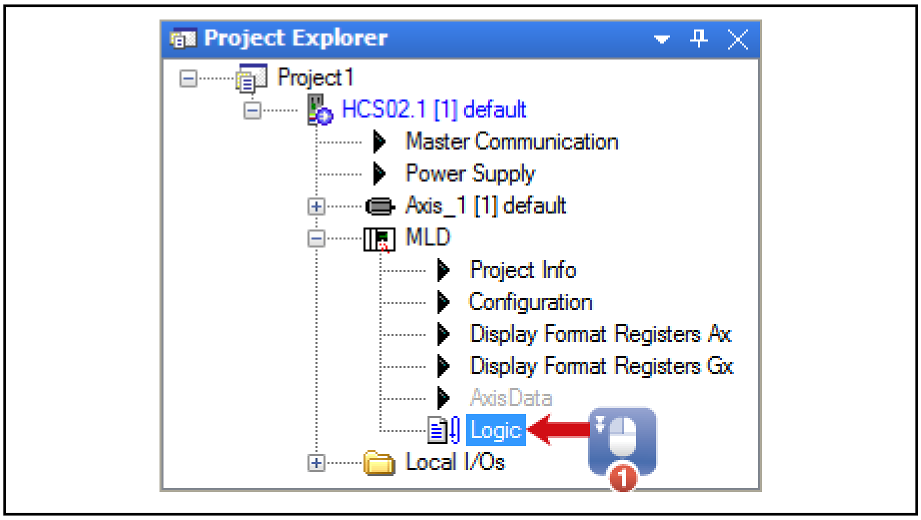


Fig. 7-65: Creating the logic branch

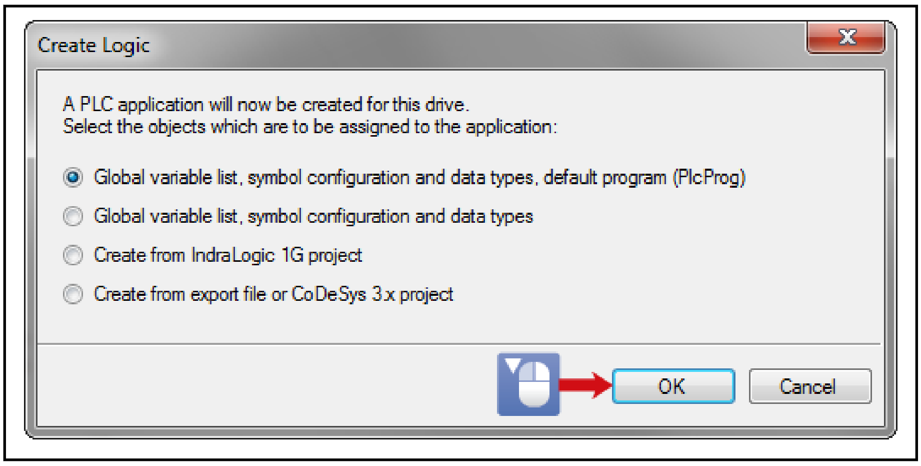


Fig. 7-66: Creating the logic

Libraries

Add the **Position Force Control (20.3.x.x)** library to the library manager.

For this purpose, first install **Position Force Control (20.3.x.x)** via the library repository.

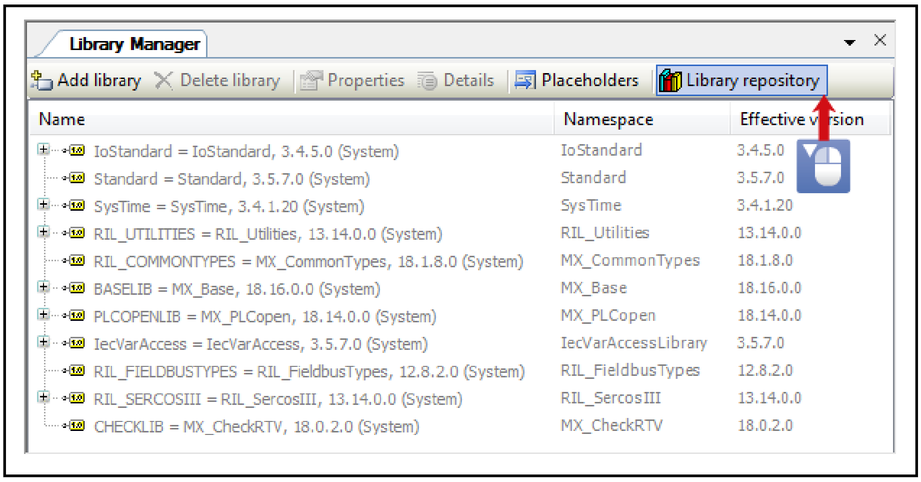


Fig. 7-67: Installing via library repository

Specify the repository path of the file "FWS-MLDSYx-PFC-03V**-D0-MP20-**.compiled-library" in the installation dialog.

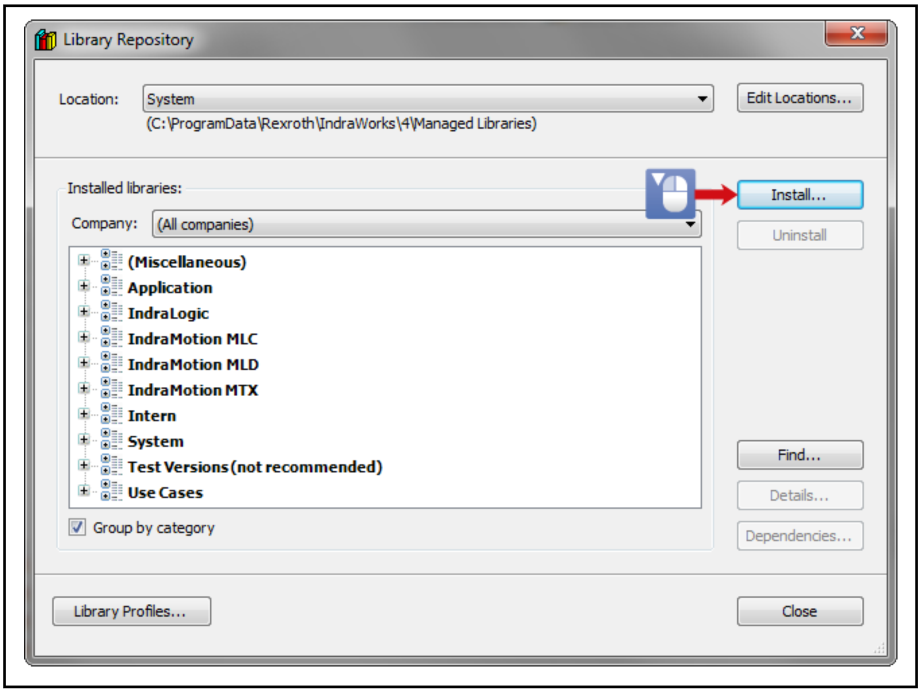


Fig. 7-68: Installing via library repository

Upon successful installation, the "Position Force Control" library is listed in the library repository.

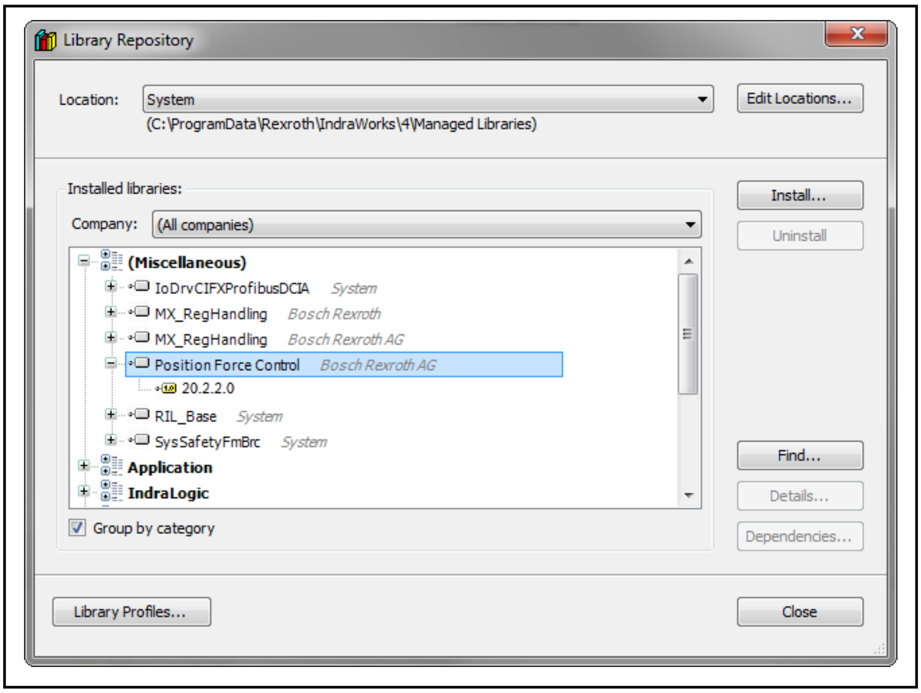


Fig. 7-69: "Position Force Control" library listed in the library repository

It is now possible to include all the additionally required libraries in the library manager.

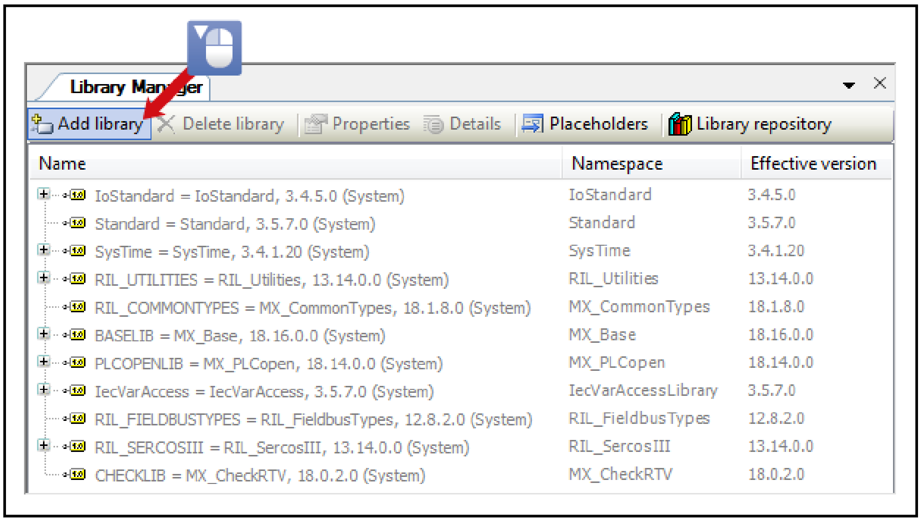


Fig. 7-70: Adding a library

Task configuration

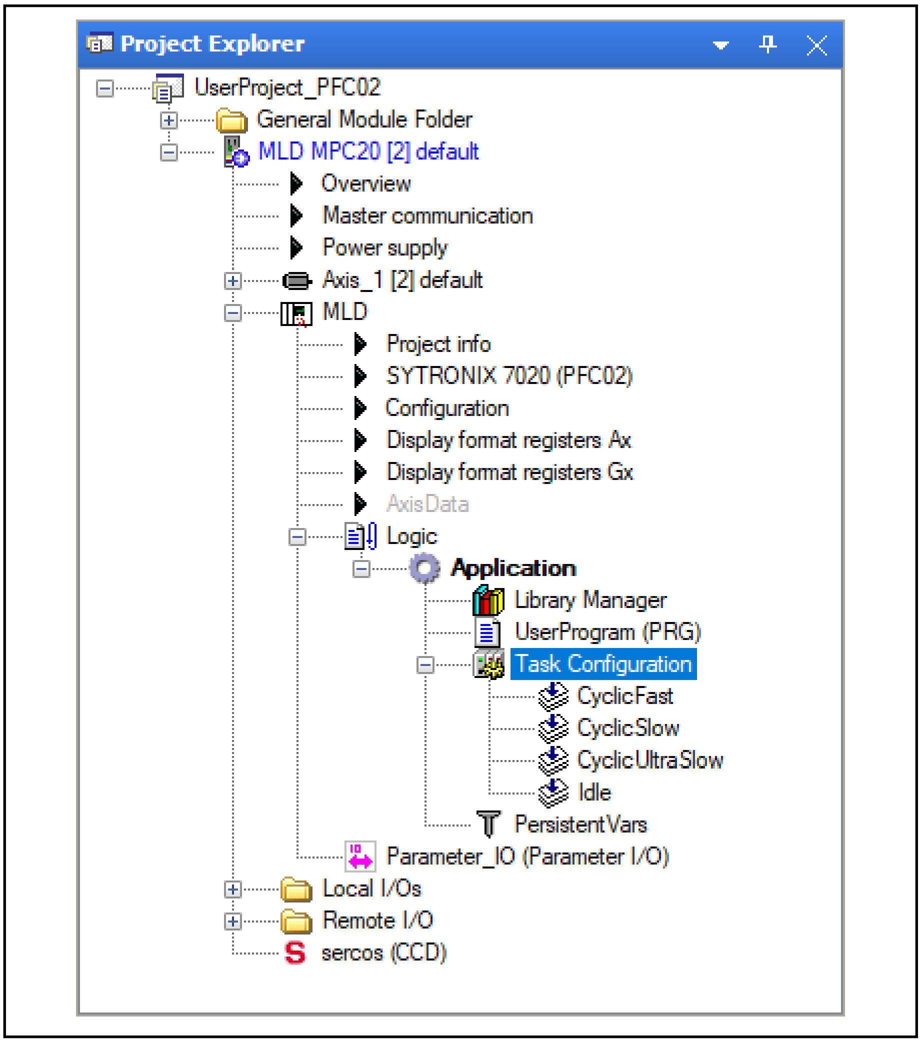


Fig. 7-71: Task configuration

The task configuration has to have the following structure:

Task	Priority	Type	Interval	Watchdog (sensitivity)	Appended POUs
CyclicFast	0	Cyclic	1 ms	1 ms (3)	TaskCyclicFast
CyclicSlow	1	Cyclic	20 ms	20 ms (3)	TaskCyclicSlow
CyclicUltraSlow	2	Cyclic	200 ms	200 ms (3)	RegisterMapping TaskCyclicUltraSlow
Idle	3	Freewheeling	Acyclic	-	TaskIdle

Tab. 7-9: Task configuration structure

Persistent variables

☞ The task configuration, persistent variables and the library manager can also be imported from the file “Application_4UserProject_PFC_03Vxx.iwx”.

☞ If the cycle time of the fast task (TaskCyclicFast) is changed to a value greater than 1 ms, this also has to be specified in the controller cycle time "P-0-1311[177], PFC cycle time".

7.4 Commissioning PFC

7.4.1 Basic settings

In order for the technology function to work without errors, it is obligatory to make various basic settings. They can be loaded using a basic parameter file (BasicConfiguration_PFC_03V**.par) specific to the technology function. This file includes the following parameters with recommended values:

Parameter	Function	Recommended value	Value in basic parameter file
P-0-1311[177]	Cycle time of the fast MLD task (PFC controller clock cycle)	2 ms	2 ms
P-0-2943	Pump displacement	Pump displacement	10 cm³
S-0-0828	Maximum pressure command value	300 bar	250 bar
P-0-1311[101]	Minimum pressure command value	5 bar	5 bar
P-0-1311[102]	Maximum force command value	100,000 N	100,000 N
P-0-1311[103]	Minimum force command value	- 100,000 N	- 100,000 N
P-0-1311[116]	Lag error monitoring: Reference velocity	Cf. S-0-0091	1000
P-0-1377	Moving mass	Moving mass	100 kg
P-0-1311[131]	Switching factor for rapid mode/press mode	1	1
P-0-1370	Axis structure configuration	Depending on the hydraulic axis	16#04008000
P-0-1372	Configuration, axis controller function	Depending on the application	16#25002000
P-0-1383	Monitoring configuration	Depending on the application	16#00000000

Parameter	Function	Recommended value	Value in basic parameter file
P-0-0113	Bipolar velocity limit value of motor	Maximum pump speed	3000 rpm
P-0-1311[137]	Max. process pressure	Max. process pressure	250 bar
P-0-1311[141]	Elastic modulus	10,000 bar	10,000 bar
P-0-1376	Cylinder volume with closed-loop force control	Cylinder volume	10,000 cm³
S-0-0820	Piston area 1 (A)	Depending on cylinder type	0 mm²
S-0-0821	Piston area 2 (B)	Depending on cylinder type	0 mm²
P-0-1311[135]	Factor for pump switching rapid mode/ press mode	1	1
P-0-1311[138]	Piston area 3	Depending on cylinder type	0 mm²
P-0-1311[139]	Piston area 4	Depending on cylinder type	0 mm²
P-0-1311[192]	Pressure differential for load-dependent feed switching	5 bar	5 bar
P-0-1311[193]	Debounce time for load-dependent feed switching	10 ms	10 ms
P-0-1311[198]	Stiffness of mechanical system	100000 N/m	100000 N/m
P-0-1311[219]	Debounce time for recognizing the load side of single rod cylinders	10 ms	10 ms
P-0-1311[220]	Pressure threshold for recognizing the load side of single rod cylinders	5 bar	5 bar
P-0-1311[221]	Velocity window for recognizing the direction of movement of single rod cylinders	Dependent on the noise of the command velocity from the controller	1 mm/s
P-0-1311[222]	Monitoring of summated pressure: Debounce time	50 ms	50 ms
P-0-1311[223]	Monitoring of summated pressure: Warning threshold	Dependent on pressure resistance of the pump	100 bar
P-0-1311[224]	Monitoring of summated pressure: Alarm threshold	Dependent on pressure resistance of the pump	120 bar
P-0-1311[146],	Critical pressure differential of the pump for detecting high load	Depending on pump type	50 bar
P-0-1311[147]	Speed limit value for detecting low speed	Depending on pump type	200 rpm
P-0-1311[148]	Time limit for operation in B2	Depending on pump type	180000 ms
P-0-1311[149]	Time limit for operation in B1	Depending on pump type	200 ms
P-0-1311[150]	Critical Vg for detecting high load of the pump	Depending on pump type	40 %
P-0-1311[151]	Factor for reducing the commanded Vg in relation to the critical Vg	Depending on pump type	0.8

Tab. 7-10: Basic settings - Parameters with recommended values

7.4.2 Overview

Dialogs specifically developed for the technology function are available to facilitate commissioning. The introductory overview dialog is started using the "SYTRONIX (PFC)" menu item under the "MLD" branch in the IndraWorks tree:

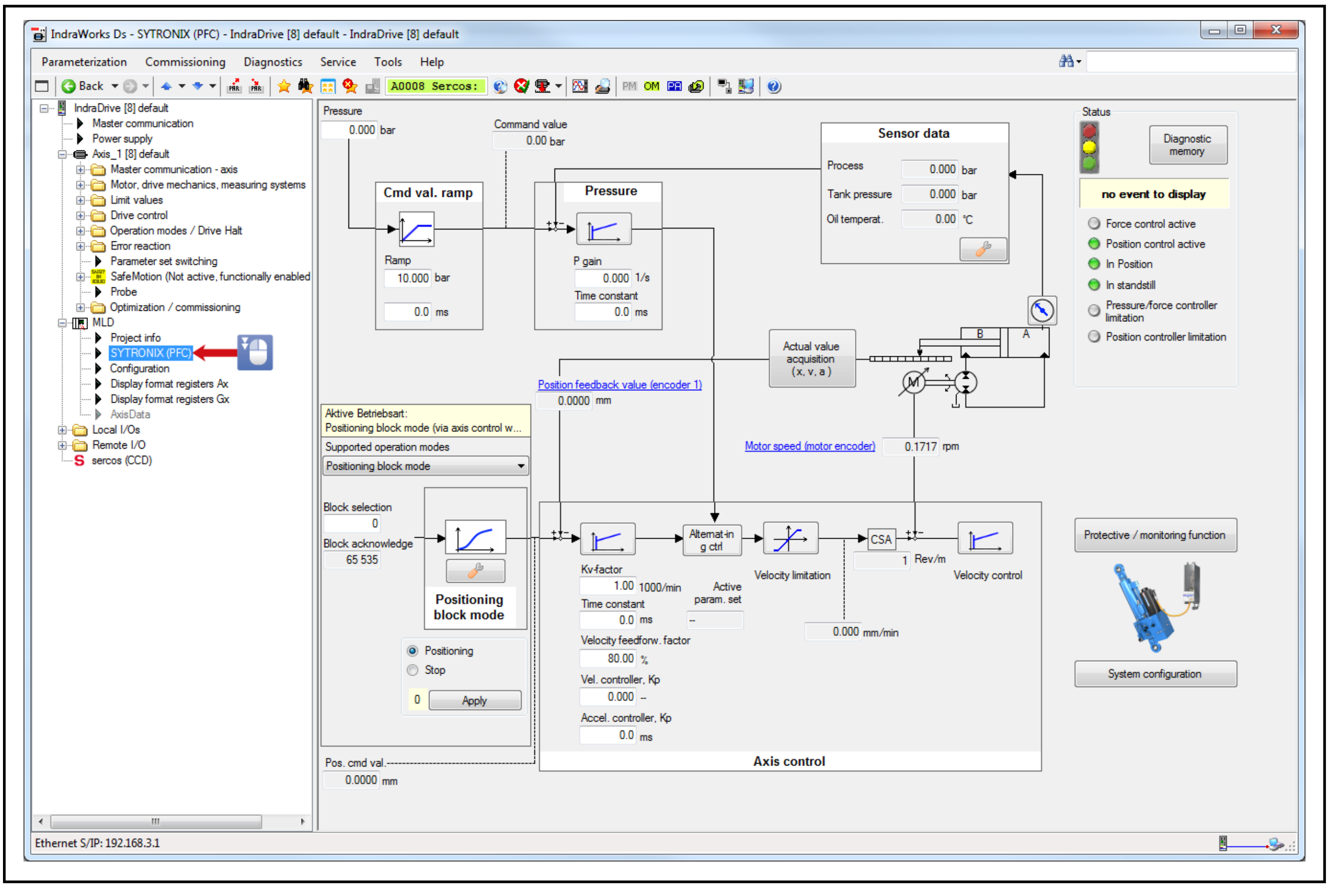


Fig. 7-72: Start dialog of the technology function, PFC

The overview dialog is divided into the following functional areas that provide more detailed dialogs:

1. System configuration
2. IndraDrive operation mode
3. Position controller
4. Pressure/force controller
5. Alternating control
6. IndraDrive velocity/speed limitation
7. IndraDrive velocity/speed controller
8. Actual value acquisition and sensor data
9. Protective functions
10. Diagnostics incl. logbook

From each sub-dialog it is possible to return to the overview dialog using the link in the top left corner.

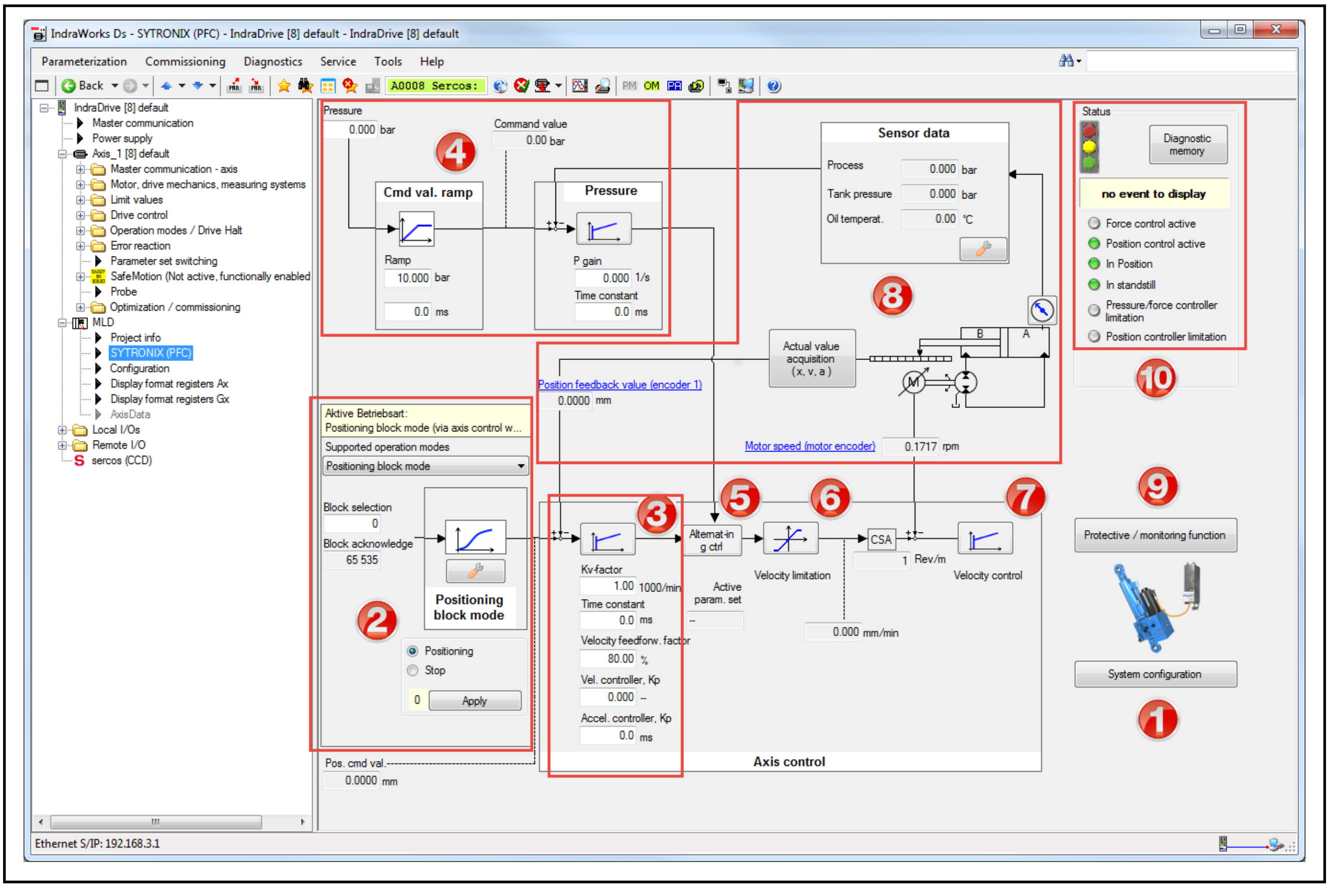


Fig. 7-73: Functional areas

7.4.3 System configuration

Overview

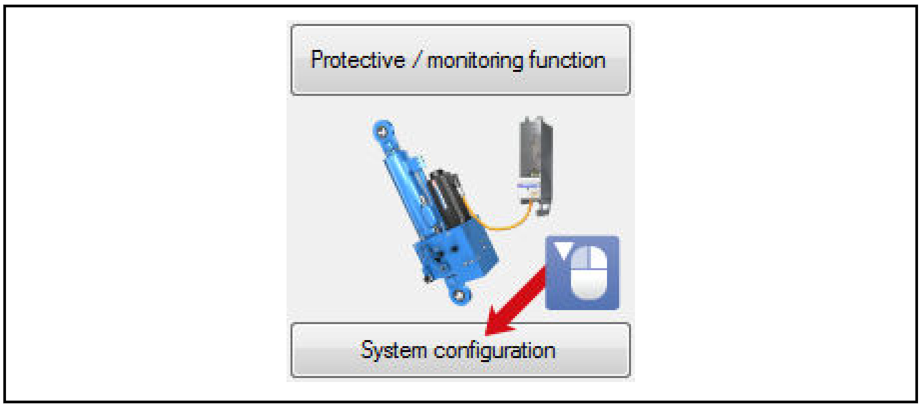


Fig. 7-74: System configuration

The system configuration describes the characteristics and setup of the hydraulic actuator. The configuration is divided into:

1. General type of actuator and hydraulic circuit
2. Cylinder type
3. Pump type
4. Decompression and refilling
5. Valve circuit

6. System pressure increase
7. Isolation and reactivation
8. Symbol-based patch function

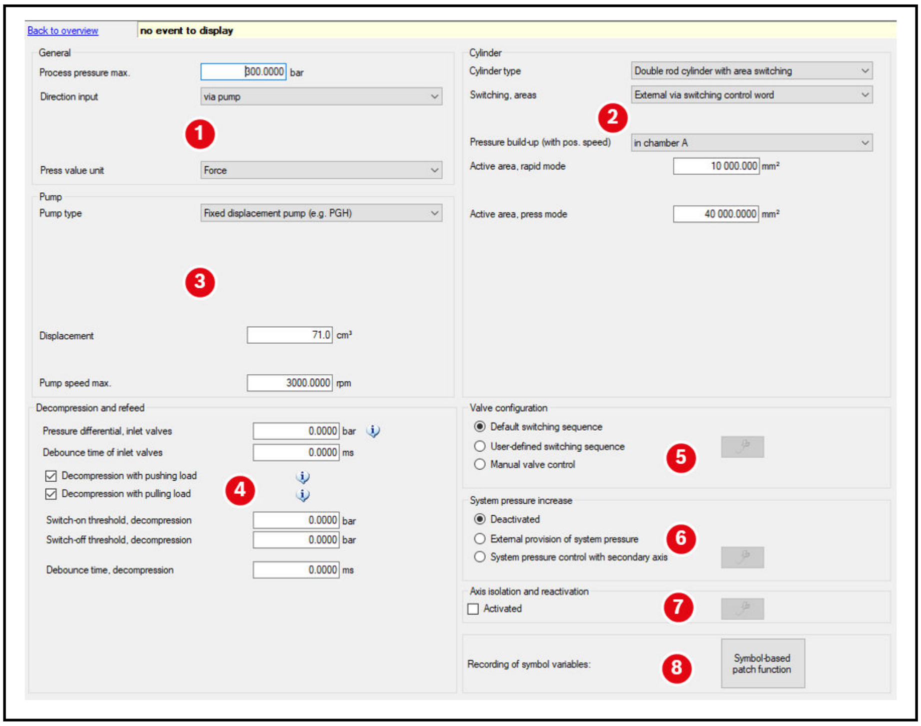


Fig. 7-75: System configuration

These settings are irrelevant for mechanical actuators. For them, merely the following variables have to be entered:

- Feed constant, S-0-0123: from spindle pitch or circumference of the pulley of a belt drive
- If required, gear input and output S-0-0121 / S-0-0122 (may also be included in the feed factor)
- Mechanical stiffness, P-0-1311[198] in N/m: Mechanical transmission ratio specified in the data sheet

General setting

The preset direction of the actuator is usually determined by the type of hydraulic circuit.

In the closed circuit, the direction of motion of the cylinder is put into effect by the pump's direction of rotation (P-0-1370; bit 7 = 0). A 4-quadrant pump displaces the oil from one side of the cylinder to the other.

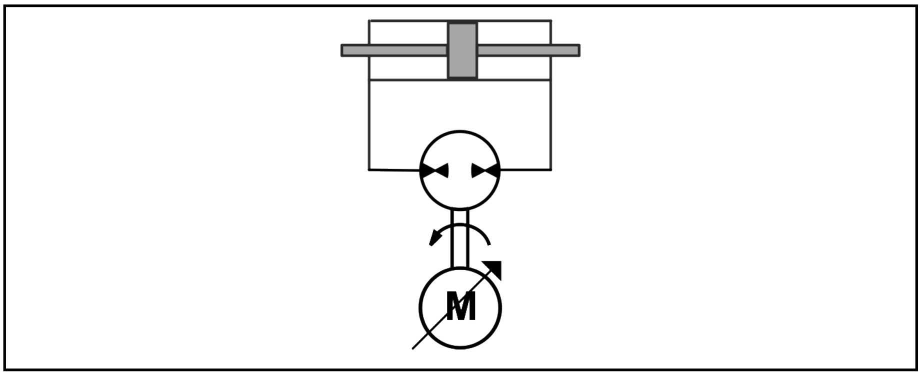


Fig. 7-76: Direction of motion of cylinder via the direction of rotation of the pump in the closed circuit

Alternatively, the direction of motion of the cylinder can be determined via a valve (P-0-1370; bit 7 = 1); in this case, the valve directs the active flow to the relevant cylinder chamber.

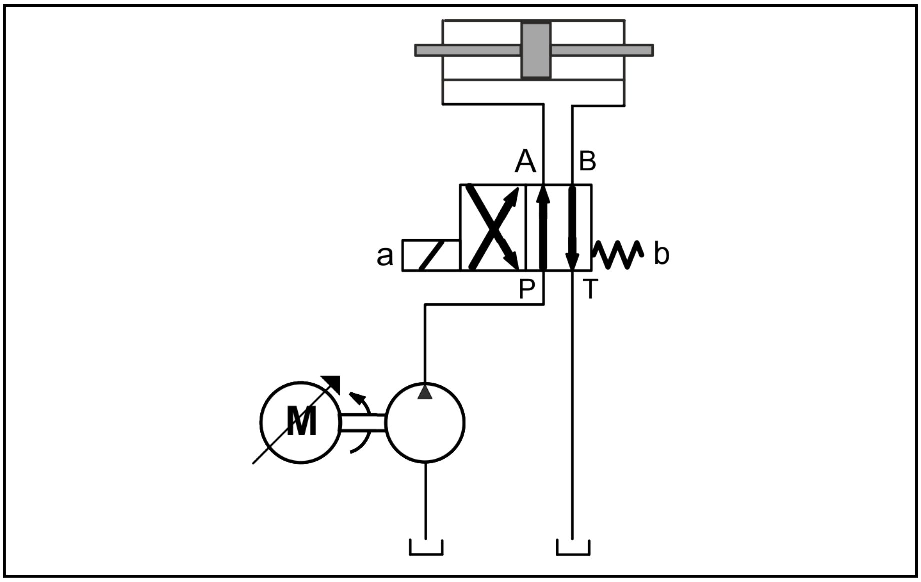


Fig. 7-77: Determination of direction of cylinder movement via valves in the open circuit

A specific, maximum pressure develops (e.g., via pressure relief valves) depending on the application and the setup of the hydraulic system. The maximum possible process force is generated using this pressure. To this end, the maximum pressure has to be set in P-0-1311[137].

Cylinder type

We differentiate between single rod cylinders and double rod cylinders, which can each feature effective area switching for rapid mode und press mode. The distinguishing feature of the cylinder types is the number of areas to be parameterized. For extending the cylinder (flow rate in chamber A) and retracting the cylinder (flow rate in chamber B), different areas may have to be parameterized just as with effective area switching. It is always necessary to parameterize the entire surface effective in the respective mode.

Double rod cylinder

In the case of a simple double rod cylinder, it is only necessary to parameterize one area, since the annular areas for extending and retracting are of the same size.

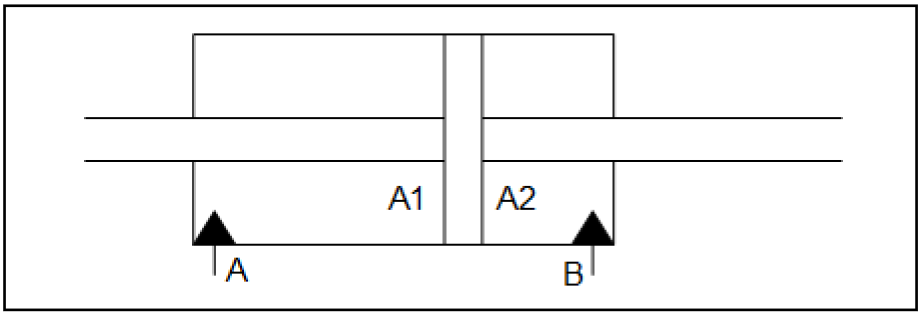


Fig. 7-78: Double rod cylinder

Example:

A1 = A2 = 3000 mm²

Annular area (S-0-0820) = 3000 mm²

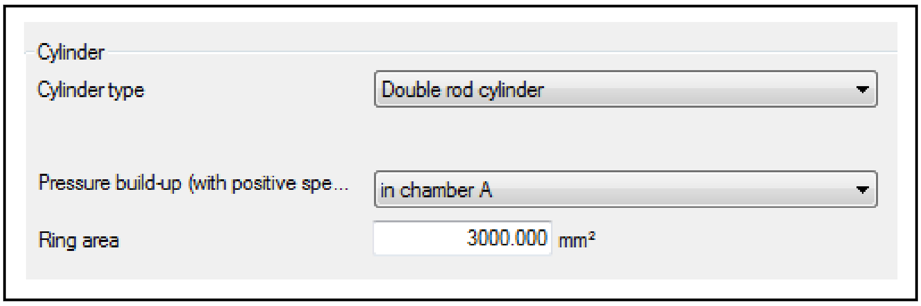


Fig. 7-79: Configuring the double rod cylinder

Single rod cylinder

In the case of a single rod cylinder, it is necessary to parameterize two areas, since the piston area for extending and the annular area for retracting are of different sizes.

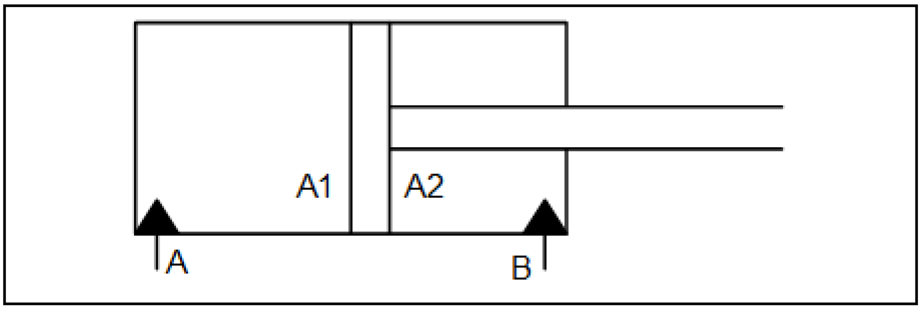


Fig. 7-80: Single rod cylinders

Example:

Piston area (S-0-0820) = A1 = 3000 mm²

Ring area (S-0-0821) = A2 = 2000 mm²

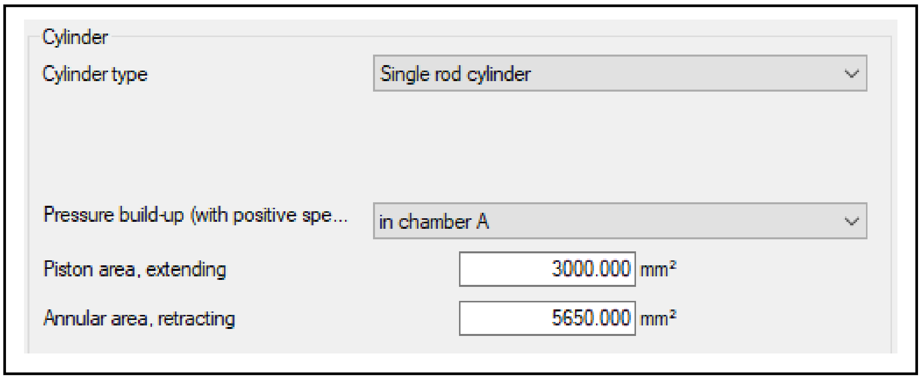


Fig. 7-81: Configuring the single rod cylinder

Switching between the gain factor for the piston area and the annular area can be configured in dependence on the direction or in dependence on pressure via P-0-1370, bits 10...9. In the case of direction-dependent switching, the sign of the controller output (output of alternating control) is evaluated. If it indicates the direction of extension, the piston area becomes active. If it indicates the direction of retraction, the annular area becomes active. In the case of pressure-related switching, the actual values of the pressure on the A-side and on the B-side are compared. If the pressure on the A-side exceeds the sum of the pressure on the B-side and the threshold value in P-0-1311[192], the piston area becomes active. If the pressure on the B-side exceeds the sum of the pressure on the A-side and the threshold value in P-0-1311[192], the annular area becomes active. Switching may also be debounced via P-0-1311[193]. This automatism serves to map pilot operated check valves. For both switching types the chamber of the area currently not active is regarded as "connected to low pressure".

Controlling the effective area switching

There are three different modes for controlling the effective area switching between rapid mode and press mode. They are selected via the configuration of the coordination type (P-0-1372; bits 8/7).

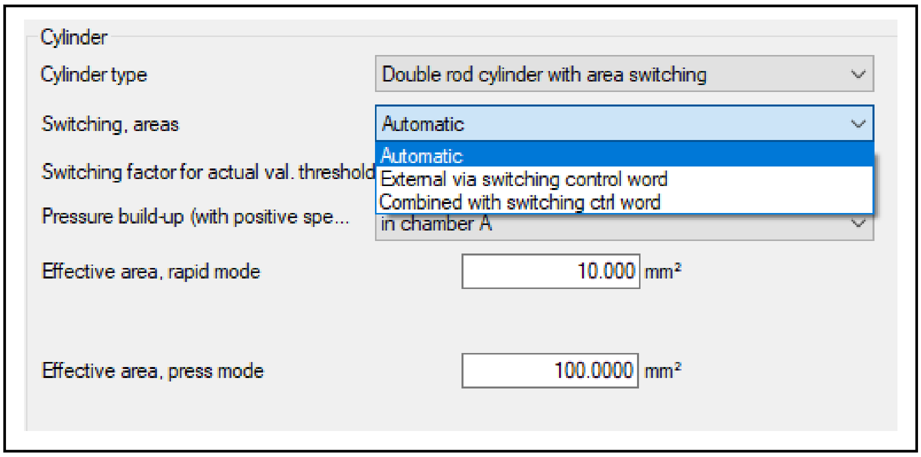


Fig. 7-82: Area switching

- **00:** Direct input via the valve switching control word, P-0-1283; can be made using:
  - Master communication (higher-level control)
  - Digital inputs
  - Application-specific MLD program

- **01:** Automatic mode of the technology function using command values and feedback values of positioning velocity and pressure/force (P-0-1372, bit 6, to be considered).
  - **Rapid mode**, if actual force is small, command force is small (observe P-0-1372; bit 6) and command velocity is high
  - **Press mode**, if actual velocity is small, command velocity is small and command force is large (observe P-0-1372; bit 6)
- **10:** Validation of selection in the control word of valve switching, P-0-1283, via the actual values of speed and pressure
  - **Rapid mode**, if actual force small and activation via control word
  - **Press mode**, if actual velocity small and activation via control word

Double rod cylinder with effective area switching

In the case of a double rod cylinder with effective area switching, it is necessary to parameterize two areas. Although areas of the same size take effect for retracting and extending, the areas for rapid mode and press mode are of different sizes. See also Functional Description: Effective area switching

To get the operating principle of a double rod cylinder, the area of the switchable chamber has to have the size equal to the difference of the areas in the two other chambers.

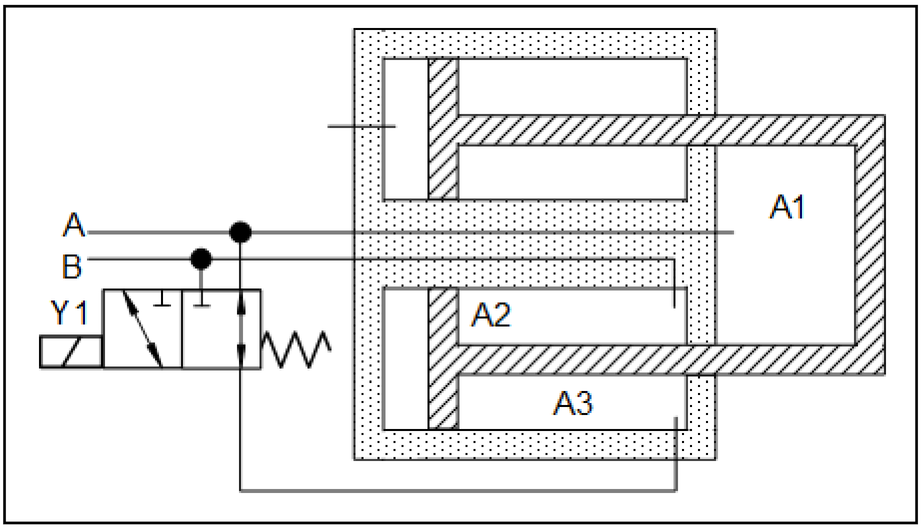


Fig. 7-83: Double rod cylinder with effective area switching

Example:

A1 = A2 + A3

A1 = 3000 mm²

A2 = 2000 mm²

A3 = 1000 mm²

Effective area rapid mode (S-0-0820) = A1 - A3 = A2 = 2000 mm²

Effective area press mode (P-0-1311[138]) = A1 = A2 + A3 = 3000 mm²

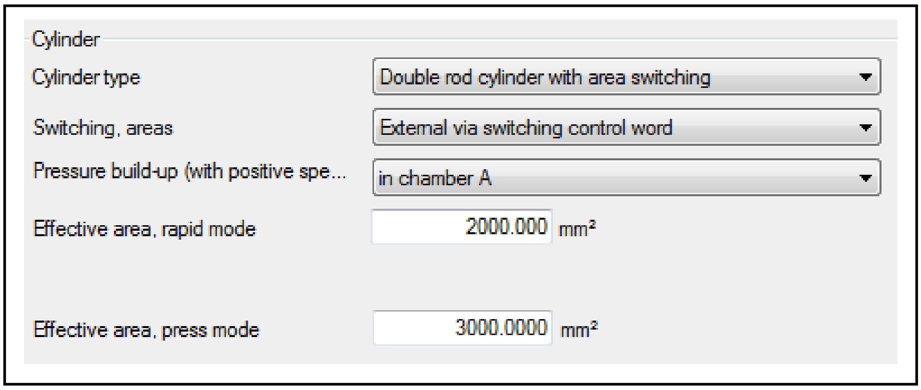


Fig. 7-84: Configuring the double rod cylinder with effective area switching

Single rod cylinder with effective area switching

In the case of a single rod cylinder with effective area switching, it is necessary to parameterize four areas. The areas effective for retracting and extending, as well as for rapid mode and press mode are of different sizes. See also Functional Description: Effective area switching

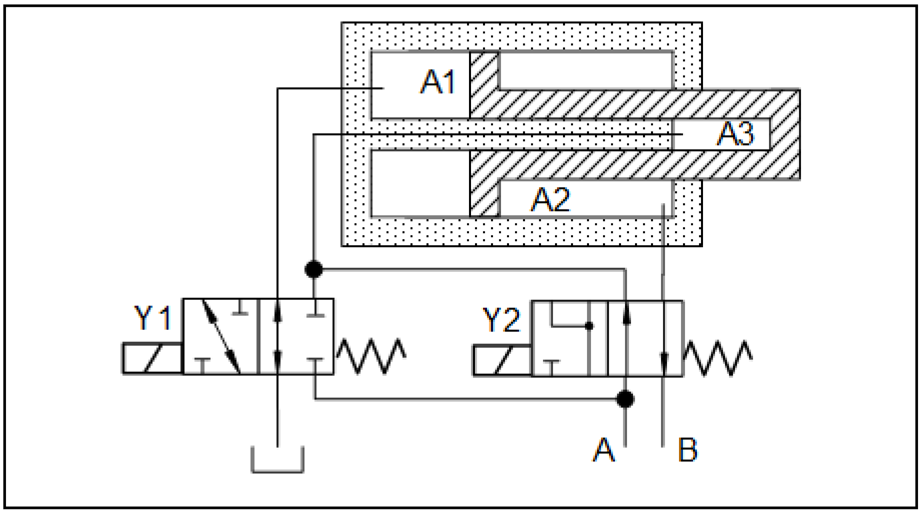


Fig. 7-85: Single rod cylinder with effective area switching

In order that rapid mode and press mode can be implemented for retracting and extending by regenerating the chambers, area A1 has to be larger than area A2, and area A2 has to be larger than area A3.

Example:

A1 > A2 > A3

A1 = 3000 mm²

A2 = 2000 mm²

A3 = 500 mm²

Effective area for extending in rapid mode (S-0-0820) = A3 = 500 mm²

Effective area for retracting in rapid mode (S-0-0821) = A2 - A3 = 1500 mm²

Effective area for extending in press mode (P-0-1311[138]) = A1 + A3 = 3500 mm²

Effective area for retracting in press mode (P-0-1311[139]) = A2 = 2000 mm²

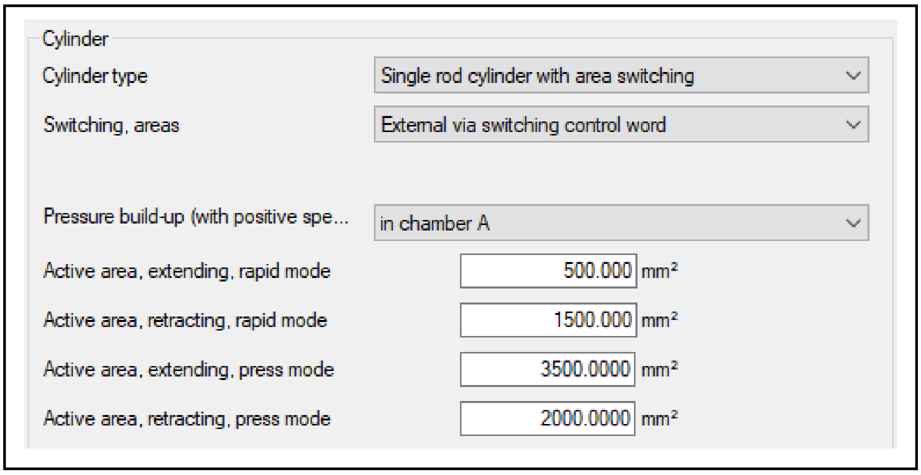


Fig. 7-86: Configuring the single rod cylinder with effective area switching

Activating the valve for switching the effective areas is currently not supported for this circuit. The activation has to be realized externally.

Pump type

The following pump types are supported:

- Pump with 2 or 4 operating quadrants
- Fixed displacement pump
- Variable displacement pump, continuously variable
- Variable displacement pump, two-point control

The mechanical configuration (axial piston, internal/external gear, etc.) does not play a role. The allowed operating regions (2-quadrant, 4-quadrant, etc.) are also irrelevant.

The maximum speed and the maximum acceleration of the pump have to be specified in "P-0-0113, Bipolar velocity limit value of motor" and "P-0-0564, Motor acceleration limit value". This protects the pump.

Fixed displacement pump

Only the displacement has to be entered in the case of a fixed displacement pump.

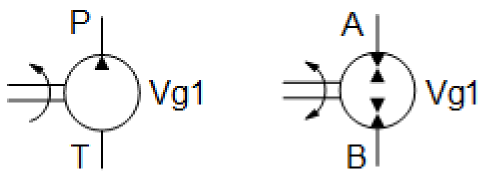


Fig. 7-87: Fixed displacement pump

Example:

Vg1 = 10 cm³/rev

Displacement (P-0-2943) = Vg1 = 10 cm³

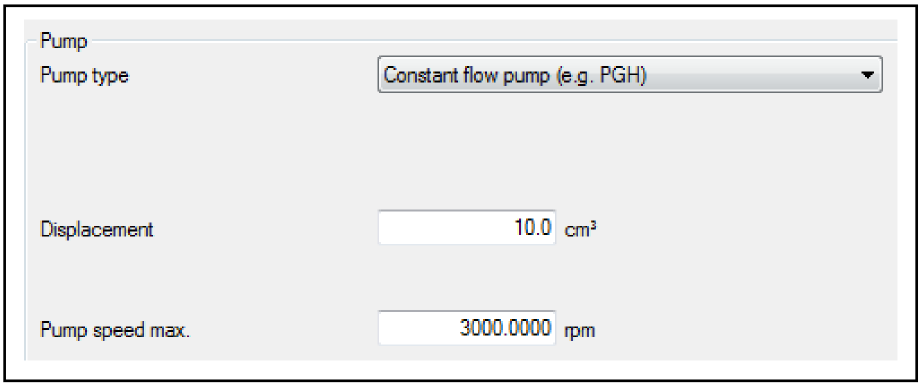


Fig. 7-88: Fixed displacement pump, displacement

Variable displacement pump, continuously variable

In the case of a pump with a continuously variable displacement and external swivel angle control, the minimum and maximum volume are configured. The swivel angle can be controlled by an external controller or by the internal swivel angle command value generator with swivel angle controller. Accordingly, the active displacement can be written externally or the current active displacement is shown (see also chapter 7.4.15 "Closed-loop swivel angle control" on page 232).

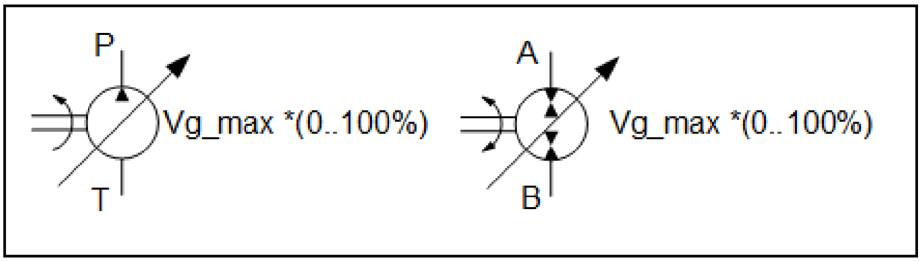


Fig. 7-89: Variable displacement pump, continuously variable

Example:

Vg_max = 10 cm³

Vg_min = 6 cm³

Vg_min ≤ Vg_act ≤ Vg_max

Displacement max. (P-0-2943) = Vg_max = 10 cm³

Displacement min. (P-0-1371) = Vg_min = 6 cm³

Effective displacement (P-0-1275) = Vg_act

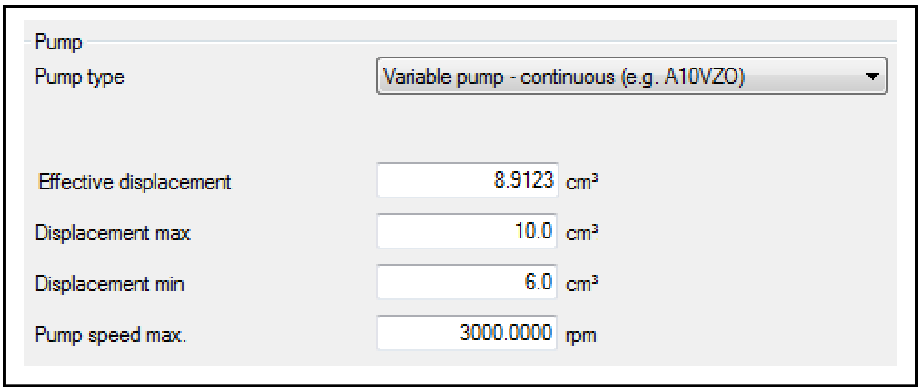


Fig. 7-90: Variable pump, continuous

Variable displacement pump, two-point control

In the case of a pump system with two-point control, only the minimum and maximum volume are configured. The effective displacements are always configured, irrespective of the hydraulic setup of the variable displacement system.

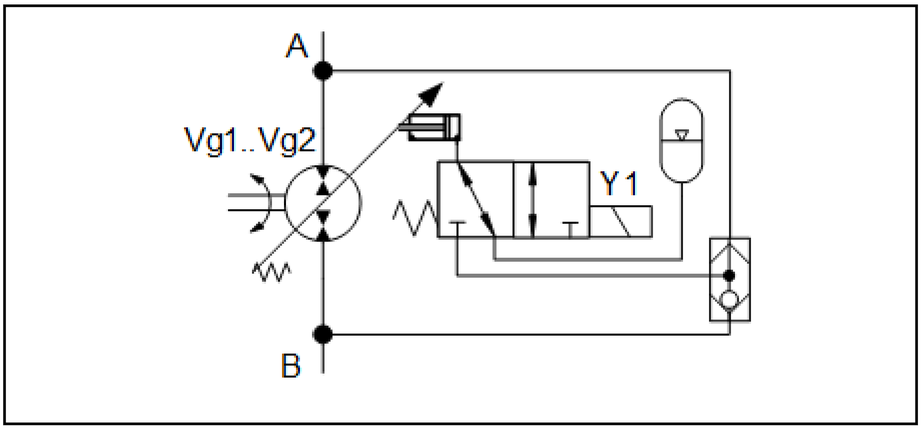


Fig. 7-91: Variable displacement pump with on/off selection

Example:

A pump with two-point control

Vg1 = 10 cm³

Vg2 = 6 cm³

Displacement max. (P-0-2943) = Vg1 = 10 cm³

Displacement min. (P-0-1371) = Vg2 = 6 cm³

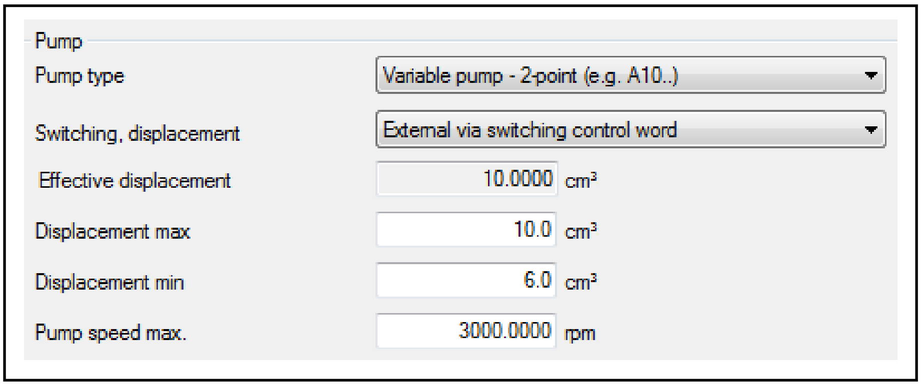


Fig. 7-92: Variable pump, two-point

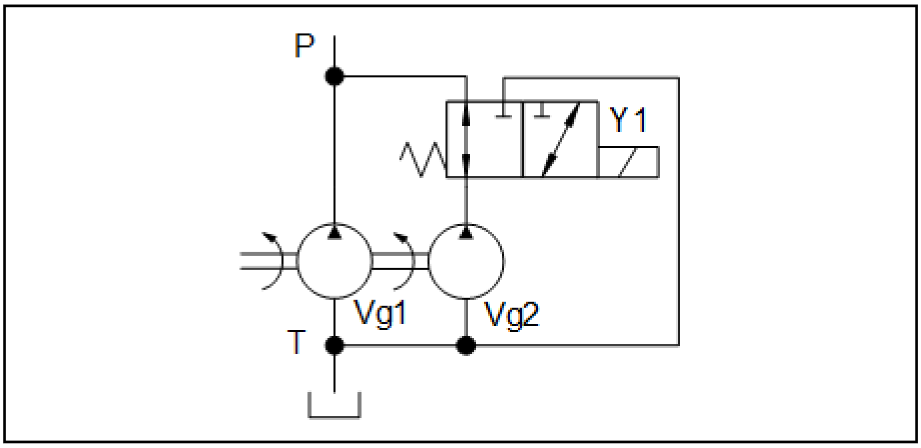


Fig. 7-93: Two pumps, interconnected using a valve

Example:

Two interconnected pumps

Vg1 = 10 cm³

Vg2 = 6 cm³

Displacement max. (P-0-2943) = Vg1 + Vg2 = 16 cm³

Displacement min. (P-0-1371) = Vg1 = 10 cm³

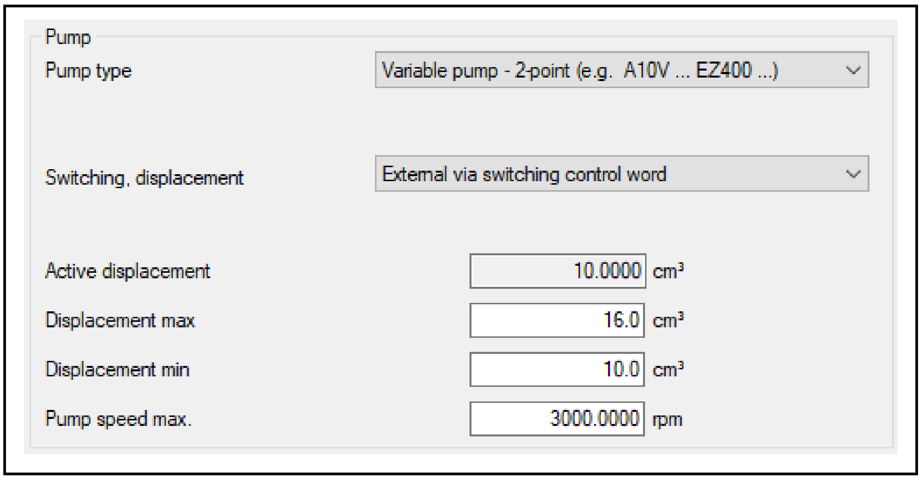


Fig. 7-94: Variable pump, two-point

There are three different modes for controlling the changeover between small and large displacement, which can be selected via the configuration of the coordination type (P-0-1370; bits 14/13).

- 00: Direct input via the valve switching control word, P-0-1283; can be made using:
  - Master communication (higher-level control)
  - Digital inputs
  - Application-specific MLD program
- 01: Automatic mode of the technology function using command values and feedback values of flow and pressure (as of release 02V04):
  - **Large volume** (rapid mode), if actual pressure is small, setpoint pressure is small (observe P-0-1372; bit 6) and setpoint flow is large
  - **Small volume** (press mode), if actual flow is small, setpoint flow is small and setpoint pressure is high (observe P-0-1372; bit 6)
- 10: Validation of the selection in the control word of valve switching, P-0-1283, via the actual values of speed and torque (as of release 02V04):
  - **Large volume** (rapid mode), if: Actual pressure is small and activation via control word
  - **Small volume** (press mode), if actual flow is small and activation via control word

Valve operation

The valve switching words P-0-1410 and P-0-1411 are used to actuate the hydraulic valves from the technology function. To compensate different valve switching times, individual switching sequences are provided for changing between the valve positions. The respective valve operation is selected using the switching control word (P-0-1283). Switching between rapid mode and press mode may take place automatically. It is possible to use a standard switching sequence or a user-defined switching sequence. For commissioning purposes, the valves can furthermore be controlled manually without any automatic sequencing.

Default

The default switching sequences (P-0-1370; bits 27/26 = 00) are suitable for simple rapid mode/press mode switching.

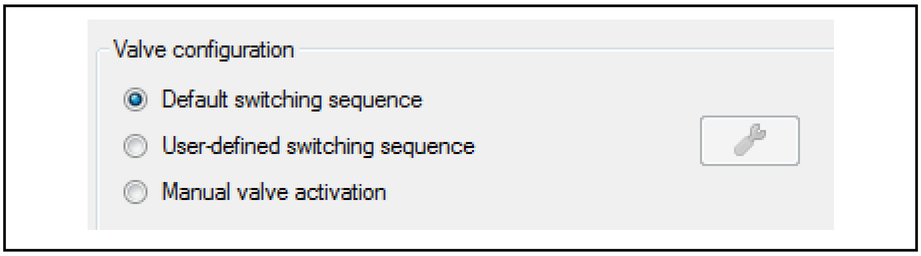


Fig. 7-95: Valve configuration: Default switching sequence

Standard sequence for rapid mode switching

Valves (P-0-1410)	0 ms	40 ms	Final state
Enable A (bit 0)	x	■	■
Enable B (bit 1)	x	■	■
Rapid mode (bit 2)	x	■	■
Press mode (bit 3)	x	■	□

■ High: Valve operated
□ Low: Valve not operated
x Unknown state, depending on previous activation

Tab. 7-11: P-0-1283; bits 7...4 = 2#0001

Standard sequence for press mode switching

Valves (P-0-1410)	0 ms	40 ms	Final state
Enable A (bit 0)	x	■	■
Enable B (bit 1)	x	■	■
Rapid mode (bit 2)	x	□	□
Press mode (bit 3)	x	□	■

■ High: Valve operated
□ Low: Valve not operated
x Unknown state, depending on previous activation

Tab. 7-12: P-0-1283; bits 7...4 = 2#0010

User-defined

The user-defined switching sequences (P-0-1370; bits 27/26 = 01) are primarily suitable for rapid mode/press mode switching where the valve switching times or the order have to be adjusted to suit the hydraulic requirements. It is possible to control rapid mode and press mode valves (P-0-1410; bit 2 and bit 3), as well as A- and B-side enable valves (P-0-1410; bit 0 and bit 1).

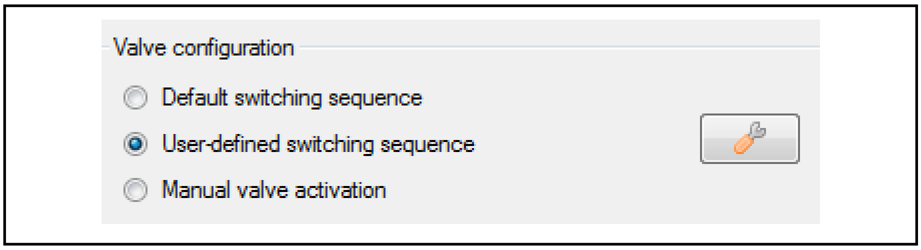


Fig. 7-96: Valve configuration, user-defined switching sequence

The sequence consists of multiple valve states that are maintained for a given duration. At the end of the sequence, the last valve state persists until a new switching sequence is activated. The sequence ends either with its explicit completion or upon reaching the fifteenth state.

The configuration dialog for the valve switching sequences has been designed similarly to a time bar. A control duration is parameterized for each valve status (high/low). This duration may be 0 ms. More sequence sections can be added by inputting a new control time in the next available column. For additional information on the handling, please see the dialog-specific help.

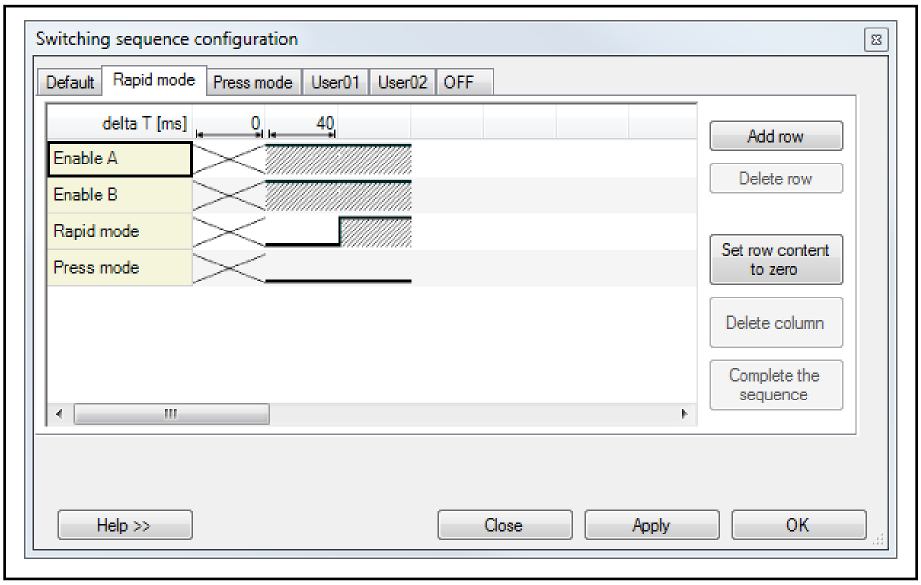


Fig. 7-97: Example of user-defined switching sequence to rapid mode

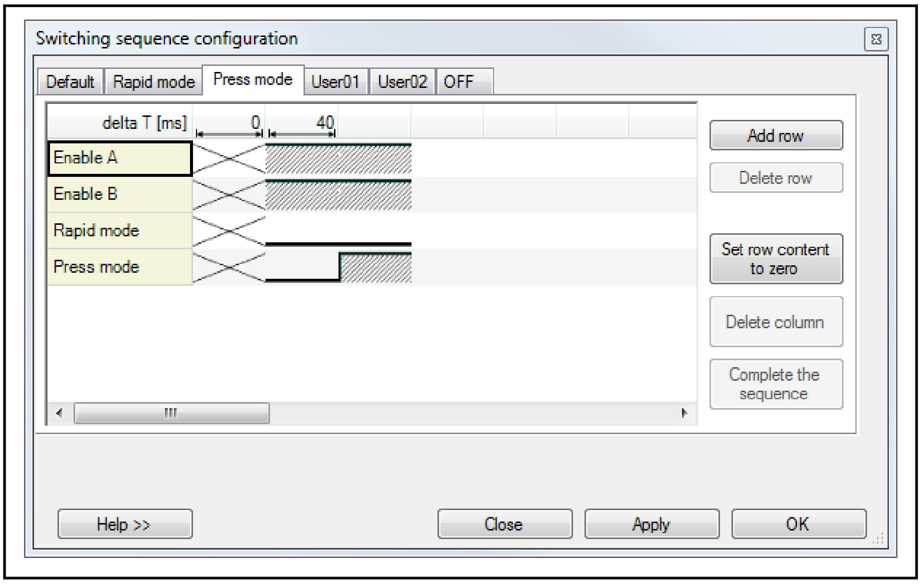


Fig. 7-98: Example of user-defined switching sequence to press mode

☞ By default, the feed rate is calculated on the basis of the switched functional valves in the action path depending on the selected cylinder (P-0-1370, bit 25 = 0). In exceptional cases it may be required to configure a deviating circuit (P-0-1370 bit 25 = 1). This case is not documented and not released with the standard setting. Should this configuration (P-0-1370 bit 25 = 1) be set for a system, contact the responsible application engineer in the case of necessary changes.

Manual

The manual valve mode (P-0-1370; bits 27/26 = 1x) can be used to monitor the valve control from the configuration of the digital outputs, the wiring in the control cabinet through to the valve connector at the hydraulic valve.

⚠ WARNING

As soon as the manual valve mode is used, the technology function can in no way intervene in the control of any valves. Inadvertent operation under drive enable can cause high pressures and might damage hydraulic components.

Use manual valve control with extreme caution and, if possible, without drive enable.

☞ Only use manual valve control for commissioning purposes. Do not use manual valve control during operation. After the wiring has been checked, the manual valve switching mode has to be deactivated.

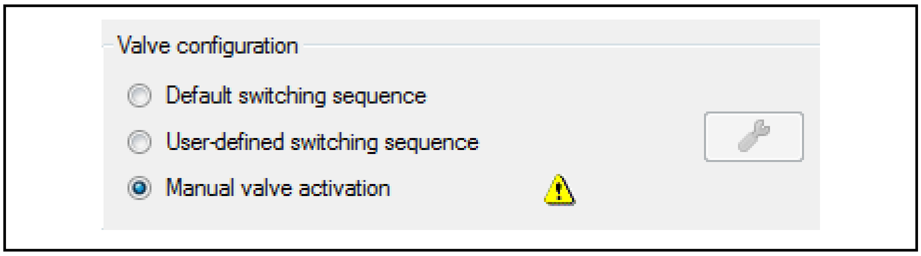


Fig. 7-99: Valve configuration, manual valve control

Decompression and refilling

In the case of tandem or double-rod cylinders

The decompression of the high-pressure side of the cylinder is handled by/via the pump, which displaces fluid from the chamber on the high-pressure side to the opposite side, from where it is fed via the decompression valve to the accumulator.

In conjunction with pulling load, decompression requires a decompression valve on cylinder A-side.

In conjunction with pushing load, decompression requires a decompression valve on cylinder B-side.

☞ The function of decompression with pulling load is available as of PFC03V04.

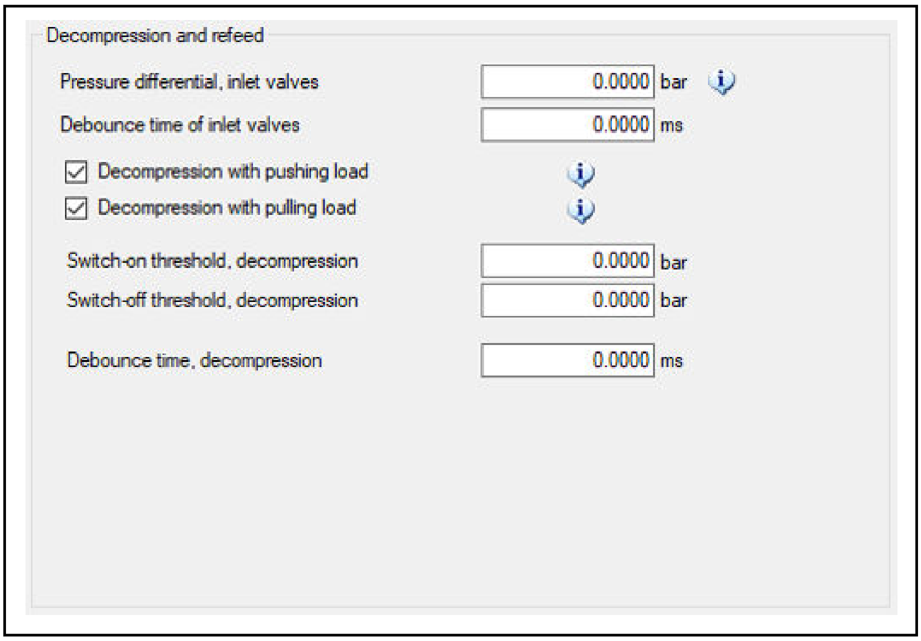


Fig. 7-100: Configuration of decompression for tandem or double-rod cylinders

This function is provided for SHAs with electrically controllable decompression valve on the A and/or B-side of the cylinder. The automatic decompression function is activated separately for pulling and pushing loads using P-0-1372, Configuration, axis controllers/functions, bit 3/2. An activation via the control word is not provided. The relevant decompression valve is activated via P-0-1411, Valve switching outputs 2; bit 5/4. The function is not provided in conjunction with a directional valve.

Decompressing is carried out when, while the function is activated, the high-pressure side is above the switch-on threshold (P-0-1311[194]) after the debounce time, and the opposite side is refilling. Refilling of a cylinder chamber is recognized when the difference between the pressure in the relevant chamber and low pressure is less than the pressure differential of the inlet valves entered in P-0-1311[206]. This detection is subject to debouncing. If the high pressure side falls below the switch-off threshold (P-0-1311[196]) the relevant decompression valve (P-0-1411, bit 5/4) is no longer activated.

The inlet valves also have to be configured, if no electrically activatable decompression valves are used, in order to calculate the cylinder force correctly.

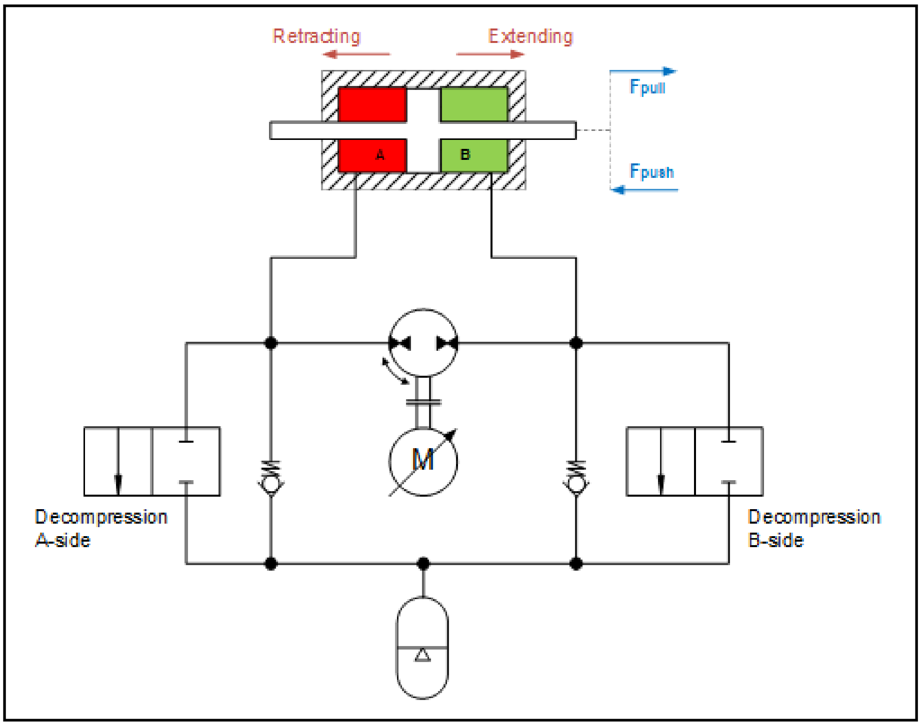


Fig. 7-101: Schematic diagram of decompression of a double rod cylinder

The hydraulic functions of decompression and rapid mode must not be active together. They are therefore interlocked. If rapid mode is selected or active, decompression is deselected. If decompression is selected or active, rapid mode is not selected via the automatic mode or validation. Rapid mode can always be selected via the control word.

In case of single-rod cylinders WITH electrically activatable decompression valves

Electrically controllable decompression valves on the piston side (cylinder A-side) and annular side (cylinder B-side) of a single rod cylinder are activated. For this function, decompression valves are required on the cylinder A- and B-side.

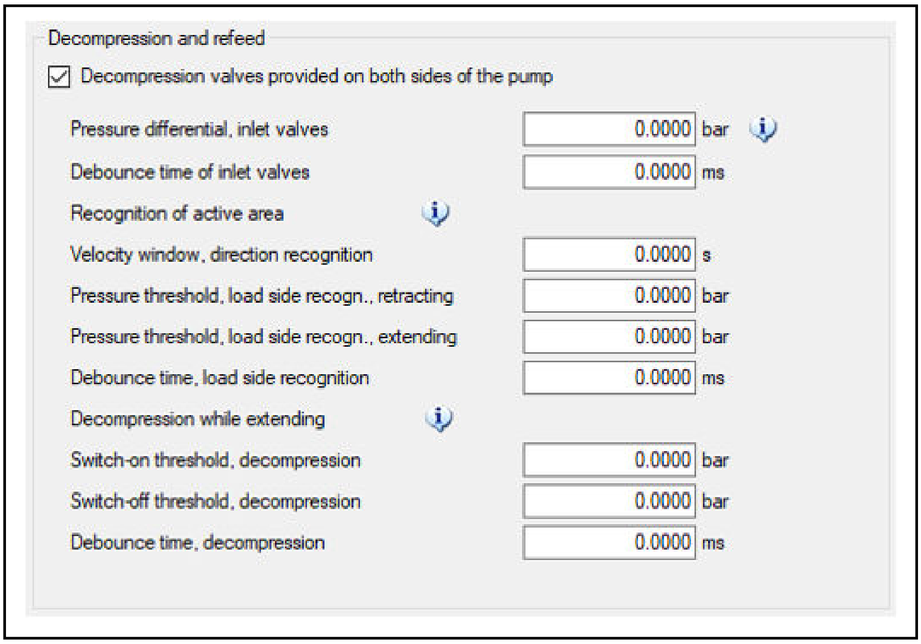


Fig. 7-102: Configuration of decompression for tandem or double-rod cylinders

This function is provided for SHAs with electrically controllable decompression valve on the A and the B-side of the cylinder. The automatic decompression function is activated using P-0-1372, Configuration, axis controllers/functions, bit 3/2. An activation via the control word is not provided. The relevant decompression valve is activated via P-0-1411, Valve switching outputs 2; bit 5/4. The function is not provided in conjunction with a directional valve.

The velocity window P-0-1311[221] in the positive and in the negative direction is used for determining the direction of cylinder movement; in between, the direction of movement remains unchanged. Separate pressure thresholds (P-0-1311[220] and P-0-1311[112]) can be entered for the retracting and extending movement to differentiate between pulling and pushing loads. This detection is subject to debouncing using P-0-1311[219]. The actuator feed is switched over in dependence on the load.

Refilling of a cylinder chamber is recognized when the difference between the pressure in the relevant chamber and low pressure is less than the pressure differential of the inlet valves entered in P-0-1311[206]. This detection is subject to debouncing. For decompression in the extending direction, the direction of load can be identified by means of the switch-on and switch-off threshold for decompression (P-0-1311[194] and P-0-1311[195]). For this, the load pressure has to be sufficiently high and the opposite side has to be refilling. As a consequence, the corresponding decompression valve is activated via P-0-1411, Valve switching outputs 2; bit 5/4.

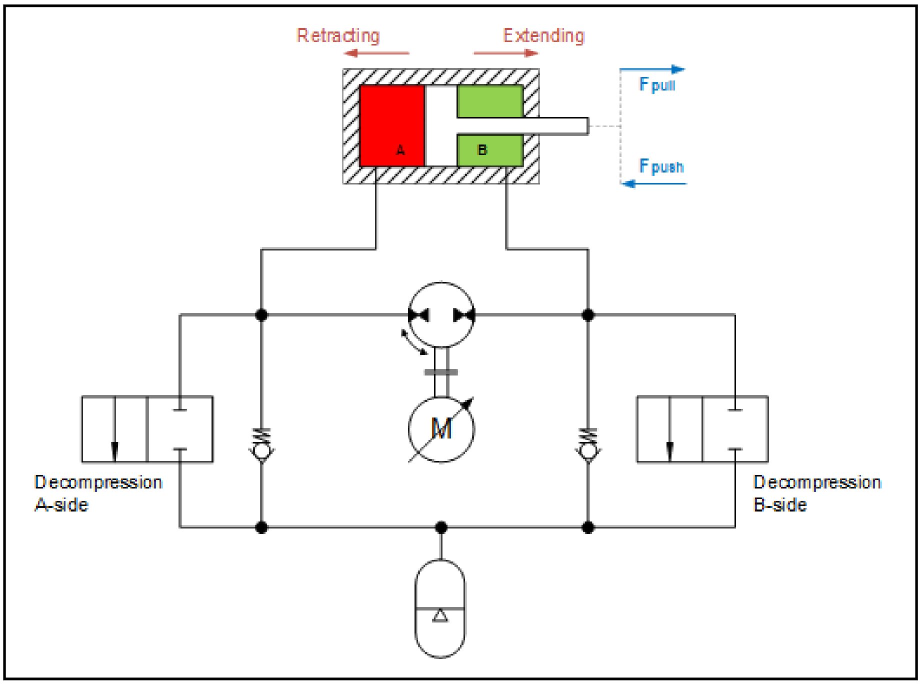


Fig. 7-103: Schematic diagram of decompression of a single rod cylinder

For electrical activation, electrical valves are always required for this purpose on the cylinder A-side and B-side.

☞ If the cylinder is retracting, the decompression valve on the non-active cylinder side is opened to discharge oil.

When activated the decompression valves connect the low-pressure side of the pump to the system pressure or the tank. The switching thresholds refer to the high-pressure side.

Setting criteria for single rod cylinders

In the case of equivocal load conditions, the valves may mutually activate each other at high frequency during retracting, which results in the non-opening of both decompression valves and the generation of high summated pressures.

To improve this behavior during **retracting**, set a debounce time (P-0-1311[219]), which should be between ca. 10 ms and the switching time of the valves.

To improve this behavior during **extending**, set a debounce time (P-0-1311[196]), which should be between ca. 10 ms and the switching time of the valves.

In the **retracting** direction the pressure threshold P-0-1311[220] should be set to a value greater than the pressure on the cylinder A-side, which, based on a balance of forces ($p_B = p_A$ * area ratio), is required to overcome friction (internal and external).

In the **extending** direction the pressure threshold P-0-1311[112] should be set to a value greater than the pressure on the cylinder B-side, which, based on a balance of forces ($p_B = p_A$ * area ratio), is required to overcome friction (internal and external). Pressure threshold P-0-1311[194] should correspond to the pressure level at which a volume compression takes place in the cylinder chamber. P-0-1311[196] can be used to set a debounce time for disabling the decompression valve activation. The pressure differential for recognizing refilling P-0-1311[206] should be set large enough to reliably recognize refilling and, at the same time, small enough so that switching of the decompression valve and the resulting reduction of the residual pressure will not result in significant disturbance.

The velocity window for recognizing the direction of movement P-0-1311[221] can be calculated on the basis of the positioning window (S-0-0057) multiplied by the position controller Kv factor (S-0-0104).

☞ Please note that when acceleration feedback is used, the controller output in “Additive velocity command value, process loop” (P-0-0690) heavily fluctuates at standstill. In this case, select the velocity window large enough so that the valves are not operated at standstill. If the valves are activated at high frequency (> 1 Hz) at a standstill, the valves or upstream relays may be damaged.

In case of single-rod cylinders WITHOUT electrically activatable decompression valves

No decompression valves on the piston side (cylinder A-side) and annular side (cylinder B-side) of a single rod cylinder are electrically activated. Discharging fluid from or filling the cylinder chambers with fluid is implemented using a suitable hydraulic circuit (e.g. by means of pilot operated check valves).

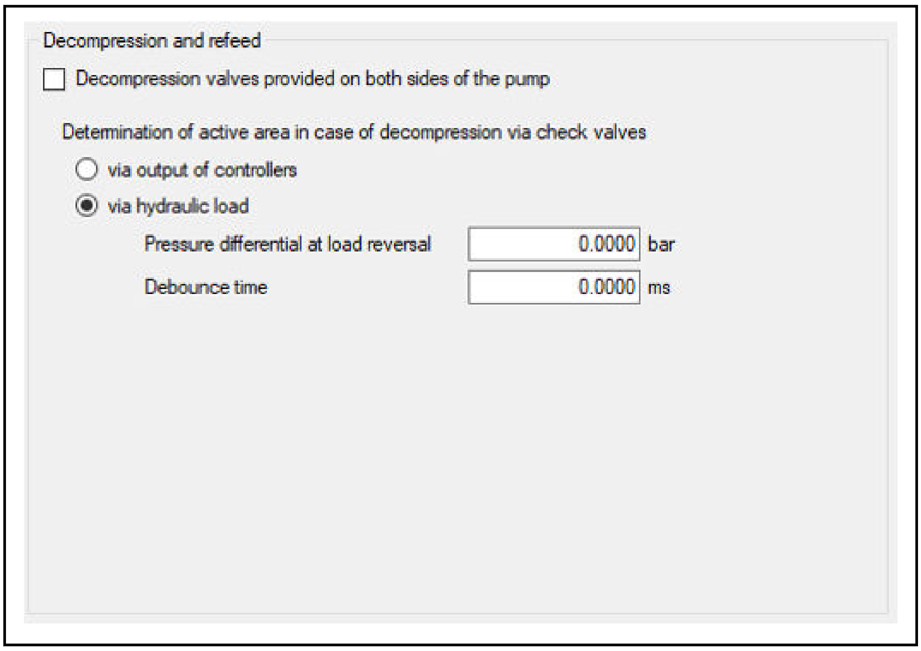


Fig. 7-104: Recognizing the effective area for single rod cylinders

If no electrically operated valves for decompression are installed, the function has to be configured using "P-0-1372, Configuration, axis controllers/functions"; bit 3/2 = 00. In this case you can select, according to which principle the current effective area and the resulting feed are to be calculated. The following functions are available:

- The feed is calculated in dependence on the controller output (sign)
  - positive controller output → feed for effective area A
  - negative controller output → feed for effective area B
- The feed is calculated in dependence on the hydraulic load, which, in this case, is the pressure differential without area scaling with debouncing using P-0-1311[193].
  - $p_A > p_B$ + P-0-1311[192] → feed for effective area A
  - $p_B > p_A$ + P-0-1311[192] → feed for effective area B

7.4.4 Sensor data

Depending on the characteristic, there are various operating variables that can be generated using analog sensors or also master communication.

- Process pressure (pressure feedback value A, pressure feedback value B, pressure feedback C)
- Force feedback value from force sensor
- Tank pressure
- System pressure
- Pilot oil pressure
- Oil temperature
- Swivel angle feedback value
- Swivel angle command value

The following selection is shown in the overview dialog:

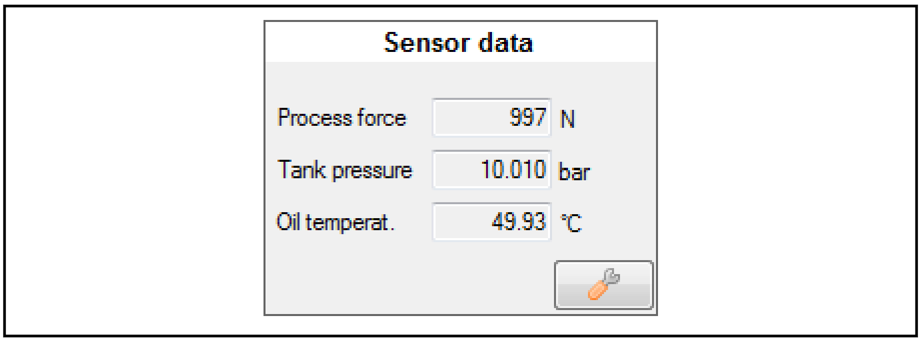


Fig. 7-105: Sensor data

All sensor data can be read as analog signals. Function-oriented dialogs are available to configure the analog inputs and to simplify commissioning. For each analog input, various signal sources can be selected via a parameter (see also chapter 7.2.10 "Analog interfaces" on page 152).

If signals are merely to be monitored, it is also possible to read digital signals from pressure or temperature switches (see also chapter 7.2.11 "Digital interfaces" on page 156). A warning and an alarm signal each are available for monitoring for too high and too low values. When digital monitoring signals are used the parameter of the signal has no function. Reading of digital signals is supported for:

- System pressure
- Pilot oil pressure
- Oil temperature

Force/pressure acquisition

The process force can be specified as either force or pressure (P-0-1370; bit 15) (see also force control dialog). When force is used, the current force feedback value is displayed in "S-0-0552, Torque/force feedback value 2"; when pressure is used, the current pressure feedback value is displayed in "S-0-0809, Pressure feedback value". For determining force/pressure feedback values, various analog sensor data are available:

- S-0-0803, Pressure feedback value A
- S-0-0804, Pressure feedback value B
- P-0-1282, Pressure feedback value C
- P-0-2937.0.3, Input of force feedback value

The respective unit complies with the scaling setting for force (S-0-0086) or pressure data (S-0-0806).

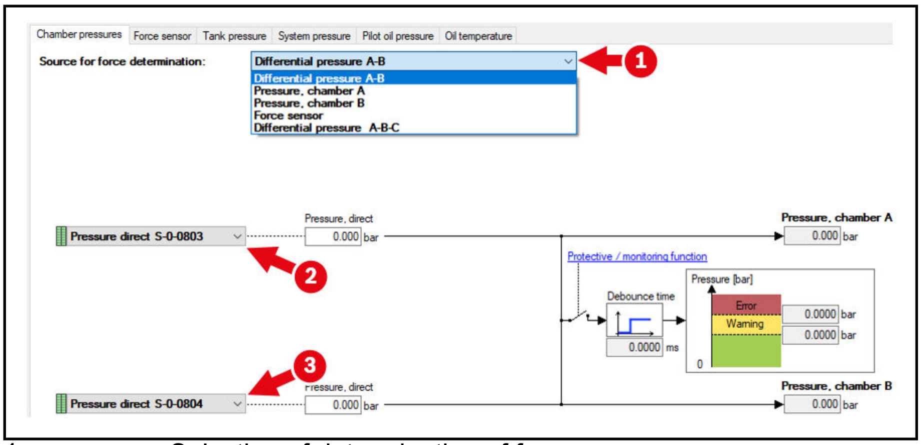
The calculation of the process force/pressure is configured in "P-0-2937.0.1, Force acquisition control word". The following settings are possible for calculating the process force:

- Force differential (force feedback value A * area A - force feedback value B * area B)
- Force on A-side (force feedback value A * area A)
- Force on B-side (force feedback value B * area B)
- Force sensor
- Force sensor inverted
- Force differential (force feedback value A * area A - force feedback value B * area B - force feedback value C * area C)

The following settings are possible for calculating the process pressure:

- Pressure feedback value A
- Pressure feedback value B

For calculating the process force/pressure from the chamber pressures or for the use of force sensors, separate dialogs are available. In these dialogs the signal selection of the analog input signals is also made.



1 Selection of determination of force
2 Signal selection of pressure feedback value A
3 Signal selection of pressure feedback value B

Fig. 7-106: Determination of force from chamber pressures

For pressure feedback value A, pressure feedback value B and pressure feedback value C, overpressure monitoring is available. It can be set in the separate dialog for protective/monitoring functions. Pressure feedback value A and pressure value B are always read. Pressure feedback value C is read when it is used for determining the force or when associated monitoring is active. The input of the force feedback value is read, when the force sensor has been selected for acquiring the force.

When pressure feedback A or the force sensor is used, alternating control is only possible in the positive direction of force. When pressure feedback B or the inverted force sensor is used, alternating control is only possible in the negative direction of force.

Pressure feedback value A

Pressure feedback value A is always displayed in S-0-0803. The unit can be set in the scaling settings for pressure data (S-0-0806). The signal source is configured in "P-0-1311[253], Pressure feedback value A, signal selection".

If pressure feedback value A is to be read via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iPressureFeedbackValueA" can be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[253]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[254] Max.: P-0-1311[255]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[256] Max.: P-0-1311[257]	S-0-0806	-	✓	✓
Scaling, signal range	Min.: P-0-1311[258] Max.: P-0-1311[259]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[260]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-13: Signal processing for pressure feedback value A

Pressure feedback value B

Pressure feedback value B is always displayed in S-0-0804. The unit can be set in the scaling settings for pressure data (S-0-0806). The signal source is configured in "P-0-1311[261], Pressure feedback value B, signal selection".

If pressure feedback value B is to be read via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iPressureFeedbackValueB" can be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[261]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[262] Max.: P-0-1311[263]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[264] Max.: P-0-1311[265]	S-0-0806	-	✓	✓

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Scaling, signal range	Min.: P-0-1311[266] Max.: P-0-1311[267]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[268]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-14: Signal processing for pressure feedback value B

Pressure feedback value C

Pressure feedback value C is always displayed in P-0-1282. The unit can be set in the scaling settings for pressure data (S-0-0806). The signal source is configured in "P-0-1311[269], Pressure feedback value C, signal selection".

If pressure feedback value C is to be read via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iPressureFeedbackValueC" can be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[269]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[270] Max.: P-0-1311[271]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[272] Max.: P-0-1311[273]	S-0-0806	-	✓	✓
Scaling, signal range	Min.: P-0-1311[274] Max.: P-0-1311[275]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[276]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-15: Signal processing for pressure feedback value C

Force sensor

If a force sensor is to be used, it has to be configured in "P-0-2937.0.1, Force acquisition control word". The unit can be set in the weighting settings for force data (S-0-0086). The signal source is configured in "P-0-1311[67], Input of force feedback value, signal selection".

If the force sensor is to be read via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iInputForceFeedbackValue" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[67]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[68] Max.: P-0-1311[69]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[70] Max.: P-0-1311[71]	S-0-0086	-	✓	✓
Scaling, signal range	Min.: P-0-1311[72] Max.: P-0-1311[73]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[74]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-16: Signal processing for input of force feedback value

Tank pressure

The tank pressure is always displayed in S-0-0814. The unit can be set in the scaling settings for pressure data (S-0-0806). The signal source is to be configured in "P-0-1311[277], Pilot oil pressure signal selection".

If the tank pressure is to be read in via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iTankPressure" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[277]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[278] Max.: P-0-1311[279]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[280] Max.: P-0-1311[281]	S-0-0806	-	✓	✓
Scaling, signal range	Min.: P-0-1311[282] Max.: P-0-1311[283]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[284]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-17: Signal processing for tank pressure

System pressure

The system pressure can be read in as analog signal or in the form of digital monitoring signals. The signal source and thus the signal type is configured in "P-0-1311[225], System pressure, signal selection".

If the analog value is used, the system pressure is shown in S-0-0813. The unit can be set in the scaling settings for pressure data (S-0-0806).

If the system pressure is to be read in via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iSystemPressure" may be used as an interface.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[225]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[226] Max.: P-0-1311[227]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[228] Max.: P-0-1311[229]	S-0-0806	-	✓	✓
Scaling, signal range	Min.: P-0-1311[230] Max.: P-0-1311[231]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[232]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-18: Signal processing for system pressure

Alternatively to the analog value, digital monitoring signals from pressure switches may also be read in. For this purpose, either bits 5 - 2 of parameter P-0-1392 can be assigned in the configuration of the local IOs of IndraDrive (P-0-1311[225] = 7) or the PLC structure "Position_Force_Control.Global_Interface.stSystemPressure" can be assigned to digital inputs in the Sercos configurator (P-0-1311[225] = 8). The state of the digital signals is displayed in P-0-1413 bit 5 - 2.

Pilot oil pressure

The pilot oil pressure can be read in as analog signal or in the form of digital monitoring signals. The signal source and thus the signal type are configured in "P-0-1311[229], Pilot oil pressure, signal selection".

If the analog value is used, the system pressure is shown in S-0-1288. The unit can be set in the scaling settings for pressure data (S-0-0806).

If the pilot oil pressure is to be read in via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iControlPressure" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[239]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[240] Max.: P-0-1311[241]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[242] Max.: P-0-1311[243]	S-0-0806	-	✓	✓
Scaling, signal range	Min.: P-0-1311[244] Max.: P-0-1311[245]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[246]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-19: Signal processing for pilot oil pressure

Alternatively to the analog value, digital monitoring signals from pressure switches may also be read in. For this purpose, either bits 9 - 6 of parameter P-0-1392 can be assigned in the configuration of the local IOs of IndraDrive (P-0-1311[239] = 7) or the PLC structure "Position_Force_Control.Global_Interface.stControlPressure" can be assigned to digital inputs in the Sercos configurator (P-0-1311[239] = 8. The state of the digital signals is displayed in P-0-1413 bit 9 - 6.

Oil temperature

The oil temperature can be read in as analog signal or in the form of digital monitoring signals. The signal source and thus the signal type are configured in "P-0-1311[162], Oil temperature, signal selection".

If the analog value is used, the oil temperature is shown in S-0-1284. The unit can be set in the scaling settings for the temperature (S-0-0208).

If the oil temperature is to be read in via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iOilTemperature" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[162]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[155] Max.: P-0-1311[156]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[157] Max.: P-0-1311[158]	S-0-0208	-	✓	✓

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Scaling, signal range	Min.: P-0-1311[159] Max.: P-0-1311[161]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[161]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-20: Signal processing for oil temperature

Alternatively to the analog value, digital monitoring signals from temperature switches may also be read in. For this purpose, either bits 13 - 10 of parameter P-0-1392 can be assigned in the configuration of the local IOs of IndraDrive (P-0-1311[162] = 7) or the PLC structure "Position_Force_Control.Global_Interface.stOilTemperature" can be assigned to digital inputs in the Sercos configurator (P-0-1311[162] = 8). The state of the digital signals is displayed in P-0-1413 bit 13 - 10.

Swivel angle command value

If swivel angle control is used, the swivel angle command value can be provided via S-0-0880 in "%". The signal source is configured in "P-0-1311[42], Swivel angle command value signal selection".

If the swivel angle command value is to be read in via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iManualSwivelAngle_cmd" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[42]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[43] Max.: P-0-1311[44]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[45] Max.: P-0-1311[46]	°	-	✓	✓
Scaling, signal range	Min.: P-0-1311[47] Max.: P-0-1311[48]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[49]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-21: Signal processing for swivel angle command value

Swivel angle value feedback value

If swivel angle control is used, the swivel angle feedback value is always displayed in P-0-1289 in "%". The signal source is configured in "P-0-1311[17], Swivel angle feedback value signal selection".

If the swivel angle feedback value is to be read via external IOs, the 16-bit integer variable "Position_Force_Control.Global_Interface.iSwivelAngle_act" may be used.

Meaning	Parameter	Unit / weighting	Parameter	Analog input 1 - 5	PLC variable
Signal selection	P-0-1311[17]	-	0	1 - 5	6
Signal range limitation	Min.: P-0-1311[18] Max.: P-0-1311[19]	-	-	-	✓
Scaling, value range	Min.: P-0-1311[20] Max.: P-0-1311[21]	°	-	✓	✓
Scaling, signal range	Min.: P-0-1311[22] Max.: P-0-1311[23]	Analog input: V, mA PLC variable: -	-	✓	✓
Filter time	P-0-1311[24]	ms	-	-	✓

✓ Parameter active for this selection
- Parameter not active for this selection

Tab. 7-22: Signal processing for swivel angle feedback value

7.4.5 Actual value acquisition

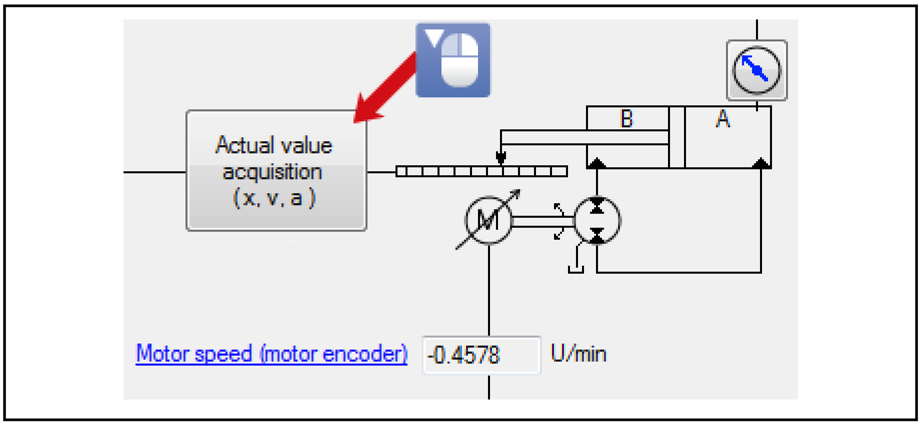


Fig. 7-107: Actual value acquisition

The actual value acquisition dialog is used to adjust the position, velocity and acceleration data of the actuator.

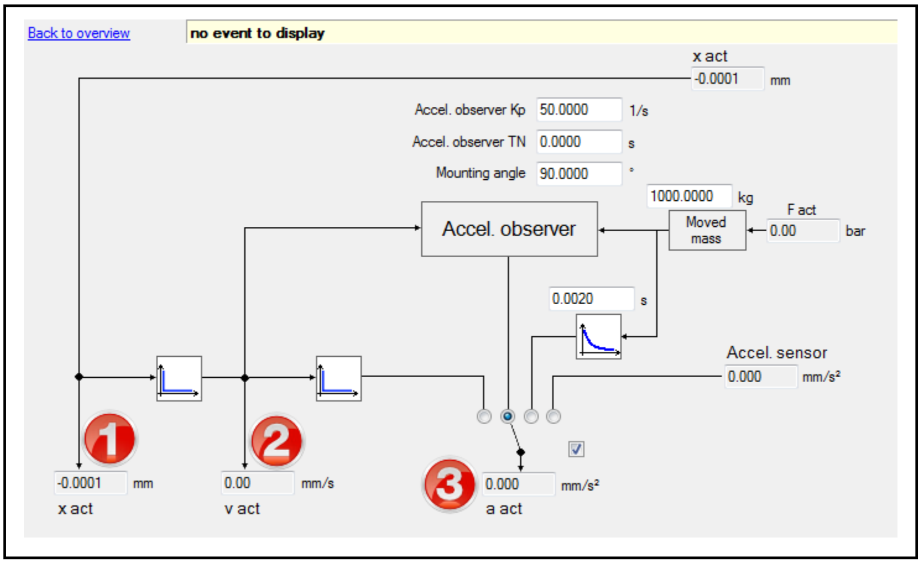


Fig. 7-108: Actual value acquisition

1. Position data Position data need not to be adjusted. Simply the active position feedback value (S-0-0386) is displayed here.

2. Velocity data Velocity data are simply the first derivative, taken from the position data. They are displayed in P-0-1276.

3. Acceleration data Four different methods are available for generating the actuator-side acceleration feedback value. Select the appropriate method in accordance with the signal availability and signal quality.

1. Second derivative calculated from the position data (P-0-1370; bits 24/23/22 = 010):
   - No further parameterization required
   - Signal quality strongly depends on the precision of the encoder
2. Acceleration observer (P-0-1370; bits 24/23/22 = 011):
   - Observer structure featuring adjustment of model values and feedback values from force (S-0-0552) and velocity
   - Parameterization required (mass, mounting angle, P-gain, integral-action time)
   - Reliable signal in the case of correct parameterization with compensation of load offset (vertical axes, friction), oil compressibility and leakages
3. Simplified model (P-0-1370; bits 24/23/22 = 100):
   - From force feedback value (S-0-0552) and moving mass with high-pass filtration
   - Minor parameterizing effort (mass, filter time)
   - Load offset compensation (vertical axes, friction)
   - Signal is falsified by oil compressibility and leakages
4. Acceleration sensor (P-0-1370; bits 24/23/22 = 001):
   - From analog sensor signal
   - Assignment and parameterization of analog input required
   - Compensation of any parasitic effects
   - High signal quality possible, depending on sensor

The calculated acceleration signal is displayed in P-0-1277.

7.4.6 Operation modes

The following IndraDrive operation modes are supported as interfaces for command value provision:

- Drive-controlled positioning
- Closed-loop position control
- Positioning block mode
- Drive-internal interpolation
- Velocity control
- ab PFC03V04: Drive Halt

For the configuration of the operation modes, please see chapter 7.2.8 "Operation modes (IndraDrive)" on page 148.

Not supported or supported with restrictions:

- PFC03V02: Drive Halt (AH),

  because it is impossible to ensure that the controller output of the technology function can reach the axis in AH. In AH the axis thus is not kept in position under closed-loop control, but the enable valves are closed to lock the axis in a fixed position.
- Synchronization modes,

  because the required Sytronix functional package (SYX) excludes the use of the synchronization functional package (SNC). Consequently, the synchronization modes cannot be selected.

☞ The **operation mode** selected in IndraDrive and the **operating mode** of the technology function are two settings that have to be distinguished. They interdepend only to some extent!

The active operation mode is always displayed in the info section highlighted in color in the overview dialog.

In the lower configuration section, each of the supported operation modes can be selected and parameterized. Here, the most important operation mode settings can be made and command values can be input. The configuration button leads to the detailed dialog of the respective operation mode. If necessary, advanced settings can be made in the detailed dialog.

☞ Selecting the operation mode here will only allow it to be parameterized. This does not activate the operation mode.

The operation mode is activated using the usual mechanisms of the control word of device control (P-0-0116).

Drive-controlled positioning

The following parameters can be set in the overview dialog:

- Positioning command value (S-0-0282)
- Positioning velocity (S-0-0259)
- Positioning acceleration (S-0-260)
- Positioning deceleration (S-0-359)
- Positioning jerk (S-0-0193)

In addition, positioning can be started and stopped (S-0-0346, Positioning control word).

The interpolated command value as the input for the controller is displayed in the position command value of the controller (P-0-0434).

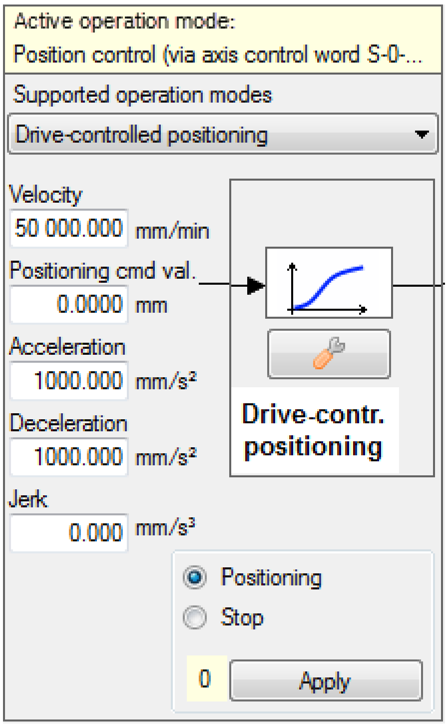


Fig. 7-109: Drive-controlled positioning

Closed-loop position control

The following parameters can be set in the overview dialog:

- Position command value control (P-0-0047)

The interpolated command value as the input for the controller is displayed in the position command value of the controller (P-0-0434).

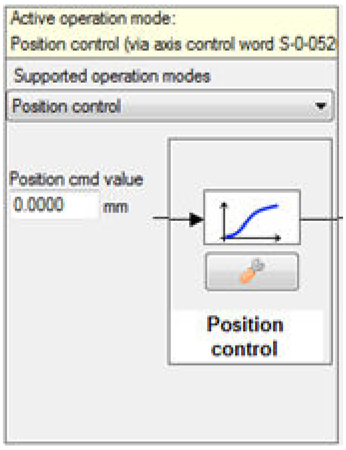


Fig. 7-110: Closed-loop position control

Positioning block mode

The following parameters can be set or checked in the overview dialog:

- Positioning block selection (P-0-4026)
- Positioning block acknowledgment (P-0-4051)

In addition, positioning can be started and stopped (S-0-0346, Positioning control word).

The interpolated command value as the input for the controller is displayed in the position command value of the controller (P-0-0434).

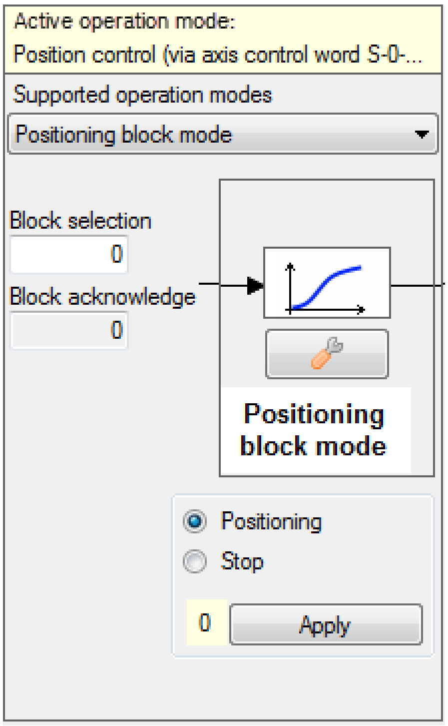


Fig. 7-111: Positioning block mode

Drive-internal interpolation

The following parameters can be set in the overview dialog:

- Target position (S-0-0258)
- Positioning velocity (S-0-0259)
- Positioning acceleration (S-0-260)
- Positioning deceleration (S-0-359)
- Positioning jerk (S-0-0193)

The interpolated command value as the input for the controller is displayed in the position command value of the controller (P-0-0434).

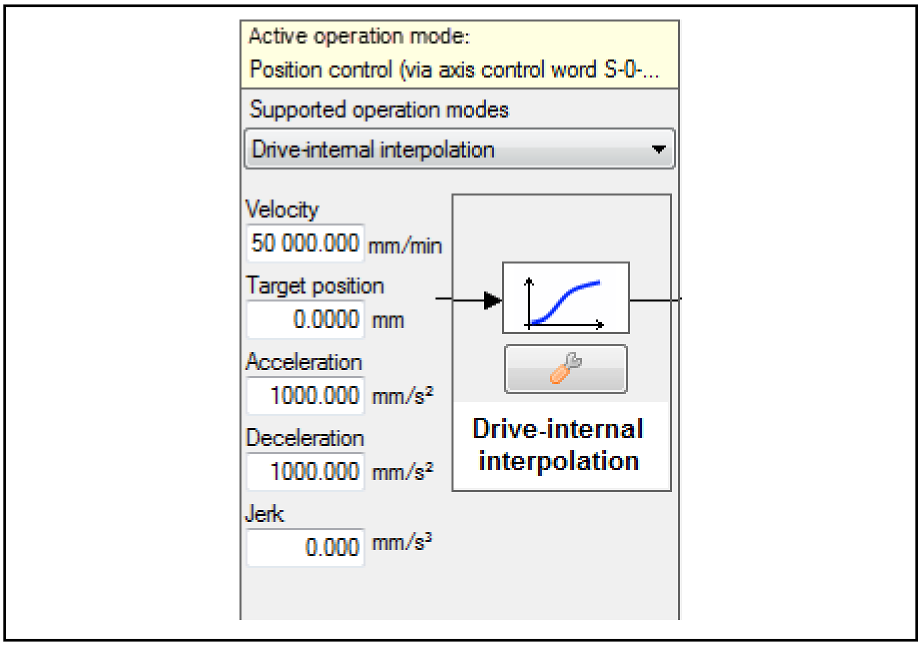


Fig. 7-112: Drive-internal interpolation

Velocity control

The following parameters can be set in the overview dialog:

- Velocity command value (S-0-0036)

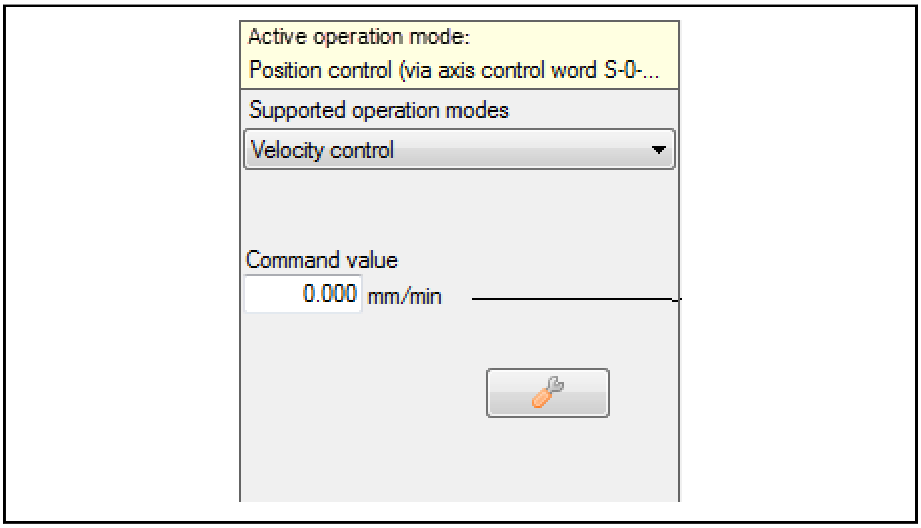


Fig. 7-113: Closed-loop velocity control

The velocity command value is converted into a speed command value by output adjustment, which generates the required velocity of the actuator via the active advance.

☞ On the technology function side, this merely is an open-loop velocity control of the actuator; the motor speed alone is closed-loop controlled. Non-linearities (pump efficiency) and disturbances (leakages) that take effect on the actuator velocity are not corrected.

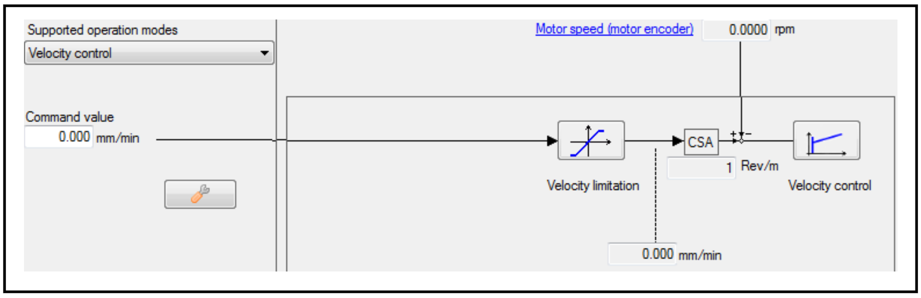


Fig. 7-114: Velocity control

A transition from open-loop velocity control (velocity control mode) to closed-loop force control is not possible.

Drive Halt

The "Drive Halt (AH)" function is provided as of PFC03V04.

The "Drive Halt" (AH) function is used to shut down an axis with defined acceleration and defined jerk. The AH function is executed as operating stop in the active operation mode with zeroing of the command value change. The AH mode can be configured under "Operation modes / Drive Halt".

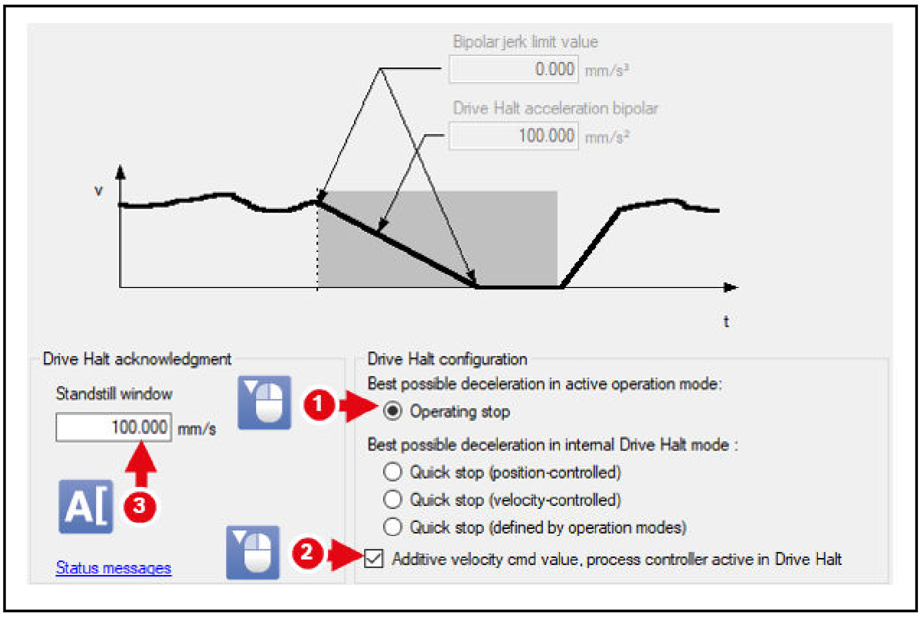


Fig. 7-115: Drive Halt (AH)

AH is only supported as operating stop. For applying the function to the axis the process controller has to be active in AH. In the case of deviations from this configuration, error D507F is generated.

The Drive Halt function as an operating stop is activated by disabling the Drive Halt bit in the control word of the master communication (e.g. with Sercos bit 13 in "S-0-0134, Master control word"). If in the AH configuration the operating stop is selected, P-0-0558, Drive Halt configuration, bit 0 = 1), the active operation mode and the operating mode (position control, with alternating control where applicable) are maintained.

In the case of AH, position control is stopped with setpoint velocity = 0. For shutdown, the parameters of the active operation mode are used.

In the case of AH, position control is stopped with setpoint velocity = 0. Stopping is carried out abruptly.

After AH has been removed, the operation mode and the axis motion, if applicable, continue.

☞ During AH the axis is in closed-loop control and all protective and monitoring functions are active.

The status AH of the axis is acknowledged in "P-0-0115, Device control: status word, bit 4", when the velocity of the axis is within the "S-0-0124, Standstill window".

7.4.7 Position controller

Overview

The most important parameters for the position controller can already be set in the overview dialog. These values are:

- Kv factor [1000/min], S-0-0104
- Position controller integral action time (Ti) [ms], S-0-0105
- Velocity feedforward [%], P-0-0040
- Velocity state controller Kp [-], P-0-1380
- Acceleration state controller Kp [ms], P-0-1379

These parameters can also be switched using four different parameter sets. See "Parameter set switching". The active parameter set and the effective factors are also displayed in the overview dialog.

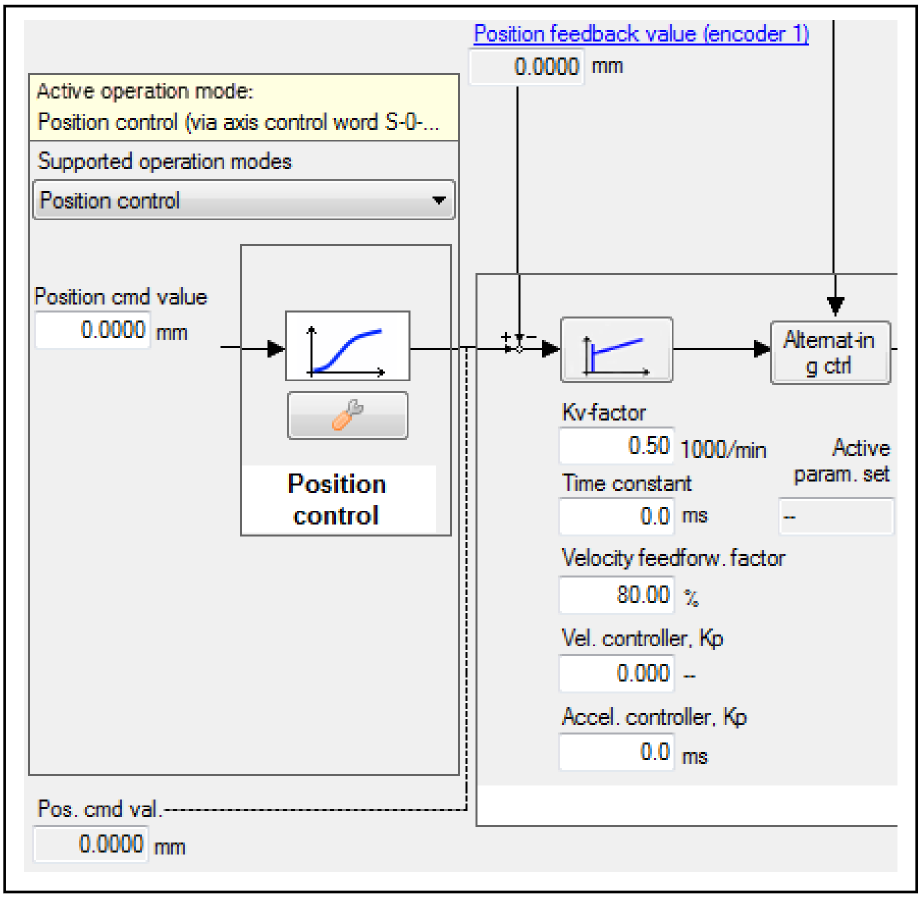


Fig. 7-116: Position controller, overview

☞ For an activated parameter set, the active values are displayed here. They cannot be changed.

Further settings can be made in the detailed dialog. The controller symbol is the corresponding button.

Structure The position controller makes available the following functions:

1. Proportional gain of control error
2. Integral term for P-controller output with switching logic and down ramp
3. Velocity feedforward
4. Velocity state controller (P-gain)
5. Acceleration state controller (P-gain)
6. Parameter set switching

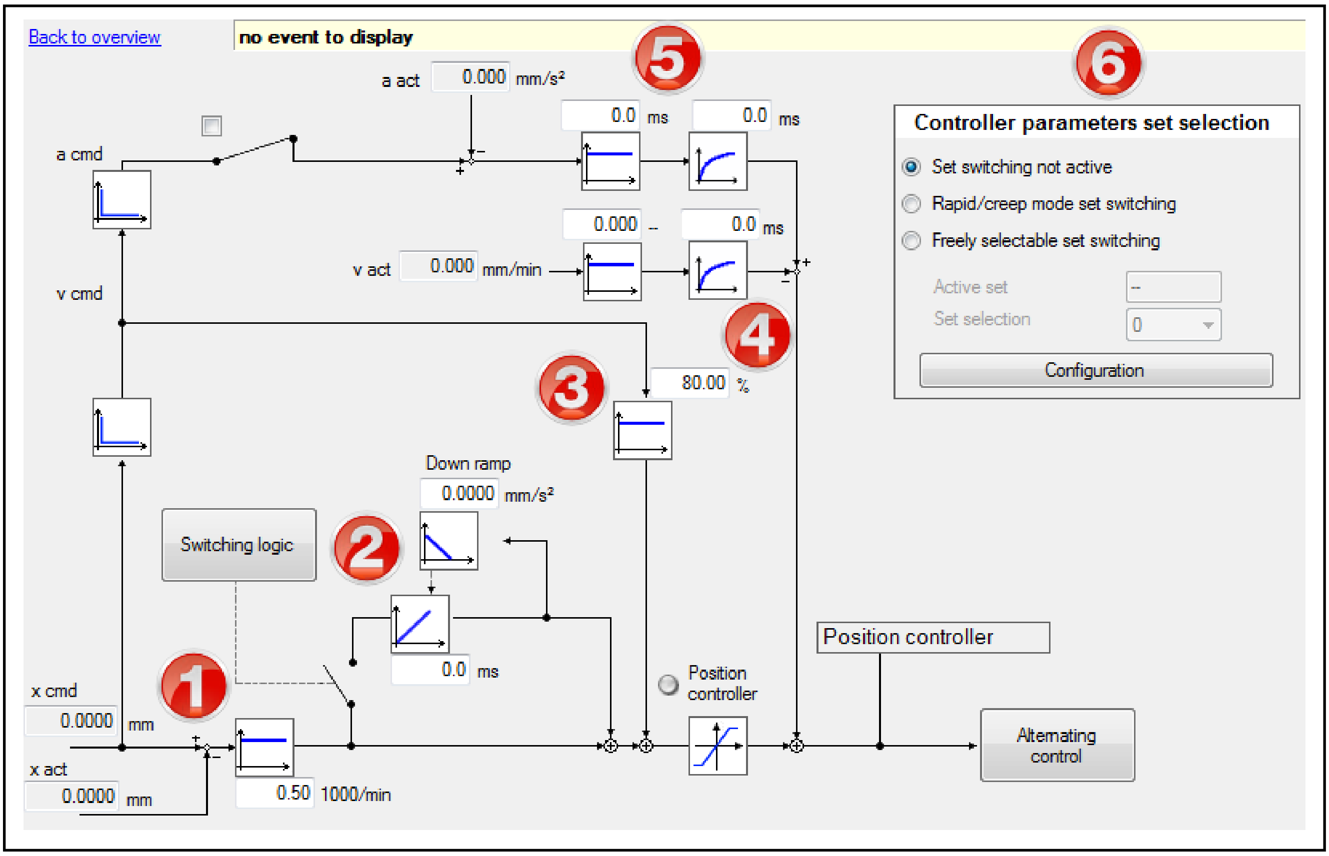


Fig. 7-117: Position controller, dialog

The command value of the position controller is the "position command value of controller" (P-0-0434). It is generated by the IndraDrive interpolator. The feedback value of the position controller is the "active position feedback value" (S-0-0386). For hydraulic actuators it corresponds to the "S-0-0051, Position feedback value of encoder 1".

Unless drive enable has been set in IndraDrive, the command value is set to the feedback value.

The sum of PI-controller output, velocity feedforward and state controller outputs is taken into account for alternating control as the overall controller output of the position controller.

PI-controller

The proportional gain (Kv) of the PI-controller amplifies the control error of the position and thereby generates the corrective controller output for the speed controller in IndraDrive. The integral term (I-term) takes effect in series connection with the P-controller. Using a switching logic, the I-controller is activated, frozen or deactivated at runtime.

These are typical controller parameter values for PFC applications:

- Proportional gain (S-0-0104) ≤ 0.5 [1000/min])
- Integral action time (S-0-0105) ≥ 500 [ms]

☞ See also controller optimization in the Annex, chapter 9.3 "Controller optimization" on page 508

In hydraulic applications, the I-term is primarily used to compensate leakages in the system. If the I-term is to run permanently, only the threshold values for the change thresholds of command values and actual values have to be overwritten by "0"; see below. During force control, the I-term of the position controller is always deactivated.

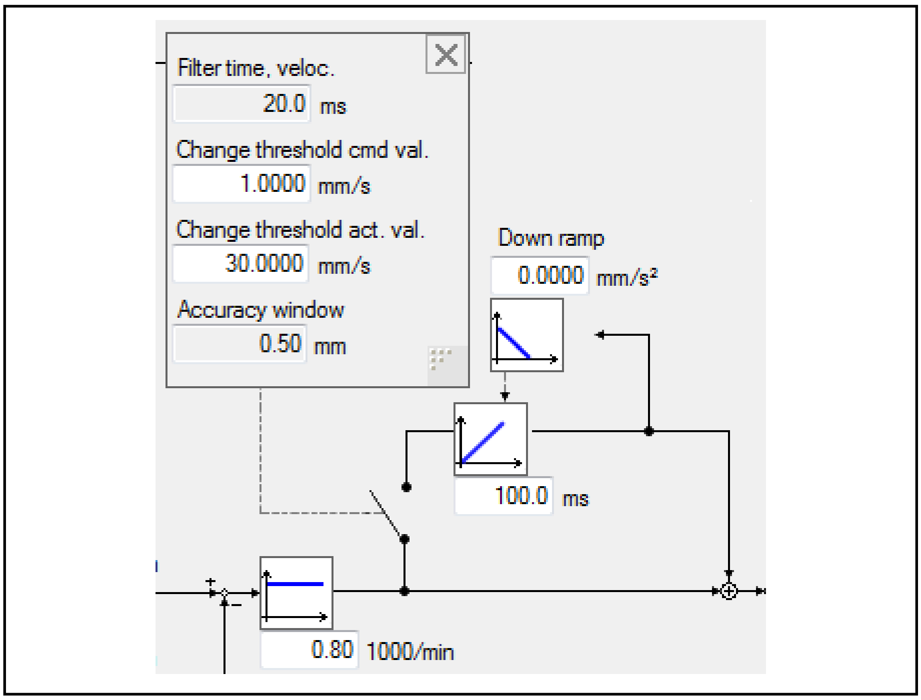


Fig. 7-118: Position controller with P-gain and switching I-term

The switching logic for the I-term compares three signals:

1. Absolute value of the interpolated command velocity
2. Absolute value of the actual velocity
3. Absolute value of the lag error

with the three thresholds:

1. Change threshold command values; P-0-1311[113] e.g. = 1 [mm/s]
2. Change threshold actual values; P-0-1311[114] e.g. = 30 [mm/s]
3. Positioning window; S-0-0057 e.g. = 0.5 [mm]

and thereupon switches to three different states:

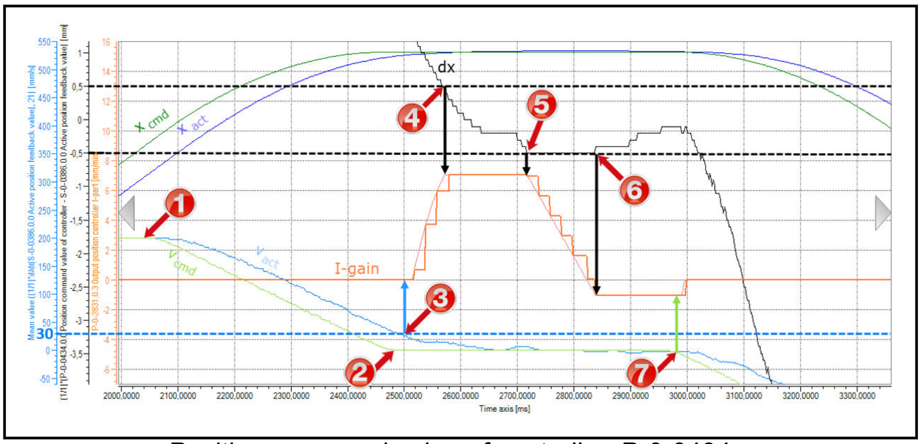
- Deactivated: if |interpolated command velocity| > command threshold OR |actual velocity| > actual threshold

- Integrate: if NOT deactivated AND |lag error| ≥ positioning window
- Freeze: if NOT deactivated AND |lag error| < positioning window OR force control active

To transmit a smoothed velocity signal to the switching logic and thereby avoid "bouncing", a filter time for the command velocity and actual velocity can be set in P-0-1385. The value (20 [ms] in this case) has to be adjusted depending on the quality of the encoder signal. However, please consider that this also delays the signals of command velocity and actual velocity for the switching logic. See also description of parameter P-0-1385.

Example of switching I-term, position controller

With the parameterization in the above example, the logical operating sequence might be as follows, depending on the travel profile:



x_{cmd}	Position command value of controller, P-0-0434
x_{act}	Active position feedback value, S-0-0386
dx	Lag error, P-0-0434 - S-0-0386
v_{cmd}	Interpolated command velocity, d (P-0-0434) / dt smoothed
v_{act}	Actual velocity, d (S-0-0386) / dt smoothed
I-gain	Integral term of position controller, P-0-2831.0.4 (enhanced here with a faster refresh rate)

Fig. 7-119: Principle of switching I-term, position control

1. Traveling, I-term deactivated: Command velocity and actual velocity are above the threshold value, I-term is zero
2. Decelerating, I-term deactivated: Command velocity is "0 [mm/s]" and thus has fallen below the threshold value, actual velocity still is above the threshold value, I-term is zero
3. Positioning, I-term activated: Actual velocity has also fallen below the threshold value of "30 [mm/s]", integrator starts running
4. Holding position, I-term frozen: Lag error is within positioning window, leakages are compensated for by I-term that is present
5. Correcting position, I-term activated: Axis overshoots due to excessive I-term, lag error is outside positioning window, integrator restarts and integrates negatively
6. Holding position, I-term frozen: Lag error is back in positioning window
7. Starting to move, I-term deactivated: Command velocity exceeds the threshold value, I-term is ramped down to zero using the preset deceleration ramp

The signals shown here are suitable for oscilloscope-supported parameterization of the individual thresholds. It is advisable to record the following signals:

- P-0-0434, Position command value of controller
- S-0-0386, Active position feedback value
- P-0-2831.0.1, Output position controller Kv-part
- P-0-2831.0.3, Output position controller I-part
- P-0-2831.0.4, Output of position controller
- If necessary, P-0-0690, Additive velocity command value, process controller
- Calculating the lag error: P-0-0434 - S-0-0386
- Calculating the interpolated command velocity: d (P-0-0434) / dt [s]; additionally smoothed, if necessary
- Calculating the actual velocity: d (S-0-0386) / dt [s]; additionally smoothed, if necessary

---

☞ The indication of "P-0-2831.0.1, Output position controller Kv-part", "P-0-2831.0.3, Output position controller I-part" and "P-0-2831.0.4, Output of position controller" is refreshed only in the 20-ms clock cycle to save computing resources. Therefore, the indication is rather qualitative. The values are calculated in the set control clock cycle and with every cycle is also reflected in the controller output P-0-0690.

Feedforward control

The feedforward control for the position controller amplifies the velocity differentiated from the position command values (d (P-0-0434) / dt) by the velocity feedforward weighting (P-0-0040). The velocity feedforward then is directly added to the controller output of the position controller. It can be fed forward with a maximum of "120 %" of the interpolated command velocity.

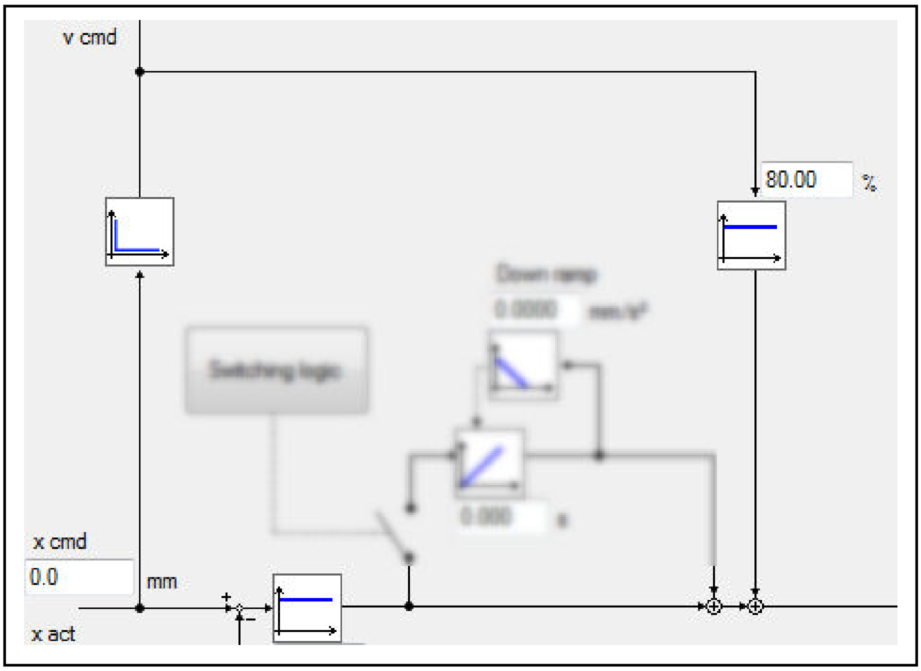


Fig. 7-120: Feedforward for the position controller

Generally, the velocity feedforward is used to minimize the lag error while traveling. For hydraulic systems, however, it can be necessary to reduce the feedforward to avoid overshoots in the position.

State controller

The state controller provides velocity feedback and acceleration feedback. They can be used for active vibration damping. The feedback values of velocity or acceleration are added in negative form in the state controller. Optionally, the acceleration command value (differentiated from position command value) can be added (P-0-1372 bit 5); only useful in systems with a very small lag error.

The feedback values are generated in accordance with the feedback value adjustment. The feedforward is weighted with a proportional gain (P-0-1380, P-0-1379) and added to the output of the position controller, if necessary in filtered form (P-0-1385, P-0-1316).

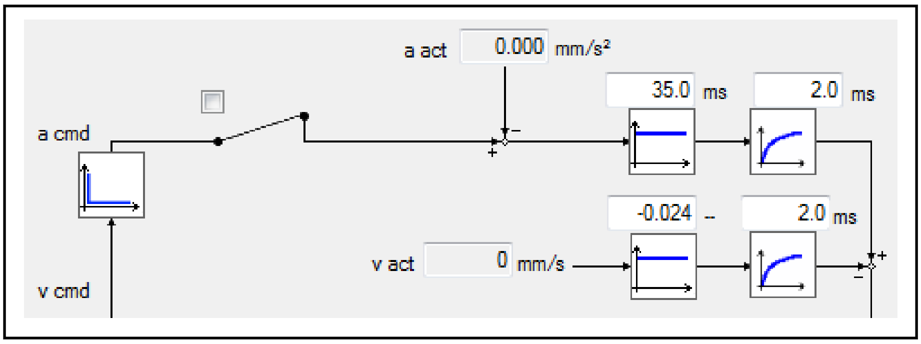


Fig. 7-121: State controller

The better the actuator can be damped using the state controller, the more dynamically can movements be performed. Higher gain factors in the position controller itself will be possible without the actuator becoming unstable.

Vibration damping does not take effect during force control.

Parameter set switching

Parameter set switching is available to adjust the position control loop parameters in the case of alternating, hydraulic loop gains, e.g. due to the switching of cylinder areas or variation of the pump volume. Clicking the "Configuration" button of the controller parameters set selection in the position controller dialog opens the detailed dialog for parameter set switching.

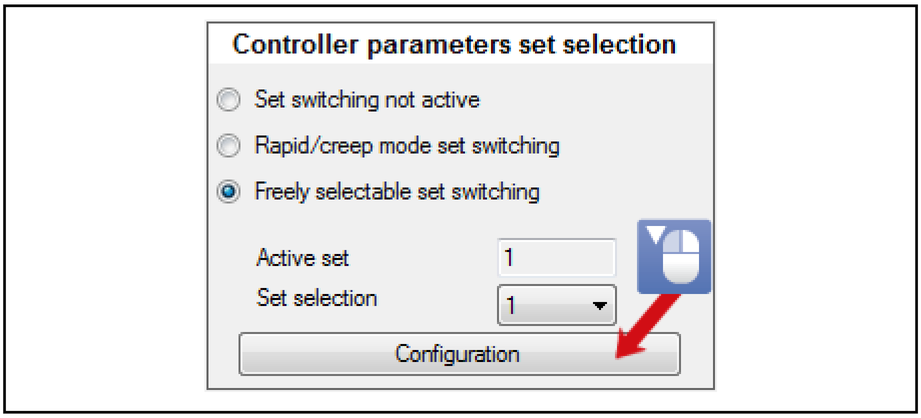


Fig. 7-122: Parameter set switching

The following position control loop parameters are switched with a set.

- Kv, position control loop
- Velocity feedforward
- Ti, position control loop
- Kp, velocity control loop
- Kp, accel. control loop

No parameters are switched for the force controller.

For the type of switching, there are the following settings in the axis controller/functions configuration word (P-0-1370) 21...19:

- 000: No set switching (parameter set switching deactivated)
- 010: Set switching linked to rapid mode (set 1) / creep mode (set 2)
- 001: Freely selectable set switching (set 1...4) using switching control word (P-1283 bits 10...8); can be input using:
  - Master communication
  - Digital inputs
  - Application-specific MLD program
  - IndraWorks dialog

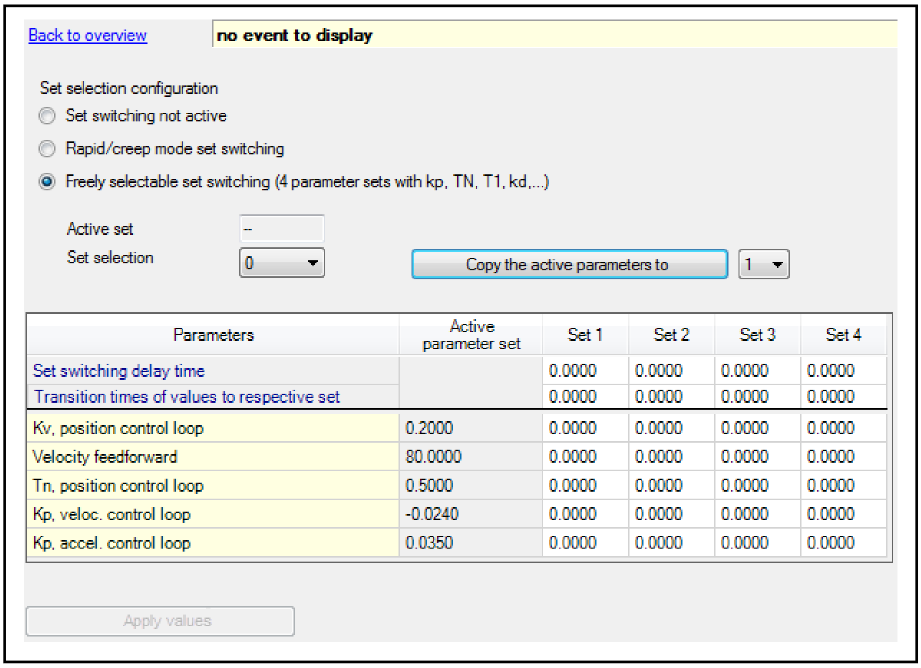


Fig. 7-123: Parameter set switching

The active parameter set is displayed in the system status word 1 (P-0-1280; bits 10...8). As soon as one of the parameter sets has been activated, the regular controller parameters are only used to display the active values. The parameters of the corresponding set are then used to parameterize the controller setting. If parameter set switching is deactivated, the last active values are retained in the regular controller parameters and can be changed there again.

To simplify the configuration of the parameter sets, two copy functions are provided in the dialog:

- Copying active values to a specific parameter set (button or context menu)

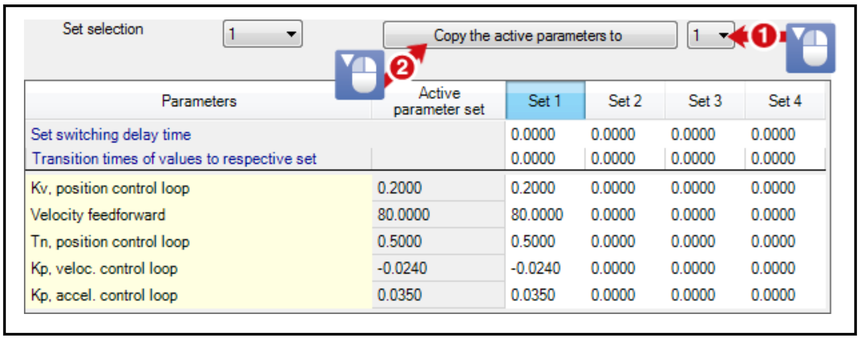


Fig. 7-124: Copying active parameter set using button

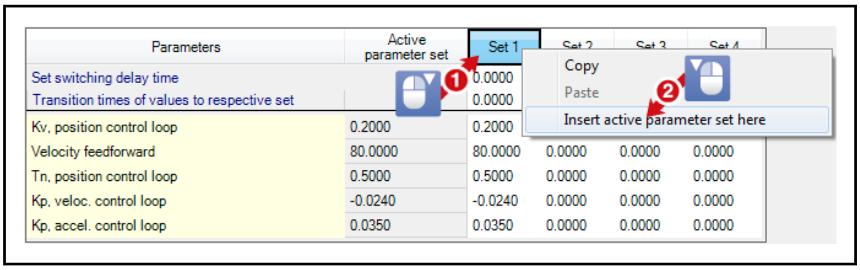


Fig. 7-125: Copying active parameter set using context menu

- Copying a specific parameter set and inserting it in another one (context menu)

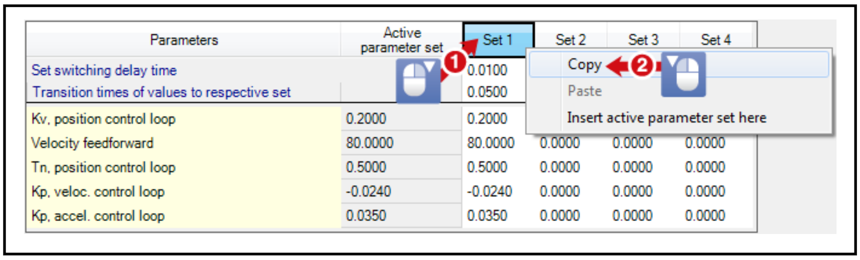


Fig. 7-126: Copying parameter set using context menu

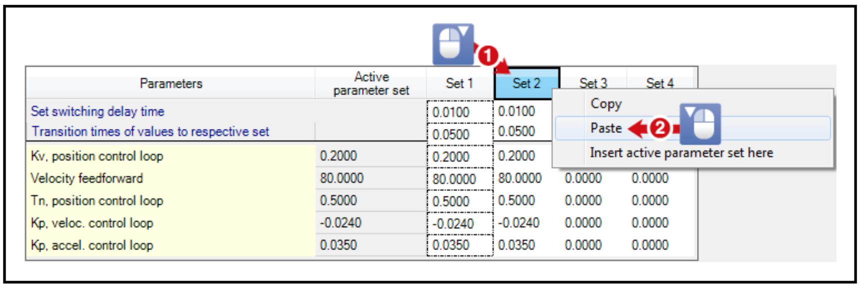
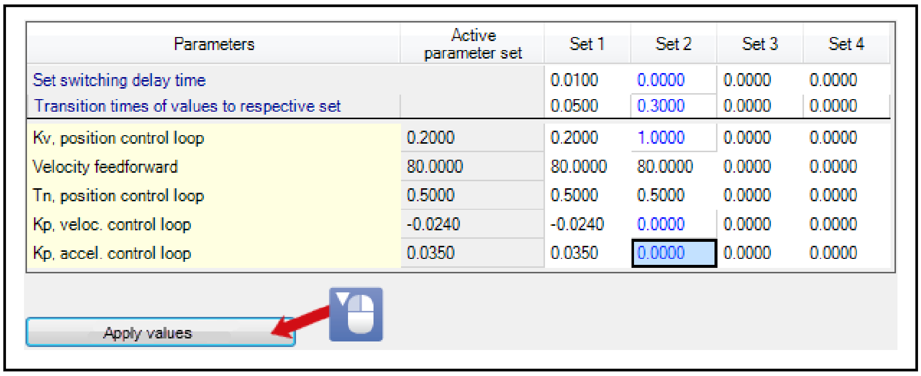


Fig. 7-127: Inserting parameter set in another parameter set using context menu

The modified parameter sets have to be explicitly written to the corresponding parameters using the "Apply values" button. See "Parameter sets structure" table.



Parameters	Active parameter set	Set 1	Set 2	Set 3	Set 4
Set switching delay time		0.0100	0.0000	0.0000	0.0000
Transition times of values to respective set		0.0500	0.3000	0.0000	0.0000
Kv, position control loop	0.2000	0.2000	1.0000	0.0000	0.0000
Velocity feedforward	80.0000	80.0000	80.0000	0.0000	0.0000
Tn, position control loop	0.5000	0.5000	0.5000	0.0000	0.0000
Kp, veloc. control loop	-0.0240	-0.0240	0.0000	0.0000	0.0000
Kp, accel. control loop	0.0350	0.0350	0.0000	0.0000	0.0000

Fig. 7-128: Applying modified values of the parameter sets

☞ Before a parameter set is selected, the required sets absolutely should have been parameterized completely, or at least the active parameters should have been copied to one of the sets. Selecting a set that has not yet been parameterized will overwrite the active controller parameters with the value "0.0000", and this cannot be undone.

7.4.8 Force controller

The controller for the process force can be used as a force controller or as a pressure controller. For details, see "Structure".

Overview

The most important parameters for the force controller can already be set in the overview dialog. These values are:

- Kv-factor [1/s], P-0-1373
- Disturbance observer time constant (Ti) [s], P-0-1374
- Torque/force command value, positive 2, S-0-0550
- If necessary, torque/force command value, negative 2, S-0-0551
- Alternatively, pressure command value, S-0-0800
- Ramp, S-0-0553 or S-0-0810/S-0-0811

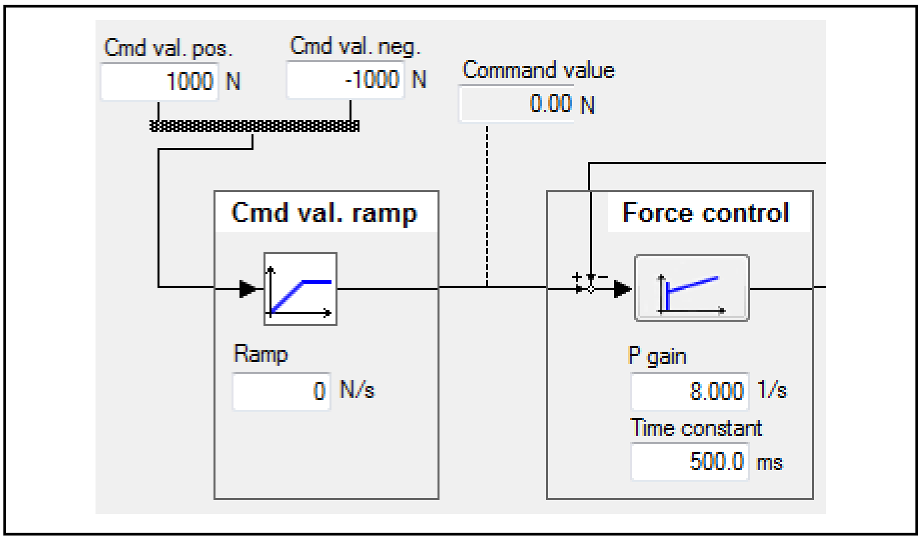


Fig. 7-129: Force controller overview

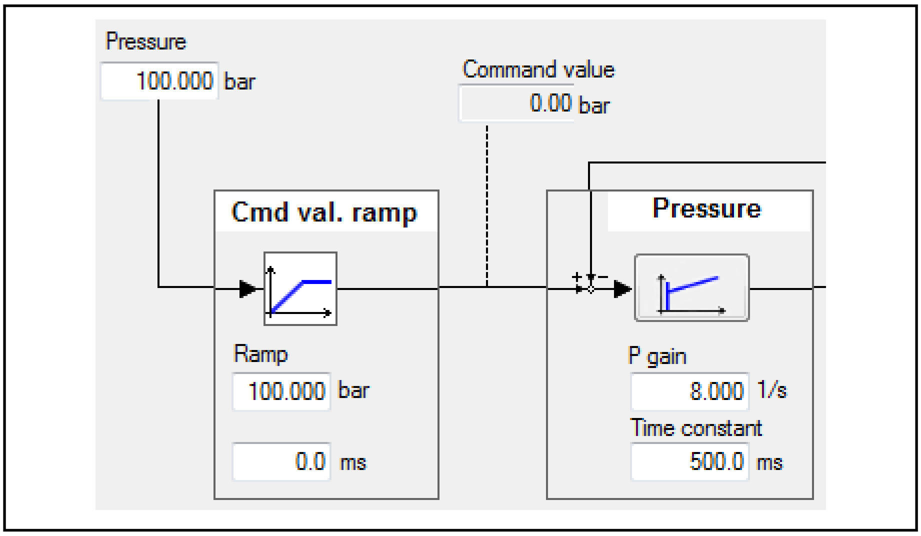


Fig. 7-130: Pressure controller overview

Further settings are displayed in the detailed dialog. The controller symbol is the corresponding button.

Structure

The force controller makes available the following functions:

1. Pressure/force control switching
2. Command value/feedback value adjustment
3. PI-controller
   - Proportional gain of control error
   - Integral term for P-controller output with switching logic and down ramp
4. Status of pressure/force
   - Pressure/force command value has reached target value
   - Pressure/force actual value is within the accuracy window
5. Velocity feedforward

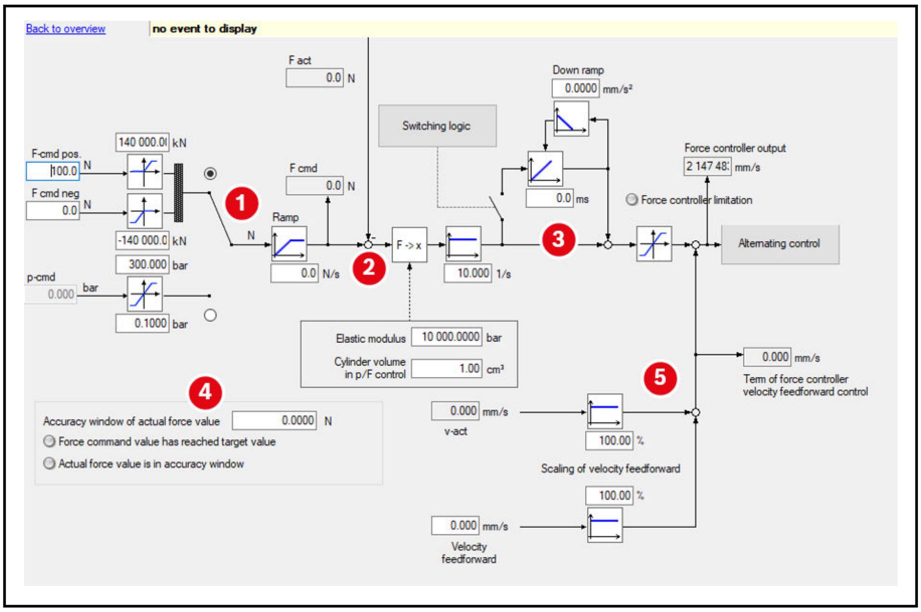


Fig. 7-131: Force controller

The sum of PI-controller output and velocity feedforward is taken into account for alternating control as the overall controller output of the pressure/force controller.

Pressure/force control switching

When switching between pressure and force control, the only thing that is set is the unit in which the command values are input and the feedback values are adjusted. The unit depends on the respective scaling setting of the force data (S-0-0086, usually "N") or pressure data (S-0-0806, usually "bar").

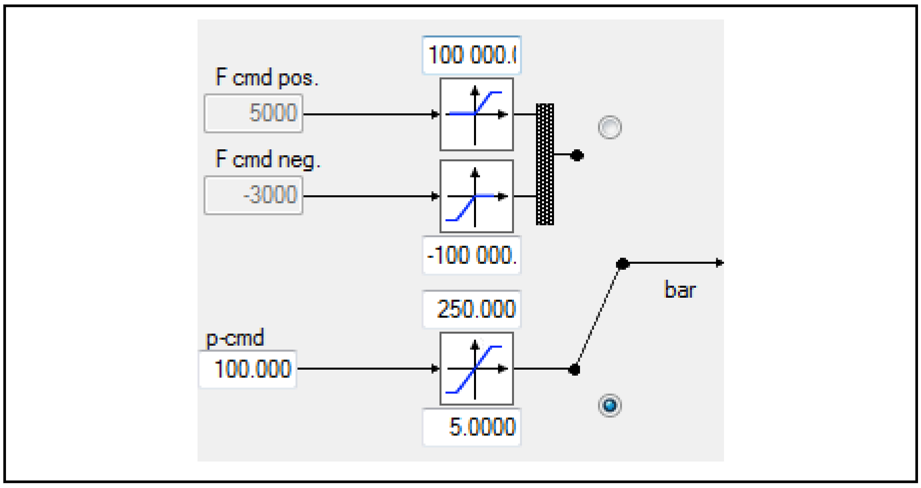


Fig. 7-132: Switching to force control

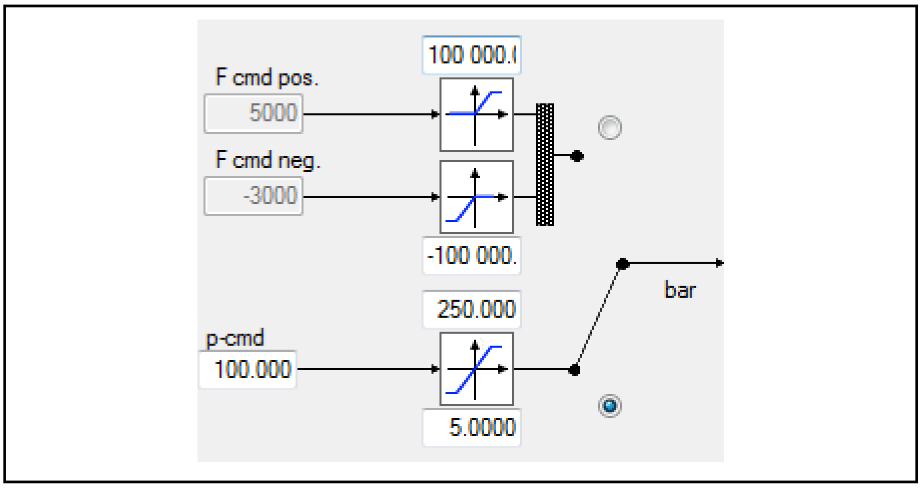


Fig. 7-133: Switching to pressure control

Switching entails dependencies for the command value and feedback value adjustment that are explained below.

Command value/feedback value adjustment

Before they are transmitted to the controller, the command values that can be cyclically input or statically configured are limited and filtered. The "effective pressure/force command value" is always displayed in P-0-1271. Unless drive enable has been set in IndraDrive, the command value is set to the feedback value.

For **force control** there is a positive and a negative force command value. The positive force command value (S-0-0550) takes effect in extending direction with pressure buildup in cylinder chamber A. It is limited to a value between "0" and the "maximum force command value" (P-0-1311[102]). The negative force command value (S-0-0551) takes effect in retracting direction with pressure buildup in cylinder chamber B. It is limited to a value between the "minimum force command value" (P-0-1311[103]) and "0". On the basis of the configuration and the position lag error during the transition to force control, the alternating control decides which of the two command values is used for control at runtime. The limited force command values are ramped using the value in "S-0-0553, Torque/force command value 2 ramp".

For **pressure control** there is only one pressure command value (S-0-0800) that is used for control. It is limited to a value between "minimum pressure command value" (P-0-1311[101]) and "positive pressure limit value" (S-0-0828). If a "minimum pressure command value" of less than "3.00 bar" has been entered, a minimum value of "5.00 bar" takes effect internally as a protective measure. The limited pressure command values are ramped using the quotient of "S-0-0811, Pressure ramp reference" and "S-0-0810, Pressure ramp time".

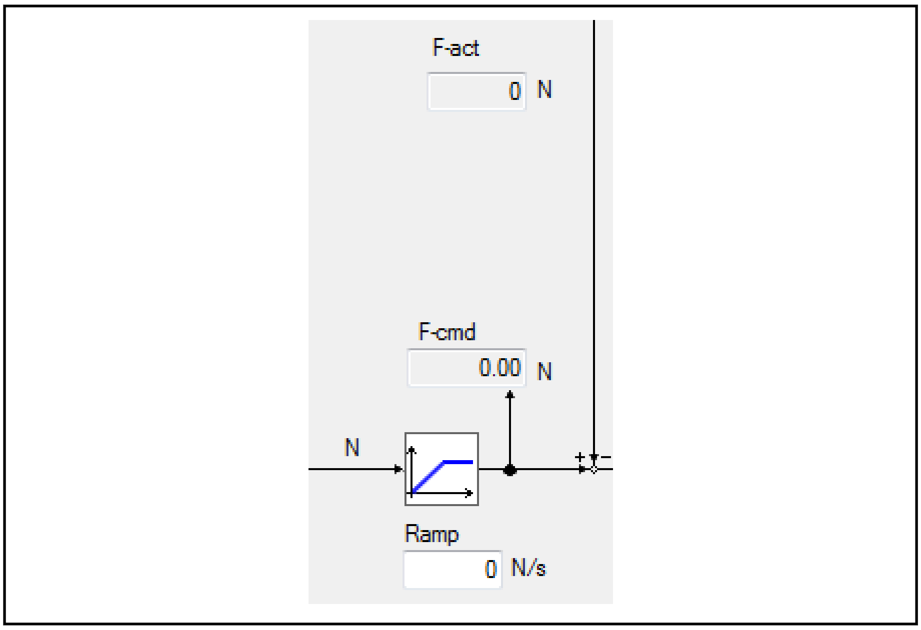


Fig. 7-134: Force command value ramp

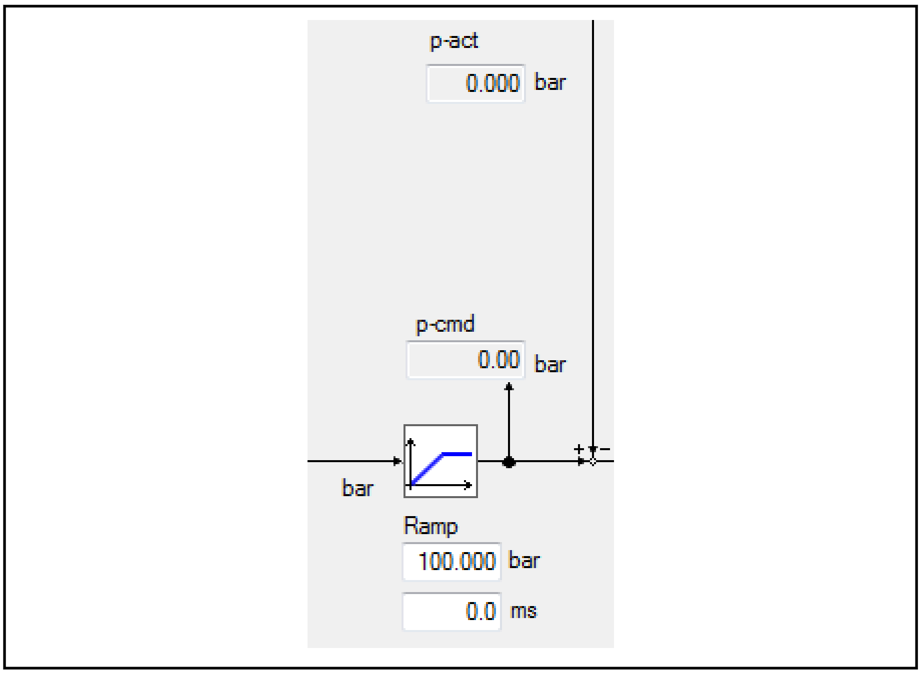


Fig. 7-135: Pressure command value ramp

The actual values are provided in accordance with the sensor data for process force/process pressure that have been set. In force control, the effective areas are taken into account for pressure sensors.

PI-controller

The proportional gain (Kv) of the PI-controller weights the control error of the pressure or the force and thereby generates the corrective controller output for the speed controller in IndraDrive. The integral term (I-term) takes effect in series connection with the P-controller. Using a switching logic, the I-controller is activated, frozen or deactivated at runtime.

These are typical controller parameter values for PFC applications:

- Proportional gain (P-0-1373) ≤ 10 [1/s]
- Integral action time (P-0-1374) ≥ 200 [ms]

See also controller optimization in the Annex, chapter 9.3 "Controller optimization" on page 508

In hydraulic applications, the I-term is primarily used to compensate leakages in the system. If the I-term is to run permanently, only the threshold values for the change thresholds of command values and actual values have to be overwritten by "0"; see below. During position control, the I-term of the pressure/force controller is always deactivated.

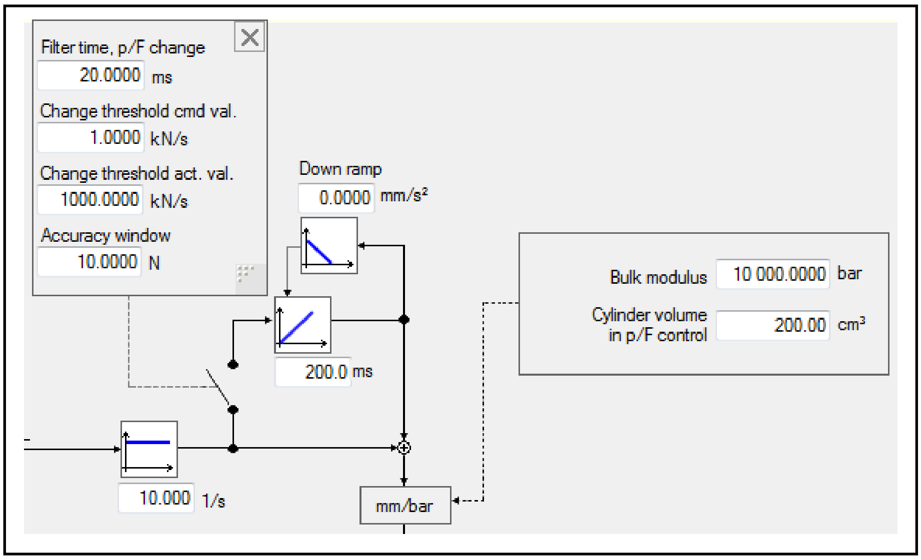


Fig. 7-136: PI-controller

The switching logic for the I-term compares three signals:

1. Absolute value of command value change [kN/s]
2. Absolute value of actual value change [kN/s]
3. Absolute value of the lag error

with the three thresholds:

1. Change threshold command values; P-0-1311[108] in "kN/s"
2. Change threshold actual values; P-0-1311[109] in "kN/s"
3. Accuracy window; P-0-1311[110] in "N"

And thereupon switches to four different states.

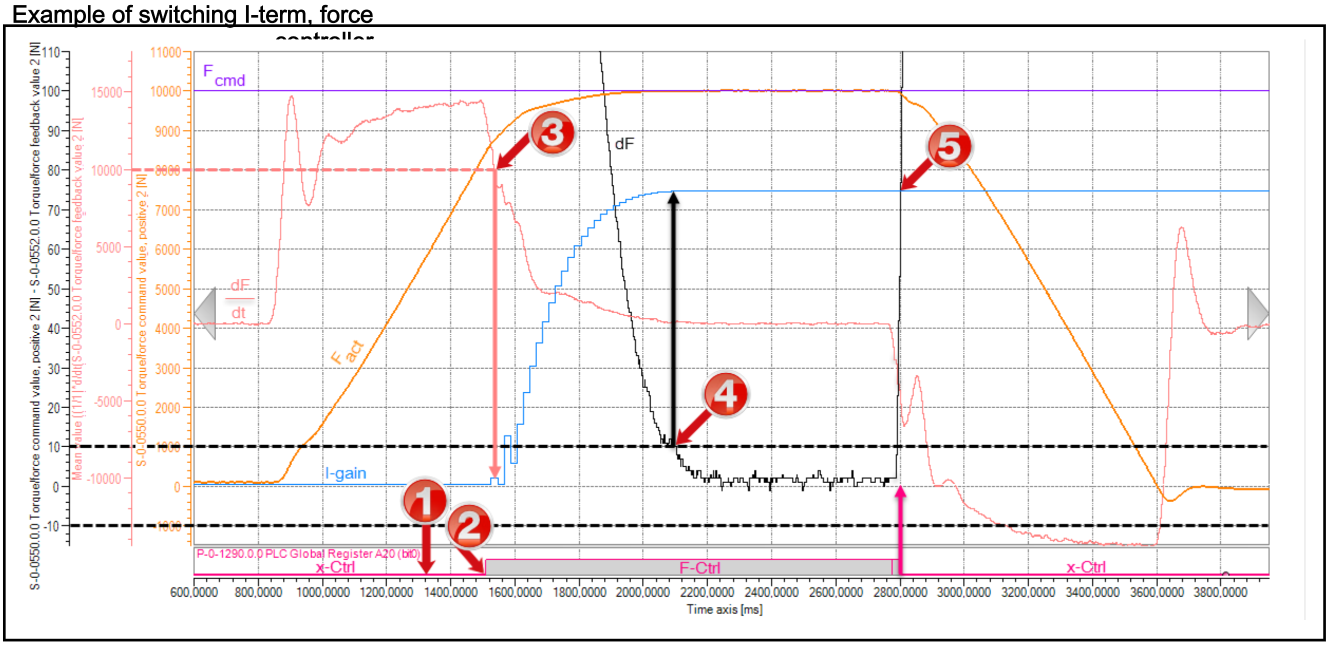
- Deactivated: if |command value change| > command threshold OR |actual value change| > actual threshold
- Integrate: if NOT deactivated AND |lag error| ≥ accuracy window

- Freeze: if NOT deactivated AND |lag error| < accuracy window OR position control active OR locking function active

To transmit a smoothed signal of the command value and actual value change to the switching logic and thereby avoid "bouncing", a filter time can be set in P-0-1311[107]. The value has to be adjusted depending on the quality of the encoder signal. However, please consider that this also delays the signals of the command value and actual value change for the switching logic.

With the parameterization in the above example, the logical operating sequence might be as follows, depending on the travel profile:

Example of switching I-term, force controller



F_{cmd}	Force command value
F_{act}	Actual force value
dF	Force control error
dF/dt	Change in force as a function of time
I-gain	Integral term of force controller
x-Ctrl	Position control, operating mode
F-Ctrl	Force control, operating mode

Fig. 7-137: Principle of switching I-term, force control

1. Position control, I-term of force controller deactivated: Transition to force control has not yet taken place, I-term is zero
2. Force buildup, I-term deactivated: Force control active, change in force command value is "0 [N/s]" and thus has fallen below the threshold value, change in actual force value still is above the threshold value, I-term is zero
3. Decreasing the deviation, I-term activated: Change in actual force value has also fallen below the threshold value of "10 [kN/s]", integrator starts running
4. Holding force, I-term frozen: Lag error is within positioning window, leakages are compensated for by I-term that is present
5. Position control, I-term frozen: position controller becomes immediately active by the axis moving back; I-term remains frozen

The signals shown here are suitable for oscilloscope-supported parameterization of the individual thresholds. It is advisable to record the following signals:

- P-0-1271, Effective pressure/force command value
- S-0-0552, Torque/force feedback value 2 or S-0-0809, Pressure feedback value
- P-0-2846.0.2, Output force controller I-part
- If necessary, P-0-0690, Additive velocity command value, process controller
- S-0-0550, Torque/force command value, positive 2 or S-0-0800, Pressure command value
- Calculating the lag error: P-0-1271 - (S-0-0552 or S-0-0809)
- Calculating the command value change: d (P-0-1271) /dt [s], additional smoothing, if necessary
- Calculating the actual value change: d (S-0-0552 or S-0-0809) / dt [s], additional smoothing, if necessary

---

☞ The displays of the effective command value and I-term in the pressure/force controller are only updated in a 20-ms clock cycle to save computing resources. Therefore, the indication is rather qualitative. The I-term is calculated in a 2-ms MLD clock cycle and with every cycle is also reflected in the controller output P-0-0690.

Force feed

The control difference of the pressure/force controller first is converted into a velocity (in "mm/s", unit of the standard axis) so that the controller output can be compared to the controller output of the position controller in alternating control. The "**force feed**" is taken into account in the conversion factor. The advance can be calculated from the elastic modulus (P-0-1311[141]), the volume of the pressing cylinder chamber (P-0-1376) and the effective cylinder area. The unit of the factor is "mm/bar" or "mm/N".

Status of pressure/force command and feedback value

The status of pressure/force is provided as of PFC03V04.

For the provision of pressure/command value provision, the function of a ramp is available as input processing. Depending on the current operation mode of pressure or force control (P-0-1370 Bit 15) the status information "pressure/force command value has reached target value". In addition, it is displayed whether the relevant feedback value is within the accuracy window.

In the case of pressure control an accuracy window (P-0-1311[106] has to be specified around the actual pressure value. P-0-1280 bit 1 = 0/1 indicates whether the pressure command value has reached/not reached the target value. P-0-1280 bit 2 = 0/1 indicates whether the actual pressure value is outside/within the accuracy window.

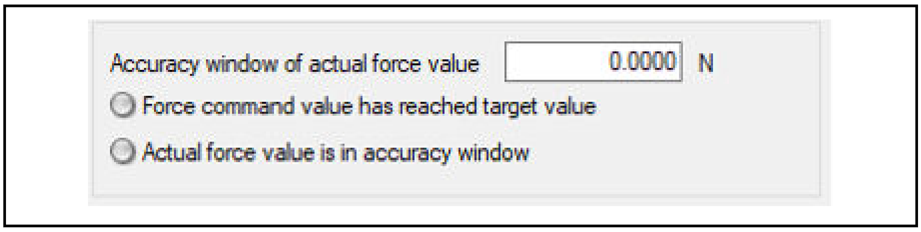


Fig. 7-138: Force status

In the case of force control an accuracy window (P-0-1311[104]) has to be specified around the actual force value. P-0-1280 bit 1 = 0/1 indicates whether the force command value has reached/not reached the target value. P-0-1280 bit 2 = 0/1 indicates whether the actual force value is outside/within the accuracy window.

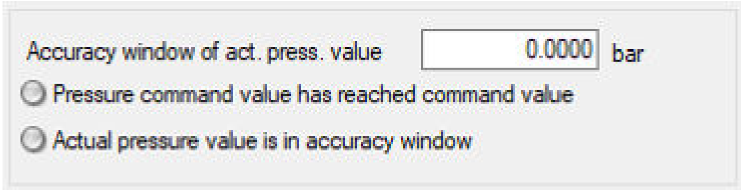


Fig. 7-139: Pressure status

Velocity feedforward for force controller

If the actuator moves during force control because it is, for example, displaced, a lag error will occur in the force control. This lag error will correspond exactly to the controller output that is required for the motion.

To be able to compensate this effect, a velocity feedforward can be realized in the following characteristics:

- The actual velocity value of the axis, P-0-1276, generated from the linear position can be multiplied by "P-0-1378, Gain factor for pressure/force controller velocity feedback" and added to the controller output.
- Via P-0-2844 an external velocity feedforward can be provided (e.g., via field bus), multiplied by "P-0-2845.0.8, Scaling of force controller velocity feedforward" and added to the controller output. This function is available as of PFC03V04.

Both feedforward paths can be operated independently of one another. The feedforward sum is displayed in P-0-2846.0.3.

The velocity feedforward can also be used to reach the command value faster.

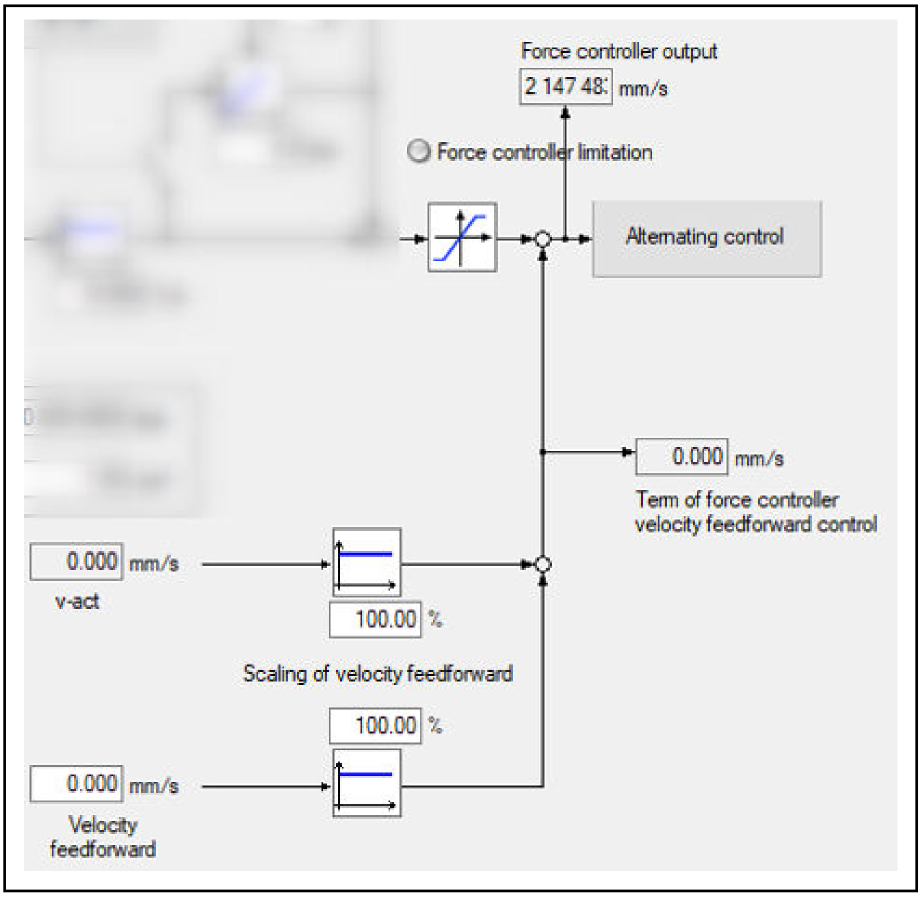


Fig. 7-140: Velocity feedforward for force controller

See also details on controller optimization in the Annex, chapter 9.3 "Controller optimization" on page 508

7.4.9 Alternating control

The alternating control has been implemented as a minimum value generator of the outputs of position controller and pressure/force controller. Thus, the controller with the lower controller output takes effect.

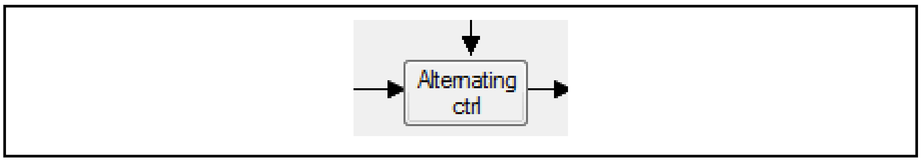


Fig. 7-141: Alternating control

To switch between the controller outputs, it is possible to configure a logic that influences the switching behavior.

Structure

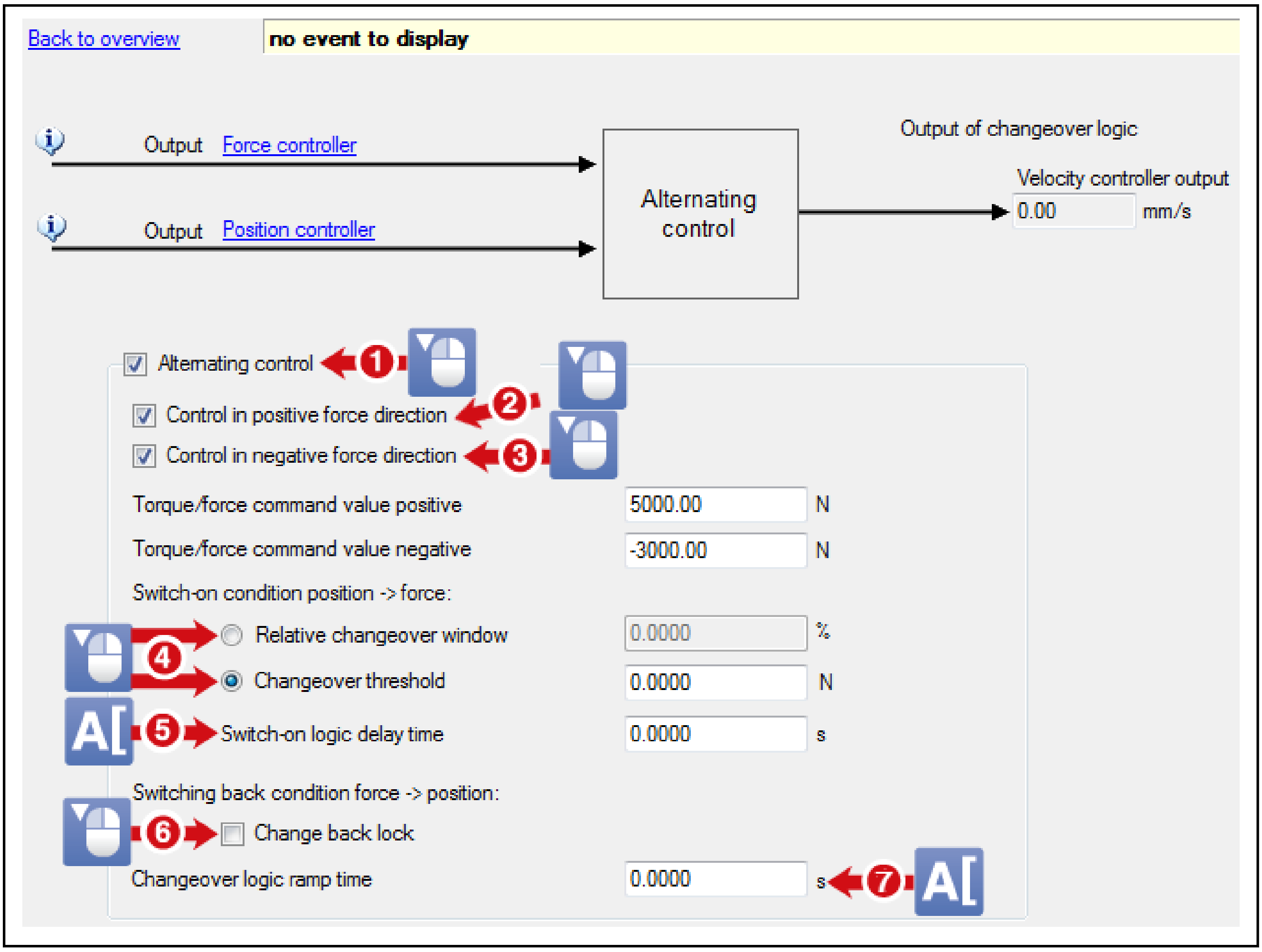


Fig. 7-142: Details of alternating control

Alternating control provides the following functions:

1. Enabling switching of controllers (P-0-2853; bit 0)

   If alternating control has not been enabled, the controller output of the position controller is always dominant.

2. Enabling switching of controllers in extending direction, positive force/ pressure (P-0-1372; bit 14)

   For control with regard to "S-0-0550, Torque/force command value, positive 2" or "S-0-0800, Pressure command value"

3. Switching of controllers in retracting direction, negative force (P-0-1372; bit 15); for force control only

   For control with regard to "S-0-0551, Torque/force command value, negative 2"

4. Switching threshold for the effective pressure/force feedback value:

   - As a relative window around the effective command value (P-0-1311[124]); with a dynamic command value, the absolute width of the window changes because the window is related to the command value in a percentage-based way.
   - As an absolute threshold (P-0-1311[123])

5. Switch-on logic delay time (P-0-1311[125])

For transition from position control to force control

6. Change back lock (P-0-1372; bit 12)

   For transition from force control to position control

7. Changeover logic ramp time (P-0-1311[126])

   When switching, to smoothen the difference between the controller outputs that has built up during a logical delay.

☞ The switching logics are primarily used to avoid an unwanted or premature transition to force control.

To deactivate the switching logics, the switching thresholds, delay time and ramp time have to be set to "0", and the change back lock and must not be activated.

In accordance with the configuration of alternating control, there are different qualitative characteristics of the transition to force control. The following paragraphs show four exemplary scenarios. We distinguish between:

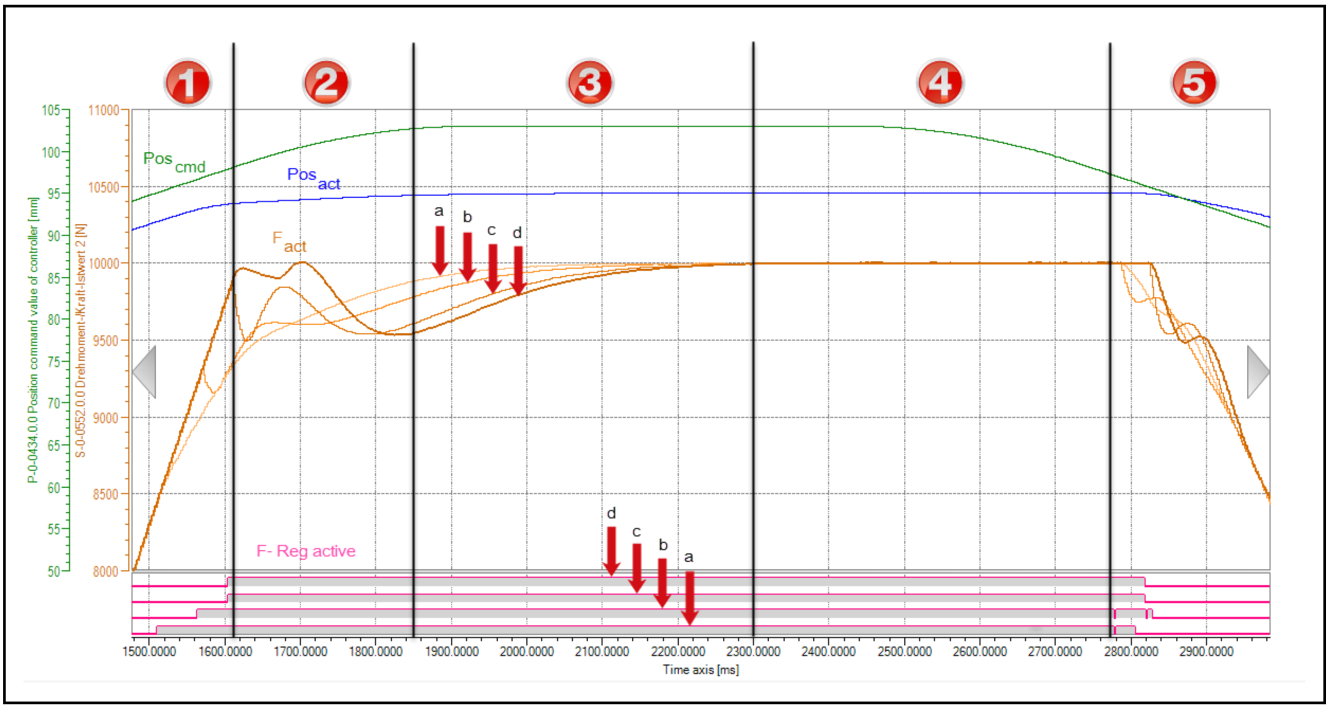
a) No switching thresholds

b) Absolute switching threshold (9300 N), no ramp

c) Absolute switching threshold (9300 N) and delay (40ms), no ramp

d) Absolute switching threshold (9300 N), delay (40 ms) and ramp (400 mm/s / 800 ms = 500 mm/s²)

The logical operating sequence in different functional characteristics can be as follows, depending on the travel profile:



Pos_{cmd}	Position command value
Pos_{act}	Actual position value
F_{act}	Actual force value (a...d)
F - Reg active	Force control active (a...d)

Fig. 7-143: Alternating control - switching logic diagram

1. Transition from position control to force control:

a) Switching of controllers at intersection of the controller outputs of position and force controller

b) Switching after actual force value threshold has been reached (P-0-1311[123] = 9300 N)

c) Switching after actual force value threshold has been reached and delay time has elapsed (P-0-1311[125] = 40 ms)

d) Transition after actual force value threshold has been reached and delay time has elapsed

2. Transition of the controller outputs:

   a) Completed since controllers were switched

   b) At acceleration limit value (S-0-0138) due to jump in controller output; excites the system

   c) At acceleration limit value (S-0-0138) due to big jump in controller output; considerably excites the system

   d) By transition of the controller outputs using a ramp (= 500 mm/s²) that results from "alternating control: max. velocity" (P-0-1311[127] = 400 mm/s) and "alternating control: ramp time for switching" (P-0-1311[126] = 800 ms); attenuates the excitation by the switching behavior; in the oscillation already reaches the command value for a short time

3. Decreasing the deviation:

   a) With a small following distance

   b) With a medium following distance

   c) With an increased following distance

   d) With a highly increased lag distance

4. Holding force:

   a), b), c), d) No differences, because switch-on effects have died down

5. Transition from force control to position control at intersection of controller outputs:

   a), b), c), d) No differences, because change back lock not used; excitation because force has not been reduced beforehand, e.g., by ramping down the force command value (S-0-0550)

Positive/negative force command value switching

If switching of controllers has been enabled both in positive and in negative direction, the alternating control decides at runtime whether the force controller is to control the actual force value with regard to the positive or negative force command value. This depends on the current sign of the position controller output.

In the case of extending motion with a positive position lag error (internal reference to standard axis), the force controller controls on the basis of the positive force command value. In the case of retracting motion with a negative position lag error (internal reference to standard axis), the force controller controls on the basis of the negative force command value.

As soon as the controller output of the force controller has become smaller than the output of the position controller, the force thresholds have been exceeded and switching from position control to force control has been initiated, the command value of the force controller is not switched any more. Only if the controller output of the position controller becomes smaller than the one of the force controller and changing back to position control has been enabled, is the sign of the position controller output used again for selecting the force command value.

7.4.10 Velocity limitation

The effective controller output is limited with the linear velocity limit values of the IndraDrive. The limit values can be set using the button with the limitation symbol.

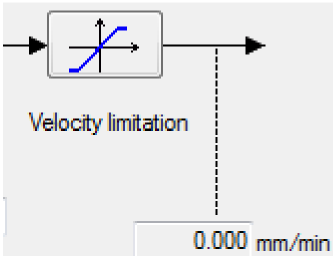


Fig. 7-144: Velocity/speed limitation

In addition, the controller outputs are limited to the lowest effective limit value. A warning is generated when the limit value has been reached. Additive values, such as feedforward or the state controller outputs, are not taken into account for the limitation of the controller output.

7.4.11 Output adjustment

The output adjustment is the interface between the hydraulic actuator and the electric motor.

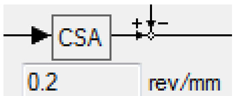


Fig. 7-145: Output adjustment

For a cylinder, the linear command velocity is converted here into the corresponding rotary speed command value. Advance rate variations of the hydraulic actuator at runtime, for example when switching the effective area, are taken into account and compensated for. If a cylinder with an area ratio of 1 : 2 is switched from rapid mode to press mode, a motor speed command value that is twice as high is generated in position control using the output adjustment in order to maintain a specific linear velocity of the cylinder. The corresponding factor is displayed in "P-0-0562, Actuator feed/gear ratio compensation".

☞ In the case of an electromechanical axis with linear transmission ratio, the feed constant is indicated in parameter S-0-0123. The inverse value as feed factor is also displayed in "P-0-0562, Actuator infeed/gear ratio compensation".

7.4.12 Speed limitation

The command speed is limited with the rotary velocity limit values of the IndraDrive. The limit values can be set using the button with the limitation symbol.

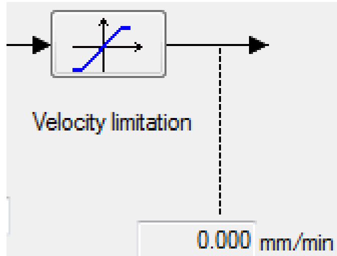


Fig. 7-146: Velocity/speed limitation

7.4.13 Velocity/speed controller

The speed command value for the motor is compared to the actual speed value of the motor encoder and transmitted as the controller output to the speed control loop of the IndraDrive. If required, the control loop can be set using the "velocity control" button with the controller symbol.

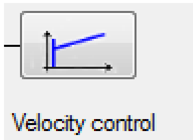


Fig. 7-147: Velocity/speed controller

7.4.14 Holding function

☞ The holding function is provided as of PFC03V04.

The holding function serves to reduce thermal loading of the motor and to achieve energy savings. For this purpose, a cylinder chamber is hydraulically isolated after successful force build-up. As a precondition for this is, one or more electrically activatable valves are required in the action path between the loaded effective area and pump. As functional valve switching output, valve "enable A" (P-0-1410 bit 0) or "enable B" (P-0-1410 bit 1) is usually utilized. The decisive factor for the quality of the holding function is leakage of the isolator valves. The lower the leakage of the isolator valves, the lower is the force gradient while the effective chamber is isolated and the longer can a force be held within the tolerance band before fluid has to be refilled.

The holding function can be configured in the user interface "System configuration". Here, the following parts are required:

- In the valve configuration the circuit for isolating can be configured under the user-defined switching sequence.
- The holding function and its time sequence are configured with axis isolation and reactivation. Changing to the configuration dialog is only offered, when the holding function has been activated (P-0-1370 bit 0 = 0).

Fig. 7-148: Configuration of the holding function

Valve configuration "isolation"

The hydraulic switching state can be set in the switching sequences under "Isolation". The isolation process follows the time sequence of the configured switching sequence.

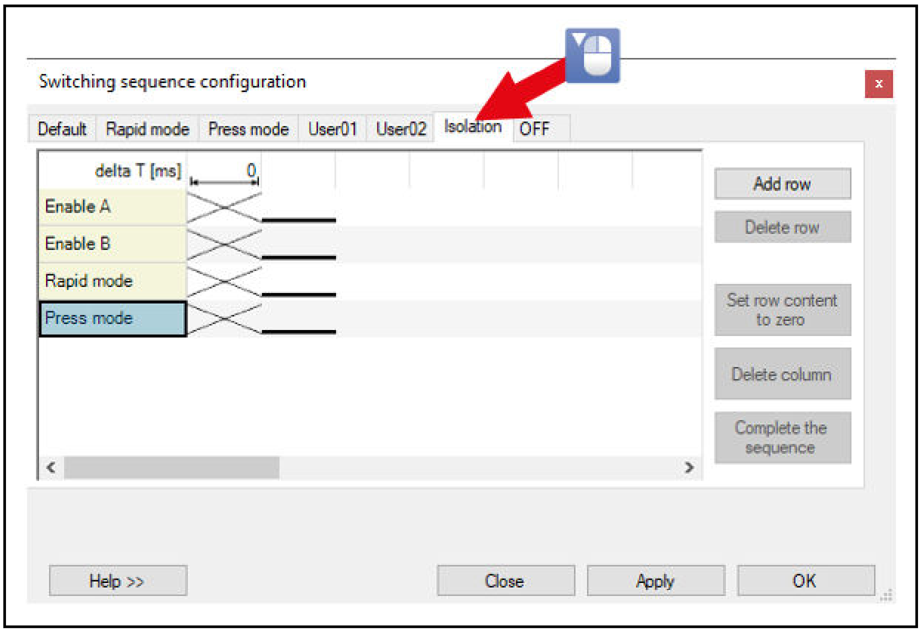


Fig. 7-149: Configuring the switching sequence "Isolate and reactivate axis"

When isolating is completed and the system switches back to another valve switching sequence, the sequence is not followed, but the configured final state is reached.

Configuration "isolate and reactivate axis"

P-0-1372 bit 11 can be used to select between automatic recognition for isolation and reactivation and manual commanding via the control word P-0-1283 bit 13. To this end the GUI switches to the required configurations.

Automatic recognition of isolation/reactivation

If automatic recognition of isolation/reactivation has been selected, the sequence of the holding function is schematically displayed with the related criteria. It is displayed whether the axis is "in/not in control".

The criteria for the automatic recognition for isolation/reactivation can be configured. The conditions for isolating are met, if the force control deviation (F_{cmd} - F_{act}) is within the force accuracy window ($F_{Accuracy}$) and the position control deviation (x_{cmd} - x_{act}) is within the position accuracy window ($x_{Accuracy}$)

and the actual torque/force value (M_{act}) is above the torque threshold M1. The isolation condition is debounced using the time t1. This combination allows a high load on the motor/pump unit to be recognized. Reactivating is started when the force control deviation is by the settable force hysteresis (F_{Hyst}) higher or lower than $F_{Accuracy}$ or the position control deviation is by the settable position hysteresis (x_{Hyst}) higher or lower than $x_{Accuracy}$ or a change in value is recognized in the active target position (S-0-0430).

It is possible to configure the valve switching times. The closing time of the isolator valves can be entered via t2. The closing time of the isolator valves is the time from the activation to the completed functional isolation of the loaded chamber. The configured total time of the "isolation" switching sequence can be used as a basis. t3 can be used to configure a free delay for the reactivation, before the isolator valves opens directly based on time t4. In t4 you have to enter the time from the activation until the active connection of the loaded cylinder chamber.

The restarting behavior for the reactivation can be configured. For restarting, which is activated with a change in the active target position (S-0-0430), it may happen that a large following error occurs in the position, because the axis takes some time until it can follow the preset command value. The following error results in the generation of a large controller output, which can cause a jerky start. For this reason, a function is provided which freezes the external position command value provision via the holding function for the time of the torque build-up until the valves are completely open. Only when the connection to the loaded cylinder chamber has been reestablished will the external position command value input be followed again.

☞ For automatic freezing/following the feedrate override (S-0-0108) of the holding function is written. If this parameter is required for other functions, an individual compatibility check has to be carried out. In case of doubt, the external position command value change always has to be configured as active (P-0-1370, bit 1 = 0).

Closed-loop torque control can be configured. For reducing the load as well as for reactivating, a torque profile can be configured with a defined slope. During ramping the motor is operated in closed-loop torque control. For this, a P-controller is used, which follows the profile. A gain of 1/s may be used for the controller. Due to the fact that the actual torque/force value is too noisy for this application, it is smoothened with a PT1 filter. The recommended filter time is 10 ms.

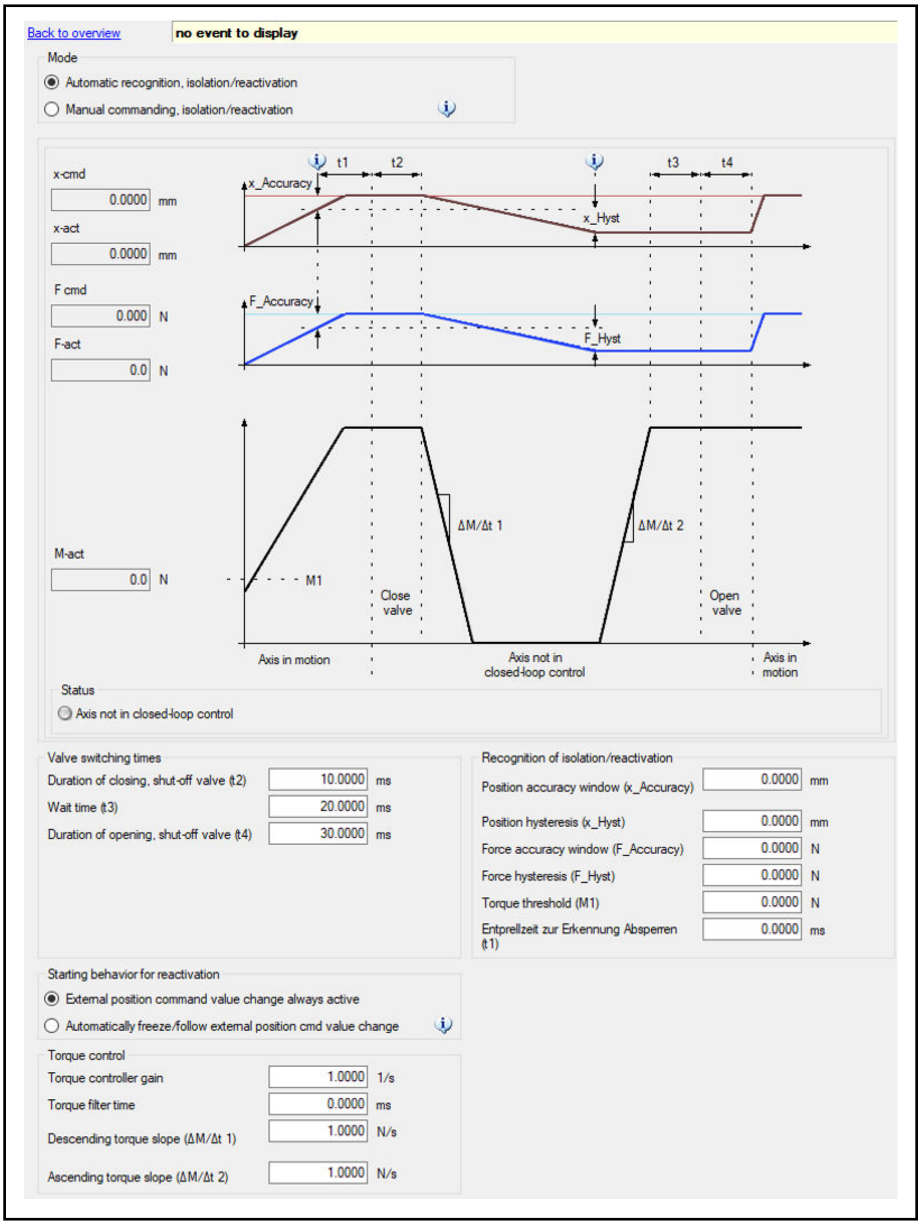


Fig. 7-150: Holding function with automatic recognition of isolation/reactivation

Manual commanding of isolation/reactivation

If manual commanding of isolation/reactivation has been selected, the sequence of the holding function is schematically displayed with the related criteria. Apart from the status display "axis in/not in control" the current command of isolating is displayed.

Commanding of isolating/reactivating is carried out via control word P-0-1283 bit 1 = 1/0. This can be done via a master communication, for example.

☞ With this commanding, the axis is isolated irrespective of the current process data. It has to be ensured that the axis is isolated in this situation and, when commanding is stopped, can be reactivated.

It is possible to configure the valve switching times. The closing time of the isolator valves can be entered via t2. The closing time of the isolator valves is the time from the activation to the completed functional isolation of the loaded chamber. The configured total time of the "isolation" switching sequence can be used as a basis. t3 can be used to configure a free delay for the reactivation, before the isolator valves opens directly based on time t4. In t4 you have to enter the time from the activation until the active connection of the loaded cylinder chamber.

The restarting behavior for the reactivation can be configured. For restarting, which is activated with a change in the active target position (S-0-0430), it may happen that a large following error occurs in the position, because the axis takes some time until it can follow the preset command value. The following error results in the generation of a large controller output, which can cause a jerky start. For this reason, a function is provided which freezes the external position command value provision via the holding function for the time of the torque build-up until the valves are completely open. Only when the connection to the loaded cylinder chamber has been reestablished will the external position command value input be followed again.

Closed-loop torque control can be configured. For reducing the load as well as for reactivating, a torque profile can be configured with a defined slope. During ramping the motor is operated in closed-loop torque control. For this, a P-controller is used, which follows the profile. A gain of 1/s may be used for the controller. Due to the fact that the actual torque/force value is too noisy for this application, it is smoothened with a PT1 filter. The recommended filter time is 10 ms.

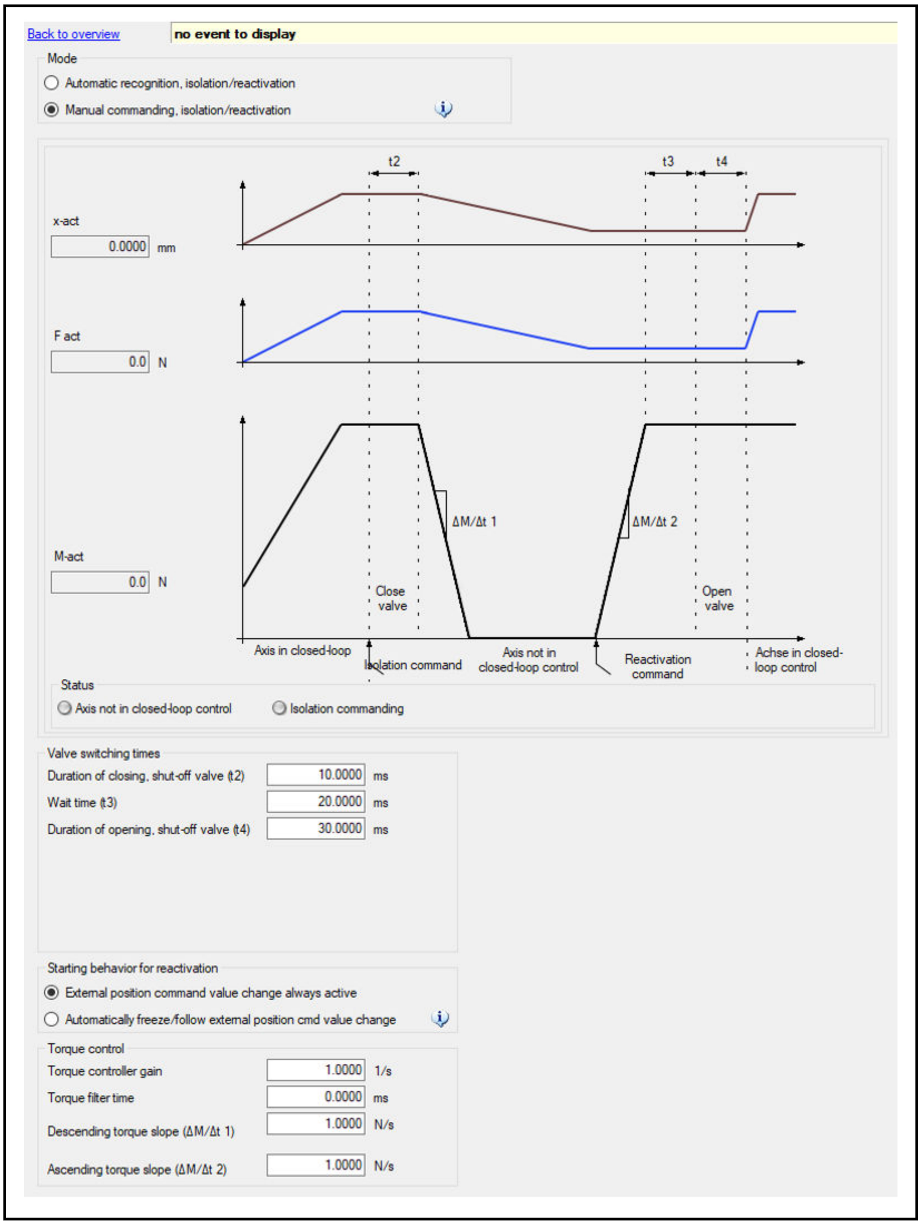


Fig. 7-151: Holding function with manual commanding of isolation/reactivation

It is possible to configure the valve switching times. The closing time of the isolator valves can be entered via t2. The closing time of the isolator valves is the time from the activation to the completed functional isolation of the loaded chamber. The configured total time of the "isolation" switching sequence can be used as a basis. t3 can be used to configure a free delay for the reactivation, before the isolator valves opens directly based on time t4. In t4 you have to enter the time from the activation until the active connection of the loaded cylinder chamber.

7.4.15 Closed-loop swivel angle control

The swivel angle control function is based on the continuous generation of command values in dependence on the load as well as a downstream control with valve command value output for controlling a pump with adjustable swivel angle. The function can be activated in the system configuration.

Pump configuration

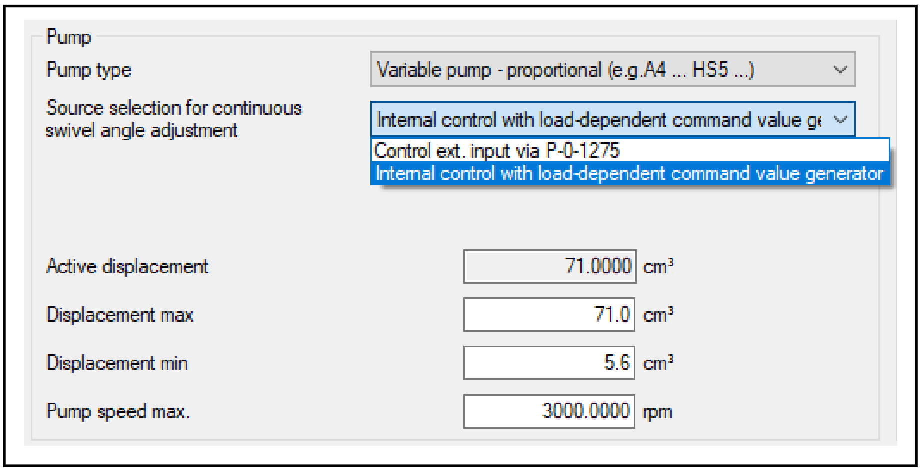


Fig. 7-152: Activation of swivel angle control

A precondition is a pump with variable displacement has to be provided, which has also to be selected as pump type in the GUI (P-0-1370 bit 12..11 = 11). The type of control can be selected via the source selection for the continuous adjustment (P-0-1370 bit 6...5). In this context, the following functions are supported:

- External closed-loop control, input via P-0-1275: The active actual swivel angle value is provided via "P-0-1275, Effective displacement" from an external control. Controlling can take place in an applicative form or in a master communication, for example. Based on the feedback of the effective displacement, the loop gain is corrected by the PFC software.
- Internal closed-loop control with load-dependent command value generator: PFC internally generates load-dependent command values as described in detail in the following. The command value is corrected by a downstream controller.

For both operation modes, the maximum displacement has to be specified in "P-0-2943, Pump displacement volume" and the minimum displacement in "P-0-1371, Small pump displacement". The maximum speed for the pump has to be entered in "P-0-0113, Bipolar velocity limit value of motor".

☞ "P-0-1275, Effective displaced volume" is limited to the minimum and maximum displacement in functional terms. Due to the use as interface for entering the active actual swivel angle value in the case of external control or the display of the active displacement based on the swivel angle of a pump it may happen that the valid range of values “minimum Vg to maximum Vg" is violated. For this purpose the warning threshold can be shifted by a percentage of the maximum Vg (P-0-2943) downwards (below the minimum Vg) or upwards (above the maximum Vg) by means of Vg "P-0-1311[117], Tolerance window for warning when active Vg is limited". If the displacement exceeds or falls below this threshold, a warning is generated.

Swivel angle generator

If the functionality of swivel angle control has been activated in the pump configuration, you can navigate via the structural overview to the configuration of the swivel angle generator.

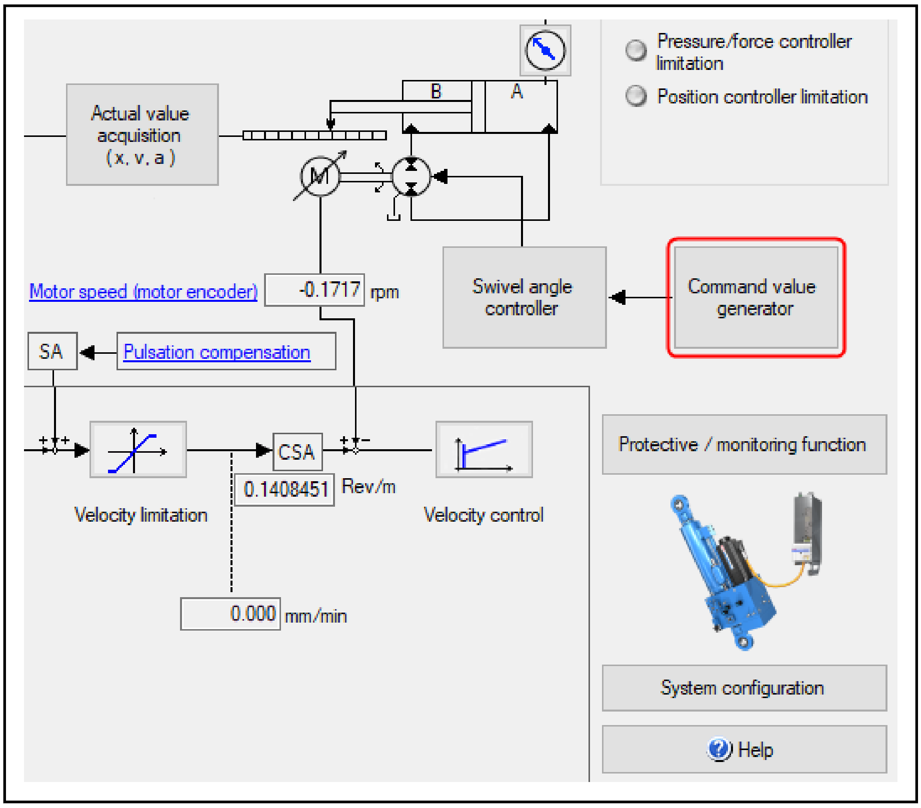


Fig. 7-153: Navigation to the swivel angle generator

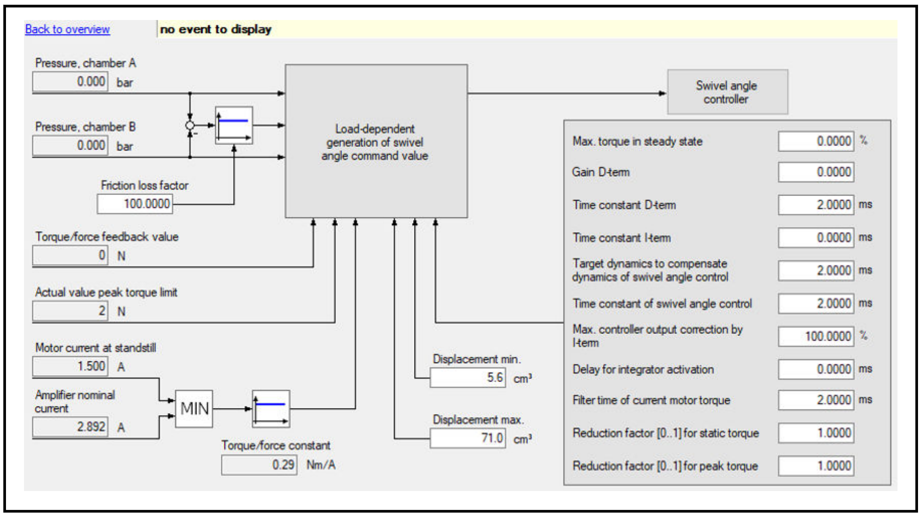


Fig. 7-154: Configuration of the swivel angle generator

The swivel angle command value is generated in dependence on the loading. For this purpose the process data on the current loading of the motor/pump unit have to be acquired. We distinguish between the hydraulic load at the pump and the electrical load at the motor:

- The hydraulic load is determined from the cylinder chamber pressures "S-0-0803, Pressure feedback value A" and "S-0-0804, Pressure feedback value B". With the help "P-0-1311[297], Swivel angle generator: Factor for pressure differential-related friction losses in the pump" friction loss-related pressure losses can be taken into account.
- The electrical load is read in via "S-0-0084, Torque/force feedback value".

The command value generator operates on the basis of percentage values. The rated torque represents the reference as 100 % value and is formed by the minimum torque from the converter and the motor. In the stationary case, the load limit used for the T0 criterion is "P-0-1311[140], Swivel angle generator: Max. motor torque, steady state", which is referred to the nominal torque. For the peak load of the Tmax criterion, the minimum peak torque from the converter and the motor is used as load limit. Due to the fact that the parameters for the provision of the nominal torque and peak load are made available from the encoder memory or dynamically from the temperature model of the firmware, the nominal and the peak torque can be adapted using the reduction factors for the torque, "P-0-1311[289], Swivel angle generator: Reduction factor [0..1] for static torque" and "P-0-1311[290], Swivel angle generator: Reduction factor [0..1] for peak torque" to suit the requirements of the application at hand.

For more detailed information on the formation of the T0 and the Tmax criteria, see chapter 6.16 "Swivel angle control" on page 70

The duration of peak loading is calculated using a DT1 element. To obtain the desired transfer behavior, "P-0-1311[199], Swivel angle generator: Gain D-term" has always to be used with the value "1".

The duration of the permissible peak load can be set in "P-0-1311[200], Swivel angle generator: Time constant D-term". For the IndraDrive C converter, a peak load of up to 400 ms is usually permitted. Above this value, the permissible peak torque is reduced to the nominal torque.

When the Tmax criterion (peak load) is formed, the dynamics of the integrated swivel angle control is taken into account in "P-0-1311[202], Swivel angle generator: Target dynamics to compensate dynamics of swivel angle control" as well as in "P-0-1311[203], Swivel angle generator: Time constant of swivel angle control". Swivel angle control should be set so that a time constant of ca. 60 ms is obtained. The actual time constant can be determined from the time offset between the swivel angle command value (stSwivelAngleControler_gb.rSwivelAngle_SetValue, see chapter 6.21 "Patch function for internal variables of PFC" on page 103) and "P-0-1289, Actual swivel angle value".

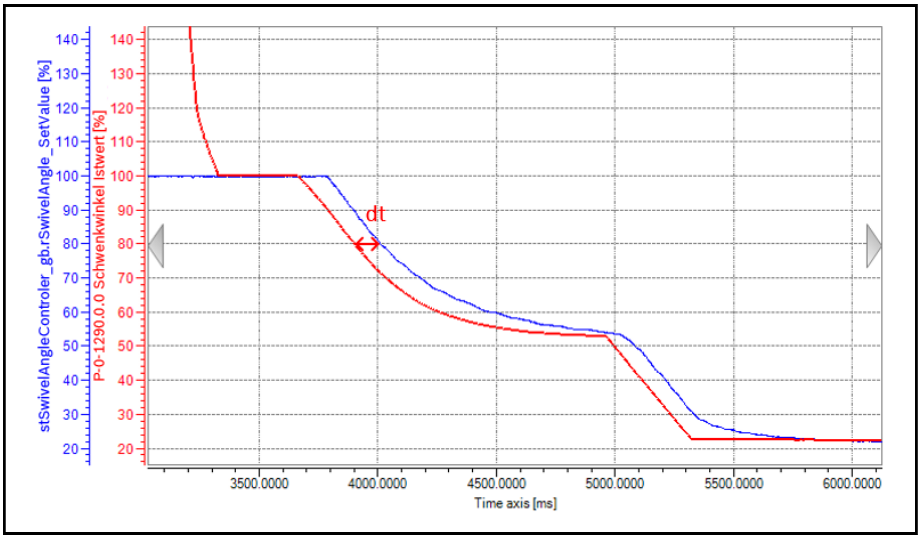


Fig. 7-155: Determination of "P-0-1311[203], Swivel angle generator: Time constant of swivel angle control"

To compensate for leakage, for example of the pump, in stationary applications, it may be useful to activate the integrator. For this purpose the activation can be delayed by means of "P-0-1311[205], Swivel angle generator: Delay for integrator activation" in order to ensure that the integrator is only activated in the stationary state. The time constant of the integrator is specified in "P-0-1311[201], Swivel angle generator: Time constant I-term". The value "0" deactivates the integrator. "P-0-1311[204], Swivel angle generator: Maximum controller output correction" can be used to limit the control output of the integrator.

When the integrator is used it may be required to employ a filter for the switch-on condition of the integrator in the case of a highly noisy "S-0-0084, Torque/force feedback value". For this purpose, a moving average filter is provided, which can be configured by means of "P-0-1311[288], Swivel angle generator: Filter time of current motor torque".

☞ Increased leakage can be recognized by the fact that over the operating time, while the load and the swivel angle remain unchanged, an increased motor speed is required to reach the operating point.

Swivel angle controller

If the functionality of swivel angle control has been activated in the pump configuration, you can navigate via the structural overview to the configuration of the swivel angle controller.

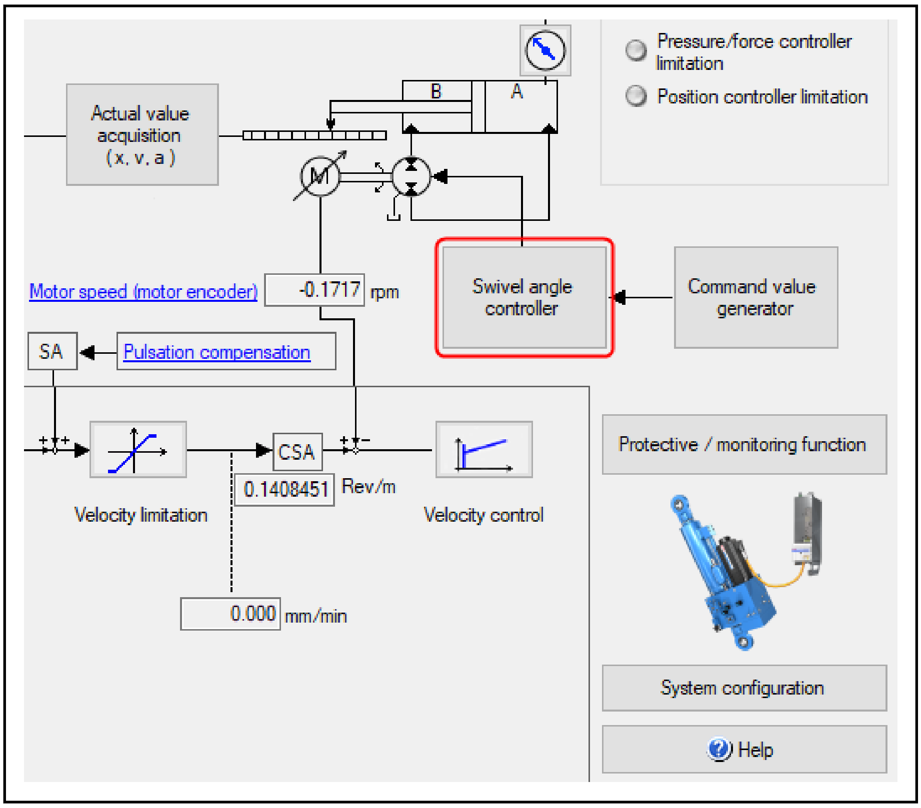


Fig. 7-156: Navigation to swivel angle controller

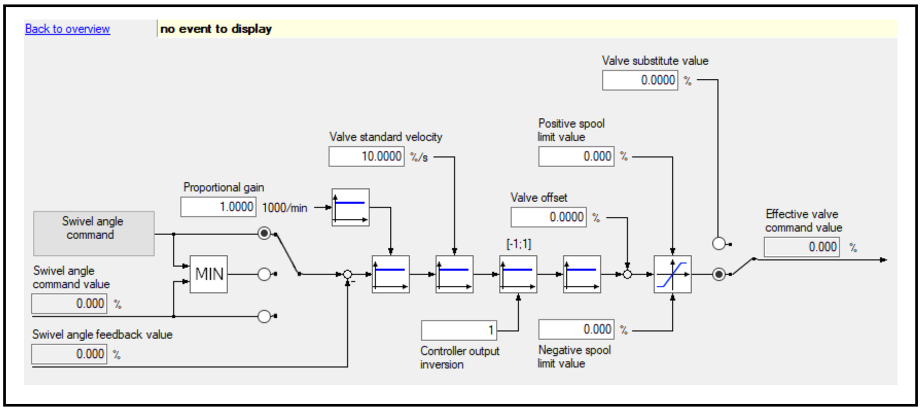


Fig. 7-157: Configuration of swivel angle controller

The command value for the swivel angle controller can be switched over by means of "P-0-1311[291], Swivel angle generator: Mode selection of swivel angle generation". In this case, the following sources may be selected:

- Command value from swivel angle generator
- Minimum value from the command value of the swivel angle generator and external input from "S-0-0880, Swivel angle command value"
- Command value from external input, "S-0-0880, Swivel angle command value"

The angle deviation from the active command value (stSwivelAngleController_gb.rSwivelAngle_SetValue, see chapter 6.21 "Patch function for internal variables of PFC" on page 103) and "P-0-1289, Actual swivel angle value" is weighted with "P-0-1311[292], Swivel angle controller: Proportional gain". An adaptation to the valve actuating speed is carried out using "P-0-1311[293], Swivel angle controller: Valve standard velocity". This can be determined on the basis of measurements. After activation with a jump in "P-0-2914, Effective valve command value" the maximum actuating speed of the pump can be derived from "P-0-1289, Actual swivel angle value". With the help of "P-0-2873.0.3, Control variable inversion" the direction of action of the controller output can be inverted.

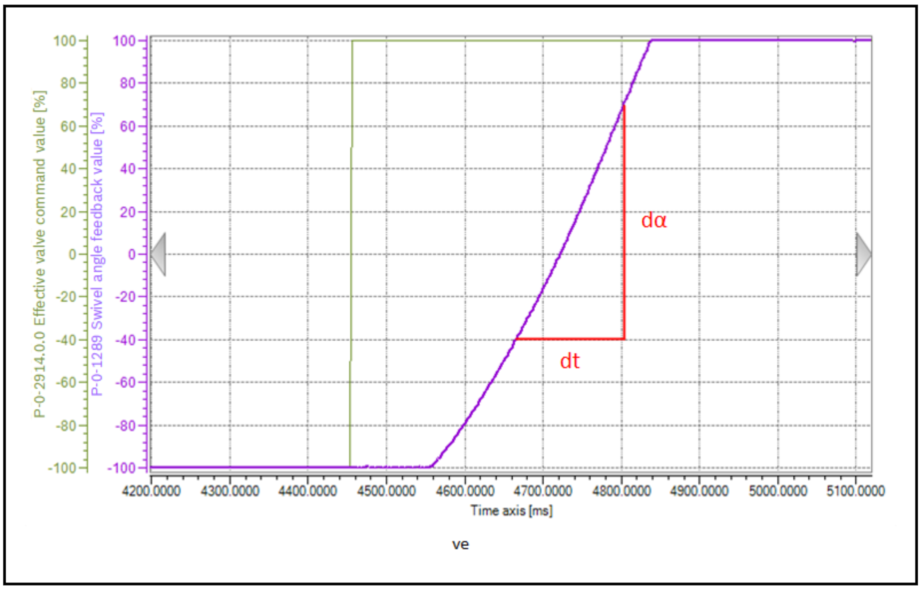


Fig. 7-158: Determination of "P-0-1311[293], Swivel angle controller: Valve standard velocity"

> ☞ Improper use of inversion while the control is active can result in a positive feedback, which can lead to uncontrolled movement of the axis.

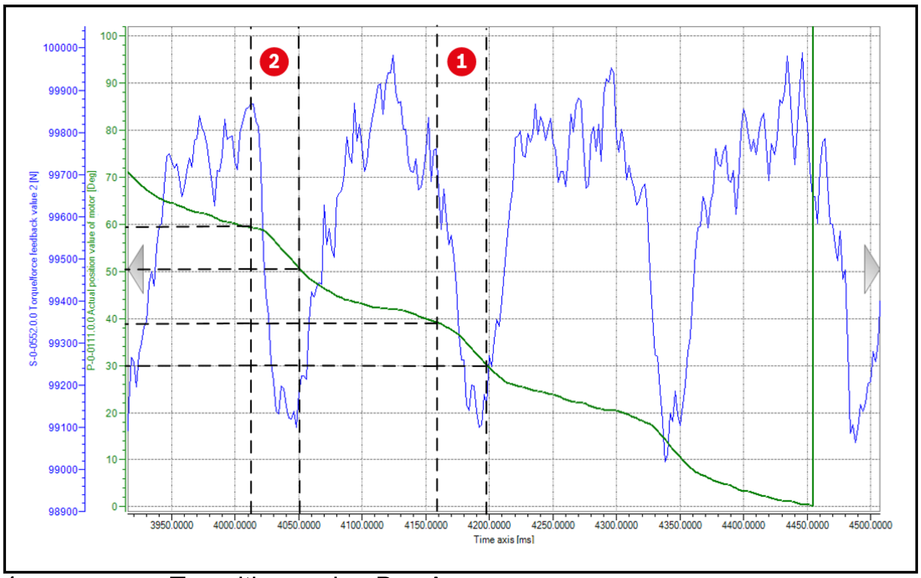
"P-0-1311[295], Swivel angle controller: Valve offset" can be used to set an offset in the controller output, whereas "S-0-0865, Positive spool limit value" and "S-0-0866, Negative spool limit value" limit the controller output in the respective direction.

By means of P-0-1283 bit 3 the output of the controller output to the valve from the control or "P-0-1311[296], Swivel angle controller: Valve substitute value while function is deactivated" can be cyclically switched over. The controller output for the valve for swivel angle control is output to "P-0-2914, Effective valve command value".

7.4.16 Pulsation compensation

Pulsation compensation is used to smoothen pressure pulsation of axial piston pumps. Pulsation results from the fact that the high pressure side and the low pressure side of the pump are short-circuited, when a pump piston is within the transition region.

For parameterization of pulsation compensation, first you have to determine the angles of the transition regions of the pump in relation to the motor. To this end, oscilloscope recording is required with the parameters "S-0-0552, Torque/force feedback value 2" und "P-0-0111, Actual position value of motor " in the operating point to be optimized (e.g. in force control with the desired setpoint force).



1 Transition region B → A

2 Transition region A → B

Fig. 7-159: Determination of transition regions

In fig. 7-159 "Determination of transition regions" on page 238 these parameters were recorded for an axis in force control with a force command value of 100 kN. Cyclic force breakdowns of the transition regions can clearly be recognized. The force breaks down after a change in the rotation angle of the motor of 20°. From this, it can be derived that the pump has 9 pump pistons (360° / (20° x 2) = 9). The number of pump pistons has to be entered in "P-0-1311[334], Pulsation compensation: Number of pump pistons".

Should the force break down alternatingly more and less strongly, the deeper force breakdown takes place in the transition region B → A and the less strong force breakdown in transition region A → B. The difference results from the fact that the volume of the pump piston is pressurized when reaching the transition region A → B, but it is not pressurized when reaching the transition region B → A. However, this cannot be recognized in the present measurement and the influence can therefore be neglected. The transition regions can therefore be optionally assigned.

When configuring the transition regions, the motor's direction of rotation has to be taken into account as follows:

- Actual position value of the motor is increasing (clockwise rotating motor)
  - The rotary angle at the beginning of transition region B → A has to be entered in P-0-1311[335]
  - The rotary angle at the beginning of transition region A → B has to be entered in P-0-1311[336]
- Actual position value of the motor is decreasing (counterclockwise rotating motor)
  - The rotation angle at the end of transition region B → A has to be entered in P-0-1311[335]
  - The rotation angle at the end of transition region A → B has to be entered in P-0-1311[336]

In the figure below, with negative speed, the pump builds up pressure in chamber A, due to which the actual position value of the motor decreases. Therefore, the respective ends of the transition regions have to be entered in parameters "P-0-1311[335], Pulsation compensation: Angular displacement of motor to transition region B → A" and "P-0-1311[336], Pulsation compensation: Angular displacement of motor to transition region A → B". The end of the transition region is reached at the motor angle, at which the pump can again build up pressure and the force starts to increase. In the measurement shown, this is the case at motor rotation angles of about 30° and 50.5°.

The beginning of the transition regions is at the spots, at which the pressure and hence the force breaks down. It is useful to start compensating somewhat earlier in order to "accelerate into" the transition region. The difference of the motor angle between the beginning and the end of the transition regions has to be entered in parameters "P-0-1311[339], Pulsation compensation: Angle of transition region B → A" und "P-0-1311[340], Pulsation compensation: Angle of transition region A → B". In fig. 7-159 "Determination of transition regions" on page 238 it is approx. 9°.

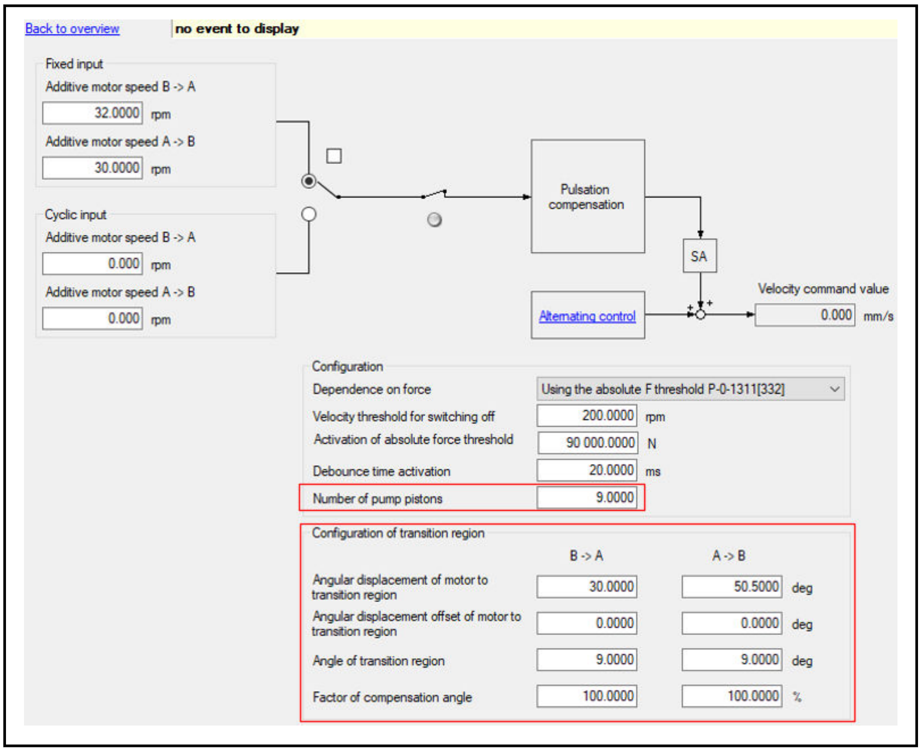


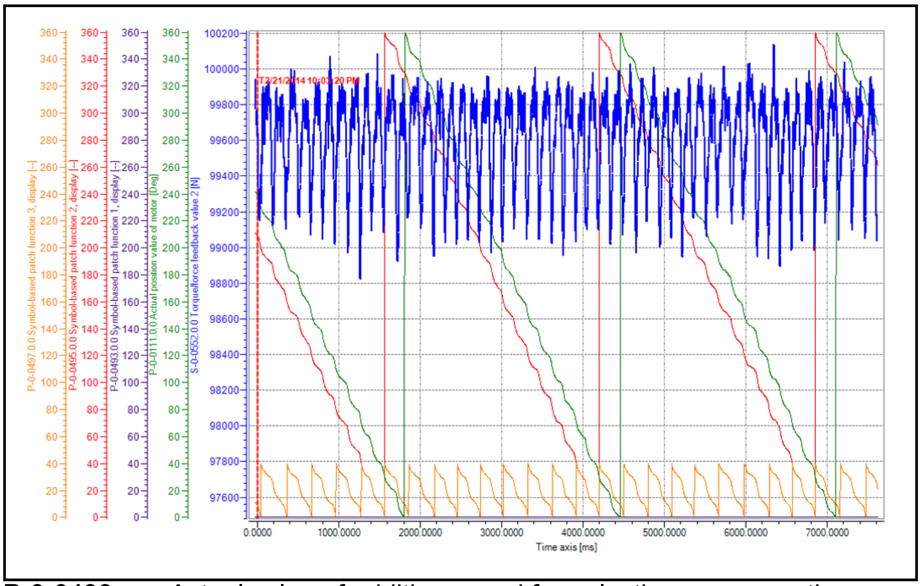
Fig. 7-160: Configuration of the pump

For optimization purposes, internally calculated rotation angles in relation to the transition regions as well as the compensation speed can be included via the patch function (see chapter 6.21 "Patch function for internal variables of PFC" on page 103).

Number of internal variable	Name of symbol variable	Description
14	stPulsationCompensation_gb.rAdditionalSpeed	Actual value of additive speed for pulsation compensation [rpm]
15	stPulsationCompensation_gb.rActAnglePump	Angle of rotation of the pump in relation to the transition region from the B-side to the A-side [°]
16	stPulsationCompensation_gb.rActAnglePistonSegment	Angle of rotation of the pump segment in relation to the transition region from the B-side to the A-side [°]

Tab. 7-23: Internal variables of pulsation compensation for the patch function

In the following figure, the internal variables were recorded via the patch function. The compensation signal consistently takes the value 0. The angle of rotation of the pump referred to the transition region from the B-side to the A-side corresponds to parameter P-0-0111, offset by the value in "P-0-1311[335], Pulsation compensation: Angular displacement of motor to transition region B → A". The angle of rotation of the pump segment referred to the transition region from the B-side to the A-side corresponds to the angle of rotation of the pump with a modulo value of 40.



P-0-0493	Actual value of additive speed for pulsation compensation [rpm]
P-0-0495	Angle of rotation of the pump in relation to the transition region from the B-side to the A-side [°]
P-0-0497	Angle or rotation of the pump segment in relation to the transition region from the B-side to the A-side [°]

Fig. 7-161: Displaying internal variables via the patch function

In a next step, an additive speed must be fed forward for compensation. The amount of the additive speed depends on the operating point. If compensation is to be optimized for a force command value of 100 kN, it can be assumed that with a force command value of 50 kN, pulsation is overcompensated with unchanged settings.

If pulsation compensation is to be used for optimizing a certain operating point, the compensation speeds can be firmly provided via the parameters "P-0-1311[343], Pulsation compensation: Additive motor speed B → A" and "P-0-1311[344], Pulsation compensation: Additive motor speed A → B" (P-0-1370 Bit 29..28 = 01). Furthermore, an absolute force threshold for activating pulsation compensation in "P-0-1311[332], Pulsation compensation: Absolute force threshold value for activation" is useful (P-0-1372 bit 17..16 = 10).

If pulsation compensation is to be used for optimizing various operating points, the compensation speeds can be cyclically provided via the parameters "P-0-1292, Pulsation compensation: Additive motor speed B → A" and "P-0-1293, Pulsation compensation: Additive motor speed A → B" (P-0-1370 Bit 29..28 = 10). They have to be updated and provided from an MLD project or from a higher-level control. Furthermore, an absolute force threshold for activating pulsation compensation in "P-0-1311[331], Pulsation compensation: Relative force threshold value for activation" is useful (P-0-1372 bit 17..16 = 01).

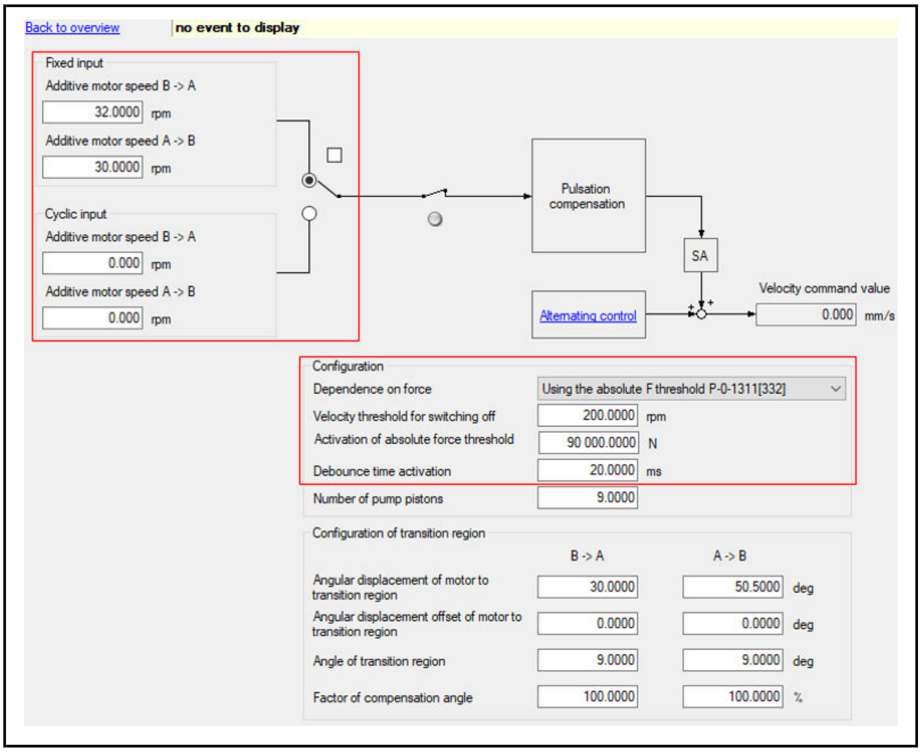


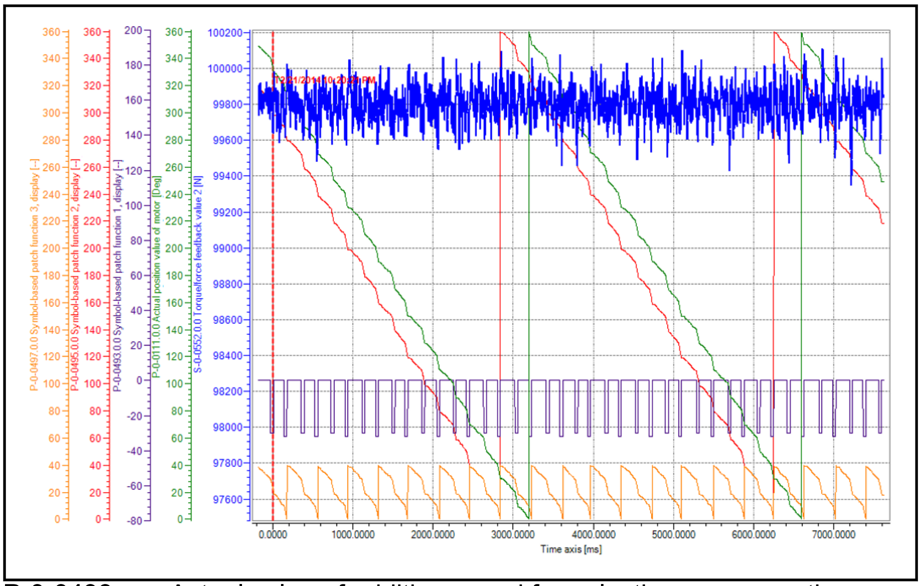
Fig. 7-162: Configuration of compensation speed and activation

The optimization of the additive motor speed should be started at the current motor speed (P-0-0112) and then be progressively increased. If no improvement is observed, check and, if required, adjust the angles of the transition regions. To this end you may also use the offsets of angular displacement (P-0-1311[337], P-0-1311[338]) and the factors for the angles of the transition regions (P-0-1311[341], P-0-1311[342]).

Make sure that the actual force value does not break down at the beginning of the transition region. This would mean that the compensation speed is too low. If an increase in the compensation speed does not result in an improvement, compensation starts too late; the angle therefore has to be adjusted.

In addition, the actual force value should not rise above the normal controller value after the transition regions were left. This would represent an overcompensation. The compensation speed should therefore be reduced.

The following figure shows optimized pulsation compensation with the scaling of fig. 7-161 "Displaying internal variables via the patch function" on page 241:



P-0-0493	Actual value of additive speed for pulsation compensation [rpm]
P-0-0495	Angle of rotation of the pump in relation to the transition region from the B-side to the A-side [°]
P-0-0497	Angle of rotation of the pump segment in relation to the transition region from the B-side to the A-side [°]

Fig. 7-163: Optimized pulsation compensation

7.4.17 System pressure increase

System pressure increase is available as of PFC03V04.

The system pressure increase can be made available by an external power unit or by an internally activated second motor-pump group (secondary axis). In the dialog “System configuration” you have to select, which of the two variants is available.

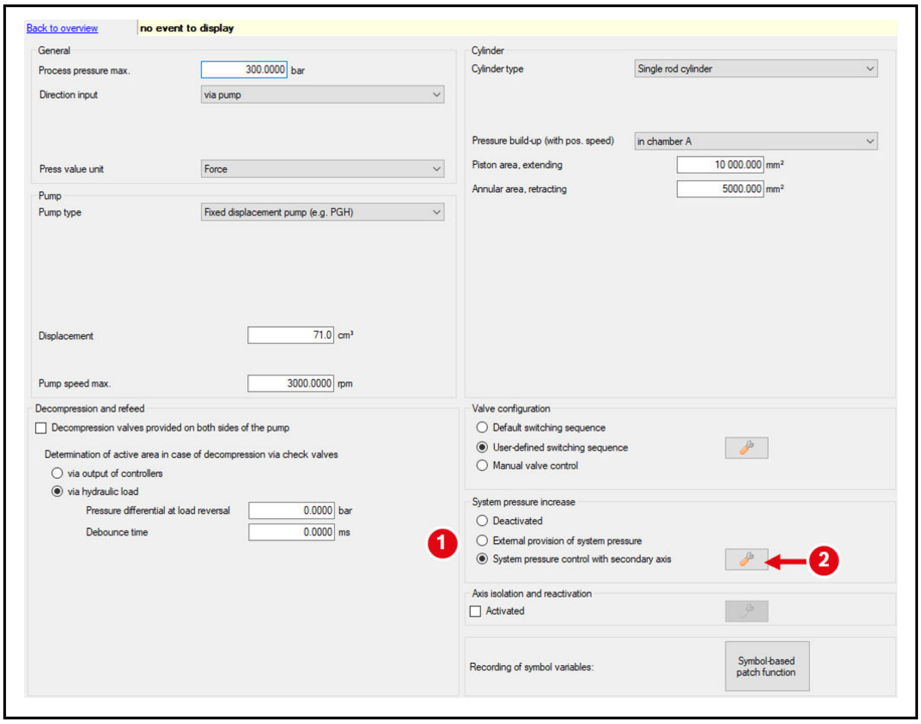


Fig. 7-164: Configuration of the system pressure increase in the dialog "System configuration"

The external provision of the system pressure (P-0-1370 bit 17/16 = 01) has to be configured so that system pressure S-0-0813 - and not tank pressure S-0-0814 - is used for other functions such as detecting the refilling process. Further configurations are not required in this case.

If system pressure control is used with a secondary axis (P-0-1370 bit 17/16 = 10), settings have to be made in the dialogs "Sercos configuration" and "System pressure control".

Sercos configuration

For configuring the primary axis (PFC) settings have to be made in the dialogs "CCD: Basic settings" and "CCD: Error reaction".

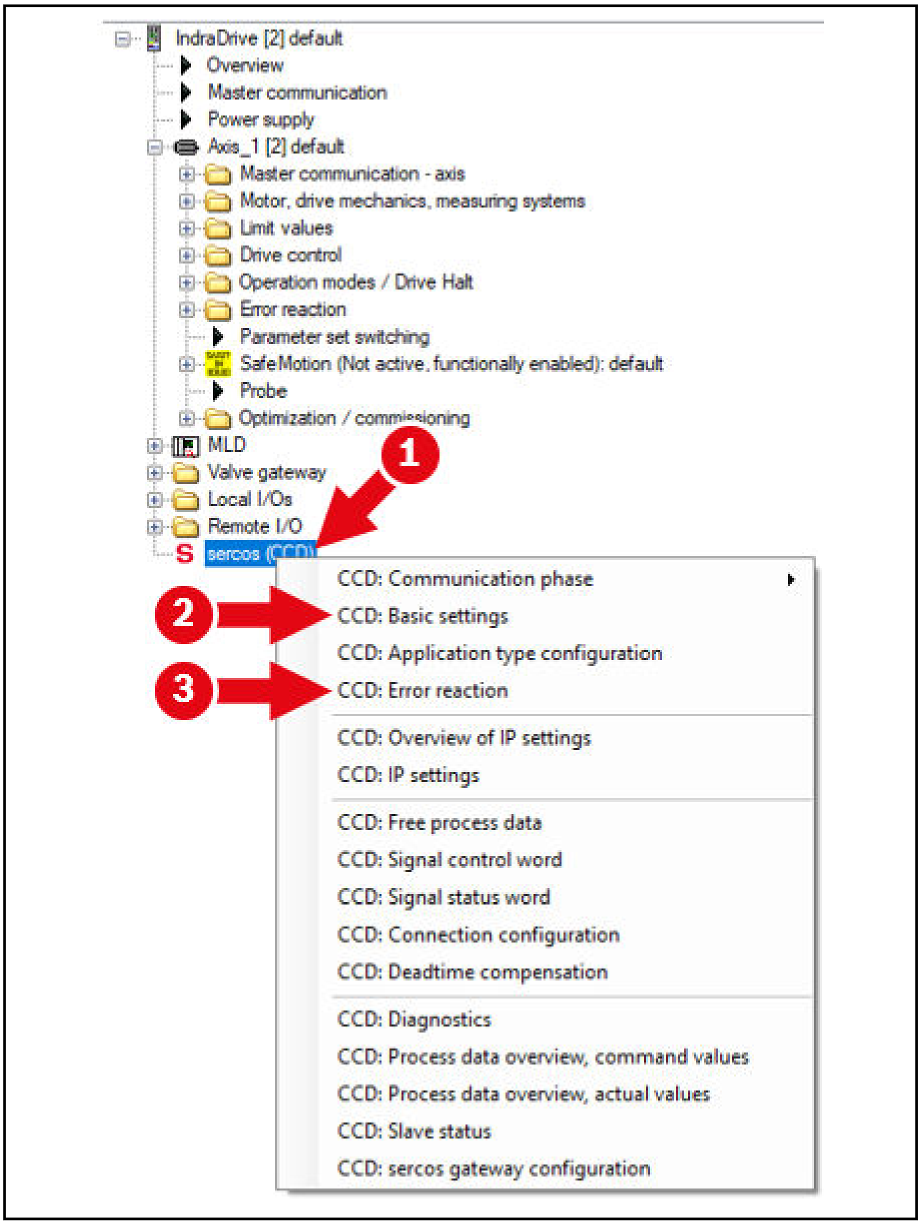


Fig. 7-165: Sercos configuration: Dialog selection

To be able to use the secondary axis, the CCD communication has to be acti-vated (P-0-1800.0.1 bit 0 = 1) in the dialog "Basic settings".

"P4 → P2 coupled to OM → PM of CCD master" has to be deactivated (P-0-1800.0.1 bit 5 = 1).

In addition "MLD-M in CCD master (MLD-M system mode)" has to be selec-ted (P-0-1800.0.1 bit 4/3 = 01).

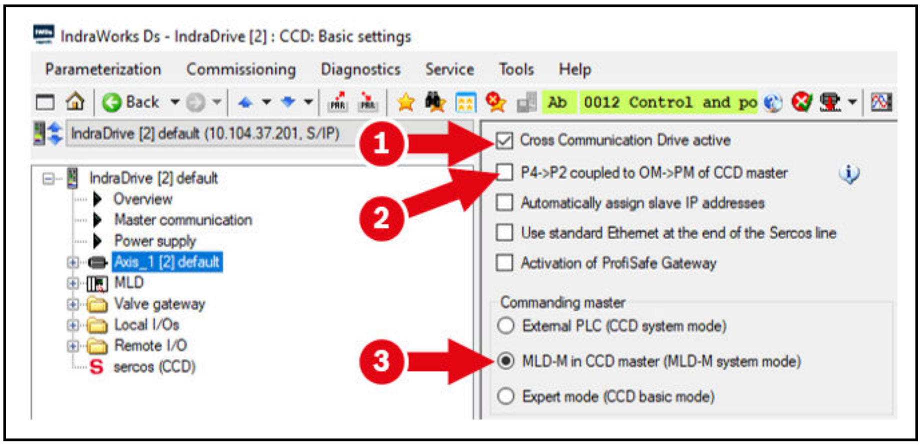


Fig. 7-166: Sercos configuration: Basic settings

To signal an error of the secondary axis via warning E2140 also to a higher-level control, "Automatic distributed reaction" has to be selected in the dialog "CCD: Error reaction" (P-0-1800.0.1 Bit 8/7 = 01).

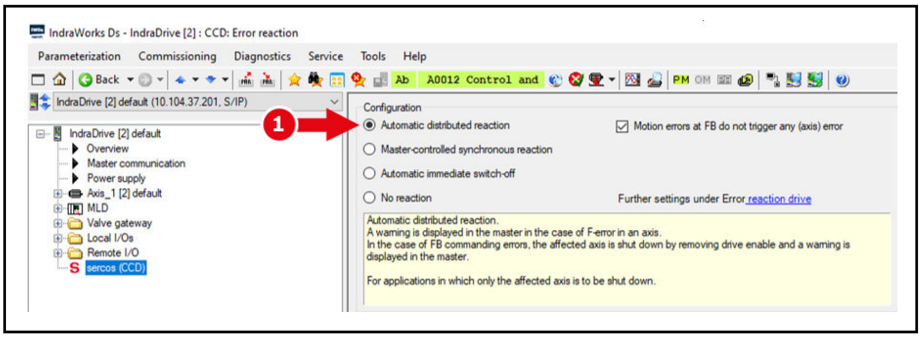


Fig. 7-167: Sercos configuration: Error reaction

Configuration of the secondary axis

The scaling settings of the secondary axis for velocity and acceleration have to be configured as “Rotary” and with “Preferred scaling” in order that it is activated by the primary axis in the correct scaling format.

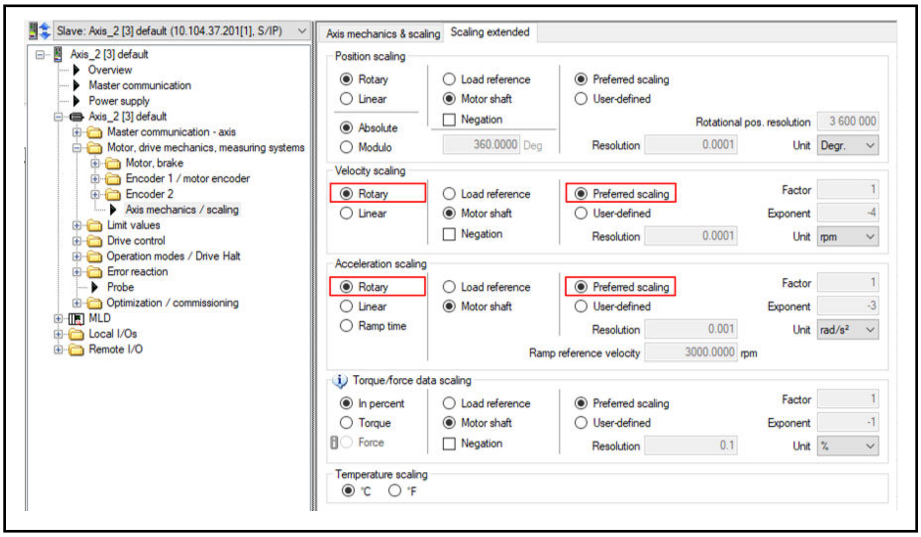


Fig. 7-168: Scaling setting of the secondary axis

System pressure increase

The configuration of the system pressure control comprises the following four parts:

1. Two-point control

2. Commanding of secondary axis
3. Enable of secondary axis
4. Setting of the secondary axis

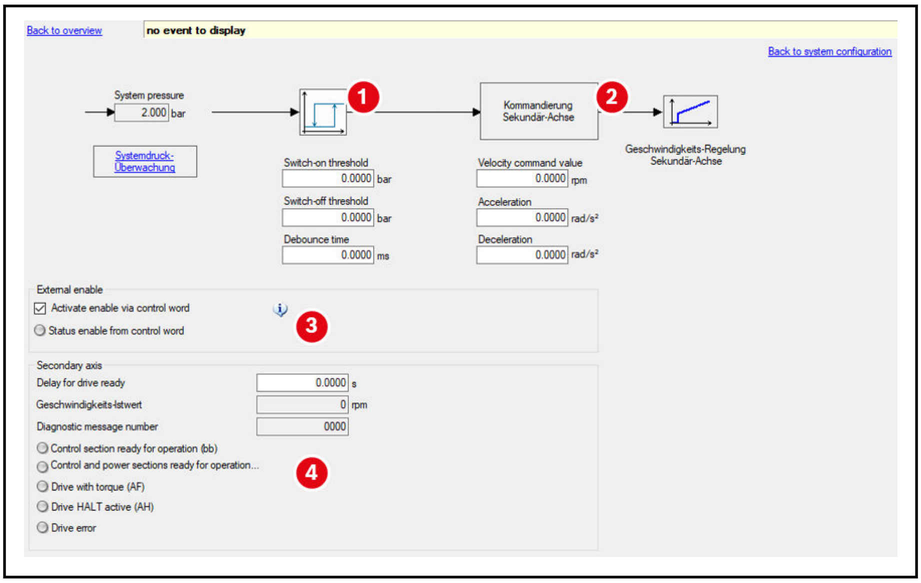


Fig. 7-169: Configuration of system pressure control

For the two-point control of system pressure the switch-on threshold (P-0-1311[386]), the switch-off threshold (P-0-1311[385]) and the debounce time (P-0-1311[384]) have to be set.

For commanding the secondary axis the velocity command value for the pressure build-up phase (P-0-1311[387]) has to be configured. Acceleration (P-0-1311[388]) and deceleration (P-0-1311[389]) can be taken from the data sheet of the pump.

For the enable of the secondary axis one can select between external enable via the control word (P-0-1283 bit 12) and internal enable. In the case of internal enable the system pressure increase is activated if both axes are in OP, the check of machine data has been completed and the secondary axis is without errors.

Moreover, the delay until the drive is ready after a change to OM (in Ab) has to be configured. If the secondary axis is not in Ab after this time has elapsed, warning "E2015, B507E: Slave not ready for control" is generated.

7.4.18 Protective/monitoring functions

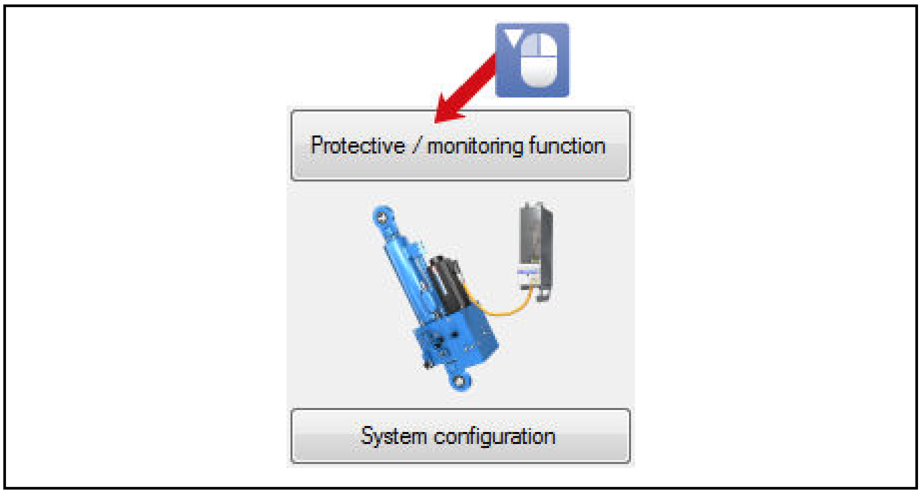


Fig. 7-170: Protective/monitoring functions

The following monitoring functions are available:

- Process pressure
- Summated pressure
- Tank pressure
- System pressure
- Pilot oil pressure
- Oil temperature
- Position lag error
- Encoder jumps
- Restraint valves
- Filter clogging
- Operating points of A10 pump

They can be configured using the corresponding tabs in the detailed dialog.

Process pressure

Overpressure monitoring is available for pressure feedback value A (S-0-0803) and pressure feedback value B (S-0-0804). An alarm threshold (P-0-1311[171]) and a warning threshold (P-0-1311[170]) can be set. For both thresholds, a debounce time (P-0-1311[169]) can be set to suppress peaks.

Monitoring can be deactivated for the two pressure signals (P-0-1372; bit 28).

In the case of double-rod cylinders with area switching, overpressure monitoring is also provided for pressure feedback value C (P-0-1282). An alarm threshold (P-0-1311[287]) and a warning threshold (P-0-1311[286]) can be set. For both thresholds, a debounce time (P-0-1311[285]) can be set to suppress peaks.

Monitoring of pressure feedback value C can be deactivated (P-0-1372; bit 18).

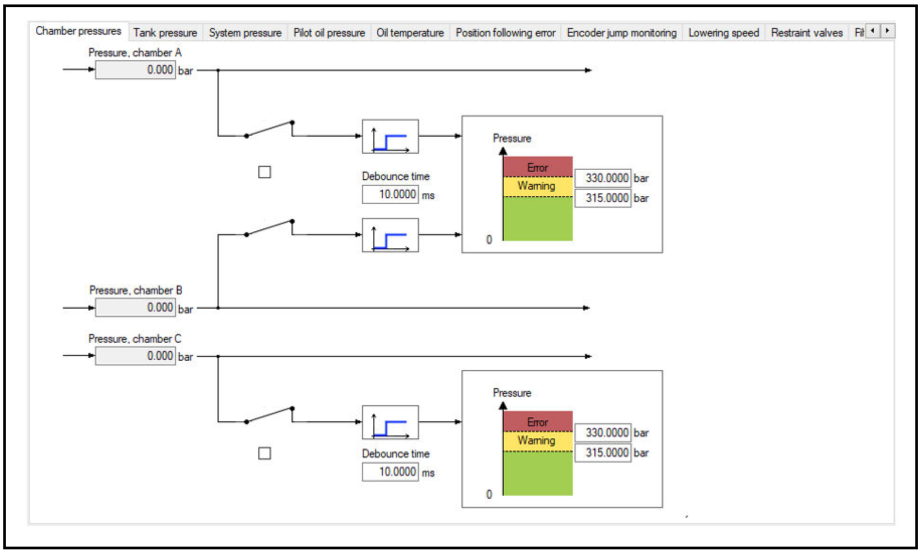


Fig. 7-171: Chamber pressures

If one of the pressure signals exceeds the alarm threshold for the duration of the debounce time, an error is generated (D5057 or D5058, respectively).

If one of the pressure signals exceeds the warning threshold for the duration of the debounce time, a warning is generated (B5058 or B5059, respectively).

For the process force, e.g. via a force sensor, monitoring is not provided.

Summated pressure

The summated pressure at the pump, the sum of chamber pressures A and B (S-0-0803 and S-0-0804) can be monitored for excessively high values.

A warning threshold (P-0-1311[223]) and an error threshold (P-0-1311[224]) can be set for monitoring the summated pressure. To suppress peaks, a debounce time (P-0-1311[222]) can be set for overpressure thresholds.

The monitoring functions of the summated pressure for too high and too low values can be deactivated separately (P-0-1383, bit 6 and bit 7, respectively).

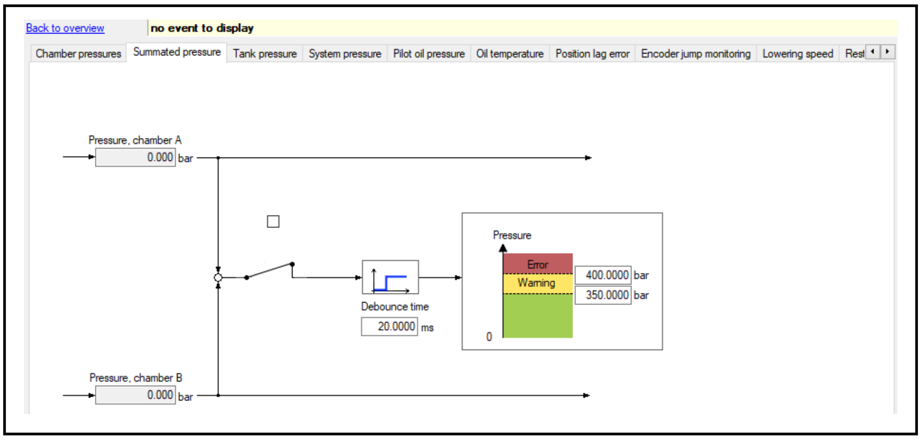


Fig. 7-172: Summated pressure

If the summated pressure exceeds the warning threshold for overpressure for the duration of the debounce time, a warning is generated (B5084).

If the summated pressure exceeds the alarm threshold for overpressure for the duration of the debounce time, an error is generated (D5085).

Tank pressure

Underpressure monitoring and overpressure monitoring are available for the tank pressure (S-0-0814). A warning threshold (P-0-1311[165], P-0-1311[167]) and an alarm threshold (P-0-1311[166], P-0-1311[168]) can be set for both. A debounce time (P-0-1311[164], P-0-1311[163]) can be set for the underpressure thresholds and for the overpressure thresholds in order to suppress peaks.

Monitoring can be deactivated for the tank pressure (P-0-1372; bit 25).

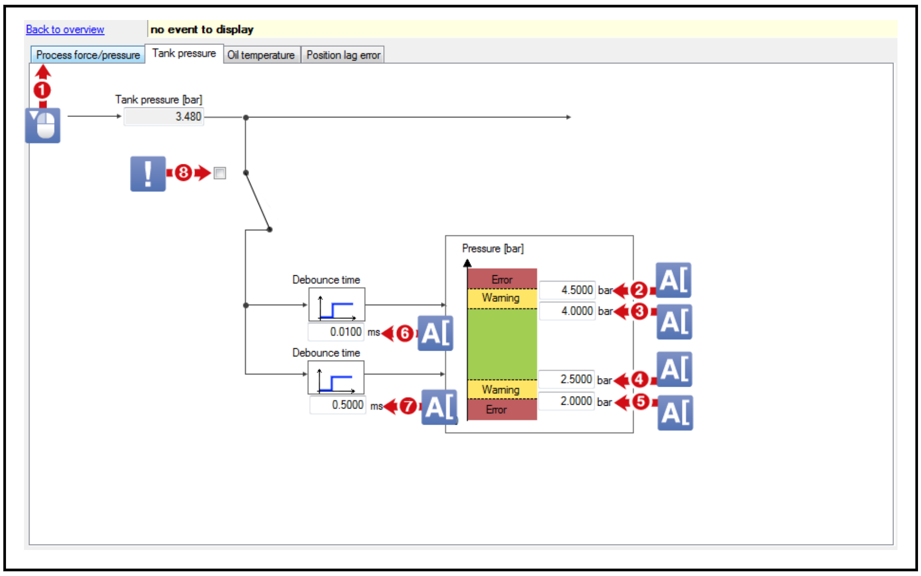


Fig. 7-173: Tank pressure

If the tank pressure signal falls below the warning threshold for underpressure for the duration of the debounce time, a warning is generated (B5054).

If the tank pressure signal falls below the alarm threshold for underpressure for the duration of the debounce time, an error is generated (D5055).

If the tank pressure signal exceeds the warning threshold for overpressure for the duration of the debounce time, a warning is generated (B5052).

If the tank pressure signal exceeds the alarm threshold for overpressure for the duration of the debounce time, an error is generated (D5051).

System pressure

The system pressure (S-0-0813) can be monitored for too low and too high values.

For monitoring the analog value, a warning threshold (P-0-1311[234], P-0-1311[237]) and an alarm threshold (P-0-1311[235], P-0-1311[238]) can be set. A debounce time (P-0-1311[233], P-0-1311[236]) can be set for the underpressure thresholds and for the overpressure thresholds in order to suppress peaks.

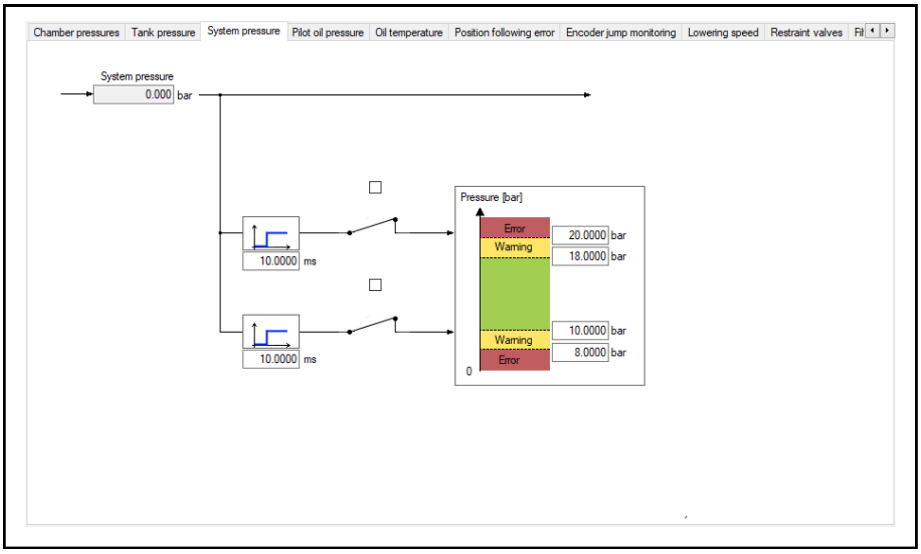


Fig. 7-174: System pressure, monitoring of the analog value

For monitoring digital signals from pressure switches, parameter P-0-1392 bit 5 - 2 or the PLC structure "Application.Position_Force_Control.Global_Interface.stSystemPressure" may be used. The current state of the input signals is output via P-0-1413, bit 5 - 2. The characteristic of the digital signals (normally closed/normally open) can be configured in P-0-1383 bit 5 - 2.

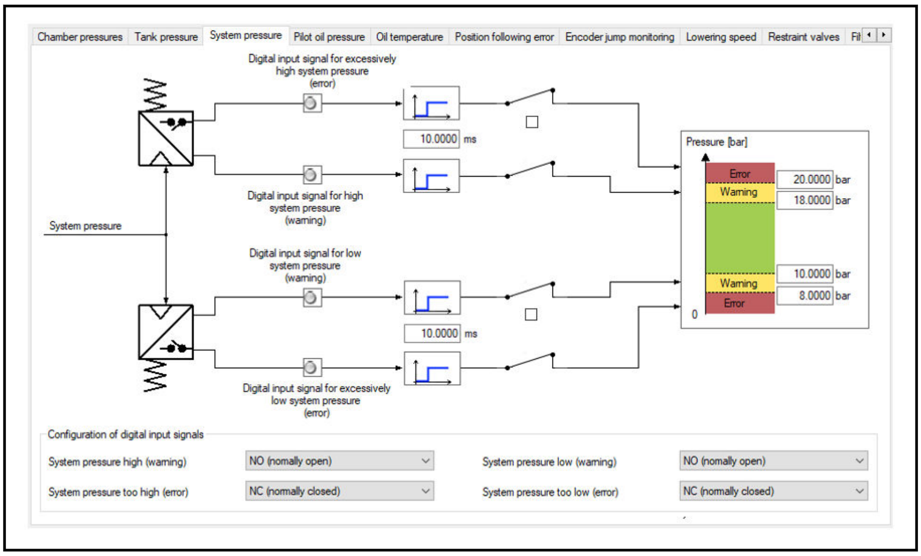


Fig. 7-175: System pressure, monitoring of digital signals

The monitoring functions of the system pressure for too high and too low values can be deactivated separately (P-0-1383, bit 0 and bit 1, respectively).

If the system pressure exceeds the warning threshold for overpressure for the duration of the debounce time, a warning is generated (B50A7).

If the system pressure exceeds the alarm threshold for overpressure for the duration of the debounce time, an error is generated (D50A6).

If the system pressure falls below the warning threshold for underpressure for the duration of the debounce time, a warning is generated (B50AA).

If the system pressure falls below the alarm threshold for underpressure for the duration of the debounce time, an error is generated (D50A9).

Pilot oil pressure

The pilot oil pressure (P-0-1288) can be monitored for too high and too low values.

For monitoring the analog value, a warning threshold (P-0-1311[248], P-0-1311[251]) and an alarm threshold (P-0-1311[249], P-0-1311[252]) each can be set. A debounce time (P-0-1311[247], P-0-1311[250], respectively) can be set for the underpressure thresholds and for the overpressure thresholds in order to suppress peaks.

For monitoring digital signals from pressure switches, parameter P-0-1392 bit 9 - 6 or the PLC structure "Application.Position_Force_Control.Global_Interface.stControlPressure" may be used as input signals. The current state of the input signals is output via P-0-1413, bit 9 - 6. The characteristic of the digital signals (normally closed/normally open) can be configured in P-0-1383 bit 11 - 8.

Monitoring of the pilot oil pressure for too high and too low values can be deactivated separately (P-0-1383, bit 6 and bit 7, respectively).

If the pilot oil pressure exceeds the warning threshold for overpressure for the duration of the debounce time, a warning is generated (B50AD).

If the pilot oil pressure exceeds the alarm threshold for overpressure for the duration of the debounce time, an error is generated (D50AC).

If the pilot oil pressure falls below the warning threshold for underpressure for the duration of the debounce time, a warning is generated (B50B0).

If the pilot oil pressure falls below the alarm threshold for underpressure for the duration of the debounce time, an error is generated (D50AF).

Oil temperature

The oil temperature (P-0-1284) can be monitored for too high and too low values.

For monitoring the analog value, a warning threshold (P-0-1311[173], P-0-1311[153]) and an alarm threshold (P-0-1311[174], P-0-1311[154]) can be set. A debounce time (P-0-1311[172], P-0-1311[152], respectively) can be set for the underpressure thresholds and for the overpressure thresholds in order to suppress peaks.

For monitoring digital signals from temperature switches, parameter P-0-1392 bit 13 - 10 or the PLC structure "Application.Position_Force_Control.Global_Interface.stOilTemperature" are available as input signals. The current state of the input signals is output via P-0-1413, bit 13 - 10. The characteristic of the digital signals (normally closed/normally open) can be configured in P-0-1383 bit 17 - 14.

The monitoring functions of the system pressure for too high and too low values can be deactivated separately (P-0-1372, bit 23 and P-0-1383, bit 13, respectively).

If the oil temperature exceeds the warning threshold for the duration of the debounce time, a warning is generated (B504F).

If the oil temperature exceeds the alarm threshold for the duration of the debounce time, an error is generated (D504E).

If the oil temperature falls below the warning threshold for the duration of the debounce time, a warning is generated (B50B7).

If the oil temperature falls below the alarm threshold for the duration of the debounce time, an error is generated (D50B6).

Position lag error

It is possible to choose between model-based and velocity-dependent lag error monitoring. To deactivate lag error monitoring, "Not active" can be selected (P-0-1372; bits 27/26 = 00). Further information can be found in chapter 6.20.14 "Model monitoring/following distance monitoring" on page 101.

Model-based lag error monitoring (P-0-1372; bits 27/26 = 01) compares a modelled lag error to the actual lag error. The monitoring window (P-0-1311[122]) is set to monitor the deviations of the two lag errors.

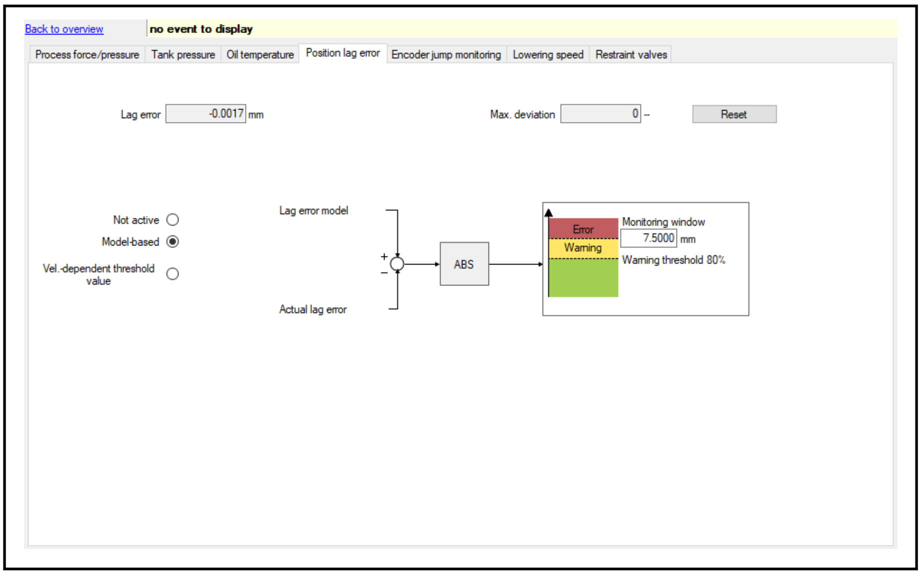


Fig. 7-176: Model-based position lag error monitoring

When the absolute value of the difference of modelled and actual lag error has reached 80 % of the monitoring window, a warning is generated (B502B).

If the absolute value of the difference of modelled and actual lag error exceeds the monitoring window, an error is generated (D502C).

The model-based method does not monitor whether the actual value follows the command value to a sufficient extent, but whether a lag error becomes larger than allowed on the basis of the controller settings. In this case, it is definitely possible to move with a large lag error.

Velocity-dependent lag error monitoring (P-0-1372; bits 27/26 = 10) monitors the absolute value of the lag error with dynamic thresholds, depending on the command velocity in the form of a line through origin with a minimum section in standstill. The slope of the straight line is given by the reference velocity (P-0-1311[116]) and the maximum lag error at this velocity (P-0-1311[118]). The minimum section is given by the maximum lag error at standstill (P-0-1311[119]). Standstill is detected if the command velocity is smaller than the standstill window (S-0-0124). For each dynamic alarm threshold value for the lag error there is a warning threshold value that is preset in percentage-based form using the warning threshold (P-0-1311[120]). In addition, a debounce time (P-0-1311[121]) can be set to suppress peaks.

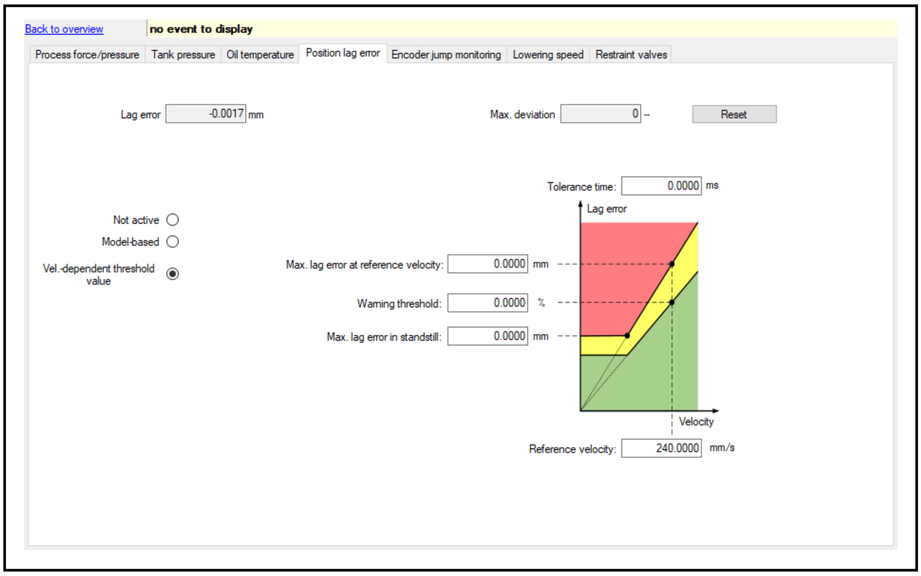


Fig. 7-177: Velocity-related position lag error monitoring

When the lag error has reached the warning threshold for the current command velocity, a warning is generated (B502B).

If the lag error exceeds the alarm threshold for the current command velocity, an error is generated (D502C).

The velocity-dependent method monitors whether the actual value can sufficiently follow the command value, irrespective of the controller settings. This means that with weaker gains it might be necessary to set more tolerant threshold values, and that with bigger gains it is possible to set stricter threshold values.

Encoder jump monitoring

Encoder jump monitoring can ignore implausible jumps in the encoder signal (S-0-0386) and keep extrapolating the internal actual position with the last valid velocity, see chapter 6.20.8 "Monitoring for impermissible encoder jumps" on page 92.

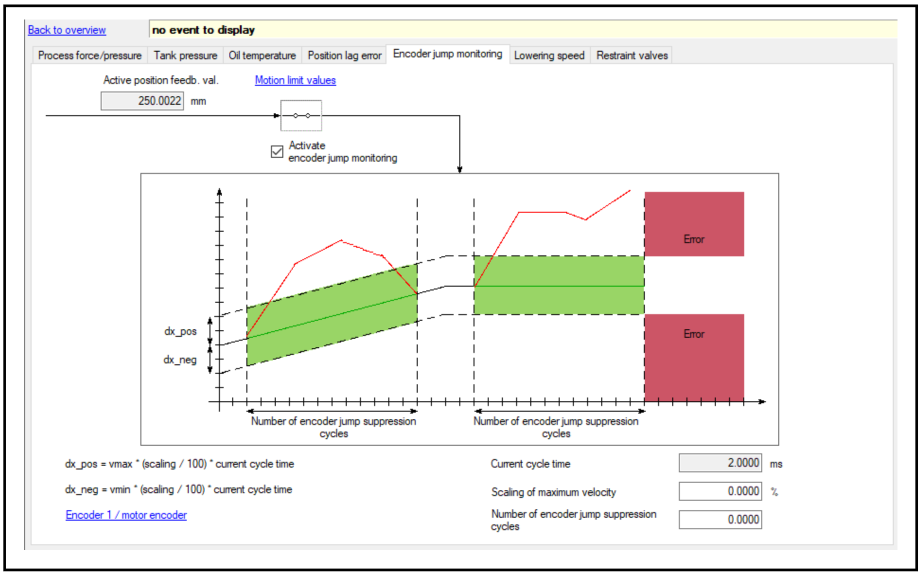


Fig. 7-178: Monitoring for inadmissible encoder jumps

Monitoring for impermissible drift rate

For the description of the function, see chapter 6.20.9 "Monitoring for impermissible drift rate" on page 93

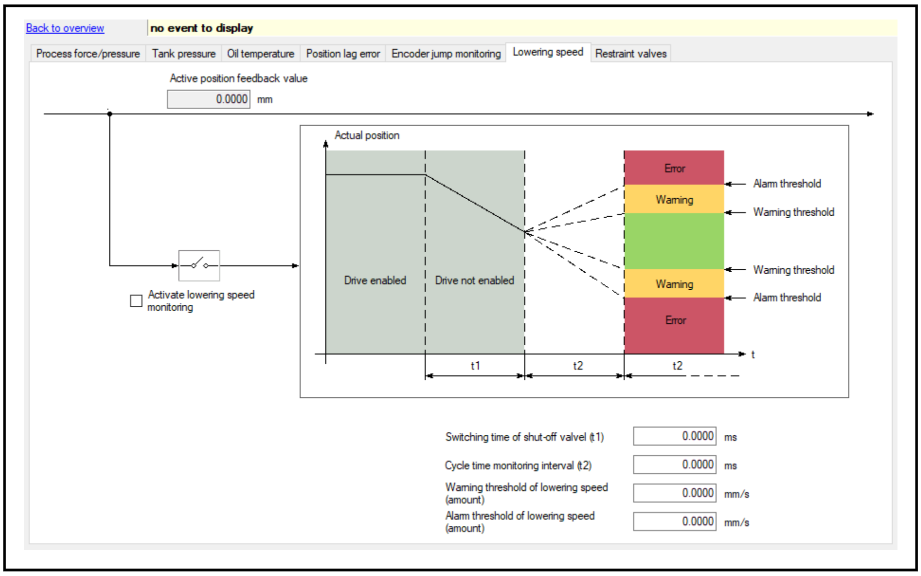


Fig. 7-179: Monitoring for impermissible drift rate

Monitoring of restraint valves

Monitoring of restraint valves should only be used for axes with pilot operated safety valves without system pressure increase. If a system pressure increase is implemented or the safety valves are direct operated valves, the position monitoring function via the HAT modules on the drive side should be selected.

Monitoring two restraint valves for correct function is provided on the basis of the feedback contacts of the restraint valves. The time taken to open and close the restraint valves as well as the time overlap of the feedback contacts (NO and NC of a valve) are monitored. If the restraint valves are not closed within configurable periods of time, a warning or an error is issued additionally.

Monitoring of the feedback signals of restraint valves is activated (= 0) or deactivated (= 1) via bit 0 of P-0-1311[208]. The configuration and deactivation of the diagnostic/monitoring function is locked via parameter P-0-1382 in normal operation.

The following monitoring functions are executed on the basis of the feedback contacts of the restraint valves:

- Antivalence check
- Test of safety valve opening
- Test of safety valve closing
- Monitoring of permissible time intervals

Monitoring of the restraint valves is suitable for increasing the safety level of hydraulic axes. However, in order to determine the achieved safety level, the complete system has always to be examined.

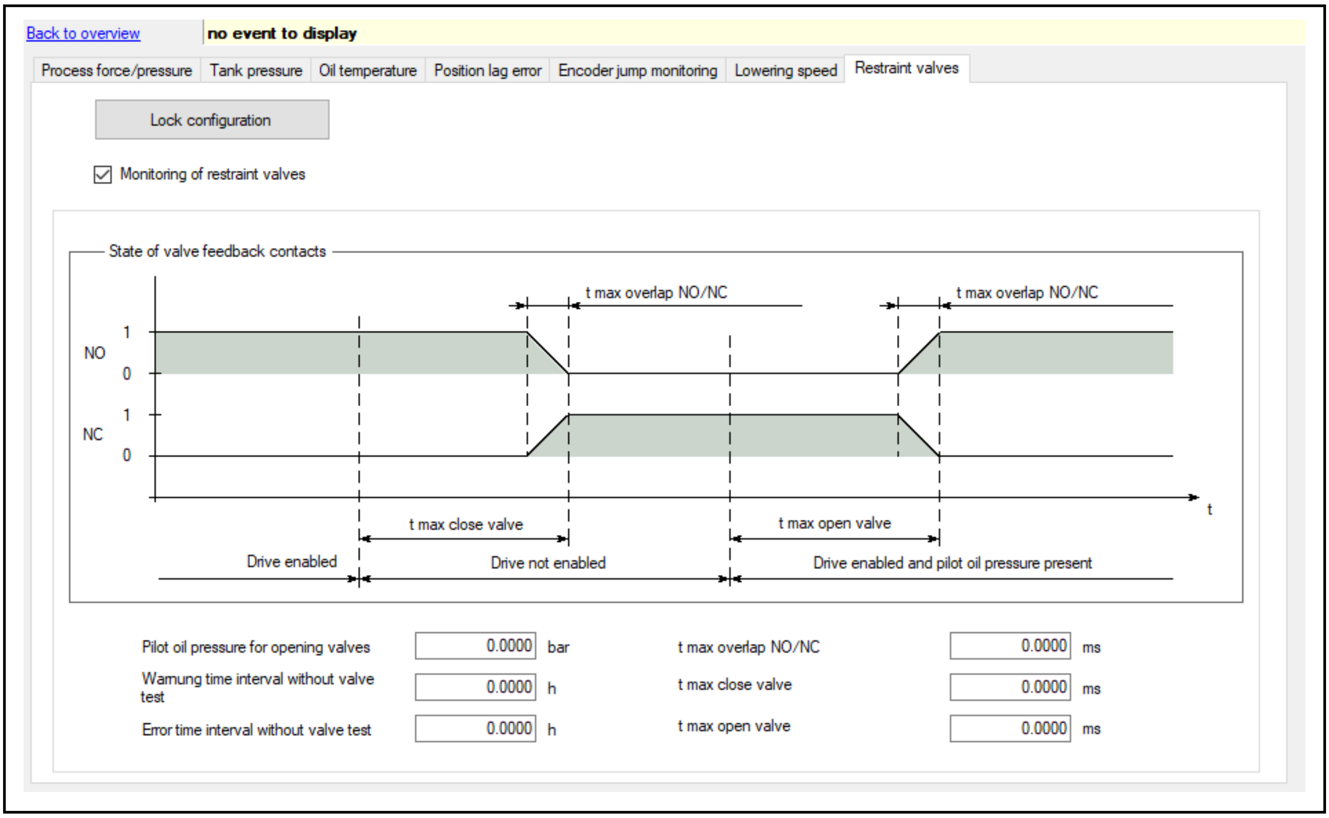


Fig. 7-180: Monitoring of restraint valves

For more detailed information, see chapter 6.20.10 "Monitoring of restraint valves" on page 94.

Filter clogging

Filter clogging can be monitored for degrees of clogging of 75 % and 100 %.

The input signals are read via P-0-1392 bit 0 (75 %) and bit 1 (100 %) The current state of the input signals is output via P-0-1413. The characteristic of the signals can be configured via P-0-1372 bit 20 (75 %) and bit 21 (100 %) (0 = normally open/1 = normally closed). To suppress peaks, a debounce time (P-0-1311[179]) can be set. Monitoring only becomes active, if the oil temperature has exceeded a threshold P-0-1311[178].

Filter clogging monitoring can be deactivated (P-0-1372; bit 22).

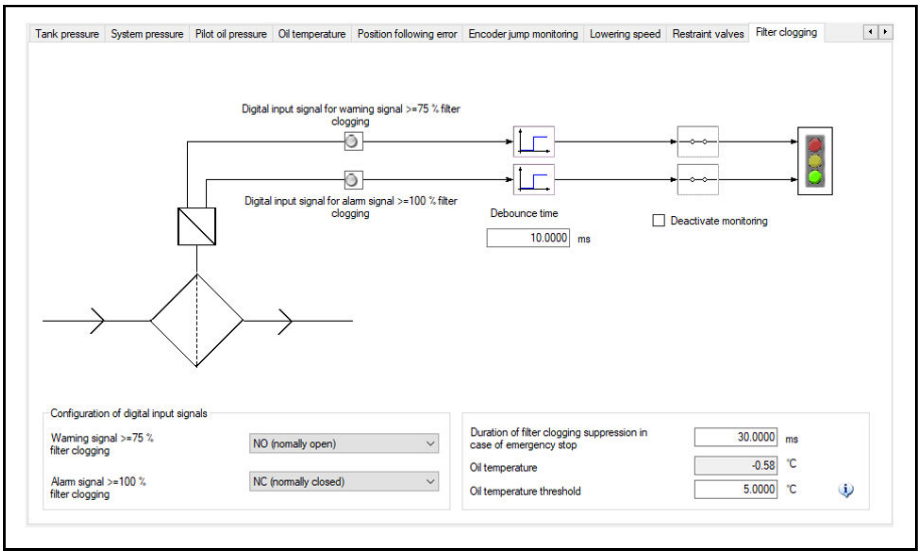


Fig. 7-181: Filter clogging

When the filter clogging degree of 75 % is exceeded, a warning is generated (B5076).

When the filter clogging degree of 100 % is exceeded, a warning is generated (B5077).

In the event of an emergency stop, filter clogging monitoring is suppressed, because during an emergency stop, pressure peaks occur in the system, which could cause the filter monitor to respond by mistake. If 100 % filter clogging is detected when an emergency stop is carried out, a warning is generated (B5091).

Operating point of A10 pump

Monitoring of operating points of a pump is provided. Bit 31 of P-0-1372 serves to activate (= 0)/deactivate (= 1) this function. The function is intended primarily for pumps of the A10 series, because their 4-quadrant capability is restricted. The correct values for the function can be taken from the data sheet of the pump.

The operating point is monitored on the basis of the pressure differential from pressure p_A (S-0-0803) and pressure p_B (S-0-0804) as well as of the active displacement Vg (P-0-1275) and the active velocity controller command value (P-0-0561). The time restrictions in the operating point are only valid, if the active displacement Vg is greater than the critical displacement Vg_{crit}, which is specified by P-0-1311[150] with reference to the maximum displacement P-0-2943. Operating range B1 is defined via a sufficiently high pressure differential P-0-1311[146] across the pump in the pressure reduction mode. Operating range B2 is defined by a low speed P-0-1311[147] in the pump mode. In addition, operating range is B2 is limited to a duty cycle of 80 %.

If operating points within the range B2 are active for longer than P-0-1311[148] at Vg > Vg_{crit}, a warning is generated (B5115).

If operating points within the range B1 are active for longer than P-0-1311[149] at Vg > Vg_{crit}, a warning is generated (B5116).

Depending on the pump characteristic with regard to the possibility of adjusting the displacement, the pump is swiveled back to a Vg less than Vg_{crit}. In the case of a continuous adjustment the command value for Vg can be entered in P-0-1311[151] as factor for reducing the displacement with reference to Vg_{crit}.

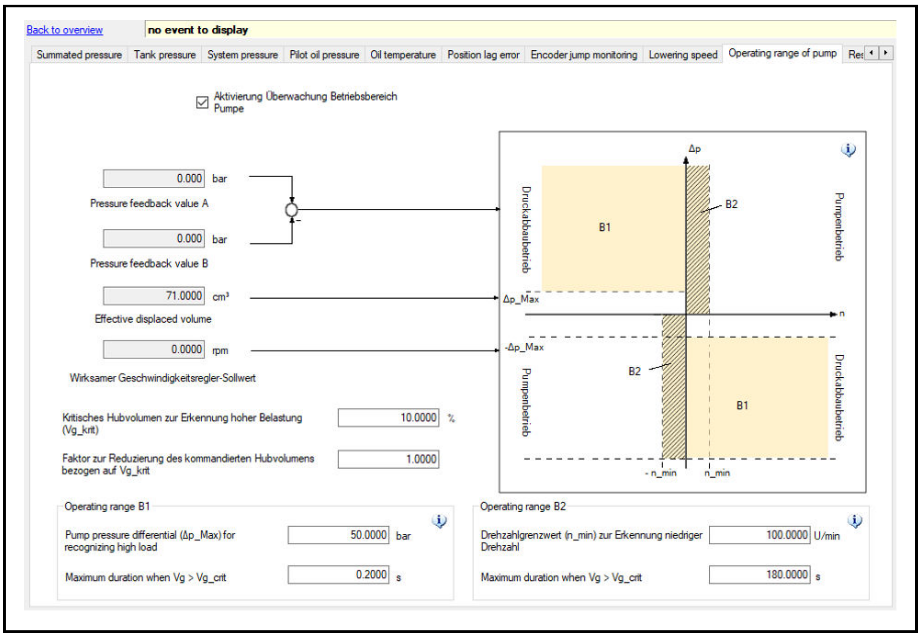


Fig. 7-182: Monitoring of the operating point

For more detailed information, see chapter 6.20.13 "Monitoring of operating points of an A10 pump" on page 99.

Example:

Entering data for a A10 pump

- Vg_{crit} (P-0-1311[150]) = 40 %
- Factor for reducing the commanded displacement (P-0-1311[151]) = 0.8
- B1 - pressure differential across the pump (dp_{max}) for detecting high load (P-0-1311[146]) = 50 bar
- B1 - maximum duration of Vg > Vg_{crit} (P-0-1311[149]) = 200 ms
- B2 - speed limit value (n_{min}) for recognizing low speed (P-0-1311[147]) = 200 rpm
- B2 - maximum duration of Vg > Vg_{crit} (P-0-1311[148]) = 180 ms

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7.4.19 Diagnostics including logbook

Any present diagnostic messages are displayed as diagnostic code in P-0-1300 and as diagnostic text in English in P-0-1387. If no diagnostic message is present, the text "no event to display" is displayed. Moreover, any warnings and errors are displayed in the diagnostics of IndraDrive (S-0-0095). See also Functional Description: Diagnostics/error handling.

Additionally, certain states such as "position control active" or "force control active" and various limit value violations are displayed.

The most important diagnostic data are summarized in the overview dialog. The signal light shows three different states of the technology function:

- Green: No diagnostics or message
- Yellow: Warning
- Red: Error

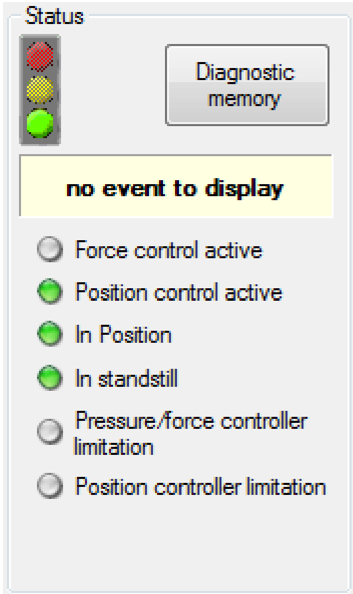

Fig. 7-183: Signal light of the states of the technology function (PFC 7020)

The diagnostic text is displayed in the overview dialog and in the header of each detailed dialog.

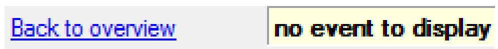

Fig. 7-184: Diagnostic text

The diagnostic logbook is displayed via the Diagnostic memory button. The last 50 diagnostic messages that occurred are recorded in the diagnostic logbook with their codes (P-0-1312[0]...[49]) and time stamps (P-0-1312[50]...[99]). The diagnostic messages covered by a diagnostic message of higher priority in the period of occurrence are also listed here. The respective time stamp represents the operating hours of the control section (P-0-0190).

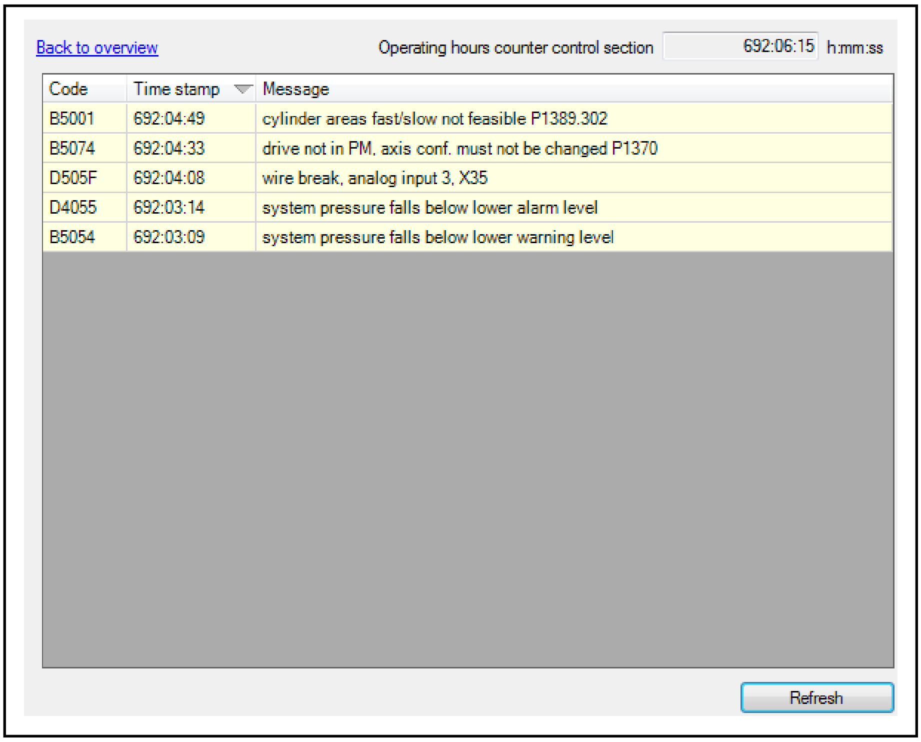

Fig. 7-185: Diagnostic logbook (PFC 7020)

If required, the diagnostic logbook can be refreshed using the button.

8 Parameters and diagnostic messages of Position Force Control (PFC)

8.1 Relevant parameters

Relevant parameters

Parameter and page in parameter description
chapter 8.2.1 "P-0-0040, Velocity feedforward" on page 277
chapter 8.2 "Parameter description" on page 277
chapter 8.2.3 "P-0-0434, Position command value of controller" on page 280
chapter 8.2.4 "P-0-0444, Actual value peak torque limit" on page 281
chapter 8.2.5 "P-0-0556, Config word of axis controller" on page 281
chapter 8.2.6 "P-0-0558, Drive Halt configuration" on page 286
chapter 8.2.7 "P-0-0560, Configuration of actuator" on page 286
chapter 8.2.8 "P-0-0561, Effective velocity controller command value" on page 288
chapter 8.2.9 "P-0-0562, Active feed/gear factor" on page 288
chapter 8.2.10 "P-0-0563, Input for velocity command value adjustment" on page 289
chapter 8.2.11 "P-0-1271, Effective pressure/force command value" on page 289
chapter 8.2.12 "P-0-1275, Effective displacement" on page 290
chapter 8.2.13 "P-0-1276, Actual velocity value" on page 290
chapter 8.2.14 "P-0-1277, Actual acceleration value" on page 290
chapter 8.2.15 "P-0-1280, System status word 1" on page 291
chapter 8.2.16 "P-0-1281, System status word 2" on page 293
chapter 8.2.17 "P-0-1282, Pressure feedback value C" on page 296
chapter 8.2.18 "P-0-1283, Hydraulic function, switching control word" on page 296
chapter 8.2.19 "P-0-1284, Oil temperature" on page 297
chapter 8.2.20 "P-0-1285, Max. model deviation, position" on page 298
chapter 8.2.21 "P-0-1287, Additive velocity command value" on page 298
chapter 8.2.22 "P-0-1288, Pilot oil pressure" on page 299
chapter 8.2.24 "P-0-1292, Pulsation compensation: Additive motor speed B -> A" on page 299
chapter 8.2.24 "P-0-1292, Pulsation compensation: Additive motor speed B -> A" on page 299
chapter 8.2.24 "P-0-1292, Pulsation compensation: Additive motor speed B -> A" on page 299
chapter 8.2.25 "P-0-1293, Pulsation compensation: Additive motor speed A -> B" on page 300
chapter 8.2.26 "P-0-1294, Reserved for application-related MLD part (user code)" on page 300

Parameter and page in parameter description
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chapter 8.2.28 "P-0-1296, Reserved for application-related MLD part (user code)" on page 301
chapter 8.2.29 "P-0-1297, Reserved for application-related MLD part (user code)" on page 302
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chapter 8.2.33 "P-0-1311, Axis-specific configuration" on page 304
chapter 8.2.34 "P-0-1311[0], Parameter set 1: Delay time" on page 304
chapter 8.2.35 "P-0-1311[1], Parameter set 1: Transition time" on page 304
chapter 8.2.36 "P-0-1311[2], Parameter set 1: Position controller, Kv-factor" on page 305
chapter 8.2.37 "P-0-1311[3], Parameter set 1: Position controller, velocity feedforward" on page 305
chapter 8.2.38 "P-0-1311[4], Parameter set 1: Position controller, disturbance observer time constant" on page 306
chapter 8.2.39 "P-0-1311[5], Parameter set 1: Vel. controller load, Kp" on page 306
chapter 8.2.40 "P-0-1311[6], Parameter set 1: Accel. controller load, Kp" on page 306
chapter 8.2.41 "P-0-1311[17], Swivel angle feedback value, signal selection" on page 307
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chapter 8.2.43 "P-0-1311[19], Swivel angle feedback value, signal range limitation, max." on page 308
chapter 8.2.44 "P-0-1311[20], Swivel angle feedback value, value range, min." on page 308
chapter 8.2.45 "P-0-1311[21], Swivel angle feedback value, value range, max." on page 309
chapter 8.2.46 "P-0-1311[22], Swivel angle feedback value, signal range, min." on page 309
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chapter 8.2.48 "P-0-1311[24], Swivel angle feedback value, filter time" on page 310
chapter 8.2.49 "P-0-1311[25], Parameter set 2: Delay time" on page 310
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chapter 8.2.51 "P-0-1311[27], Parameter set 2: Position controller, Kv-factor" on page 311

Parameter and page in parameter description
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chapter 8.2.62 "P-0-1311[49], Swivel angle command value, filter time" on page 316
chapter 8.2.63 "P-0-1311[50], Parameter set 3: Delay time" on page 316
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chapter 8.2.111 "P-0-1311[127], Debounce time for pump switching, rapid mode/press mode" on page 336
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Tab. 8-1: Pertinent parameters

☞ For further information, see MPx-20 documentation.

8.2 Parameter description

8.2.1 P-0-0040, Velocity feedforward

Function By means of the velocity feedforward control, which can be freely set via "P-0-0040, Velocity feedforward evaluation”, it is possible to set the following distance at constant velocity to a desired percentage value. A minimum (ideally = 0) is obtained at 100 %. The degree of feedforward control can be set within the range of 0 %...120 %.

☞ The activation of lagless operation (cf. "S-0-0032", "S-0-0033", "S-0-0034", "S-0-0035") causes a feedforward variable (= velocity command value), which is determined from the position command value, is fed forward as additive to the position controller output.

Min./max. value	0.00 / 120.00
Format	DEC_OV
Unit	%
Type	Output register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	100.00
Refresh time	~50 ms

Tab. 8-2: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.2 P-0-0115, Device control: Status word

Function Using this parameter, it is possible to read the drive state (device control), independent of the master communication that is used.

See also functional description "Operation modes"

See also functional description "Master communication"

See also functional description "Drive Halt"

Structure The individual bits have the following significances:

Bit	Designation/function	Comment
0	Ready for Power Supply: Enabling power supply of inverter 0: The inverter does not allow power to be enabled. The power supply has to be switched off. 1: The inverter allows power to be enabled. The supply may be switched on.	depending on P-0-0118; bit 7
1	Ready signal 1: Drive ready (ready for power output)	
2	Drive warning 1: Warning (class 2 diagnostics) is present	
3	Status of ext. command value processing (primary op. mode + secondary op. modes 1-7) 0: Drive ignores external command value input 1: Drive follows external command value input	
4	"Drive Halt" acknowledgment 1: "Drive Halt" is active and axis is in standstill	
5	Command change bit 0: No change in command state 1: Command state has changed	
6	Status of the int. command value processing (NB8-15 of the PLC) 0: Drive ignores int. command value input of PLC 1: Drive follows int. command value input of PLC	
7	Operation mode initialized 1: Primary op. mode or secondary op. mode active and initialization completed, otherwise 0	
11-8	Actual operation mode 0000: Primary operation mode is active 0001: Secondary operation mode 1 is active ... 0111: Secondary oper. mode 7 is active 1000: 1. Internal secondary operation mode is active ... 1111: Internal secondary oper. mode 8 is active	
12	Command value attained 1: Drive has attained command value input (see Detailed information on bit 12)	

Bit	Designation/function	Comment
13	**Drive error** **0:** No error **1:** Drive error	
15/14	**Ready for operation** **00:** Control and power sections not ready for operation Axis has not been completely initialized (since in parameter mode (PM) or configuration mode (CM); or the axis has been parked (see command "S-0-0139, Parking axis procedure command") **01:** Control section ready for operation (bb) Axis has been completely initialized and has not been parked. DC bus is not ready for power output. **10:** Control and power sections ready for operation (Ab) Axis has been completely initialized and has not been parked. DC bus is ready for power output. **11:** Drive with torque (AF) Axis has been completely initialized and has not been parked. DC bus is ready for power output and drive enable has been set.	

Tab. 8-3: Device control: Status word

Use

Detailed information "Ready signal" (bit 1)

The drive signals ready (bit 1 = 1) if the power voltage has been switched on and the internal device state machine is in the operating mode (OM) or the drive is in Ab.

If the drive has an error or the operating mode (OM) is exited or power voltage is switched off, the ready signal is set to 0.

Detailed information "Status of command value processing" (bit 6/3)

If the drive is torque-controlled (bit 15/14 = 11), the following cases can be distinguished via the combination of bit 6 and bit 3:

Bit 6	Bit 3	State	Comment
0	0	Drive does not follow the command value of the active operation mode	e.g.: Drive stop as quick stop, drive control command drive-controlled homing, best possible deceleration in the event of a fault or drive-controlled transition with active safety technology active
0	1	Drive follows command value of external control unit in active operation mode	Normal operating state
1	0	Drive follows command value of the active internal secondary operation mode	Internal PLC controls the drive via an MC function block or the Easy Startup mode is active
1	1		Not possible

Tab. 8-4: Cases to be distinguished for bit 6 and bit 3

☞ The internal secondary operation modes can only be used with the internal PLC or in Easy Startup mode.

Detailed information on "command value attained" (bit 12)

Bit 12 "Command value attained" is generated depending on the active operation mode whose command value the drive follows:

Active operation mode	Bit 12 command value attained
None	0
Torque/force control	**M_act = M_cmd** (S-0-0824)
Velocity control	**n_act = n_cmd** (S-0-0330)
Position control	**In position** (S-0-0336)
Position control, drive controlled	**In position** (S-0-0336)
Drive-internal interpolation	**In target position** (S-0-0437, bit 1)
Drive-controlled positioning	**In target position** (S-0-0338 or S-0-0437, bit 2)
Positioning block mode	**End position reached** (P-0-4061, Bit 4) S-0-0338 In target position && no sequential block

Tab. 8-5: Generation of bit 12

8.2.3 P-0-0434, Position command value of controller

Function This parameter displays the position command value effective at the position controller input. Depending on the active operation mode, this position command value can be

- the position command value generated and filtered by the drive itself (e.g., in the case of interpolation modes).
- the position command value cyclically set by a control unit, filtered and fine interpolated in the drive.

☞ The internal position command value "P-0-0434, Position command value of controller" is generated in the position controller clock (125 µs).

See also Functional Description "Position control with cyclic command value input"

See also Functional Description "Positioning block mode"

See also Functional Description "Drive-internal interpolation"

See also Functional Description "Synchronization modes"

Min./max. value	-- / --
Format	DEC_MV
Unit	S-0-0076
Type	Output register
Editable	--

Decimal places	S-0-0077 / S-0-0078
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-6: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.4 P-0-0444, Actual value peak torque limit

Function

Display parameters for the maximum drive torque or the maximum drive power. The value is the limit value for positive and negative torque/force command values.

Displayed is the lower value of

- P-0-0109, Torque/force peak limit
- S-0-0092, Bipolar torque/force limit value
- S-0-0530, torque/force limit value positive stop (only when traveling and homing at positive stop)
- load-dependent limitations by motor and controller
- motor-dependent limitations

The unit for the values of this parameter depends on the scaling that has been set (S-0-0086, Torque/force data scaling type).

See also Functional Description "Current and torque/force limitation"

Min./max. value	-- / --
Format	DEC_MV
Unit	S-0-0086
Type	Output register
Editable	--
Decimal places	S-0-0093 / S-0-0094
Buffered parameter	–
Default value	-
Refresh time	AT

Tab. 8-7: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.5 P-0-0556, Config word of axis controller

Function

The parameter is used for configuring functions specific to axis control and setting the control performance.

See also Functional Description "Closed-loop axis control (closed-loop operation)"

See also Functional Description "Performance data"

Structure

The individual bits of the parameter have the following significances:

Bit	Designation/function	Comment
0	**Fine interpolator** **0:** On - fine interpolation of the velocity command value can be activated if necessary. **1:** Off - (default configuration)	FW17VRS and above
1	**Velocity control loop monitoring (F8078)** **0:** On (default configuration) **1:** Off Disabling monitoring is not recommended. This should only be done in case of emergency (e.g., in case of highly non-linear gears).	
2	**Control loop performance setting for IndraDrive Cs devices (HCS01.1)** **0: Basic:** Moderate control loop cycle times - moderate control performance **1: Advanced:** Short control loop cycle times - high control performance **Exception:** IndraDrive Cs Economy, only offers Economy control loop performance. Bit 2 does not need to be configured.	Up to FW17VRS
5/2	**Control loop performance setting** **00 Basic:** Moderate control loop cycle times - moderate control performance **01 Advanced:** Short control loop cycle times - high control performance **10 Economy:** Longest control loop cycle times - low control performance **11:** Not possible Exceptions: • Basic and Advanced control loop performance are only possible with MPB and MPC firmware components. • Economy control loop performance is only possible with the MPE firmware component. • Basic control loop performance is only possible with the MPM firmware component. Which performance settings are available depends on the firmware and the device. See also functional description "Control section design and performance"	FW18VRS and above

Bit	Designation/function	Comment
3	**Execution mode C0700 Load defaults proced. command (motor-spec. controller values)** command **Prerequisite:** "F2008 RL The motor type has changed" **Reset** "F2008" by • Pressing <Esc> on the control panel or • Executing "C0500 Reset class 1 diagnostics, error reset" **0:** C0700 Load defaults procedure command is executed **1:** C0700 Load defaults procedure command is not executed	
4	**Torque/force limitation warning (E8260)** If required, the display of the warning in the case of active torque/force limitation can be deactivated. **0:** E8260 is displayed (active) **1:** E8260 is not displayed (masked)	
5	Reserved	Up to FW17VRS
6	**Motor data initialization** Motor data are read from the motor data memory: **0:** Once during boot-up **1:** Always when the drive is switched to operating mode	
7	**Selecting the velocity controller** **0:**Standard control method (PI controller) **1:** Controller with reference model Change enabled in parameterization mode only	FW21VRS and above
8	**Open position control loop** **0:** Control loop closed **1:** Control loop open If the position control loop is open, a MLD controller may take over control	FW20VRS and above
9	**Point at which "P-0-0059, Additive position command value, controller" takes effect** **0:** Has no effect on feedforward **1:** Has an effect on feedforward	

Bit	Designation/function	Comment
10	**Range of values for unipolar torque limitation (S-0-0082, Torque/force limit value positive and S-0-0083, Torque/force limit value negative)** **0:** Standard value range (default): "S-0-0082" can only have positive values, "S-0-0083" can only have negative values (negative prefix required). **1:** Extended value range: The value of "S-0-0082" has to be greater than "S-0-0083" (with sign). Both values can be entered with the same sign, i.e., with positive or with negative sign!	
11	**Activation of torque correction for synchronous motors** **0:** No dynamic correction of the torque constant **1:** Dynamic correction of the torque constant depending on the saturation and the motor temperature	Up to FW19VRS FW20VRS and above, see P-0-3945
12	**Activation of automatic determination of counterbalance of load due to weight** **0:** No automatic determination. The value parameterized in "S-0-0163, Weight counterbalance" is used when drive enable is switched on. **1:** Automatic determination of load due to weight. When drive enable is switched off, the current holding torque is copied to parameter "S-0-0163, Weight counterbalance". This value is used when drive enable is switched on the next time.	
13	**Asynchronous motors: Reduction of velocity control loop gain in field weakening operation** **0:** Reduction not active **1:** Reduction is proportional to field weakening (default value) **Synchronous motors: Velocity control loop gain is corrected when torque constant is corrected (see bit 11)** **0:** Adjustment of control loop gain to corrected torque constant **1:** Correction switched off (default value)	Up to FW19VRS FW20VRS and above, see P-0-3945

Bit	Designation/function	Comment
14	**Range of action of torque/force limitations** **0:** Unipolar limitation of the working load (velocity controller output), bipolar limitation of the total load from machining and acceleration feedforward control **1:** Unipolar and bipolar limitation of the total load from machining and acceleration feedforward control • Unipolar: "S-0-0082, Torque/force limit value positive" and "S-0-0083, Torque/force limit value negative" • Bipolar: "S-0-0092, Torque/force limit value bipolar" and "P-0-0109, Torque/force peak limit"	
15	**Position controller with hybrid position control** **0:** Encoder 2 provides velocity feedback value (default) **1:** Encoder 1 provides velocity feedback value	FW20V16 and above

Tab. 8-8: Relevant bits of P-0-0556

Use

Observe the following aspects for parameterization:

- **Bit 9: Point at which additive position command value of controller takes effect:** In the majority of cases, feedforward values have a positive effect on the control dynamics and reaction time of a drive. Feedforward values are generated from command value characteristics:
  - Velocity feedforward from the position command value characteristic
  - Acceleration feedforward from the velocity command value characteristic

  This bit is used to define whether "P-0-0059, Additive position command value, controller" is included in the generation of the feedforward values or whether it is afterwards added to the position command value generated by command value adjustment. "P-0-0059" can only be used in the following position-controlled operation modes:
  - Cycl. Position control
  - Drive-controlled positioning
  - Drive-internal interpolation
  - Positioning block mode
- **Bit 10: Value range for unipolar torque limitation:**

  The "extended range of values" allows using the same signs for "S-0-0082" and "S-0-0083". In this way, symmetric torque limitation can be implemented with respect to the basic load, for example, for axes with basic load (vertical axes without counterbalancing).

NOTICE

Property damage caused by positive feedback and impeded axis deceleration if "S-0-0082" and "S-0-0083" are incorrectly set!

The "extended value range" should only be used in appropriate applications. There is increased risk of positive feedback in the speed control loop, if, e.g., the negative sign of "S-0-0083" is omitted by mistake!

- **Bit 13: Asynchronous motors: Reduction of velocity control loop gain in field weakening operation**

  It makes sense to activate this feature, when the asynchronous motor runs steadily in the speed range of constant torque, but the torque command value in field weakening operation tends to oscillation. The reduction is active by default (value 1).
- **Bit 13: Synchronous motors: Correction of velocity control loop gain**

  Activation only makes sense when the correction of the torque/force constant has been activated (bit 11). The torque constant is reduced in the overload range of the motor. Changes in the torque constant change the effective control loop gain, this can be compensated.

Min./max. value	--- / ---
Format	BIN
Unit	--
Type	Input register
Editable	PM
Decimal places	0
Buffered parameter	✓
Default value	0x2001
Refresh time	~50 ms

Tab. 8-9: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.6 P-0-0558, Drive Halt configuration

Function This parameter is used as control word for the "Drive Halt" function.

See also Functional Description "Drive Halt"

Structure The parameter has the following structure:

Bit	Designation/function	Comment
0	**"Drive Halt" function type** 0: "Quick stop" switches over to own operation mode 1: Operational stop decelerates in the active operation mode with Vcmd = 0.	
2	**"Quick stop" control type** 0: Velocity-controlled 1: Position control	
4	**P-0-0690, Additive velocity command value, process controller in "Drive Halt"** 0: Inactive 1: Active	

Tab. 8-10: "Drive Halt" configuration

8.2.7 P-0-0560, Configuration of actuator

Function **As of MPx-20V06:** This parameter is used to configure the actuator.

☞ A distinction is made between simple actuators (0, 1) and complex actuators (4, 5).

Structure

Actuators are selected via the parameter value:

Value	Function	Comment
0	E motor (rotary)	
1	E motor (linear)	
4	E motor pump hydraulic cylinder (Sytronix) (as actuator, a motor controlled by a controller is applied, potentially non-linear behavior of the actuator path)	
5	E motor pump hydraulic motor (Sytronix) (as actuator, a motor controlled by a controller is applied, potentially non-linear behavior of the actuator path)	

Use

☞ With the Sytronix functional package, the actuator types (4, 5) are released.

For simple actuators (0, 1) without Sytronix functional package, the actuator type is permanently coupled to the motor type (P-0-4014; bit 9).

For simple actuators (0, 1) with Sytronix functional package, the actuator type is checked according to the motor type.

For complex actuators (4, 5), the motor encoder is uncoupled from the mechanical axis system.

- The motor encoder is independent with its own actual velocity motor (P-0-0112)
- For motor data, an independent scaling applies (Sercos default)
- The velocity controller refers to the motor encoder and provides "P-0-0561, Effective velocity controller command value"
- Coupling to the position controller is realized via "P-0-0562, Active in-feed/gear factor"
- Position control can still be realized using encoder 1 or encoder 2
- Acceleration feedforward (S-0-0348) is inactive

Min./max. value	--- / ---
Format	DEC_OV
Unit	--
Type	Input register
Editable	--
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-11: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.8 P-0-0561, Effective velocity controller command value

Function With this parameter, the effective velocity command value of the velocity controller can be displayed. The command value is motor-related with fixed scaling (Sercos default).

> ☞ The velocity controller is motor-related for "complex actuators". "P-0-0112, Actual velocity value of motor" is deducted from the effective velocity controller command value. The result of this calculation "S-0-0347, Velocity error" is forwarded to the velocity controller.

See also functional description "Velocity controller"

See also parameter description "P-0-0560, Configuration of actuator"

Min./max. value	-/-
Format	DEC_MV
Unit	P-0-4014
Type	Output register
Editable	--
Decimal places	P-0-4014
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-12: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.9 P-0-0562, Active feed/gear factor

Function The active infeed/gear factor is applied for controller output adjustment. For complex actuators (P-0-0560), "uncoupled motor encoder", it defines the connection between drive control and motor control.

> ☞ With the reciprocal value of the factor, the velocity command value (P-0-0048) is converted into the velocity controller command value (P-0-0561).

> ☞ The parameter is only available in the Sytronix functional package for the MPB and MPC derivatives.

Min./max. value	0.0/214748364.7
Format	FLOAT
Unit	rev/mm
Type	Output register
Editable	++
Decimal places	1
Buffered parameter	✓

Default value	1.0
Refresh time	PFC controller clock cycle

Tab. 8-13: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.10 P-0-0563, Input for velocity command value adjustment

Function The parameter displays the velocity command value that is transferred to the velocity controller for command value adjustment.

See also functional description "Velocity controller"

Min./max. value	--- / ---
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045 / S-0-0046
Buffered parameter	–
Default value	--
Refresh time	PFC controller clock cycle

Tab. 8-14: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.11 P-0-1271, Effective pressure/force command value

P-0-1271 displays the active command value for the pressure/force controller. It is the pressure/force command value (P-0-1371) filtered by the filter time constants of P-0-1384 and P-0-1385. After the associated limitation and ramping, this is:

- "S-0-0550, Torque/force command value, positive 2" with force control in positive direction
- “S-0-0551, Torque/force command value, negative 2” with force control in negative direction
- "S-0-0800, Pressure command value" in case of pressure control

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086 or S-0-0806
Type	Output register
Editable	--
Decimal places	S-0-0093/S-0-0094 or S-0-0807/ S-0-0808
Buffered parameter	
Default value	-
Refresh time	20 ms

Tab. 8-15: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.12 P-0-1275, Effective displacement

This parameter can be an input or an output, depending on the pump type used (P-0-1370 bit 12, 11). In the case of a pump with a fixed angle or a two-point operation pump, this parameter is an output and displays the actual pump volume in a 20-ms clock cycle. In the case of a pump with a continuously variable angle, this parameter is an input (in the PFC controller clock cycle) for the actual pump volume that is used, for example, for internally calculating the actuator advance.

Min./max. value	0.0000/214748.3647
Format	DEC_MV
Unit	cm³
Type	Input/output register
Editable	++ / --
Decimal places	4
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle / 20 ms

Tab. 8-16: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.13 P-0-1276, Actual velocity value

This parameter displays the currently determined actual velocity.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-17: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.14 P-0-1277, Actual acceleration value

This parameter displays the currently determined actual acceleration.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0160

Type	Output register
Editable	--
Decimal places	S-0-0161/S-0-0162
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-18: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.15 P-0-1280, System status word 1

P-0-1280, System status word 1

P-0-1280 displays basic status information on the technology function bit-by-bit.

Structure and significance of the bits:

Bit	Name/function	Comment
0	**Pressure/force control** 0: Not active 1: Active	
1	**Pressure/force command value has reached target value** 0: Active pressure/force command value (P-0-1271) deviates from pressure/force command value (S-0-0800, S-0-0550, S-0-0551) due to ramping 1: Active pressure/force command value (P-0-1271) corresponds to pressure/force command value (S-0-0800, S-0-0550, S-0-0551)	As of PFC03V04
2	**Status of actual pressure/force command value** 0: Is not within the accuracy window 1: Is within the accuracy window	As of PFC03V04
3	**Status of holding function** 0: Axis in closed-loop control 1: Axis not in closed-loop control	As of PFC03V04
4	**Warning** 0: Is not present 1: Is present	
5	**Position control** 0: Not active 1: Active	
7/6	**Reserved**	

Bit	Name/function	Comment
10-8	Active parameter set 000: None 001: Set 1 010: Set 2 011: Set 3 100 Set 4	
12/11	Reserved	
13	Error (Stop_0 or Stop_1) 0: Is not present 1: Is present	
14	Reserved	
15	Decompression valve A-side 0: Closed 1: Open	
16	Decompression valve B-side 0: Closed 1: Open	
17	Refilling on A-side 0: No refilling detected on A-side 1: Refilling detected on A-side; cylinder chambers on A-side not effective for cylinder advance	
18	Refilling on B-side 0: No refilling detected on B-side 1: Refilling detected on B-side; cylinder chambers on B-side not effective for cylinder advance	
20-19	Directional valve (only with corresponding configuration) 00: No movement 01: Extending 10: Retracting	
22-21	Two-point control of variable displacement pump (only if configured accordingly) 00: No change of swivel angle 01: Reduction of swivel angle 10: Increase in swivel angle	
26-23	Reserved	

Bit	Name/function	Comment
30-27	**Selection of block functions** **0000:** Standby **0001:** Area switching (rapid mode) **0010:** Area switching (press mode) **0011:** Decompression **0100:** Isolate chamber **--:** Not used **1100:** Isolate **1101:** OFF	Function of isolating as of PFC03V04
31	**Status of changeover process** **0:** No changeover taking place **1:** Changeover is taking place	

Tab. 8-19: Structure of status word P-0-1281 and significance of the bits

For more detailed diagnostics, see "P-0-1281, System status word 2".

Min./max. value	-/-
Format	BIN
Unit	-
Type	Output register
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-20: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.16 P-0-1281, System status word 2

P-0-1281, System status word 2

P-0-1281 displays detailed status information on the technology function bitwise.

Structure and significance of the bits:

Bit	Name/function	Comment
0	**Pulsation compensation, operating range** **0:** Axis is not within the permitted operating range **1:** Axis is within the permitted operating range	
1	**Pulsation compensation, operating range** **0:** Pump is not within the transition region from B-side to A-side **1:** Pump is within the transition region from B-side to A-side	

Bit	Name/function	Comment
2	Pulsation compensation, operating range 0: Pump is not within the transition region from A-side to B-side 1: Pump is within the transition region from A-side to B-side	
3	Status of system pressure 0: System pressure not reached 1: System pressure reached	As of PFC03V04
4-5	Reserved	
6	Oil temperature, warning Warning threshold (P-0-1311[173]) 0: Not exceeded 1: Exceeded	
7	Reserved	
8	Accumulator underpressure, warning Warning threshold (P-0-1311[165]) 0: Value has not fallen below threshold 1: Value has fallen below threshold	
9	Accumulator overpressure, warning Warning threshold (P-0-1311[167]) 0: Not exceeded 1: Exceeded	
10	Limitation in pressure/force controller 0: Not active 1: Active	
11	Limitation in position controller 0: Not active 1: Active	
12	Filter clogged 75 %	
13	Filter clogged 100 %	
14	Pressure/force controller P-gain (P-0-1373) 0: Kp > 0 1: Kp = 0	
15	Position controller P-gain (S-0-0104) 0: Kv > 0 1: Kv = 0	
16	Reserved	
17	Reserved	

Bit	Name/function	Comment
18	**Accumulator underpressure, error** Alarm threshold (P-0-1311[166]) **0:** Value has not fallen below threshold **1:** Value has fallen below threshold	
19	**Accumulator overpressure, error** Alarm threshold (P-0-1311[168]) **0:** Not exceeded **1:** Exceeded	
20	**Oil temperature, error** Warning threshold (P-0-1311[174]) **0:** Not exceeded **1:** Exceeded	
26-21	**Reserved**	
27	**Cylinder type** selection **0:** Valid **1:** Invalid	
29/28	**Reserved**	
30	**Acceleration feedforward of IndraDrive firmware** (S-0-0348) **0:** Switched off **1:** Not switched off	
31	**Selected operation mode** is **0:** supported **1:** not supported by PLC	

Tab. 8-21: Structure of status word P-0-1281 and significance of the bits

For basic diagnostics, see "P-0-1280, System status word 1".

Min./max. value	-/-
Format	BIN
Unit	-
Type	Output register
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-22: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.17 P-0-1282, Pressure feedback value C

This parameter contains the current actual value of chamber C. It can be taken into account in the calculation of the actual force value (see "P-0-2937.0.1, Force acquisition control word") and monitored separately for too high values.

The unit for the values of this parameter depends on the scaling that has been set in "S-0-0806, Pressure data scaling type".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-23: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.18 P-0-1283, Hydraulic function, switching control word

Various functions of the technology function are controlled in P-0-1283 via bit combinations. The selection is applied at runtime.

Structure of list parameter P-0-1283 and significance of the list elements:

Bit	Name/function	Comment
0	Direction input via valves 0: Extending, flow in chamber A 1: Retracting, flow in chamber B	Only takes effect with configuration "direction input via valve" and "selection via control word"
2/1	Swivel angle two-point control 00: Do not change 01: Swivel to Vg_max 10: Swivel to Vg_min	Only takes effect with "two-point control" configuration
3	Swivel angle adjustment, activation 0: Controlling the swivel angle cyclically 1: Controlling the swivel angle on the basis of a fixed value (P-0-1311[296])	
7-4	Selection of block functions 0000: Standby 0001: Area switching (rapid mode) 0010: Area switching (press mode) 1100..0011: User-defined 1101: Off	Only takes effect with configuration "valve control, actuator: Selection via control word"

10-8	**Parameter set switching: Set selection** **000**: No set **001**: Set 1 **010**: Set 2 **011**: Set 3 **100**: Set 4	
11	**Disable pulsation compensation** **0**: Pulsation compensation enabled **1**: Pulsation compensation disabled	
12	**Enable system pressure increase** is only active, if secondary axis is used (P-0-1370 bit 18 = 1) **0**: No enable of secondary axis **1**: Enable of secondary axis	As of PFC03V04
13	**Holding function, manual commanding**, is only active, if manual commanding has been configured (P-0-1372 bit 11 = 1) **0**: Unlock axis **1**: Lock axis	As of PFC03V04
31-14	**Reserved**	

Tab. 8-24: Structure of control word P-0-1283 and significance of the bits

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-25: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.19 P-0-1284, Oil temperature

This parameter contains the current actual value of the oil temperature. The latter can be monitored for too high and too low values by means of threshold values.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++

Decimal places	2
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-26: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.20 P-0-1285, Max. model deviation, position

The maximum value of the deviation is stored in "P-0-1285" and helps determine the value of the monitoring window (P-0-1311[118], [119] or [122]).

☞ Before the "test run" of an axis, P-0-1285 has to be set to "0".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input/output register
Editable	++
Decimal places	S-0-0077/S-0-0078
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-27: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.21 P-0-1287, Additive velocity command value

This parameter contains the additive velocity command value of position control.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-28: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.22 P-0-1288, Pilot oil pressure

This parameter contains the current actual value of the pilot oil pressure (also referred to as high pressure). It can be monitored for too high and too low values by means of threshold values.

The unit for the values of this parameter depends on the scaling that has been set in "S-0-0806, Pressure data scaling type".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input/output register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-29: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.23 P-0-1289, Actual swivel angle value

This parameter contains the current actual value of the swivel angle.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-30: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.24 P-0-1292, Pulsation compensation: Additive motor speed B -> A

This parameter contains the additive motor speed for compensating pulsation of axial piston pumps. It has an additive effect on the command speed of the motor, when a pump piston is within the transition region from the B-side of the pump to the A-side of the pump.

This parameter is evaluated only, if the value 10 has been set in P-0-1370, bit 29/28.

Min./max. value	-2147483647/2147483647
Format	DEC_MV

Unit	rpm
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-31: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.25 P-0-1293, Pulsation compensation: Additive motor speed A -> B

This parameter contains the additive motor speed for compensating pulsation of axial piston pumps. It acts additively on the command speed of the motor, when a pump piston is within the transition region from the A-side of the pump to the B-side of the pump.

This parameter is evaluated only, if the value 10 has been set in P-0-1370, bit 29/28.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	rpm
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-32: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.26 P-0-1294, Reserved for application-related MLD part (user code)

P-0-1294 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register

Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-33: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.27 P-0-1295, Reserved for application-related MLD part (user code)

P-0-1295 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-34: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.28 P-0-1296, Reserved for application-related MLD part (user code)

P-0-1296 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register
Editable	++

Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-35: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.29 P-0-1297, Reserved for application-related MLD part (user code)

P-0-1297 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-36: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.30 P-0-1298, Reserved for application-related MLD part (user code)

P-0-1298 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register
Editable	++
Decimal places	0

Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-37: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.31 P-0-1299, Reserved for application-related MLD part (user code)

P-0-1299 is reserved for user applications. It can be used as an interface for an additional MLD program. Its format and decimal places can be set in the corresponding IndraWorks dialog. Its name, unit and limit values can be changed with the MLD functions "MX_fSetParamName", "MX_fSetParamUnit" and "MX_fSetParamLimits".

☞ This is a volatile parameter! Parameter data will get lost when the control voltage is switched off.

Min./max. value	-/-
Format	DEC_MV
Unit	
Type	Input/output register
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	-

Tab. 8-38: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.32 P-0-1300, TF diagnostic code

P-0-1300 displays the code of a diagnostic message that is present. See also description of diagnostic messages.

Min./max. value	16#00000/ 16#FFFFF
Format	HEX
Unit	-
Type	Output register
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-39: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.33 P-0-1311, Axis-specific configuration

Machine data of different types can be input in the list elements of this parameter. The individual elements are described below.

☞ The individual machine data are read in in different units and checked for various limits. The respective attributes are specified with the corresponding list element.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-40: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.34 P-0-1311[0], Parameter set 1: Delay time

This list element is used to set the time that is to elapse between the selection of a switching action to this parameter set and the beginning of the switching process.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-41: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.35 P-0-1311[1], Parameter set 1: Transition time

This list element is used to set the time in which the individual parameters are changed to the values stored in this parameter set.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-42: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.36 P-0-1311[2], Parameter set 1: Position controller, Kv-factor

This list element is used to set the proportional gain of the position controller for this parameter set; cf. "P-0-1316, Position controller, Kv-factor".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	1000/min
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-43: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.37 P-0-1311[3], Parameter set 1: Position controller, velocity feedforward

This list element is used to set the velocity feedforward of the position controller for this parameter set; cf. "P-0-1321, Velocity feedforward".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-44: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.38 P-0-1311[4], Parameter set 1: Position controller, disturbance observer time constant

This list element is used to set the integration time constant of the position controller for this parameter set; cf. "P-0-1317, Position controller, disturbance observer time constant".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-45: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.39 P-0-1311[5], Parameter set 1: Vel. controller load, Kp

This list element is used to set the proportional gain of the optional velocity controller for this parameter set; cf. "P-0-1380, Vel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-46: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.40 P-0-1311[6], Parameter set 1: Accel. controller load, Kp

This list element is used to set the proportional gain of the optional acceleration controller for this parameter set; cf. "P-0-1379, Accel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-47: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.41 P-0-1311[17], Swivel angle feedback value, signal selection

This list element is used to select the signal source for "P-0-1289, Actual swivel angle value".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iSwivelAngle_act"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-48: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.42 P-0-1311[18], Swivel angle feedback value, signal range limitation, min.

The minimum value from the PLC variable "iSwivelAngle_act" is configured in this list element. If the value falls below this minimum, warning "B50E2" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-49: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.43 P-0-1311[19], Swivel angle feedback value, signal range limitation, max.

The maximum value from the PLC variable "iSwivelAngle_act" is configured in this list element. If this value is exceeded, warning "B50E2" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-50: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.44 P-0-1311[20], Swivel angle feedback value, value range, min.

This list element specifies the lower value range limit of the swivel angle feedback value. This parameter is used forcalculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-51: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.45 P-0-1311[21], Swivel angle feedback value, value range, max.

This list element is used to specify the upper value range limit of the swivel angle feedback value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-52: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.46 P-0-1311[22], Swivel angle feedback value, signal range, min.

This list element is used to specify the lower signal range limit of the swivel angle feedback value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-53: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.47 P-0-1311[23], Swivel angle feedback value, signal range, max.

This list element is used for specifying the upper signal range limit of the swivel angle feedback value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-54: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.48 P-0-1311[24], Swivel angle feedback value, filter time

This list element is used for specifying the filter time of the swivel angle feedback value. Filtering is active, if the value "6" has been selected in "P-0-1311[17], Swivel angle feedback value, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-55: Parameter attributes

8.2.49 P-0-1311[25], Parameter set 2: Delay time

See "P-0-1311[0], Parameter set 1: Delay time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-56: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.50 P-0-1311[26], Parameter set 2: Transition time

See "P-0-1311[1], Parameter set 1: Transition time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-57: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.51 P-0-1311[27], Parameter set 2: Position controller, Kv-factor

See "P-0-1311[2], Parameter set 1: Position controller, Kv-factor".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	1000/min
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-58: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.52 P-0-1311[29], Parameter set 2: Position controller, disturbance observer time constant

See "P-0-1311[4], Parameter set 1: Position controller, disturbance observer time constant".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-59: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.53 P-0-1311[30], Parameter set 2: Vel. controller load, Kp

See "P-0-1311[5], Parameter set 1: Vel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-60: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.54 P-0-1311[31], Parameter set 2: Accel. controller load, Kp

See "P-0-1311[6], Parameter set 1: Accel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-61: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.55 P-0-1311[42], Swivel angle command value, signal selection

This list element is used to select the signal source for "S-0-0880, Swivel angle command value".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iManualSwivelAngle_cmd"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-62: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.56 P-0-1311[43], Swivel angle command value, signal range limitation, min.

The minimum value from the PLC variable "iManualSwivelAngle_cmd" is configured in this list element. If the value falls below this minimum, warning "B50F7" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-63: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.57 P-0-1311[44], Swivel angle command value, signal range limitation, max.

This list element is used for configuring the maximum value from the PLC variable "iManualSwivelAngle_cmd". If this value is exceeded, warning "B50F7" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-64: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.58 P-0-1311[45], Swivel angle command value, value range, min.

This list element is used for specifying the lower value range limit of the swivel angle command value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-65: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.59 P-0-1311[46], Swivel angle command value, value range, max.

This list element is used for specifying the upper value range limit of the swivel angle command value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-66: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.60 P-0-1311[47], Swivel angle command value, signal range, min.

This list element is used for specifying the lower signal range limit of the swivel angle command value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-67: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.61 P-0-1311[48], Swivel angle command value, signal range, max.

This list element is used to specify the upper signal range limit of the swivel angle command value. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-68: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.62 P-0-1311[49], Swivel angle command value, filter time

This list element is used for specifying the filter time of the swivel angle command value. Filtering is active, if the value "6" has been selected in "P-0-1311[42], Swivel angle command value, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-69: Parameter attributes

8.2.63 P-0-1311[50], Parameter set 3: Delay time

See "P-0-1311[0], Parameter set 1: Delay time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-70: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.64 P-0-1311[51], Parameter set 3: Transition time

See "P-0-1311[1], Parameter set 1: Transition time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-71: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.65 P-0-1311[52], Parameter set 3: Position controller, Kv-factor

See "P-0-1311[2], Parameter set 1: Position controller, Kv-factor".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	1000/min
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-72: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.66 P-0-1311[53], Parameter set 3: Position controller, velocity feedforward

See "P-0-1311[3], Parameter set 1: Position controller, velocity feedforward".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-73: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.67 P-0-1311[54], Parameter set 3: Position controller, disturbance observer time constant

See "P-0-1311[4], Parameter set 1: Position controller, disturbance observer time constant".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-74: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.68 P-0-1311[55], Parameter set 3: Vel. controller load, Kp

See "P-0-1311[5], Parameter set 1: Vel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-75: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.69 P-0-1311[56], Parameter set 3: Accel. controller load, Kp

See "P-0-1311[6], Parameter set 1: Accel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4

Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-76: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.70 P-0-1311[67], Input of force feedback value, signal selection

This list element is used to select the signal source for "P-0-2937.0.3, Input of force feedback value".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iInputForceFeedbackValue"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-77: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.71 P-0-1311[68], Input of force feedback value, signal range limitation, min.

The minimum value from the PLC variable "iInputForceFeedbackValue" is configured in this list element. If the value falls below this minimum, warning "B510F" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-78: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.72 P-0-1311[69], Input of force feedback value, signal range limitation, max.

The maximum value from the PLC variable "iInputForceFeedbackValue" is configured in this list element. If this value is exceeded, warning "B510F" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-79: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.73 P-0-1311[70], Input of force feedback value, value range, min.

This list element is used for specifying the lower value range limit of the force feedback value input. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-80: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.74 P-0-1311[71], Input of force feedback value, value range, max.

This list element is used for specifying the upper value range limit of the force feedback value input. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-81: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.75 P-0-1311[72], Input of force feedback value, signal range, min.

This list element is used for specifying the lower signal range limit of the force feedback value input. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-82: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.76 P-0-1311[73], Input of force feedback value, signal range, max.

This list element is used for specifying the upper signal range limit of the force feedback value input. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, if a value from "1" to "6" has been selected in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-83: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.77 P-0-1311[74], Input of force feedback value, filter time

This list element is used for specifying the filter time of the force feedback value input. Filtering is active, if the value "6" has been selected in "P-0-1311[67], Input of force feedback value, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-84: Parameter attributes

8.2.78 P-0-1311[75], Parameter set 4: Delay time

See "P-0-1311[0], Parameter set 1: Delay time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-85: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.79 P-0-1311[76], Parameter set 4: Transition time

See "P-0-1311[1], Parameter set 1: Transition time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-86: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.80 P-0-1311[77], Parameter set 4: Position controller, Kv-factor

See "P-0-1311[1], Parameter set 1: Transition time".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	1000/min
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-87: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.81 P-0-1311[78], Parameter set 4: Position controller, velocity feedforward

See "P-0-1311[3], Parameter set 1: Position controller, velocity feedforward".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-88: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.82 P-0-1311[79], Parameter set 4: Position controller, disturbance observer time constant

See "P-0-1311[4], Parameter set 1: Position controller, disturbance observer time constant".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-89: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.83 P-0-1311[80], Parameter set 4: Vel. controller load, Kp

See "P-0-1311[5], Parameter set 1: Vel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-90: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.84 P-0-1311[81], Parameter set 4: Accel. controller load, Kp

See "P-0-1311[6], Parameter set 1: Accel. controller load, Kp".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-91: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.85 P-0-1311[101], Minimum pressure command value

In this list element the lower limit is set that takes effect on the cyclically input pressure command value. The possibly limited pressure command value is displayed in "P-0-1271, Effective pressure/force command value".

Min./max. value	0.0001/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-92: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.86 P-0-1311[102], Maximum force command value

This list element is used to set the upper limit that takes effect on the cyclically input force command value. The possibly limited force command value is displayed in "P-0-1271, Effective pressure/force command value".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086 * 1000 (e.g. kN)
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-93: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.87 P-0-1311[103], Minimum force command value

This list element is used to set the lower limit that takes effect on the cyclically input force command value. The possibly limited force command value is displayed in "P-0-1271, Effective pressure/force command value".

Min./max. value	-2147483647/0
Format	DEC_MV
Unit	S-0-0086 * 1000 (e.g. kN)
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-94: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.88 P-0-1311[104], Accuracy window of actual force value

In this list element, the accuracy window for the actual force value is entered for forming the corresponding status in P-0-1208, bit 1.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-95: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.89 P-0-1311[105], Ramp time for controller outputs when changing oper. modes

This list element is used to set the time for a change in the operation mode in which the controller output of the old operation mode is ramped to the value of the new operation mode.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-96: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.90 P-0-1311[106], Accuracy window of pressure

This list element is used to configure the accuracy window for the actual pressure value. "P-0-1280, System status word 1", bit 2 indicates that the actual pressure value is within the accuracy window. This function is only available when the axis is in pressure control.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-97: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.91 P-0-1311[107], Force controller, I-logic: Filter time

This list element defines the time constant which is used for filtering the inputs for command and feedback values of the I-logic in the pressure/force controller.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-98: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.92 P-0-1311[108], Pressure/force controller, I-logic: Change threshold command values

This list element is used to set the threshold value for a command value change. The values have to fall below this threshold so that the I-logic allows the control difference to be added in the pressure/force controller. Otherwise, the I-term is ramped down to zero using "P-0-1311[111], Pressure/force controller, I-term down ramp".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	kN/s
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-99: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.93 P-0-1311[109], Pressure/force controller, I-logic: Change threshold actual values

This list element is used to set the threshold value for an actual value change. The values have to fall below this threshold so that the I-logic allows the control difference in the pressure/force controller to be added. Otherwise, the I-term is ramped down to zero using "P-0-1311[111], Pressure/force controller, I-term down ramp".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	kN/s
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-100: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.94 P-0-1311[110], Pressure/force controller, I-logic: Accuracy window

This list element is used to set the threshold value below which the absolute value of the control difference in the pressure/force controller has to fall so that the I-logic freezes the added value.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	N
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-101: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.95 P-0-1311[111], Pressure/force controller, I-term down ramp

This list element is used to set the ramp with which a possibly added I-term in the pressure/force controller is ramped down as soon as this is requested by the I-logic.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	mm/s²
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-102: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.96 P-0-1311[112], Pressure threshold for recognizing the load side when extending

In this list element, the pressure for differentiating pushing and pulling loads in the extending direction of a single-rod cylinder has to be entered.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-103: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.97 P-0-1311[113], Position controller, I-logic: Change threshold command values

This list element is used to set the threshold value for a command value change. The values have to fall below this threshold so that the I-logic allows the control difference in the position controller to be added. Otherwise, the I-term is ramped down to zero using "P-0-1311[115], Position controller, I-term down ramp".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-104: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.98 P-0-1311[114], Position controller, I-logic: Change threshold actual values

This list element is used to set the threshold value for an actual value change. The values have to fall below this threshold so that the I-logic allows the control difference in the position controller to be added. Otherwise, the I-term is ramped down to zero using "P-0-1311[115], Position controller, I-term down ramp".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-105: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.99 P-0-1311[115], Position controller, I-term down ramp

This list element is used to set the ramp with which a possibly added I-term in the position controller is ramped down as soon as this is required by the I-logic.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	mm/s²
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-106: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.100 P-0-1311[116], Lag error monitoring: Reference velocity

In this list element, the velocity is entered at which the lag error is to be allowed in "P-0-1311[118], Lag error monitoring: Max. lag error at reference velocity".

Together the values make the line through origin for velocity-dependent lag error monitoring. If the line is exceeded, an error is generated.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-107: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.101 P-0-1311[117], Tolerance window for warning when active Vg is limited

This list element is used to specify the tolerance window for signaling a warning when the limitation of the active Vg is activated. The warning threshold for an impermissible Vg can be shifted downwards by a percentage of the maximum Vg (P-0-2943) (below the minimum Vg (P-0-1371) or upwards (above the maximum Vg P-0-2943). If Vg exceeds or falls below the warning threshold, warning "B5014" is generated.

Min./max. value	0/100
Format	DEC_MV
Unit	%
Type	Input register
Editability	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-108: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261

8.2.102 P-0-1311[118], Lag error monitoring: Max. lag error at reference velocity

This list element is used to enter the maximum lag error that is allowed to develop with "P-0-1311[116], Lag error monitoring: Reference velocity".

Together the values make the line through origin for velocity-dependent lag error monitoring. If the line is exceeded, error "D502C" is generated.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-109: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.103 P-0-1311[119], Lag error monitoring: Max. lag error at standstill

This list element is used to enter the maximum lag error that is allowed to develop at standstill (cf. "S-0-0124, Standstill window").

The result is the steady-state range for velocity-dependent lag error monitoring. Error "D502C" will be generated if this range is exceeded.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-110: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.104 P-0-1311[120], Lag error monitoring: Warning threshold

This list element is used to specify the threshold value for a lag error warning. This refers to the effective error threshold value in percent.

If the warning threshold is violated, warning "B502B" is generated.

Min./max. value	0 - 100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-111: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.105 P-0-1311[121], Lag error monitoring: Debounce time

This list element is used to set the minimum duration of the threshold value violation for velocity-dependent lag error monitoring. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-112: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.106 P-0-1311[122], Lag error model monitoring window

The allowed deviation of the real lag error from the model lag error is entered in this list element.

If the monitoring window is violated, error "D502C" is generated.

If the warning threshold is violated (80 % of the monitoring window), warning "B502B" is generated.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-113: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.107 P-0-1311[123], Alternating control: Absolute switching threshold

This list element is used to set the absolute switching threshold that the actual force value has to exceed so that alternating control performs the transition from position control to pressure/force control. The absolute threshold only takes effect if this has been configured accordingly in "P-0-1372, Configuration, axis controllers/functions" using "Enable condition for pressure/force control".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-114: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.108 P-0-1311[124], Alternating control: Relative switching window

This list element is used to set a percentage-based window around the pressure/force command value. The actual pressure/force value has to be within this window so that alternating control performs the transition from position control to pressure/force control. The relative window only takes effect if this has been configured accordingly in "P-0-1372, Configuration, axis controllers/functions" using "Enable condition for pressure/force control".

Min./max. value	-100/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-115: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.109 P-0-1311[125], Alternating control: Debounce time for switching condition

This list element is used to set the time that is to elapse between the fulfillment of a switching condition from position to pressure/force control and the beginning of the switching process.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-116: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.110 P-0-1311[126], Alternating control: Ramp time for switching

When switching between position and force control takes place, a control value jump may occur at the controller output. To prevent this, a ramp is used to cross-fade to the respective active controller output while switching between position and force control takes place. The input is to be made in "ms" referred to the permissible maximum cylinder velocity (S-0-0038, S-0-0091). If the ramp time is set to zero, the ramp is deactivated and changing over takes place immediately.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-117: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.111 P-0-1311[127], Debounce time for pump switching, rapid mode/press mode

This list element is used to enter the time for which a switching condition between rapid mode/press mode has to be fulfilled until the switching process is initiated.

This setting only takes effect in the case of automatic switching or in the case of manual switching with validation.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-118: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.112 P-0-1311[128], Acceleration feedback value generation: Filter time

This list element is used to set the DT1 filter time constant with which the actual acceleration value is generated using the force feedback value and "P-0-1377, Acceleration feedback value generation: Moving mass".

Valid for the following configuration: P-0-1370.24..22 = 100

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-119: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.113 P-0-1311[129], Acceleration observer: P-gain

This list element is used to set the proportional gain of the acceleration observer. The proportional gain is used to weight a model deviation that has developed.

Valid for the following configuration: P-0-1370.24..22 = 011

Min./max. value	0/2147483647
Format	DEC_MV
Unit	rps
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-120: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.114 P-0-1311[130], Acceleration feedback value generation: Installation angle

This list element is used to specify the installation angle of the cylinder. Horizontal mounting position corresponds to an angle of "0°"; vertical mounting position with a cylinder extending upwards corresponds to an angle of "-90°"; vertical mounting position with a cylinder extending downwards corresponds to an angle of "90°".

Valid for the following configuration: P-0-1370.24..22 = 011 or 100

Min./max. value	-90/90
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-121: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.115 P-0-1311[131], Factor for area switching rapid mode/press mode

For rapid mode/press mode switching, speed and pressure feedback value limits are required, which are used as a basis for switching to the other switch position.

The fixed limits can be proportionately reduced in this list element to switch only at lower feedback values (factor "<1"), thus allowing the components to be protected and the acoustic impact to be reduced.

This setting only takes effect in the case of automatic switching or in the case of manual switching with validation.

Min./max. value	0.001/2
Format	DEC_MV
Unit	%/100
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-122: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.116 P-0-1311[132], Debounce time for area switching rapid mode/press mode

This list element is used to enter the time for which a condition for switching between rapid mode/press mode has to be fulfilled until the switching process is initiated.

This setting only takes effect in the case of automatic switching or in the case of manual switching with validation.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-123: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.117 P-0-1311[133], Direction input via valve: Switching time

This list element is used to enter the switching time of the directional valve that has to elapse during a switching process before the controller output is enabled for the motor. This ensures that the valves are in the correct position before the axis keeps following the travel profile.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-124: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.118 P-0-1311[134], Direction input via valve: Allowed differential pressure when switching

This list element is used to enter the differential pressure across the directional valve that is allowed to be present during a switching process. The switching process is only continued if the pressure across the valve is below this threshold. In this way the components are protected and the acoustic impact is reduced.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-125: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.119 P-0-1311[135], Factor for pump switching rapid mode/press mode

For rapid mode/press mode switching of the pump, speed and torque value limits are required, on the basis of which switching to the other position is allowed.

The fixed limits can be proportionately reduced in this list element to switch only at lower feedback values (factor "<1"), thus allowing the components to be protected and the acoustic impact to be reduced.

This setting only takes effect in the case of automatic switching or in the case of manual switching with validation.

Min./max. value	0.001/2
Format	DEC_MV
Unit	%/100
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-126: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.120 P-0-1311[136], Two-point control, displacement: ramp time

In this list element the ramp time of the effective displacement of a pump with two-point control (rapid mode/press mode) has to be entered. The feed factor is changed with this ramp time. This ensures that the motor output matches the effective pump displacement.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-127: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.121 P-0-1311[137], Process pressure max.

This list element is used to specify the maximum allowed pressure that can be used for the process. The value is used to calculate the threshold value for the rapid mode/press mode logic.

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-128: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.122 P-0-1311[138], Cylinder area 3 (press mode, extending)

This list element is used to specify the cylinder area of a multiple-area cylinder, via which the cylinder is extended in the press mode.

☞ If the area specified here is used, it always has to be greater than "S-0-0820, Piston area A"!

Min./max. value	0.002/2147483647
Format	DEC_MV
Unit	mm²
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-129: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.123 P-0-1311[139], Cylinder area 4 (press mode, retracting)

This list element is used to specify the cylinder area of a multiple-area cylinder, via which the cylinder is retracted in the press mode. If the cylinder acts as a double rod cylinder, it suffices to input the effective press mode area in "P-0-1311[138], Cylinder area 3 (press mode, extending)".

☞ If the area specified here is used, it must not be greater than "S-0-0821, Piston area B"!

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	mm²
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-130: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.124 P-0-1311[140], Swivel angle generator: Max. motor torque, steady state

This list element is used to specify the maximum torque for the swivel angle generator, which is not to be exceeded in the steady state. The maximum torque refers to the nominal torque, calculated from the nominal currents of the motor (S-0-0111) and the converter (S-0-0112).

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-131: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.125 P-0-1311[141], Elastic modulus

Since the controller output of the technology function always is a speed command value for IndraDrive, the elastic modulus is taken into account for the gain factors of the force controller to allow for the compressibility of the oil. In this list element, the value of the elastic modulus is to be entered, which is typically effective in force control, e.g. 10,000 bar.

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-132: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.126 P-0-1311[142], Controller output switching delay (rapid to press mode)

For cylinders with rapid mode/press mode switching, the adaptation of the controller output to the new loop gain can be delayed with this list element.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-133: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.127 P-0-1311[143], Controller output switching transition time (rapid to press mode)

For cylinders with rapid mode/press mode switching, the adaptation of the controller output to the new loop gain can be ramped with this list element.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-134: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.128 P-0-1311[144], Controller output switching delay (press to rapid mode)

For cylinders with rapid mode/press mode switching, the adaptation of the controller output to the new loop gain can be delayed with this list element.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-135: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.129 P-0-1311[145], Controller output switching transition time (press to rapid mode)

For cylinders with rapid mode/press mode switching, the adaptation of the controller output to the new loop gain can be ramped with this list element.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-136: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.130 P-0-1311[146], Critical pressure differential of the pump for detecting high load

For displacers of the A10 series, this list element can be used to specify the pressure differential across the displacer, at which high load occurs in pressure reduction operation that is permitted for a limited time only.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	50
Refresh time	~50 ms

Tab. 8-137: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.131 P-0-1311[147], Speed limit value for detecting low speed

For displacers of the A10 series, this list element can be used to specify the speed limit, below which the displacer may be operated in pump operation for a limited time only.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	rpm
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	200
Refresh time	~50 ms

Tab. 8-138: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.132 P-0-1311[148], Time limit for operation in B2

For displacers of the A10 series, this list element can be used to specify the time, for which the displacer may be operated in operating range B2.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	180000
Refresh time	~50 ms

Tab. 8-139: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.133 P-0-1311[149], Time limit for operation in B1

For displacers of the A10 series, this list element can be used to specify the time, for which the displacer may be operated in operating range B1.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	200
Refresh time	~50 ms

Tab. 8-140: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.134 P-0-1311[150], Critical Vg for detecting high load of the pump

In conjunction with displacers of the A10 series, this list element is used to define the critical displacement Vg as a percentage value of "P-0-2943, Pump displacement volume", above which overloading of the displacer may occur in the operating ranges B1 and B2.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	40
Refresh time	~50 ms

Tab. 8-141: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.135 P-0-1311[151], Factor for reducing the commanded Vg with reference to the critical Vg

In conjunction with displacers of the A10 series, this list element is used to specify a factor, with which the reduced, safe Vg is commanded for reducing the load with reference to the critical Vg (P-0-1311[151]).

Min./max. value	0/1
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	0.8
Refresh time	~50 ms

Tab. 8-142: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.136 P-0-1311[152], Monitoring for oil temperature too low: Debounce time

This list element is used to set the minimum duration of threshold value violation for monitoring of the oil temperature for too low values. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV

Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-143: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.137 P-0-1311[153], Monitoring for oil temperature too low: Warning threshold

This list element is used to set the threshold for monitoring of the oil temperature for too low values. When the temperature falls below this value, warning "B50B7" is generated. The diagnosis is delayed by the value set in "P-0-1311[152], Monitoring oil temperature too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-144: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.138 P-0-1311[154], Monitoring for oil temperature too low: Alarm threshold

This list element is used to set the threshold for monitoring of the oil temperature for too low values. When the temperature falls below this value, error "D50B6" is generated. The diagnosis is delayed by the value set in "P-0-1311[152], Monitoring oil temperature too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-145: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.139 P-0-1311[155], Oil temperature, signal range limitation, min.

The minimum value from the PLC variable "iOilTemperature" is configured in this list element. If the value falls below this minimum, warning "B50C6" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-146: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.140 P-0-1311[156], Oil temperature, signal range limitation, max.

The maximum value from the PLC variable "iOilTemperature" is configured in this list element. If this value is exceeded, warning "B50C6" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-147: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.141 P-0-1311[157], Oil temperature, value range, min.

This list element is used to specify the lower value range limit of the oil temperature. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-148: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.142 P-0-1311[158], Oil temperature, value range, max.

This list element is used to specify the upper value range limit of the oil temperature. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-149: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.143 P-0-1311[159], Oil temperature, signal range, min.

This list element is used to specify the lower signal range limit of the oil temperature. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-150: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.144 P-0-1311[160], Oil temperature, signal range, max.

This list element is used to specify the upper signal range limit of the oil temperature. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[162], Oil temperature, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-151: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.145 P-0-1311[161], Oil temperature, filter time

This list element is used to specify the filter time of the oil temperature. Filtering is active, if the value "6" has been selected in "P-0-1311[162], Oil temperature signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-152: Parameter attributes

8.2.146 P-0-1311[162], Oil temperature, signal selection

This list element is used to select the signal source for "P-0-1284, Oil temperature" or digital signals for monitoring the oil temperature.

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iOilTemperature"
7:	Digital signals in P-0-1392, bits 10-13
8:	Digital signals in the PLC structure "stOilTemperature"

Min./max. value	0/8
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-153: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.147 P-0-1311[163], Monitoring Tank pressure too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for monitoring of the tank pressure for too high values. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-154: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.148 P-0-1311[164], Monitoring for tank pressure too low: Debounce time

This list element is used to set the minimum duration of the threshold value violation for monitoring of the tank pressure for too low values. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-155: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.149 P-0-1311[165], Monitoring for tank pressure too low: Warning threshold

This list element is used to set the threshold for monitoring of the oil temperature for too low values. When the pressure falls below this value, warning "B5054" is generated. The diagnosis is delayed by the value set in "P-0-1311[164], Monitoring for tank pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-156: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.150 P-0-1311[166], Monitoring for tank pressure too low: Alarm threshold

This list element is used to set the threshold for monitoring of the tank pressure for too low values. When the pressure falls below this value, error "D5055" is generated. The diagnosis is delayed by the value set in "P-0-1311[164], Monitoring for tank pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV

Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-157: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.151 P-0-1311[167], Monitoring for tank pressure too high: Warning threshold

This list element is used to set the threshold for monitoring of the tank pressure for too high values. When the pressure exceeds this value, warning "B5052" is generated. The diagnosis is delayed by the value set in "P-0-1311[163], Monitoring for tank pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-158: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.152 P-0-1311[168], Monitoring for tank pressure too high: Alarm threshold

This list element is used to set the threshold for monitoring of the tank pressure for too high values. When the pressure exceeds this value, error "D5051" is generated. The diagnosis is delayed by the value set in "P-0-1311[163], Monitoring for tank pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-159: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.153 P-0-1311[169], Monitoring for process pressure too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for overpressure monitoring in chamber A and chamber B. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-160: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.154 P-0-1311[170], Monitoring for process pressure too high: Warning threshold

This list element is used to set the threshold for overpressure monitoring in chamber A and chamber B. Warning "B5058" or "B505A" is generated if the threshold is exceeded. The diagnosis is delayed by the value set in "P-0-1311[169], Monitoring for process pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-161: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.155 P-0-1311[171], Monitoring for process pressure too high: Alarm threshold

This list element is used to set the threshold for overpressure monitoring in chamber A and chamber B. Error "D5057" or "D5059" is generated if the threshold is exceeded. The diagnosis is delayed by the value set in "P-0-1311[169], Monitoring for process pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-162: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.156 P-0-1311[172], Monitoring for oil temperature too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for monitoring of the oil temperature for too high values. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-163: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.157 P-0-1311[173], Monitoring for oil temperature too high: Warning threshold

This list element is used to set the threshold for monitoring of the oil temperature for too high values. When the temperature exceeds this value, warning "B504F" is generated. The diagnosis is delayed by the value set in "P-0-1311[172], Oil temperature monitoring: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-164: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.158 P-0-1311[174], Monitoring for oil temperature too high: Alarm threshold

This list element is used to set the threshold for monitoring of the oil temperature for too high values. When the temperature exceeds this value, error "D504E" is generated. The diagnosis is delayed by the value set in "P-0-1311[172], Oil temperature monitoring: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-165: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.159 P-0-1311[175], Encoder jump monitoring: Number of suppression cycles

Encoder jump monitoring can ignore invalid jumps in the encoder signal and keep extrapolating the internal actual position with the last plausible velocity.

This list element is used to set the desired number of cycles (in 2-ms clock cycle) during which encoder jump monitoring is to ignore implausible encoder signals.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	-
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-166: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.160 P-0-1311[176], Encoder jump monitoring: Maximum velocity factor

This factor is used to weight the maximum allowed velocity (cf. velocity limit values) to determine the threshold for the plausibility check of the changes in position per clock cycle.

Min./max. value	100.0000/200.0000
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-167: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.161 P-0-1311[177], PFC cycle time

In the case of a PLC cycle time of 1 ms, the desired cycle time of the PFC controllers has to be entered in this list element.

In the case of a PLC cycle time greater than 1 ms, the cycle time of the PLC task "TaskCyclicFast" has to be entered in this list element.

Min./max. value	1/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-168: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.162 P-0-1311[178], Oil temperature threshold, filter monitoring

This list element is used to specify the oil temperature, from which on filter monitoring is to be active. At too low temperatures the signals of filter monitoring may not be reliable. The viscosity of the oil may be too low so that the pressure differential across the filter cannot be correctly assessed with regard to clogging. This temperature range can be ignored with this list element.

Min./max. value	1/2147483647
Format	DEC_MV
Unit	S-0-0208
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-169: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.163 P-0-1311[179], Debounce time, filter monitoring

This list element is used to enter a time, with which the signals of filter monitoring are debounced.

Min./max. value	1/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-170: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.164 P-0-1311[180], Assignment A: Value range, min.

This list element is used to specify the lower value range limit of a connected sensor linked to assignment A (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-171: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.165 P-0-1311[181], Assignment A: Value range, max.

This list element is used to specify the upper value range limit of a connected sensor linked to assignment A (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-172: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.166 P-0-1311[182], Assignment A: Signal range, min.

This list element is used to specify the lower signal range limit of a connected sensor linked to assignment A (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V or mA
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-173: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.167 P-0-1311[183], Assignment A: Signal range, max.

This list element is used to specify the upper signal range limit of a connected sensor linked to assignment A (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V or mA
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-174: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.168 P-0-1311[184], Assignment B: Value range, min.

This list element is used to specify the lower value range limit of a connected sensor linked to assignment B (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-175: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.169 P-0-1311[185], Assignment B: Value range, max.

This list element is used to specify the upper value range limit of a connected sensor linked to assignment B (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-176: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.170 P-0-1311[186], Assignment B: Signal range, min.

This list element is used to specify the lower signal range limit of a connected sensor linked to assignment B (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V or mA
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-177: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.171 P-0-1311[187], Assignment B: Signal range, max.

This list element is used to specify the upper signal range limit of a connected sensor linked to assignment B (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V or mA
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-178: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.172 P-0-1311[188], Assignment C: Value range, min.

This list element is used to specify the lower value range limit of a connected sensor linked to assignment C (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-179: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.173 P-0-1311[189], Assignment C: Value range, max.

This list element is used to specify the upper value range limit of a connected sensor linked to assignment C (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086/S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-180: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.174 P-0-1311[190], Assignment C: Signal range, min.

This list element is used to specify the lower signal range limit of a connected sensor linked to assignment C (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-181: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.175 P-0-1311[191], Assignment C: Signal range, max.

This list element is used to specify the upper signal range limit of a connected sensor linked to assignment C (cf. "P-0-0218, Analog input, control parameter"). This value is only used as an interface for the dialogs related to the technology function.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V or mA
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-182: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.176 P-0-1311[192], Pressure difference for load-dependent feed switching

This list element is used to specify the difference between pressure A (S-0-0803) and pressure B (S-0-0804), at which the load at the cylinder is switched by means of pilot operated check valves and the unloaded cylinder chamber is connected to low pressure. The chamber connected to low pressure then changes to the refilling mode and is not relevant for calculating the cylinder movement.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-183: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.177 P-0-1311[193], Debounce time for load-dependent feed switching

This list element specifies the time for which the load-dependent switching condition has to be fulfilled in order that feed switching takes place.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-184: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.178 P-0-1311[194], Switch-on threshold for decompression

This list element is used to specify the threshold value for the high pressure side of the cylinder, above which decompression and the corresponding valve on the opposite side are to be switched on.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-185: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.179 P-0-1311[195], Switch-off threshold for decompression

This list element is used to specify the threshold value for the high pressure side of the cylinder, below which decompression and the corresponding valve on the opposite side are to be switched off.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-186: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.180 P-0-1311[196], Debounce time for decompression

In conjunction with a **double rod cylinder** this list element is used to specify the time, during which the switch-on condition for decompression has to be fulfilled in order to become effective.

In conjunction with a **single rod cylinder** this list element is used to specify the time, during which the switch-on and switch-off condition for decompression have to be fulfilled in order to become effective.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-187: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.181 P-0-1311[198], Stiffness of mechanical system (for force build-up with electromechanical system)

This list element is used to specify the stiffness of the mechanical system (torsion of a ball screw assembly, elasticity of a belt drive...), which is used in the force controller for determining the change in position required for building up force. The value can be found in the data sheet of the mechanical system used.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	N/m
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-188: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.182 P-0-1311[199], Swivel angle generator: Gain of D-term

This list element specifies the gain of the D-term in the command value path for the swivel angle generator. To obtain the desired filter function of a PT1, value “1” has always to be used. With values <> 1, the filter function differs.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-189: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.183 P-0-1311[200], Swivel angle generator: Time constant of D-term

This list element specifies the filter time constant of the D-term for the swivel angle generator. It is determined by the overload range of the motor. Usually, overloading is possible for 400 ms. This value defines the time constant.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-190: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.184 P-0-1311[201], Swivel angle generator: Time constant of I-term

This list element specifies the integrator time constant for the swivel angle generator.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-191: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.185 P-0-1311[202], Swivel angle generator: Target dynamics to compensate dynamics of swivel angle control

This list element specifies the target dynamics of the swivel angle control.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-192: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.186 P-0-1311[203], Swivel angle generator: Time constant of swivel angle control

This list element specifies the time constant of swivel angle control for the swivel angle generator. Swivel angle control should be set so that there is a time offset of ca. 60 ms between the swivel angle command value and actual value. The real time offset is then to be entered in list element P-0-1311[203].

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-193: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.187 P-0-1311[204], Swivel angle generator: Maximum controller output correction

This element specifies the maximum permissible correction of the controller output by the integrator for the swivel angle generator.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-194: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.188 P-0-1311[205], Swivel angle generator: Delay for integrator activation

This list element specifies the delay for activating the integrator in the swivel angle generator.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-195: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.189 P-0-1311[206], Pressure differential to low pressure when refilling

Opening of the inlet valve of a cylinder chamber (refilling A/B) is recognized when the difference between the chamber pressure (S-0-0803/S-0-0804) and low pressure (S-0-0813 or S-0-0814, respectively) is less than the pressure difference entered in this list element.

- Refilling A, when: Pressure A (S-0-0803) - low pressure (S-0-0813 or S-0-0814) < entered pressure difference (P-0-1311[206])
- Refilling B, when: Pressure B (S-0-0804) - low pressure (S-0-0813 or S-0-0814) < entered pressure difference (P-0-1311[206])

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-196: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.190 P-0-1311[207], Debounce time for refilling

In this list element, the switch-on/switch-off logic for detecting refilling on the A and B-side can be debounced.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-197: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.191 P-0-1311[208], Monitoring of restraint valves: Deactivation

This list element is only effective with PFC EXTENDED.

In this list element, monitoring of the restraint valves can be deactivated by means of value "0.0001" (DINT: 1). With value "0" or "0.0000" monitoring is activated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-198: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.192 P-0-1311[209], Monitoring of restraint valves: Max. time overlap of NO and NC contacts

This list element is only effective with PFC EXTENDED.

This list element specifies the permissible maximum duration of overlap of NO and NC signals. If this time is exceeded, error "D57D4" or "D57D5" is generated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-199: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.193 P-0-1311[210], Monitoring of restraint valves: Max. valve closing time

This list element is only effective with PFC EXTENDED.

This list element specifies the permissible maximum time for closing the restraint valves. If this time is exceeded, error "D57D8" or "D57D9" is generated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-200: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.194 P-0-1311[211], Monitoring of restraint valves: Max. valve opening time

This list element is only effective with PFC EXTENDED.

This list element specifies the permissible maximum time for opening the restraint valves. If this time is exceeded, error "D57D6" or "D57D7" is generated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-201: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.195 P-0-1311[212], Monitoring of restraint valves: Pilot oil pressure for opening safety valves

☞ This list element is only effective with PFC EXTENDED.

This list element is used to specify the threshold value for the pilot oil pressure, at which a controlled restraint valve can be opened. Only then expects the monitoring function that the feedback signals switch accordingly. The reference used for the pilot oil pressure is pressure B (S-0-0804).

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-202: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.196 P-0-1311[213], Monitoring of restraint valves: Permissible time interval between 2 tests (warning)

☞ This list element is only effective with PFC EXTENDED.

This list element is used to specify the time interval within which a closing cycle of the restraint valves has to be carried out. Otherwise, warning "B57D2" or "B57D3" is generated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	h
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-203: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.197 P-0-1311[214], Monitoring of restraint valves: Permissible time interval between 2 tests (error)

☞ This list element is only effective with PFC EXTENDED.

This list element is used to specify the time interval within which a closing cycle of the restraint valves has to be carried out. Otherwise, error "D57DA" or "D57DB" is generated.

The configuration is locked by P-0-1382, "Lock safety configuration" and has to be unlocked before changes can be made.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	h
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-204: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.198 P-0-1311[215], Drift monitoring: Switching time of shut-off valve

☞ This list element is only effective with PFC EXTENDED.

This list element is used to set the “switching time of the shut-off valve”. When the drive is disabled, this time has to elapse before monitoring of the drift rate is started.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-205: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.199 P-0-1311[216], Drift monitoring: Cycle time of monitoring interval

This list element is only effective with PFC EXTENDED.

This list element is used to specify the cycle time of the monitoring interval. After this time has elapsed, the position is monitored for excessive changes. The permissible value results from the specified velocity threshold values.

The longer the entered time interval, the more tolerating becomes the monitoring function in terms of noise on the position signal.

The shorter the specified time interval, the earlier is an impermissible change in position detected.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-206: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.200 P-0-1311[217], Drift monitoring: Warning threshold for lowering speed

This list element is only effective with PFC EXTENDED.

This list element is used to set the warning threshold for drift rate monitoring. If the threshold is exceeded, warning "B57DD" is generated.

Monitoring is independent of the direction of movement.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-207: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.201 P-0-1311[218], Drift monitoring: Alarm threshold for drift rates

This list element is only effective with PFC EXTENDED.

This list element is used to set the alarm threshold for drift rate monitoring. If the threshold is exceeded, error "D57DE" is generated.

Monitoring is independent of the direction of movement.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-208: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.202 P-0-1311[219], Debounce time for recognizing the load side of single-rod cylinders

This list element is used to enter the debounce time, with which the recognition of a pulling or pushing load can be debounced for single-rod cylinders.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-209: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.203 P-0-1311[220], Pressure threshold for recognizing the load side of single-rod cylinders

This list element is used to enter the pressure differential for detecting a pulling or pushing load on the basis of weighted pressures in the cylinder chambers.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	bar
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-210: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.204 P-0-1311[221], Velocity window for recognizing the direction of movement of single-rod cylinders

This list element is used to enter the velocity window for recognizing the direction of movement of a single-rod cylinder to determine whether the axis extends or retracts.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0045
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-211: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.205 P-0-1311[222], Monitoring for summated pressure too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for monitoring of the summated pressure. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4

Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-212: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.206 P-0-1311[223], Monitoring for summated pressure too high: Warning threshold

This list element is used to set the threshold for monitoring of the summated pressure. Warning “B5085” is generated if the value exceeds this threshold. The diagnosis is delayed by the value set in “P-0-1311[222], Monitoring of summated pressure: Debounce time”.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-213: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.207 P-0-1311[224], Monitoring for summated pressure too high: Alarm threshold

This list element is used to set the threshold for monitoring of the summated pressure. Error “D5084” is generated if this threshold is exceeded. The diagnosis is delayed by the value set in “P-0-1311[222], Monitoring of summated pressure: Debounce time”.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-214: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.208 P-0-1311[225], System pressure, signal selection

The signal source for "S-0-0813, System pressure" or the digital signals for monitoring the system pressure are selected in this list element.

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iSystemPressure"
7:	Digital signals in P-0-1392, bits 2-5
8:	Digital signals in the PLC structure "stSystemPressure"

Min./max. value	0/8
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-215: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.209 P-0-1311[226], System pressure, signal range limitation, min.

The minimum value from the PLC variable "iSystemPressure" is configured in this list element. If the value falls below this minimum, warning "B50BA" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-216: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.210 P-0-1311[227], System pressure, signal range limitation, max.

The maximum value from the PLC variable "iSystemPressure" is configured in this list element. If this value is exceeded, warning "B50BA" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-217: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.211 P-0-1311[228], System pressure, value range, min.

This list element is used to specify the lower value range limit of the system pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-218: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.212 P-0-1311[229], System pressure, value range, max.

This list element is used to specify the upper value range limit of the system pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-219: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.213 P-0-1311[230], System pressure, signal range, min.

This list element is used to specify the lower signal range limit of the system pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-220: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.214 P-0-1311[231], System pressure, signal range, max.

This list element is used to specify the upper signal range limit of the system pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[225], System pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-221: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.215 P-0-1311[232], System pressure, filter time

This list element is used to specify the filter time of the system pressure. Filtering is active, if the value "6" has been selected in "P-0-1311[225], System pressure signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-222: Parameter attributes

8.2.216 P-0-1311[233], Monitoring for system pressure too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for overpressure monitoring of the system pressure. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-223: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.217 P-0-1311[234], Monitoring for system pressure too high: Warning threshold

This list element is used to set the threshold for overpressure monitoring of the system pressure. Warning "B50A7" is generated if the value exceeds this threshold. The diagnosis is delayed by the value set in "P-0-1311[233], Monitoring for system pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-224: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.218 P-0-1311[235], Monitoring for system pressure too high: Alarm threshold

This list element is used to set the threshold for overpressure monitoring of the system pressure. Error "D50A6" is generated if this threshold is exceeded. The diagnosis is delayed by the value set in "P-0-1311[233], Monitoring for system pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-225: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.219 P-0-1311[236], Monitoring for system pressure too low: Debounce time

This list element is used to set the minimum duration of the threshold value violation for underpressure monitoring of the system pressure. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-226: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.220 P-0-1311[237], Monitoring for system pressure too low: Warning threshold

This list element is used to set the threshold for underpressure monitoring of the system pressure. Warning "B50AA" is generated if the value falls below this threshold. The diagnosis is delayed by the value set in "P-0-1311[236], Monitoring for system pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-227: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.221 P-0-1311[238], Monitoring for system pressure too low: Alarm threshold

This list element is used to set the threshold for underpressure monitoring of the system pressure. Error "D50A9" is generated if the value falls below this threshold. The diagnosis is delayed by the value set in "P-0-1311[236], Monitoring for system pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-228: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.222 P-0-1311[239], Pilot oil pressure, signal selection

The signal source for "S-0-1288, Pilot oil pressure" or the digital signals for monitoring the system pressure are selected in this list element.

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iControlPressure"
7:	Digital signals in P-0-1392, bits 6-9
8:	Digital signals in der PLC structure "stControlPressure"

Min./max. value	0/8
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-229: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.223 P-0-1311[240], Pilot oil pressure, signal range limitation, min.

The minimum value from the PLC variable "iControlPressure" is configured in this list element. If the value falls below this minimum, warning "B50C0" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[239], Pilot oil pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-230: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.224 P-0-1311[241], Pilot oil pressure, signal range limitation, max.

The maximum value from the PLC variable "iControlPressure" is configured in this list element. If this value is exceeded, warning "B50C0" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[239], Pilot oil pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-231: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.225 P-0-1311[242], Pilot oil pressure, value range, min.

This list element is used to specify the lower value range limit of the pilot oil pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[239], Pilot oil pressure signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-232: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.226 P-0-1311[243], Pilot oil pressure, value range, max.

This list element is used to specify the upper value range limit of the pilot oil pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[239], Pilot oil pressure signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-233: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.227 P-0-1311[244], Pilot oil pressure, signal range, min.

This list element is used to specify the lower signal range limit of the pilot oil pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[239], Pilot oil pressure signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-234: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.228 P-0-1311[245], Pilot oil pressure, signal range, max.

This list element is used to specify the upper signal range limit of the pilot oil pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[239], Pilot oil pressure signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-235: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.229 P-0-1311[246], Pilot oil pressure, filter time

This list element is used to specify the filter time of the pilot oil pressure. Filtering is active, if the value "6" has been selected in "P-0-1311[239], System pressure, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-236: Parameter attributes

8.2.230 P-0-1311[247], Monitoring for pilot pressure too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for overpressure monitoring of the pilot oil pressure. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-237: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.231 P-0-1311[248], Monitoring for pilot pressure too high: Warning threshold

This list element is used to set the threshold for overpressure monitoring of the pilot oil pressure. Warning "B50AD" is generated if the value exceeds this threshold. The diagnosis is delayed by the value set in "P-0-1311[247], Monitoring for pilot oil pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-238: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.232 P-0-1311[249], Monitoring for pilot pressure too high: Alarm threshold

This list element is used to set the threshold for overpressure monitoring of the pilot oil pressure. Error "D50AC" is generated if this threshold is exceeded. The diagnosis is delayed by the value set in "P-0-1311[247], Monitoring for pilot oil pressure too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-239: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.233 P-0-1311[250], Monitoring for pilot oil pressure too low: Debounce time

This list element is used to set the minimum duration of the threshold value violation for underpressure monitoring of the pilot oil pressure. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-240: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.234 P-0-1311[251], Monitoring for pilot oil pressure too low: Warning threshold

This list element is used to set the threshold for underpressure monitoring of the pilot oil pressure. Warning "B50B0" is generated if the pressure falls below this threshold. The diagnosis is delayed by the value set in "P-0-1311[250], Monitoring for pilot oil pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-241: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.235 P-0-1311[252], Monitoring for pilot oil pressure too low: Alarm threshold

This list element is used to set the threshold for underpressure monitoring of the pilot oil pressure. Error "D50AF" is generated if the pressure falls below this threshold. The diagnosis is delayed by the value set in "P-0-1311[250], Monitoring for pilot oil pressure too low: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-242: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.236 P-0-1311[253], Pressure feedback value A, signal selection

This list element is used to select the signal source for "S-0-0803, Pressure feedback value A".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iPressureFeedbackValueA"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-243: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.237 P-0-1311[254], Pressure feedback value A, signal range limitation, min.

The minimum value from the PLC variable "iPressureFeedbackValueA" is configured in this list element. If the value falls below this minimum, warning "B50CA" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-244: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.238 P-0-1311[255], Pressure feedback value A, signal range limitation, max.

The maximum value from the PLC variable "iPressureFeedbackValueA" is configured in this list element. If this value is exceeded, warning "B50CA" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-245: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.239 P-0-1311[256], Pressure feedback value A, value range, min.

This list element is used to specify the lower value range limit of pressure feedback value A. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has selected in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-246: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.240 P-0-1311[257], Pressure feedback value A, value range, max.

This list element is used to specify the upper value range limit of pressure feedback value A. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-247: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.241 P-0-1311[258], Pressure feedback value A, signal range, min.

This list element is used to specify the lower signal range limit of pressure feedback value A. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-248: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.242 P-0-1311[259], Pressure feedback value A, signal range, max.

This list element is used to specify the upper signal range limit of pressure feedback value A. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-249: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.243 P-0-1311[260], Pressure feedback value A, filter time

This list element is used to specify the filter time of pressure feedback value A. Filtering is active, if the value "6" has been selected in "P-0-1311[253], Pressure feedback value A, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-250: Parameter attributes

8.2.244 P-0-1311[261], Pressure feedback value B, signal selection

This list element is used to select the signal source for "S-0-0804, Pressure feedback value B".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iPressureFeedbackValueB"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-251: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.245 P-0-1311[262], Pressure feedback value B, signal range limitation, min.

The minimum value from the PLC variable "iPressureFeedbackValueB" is configured in this list element. If the value falls below this minimum, warning "B50D0" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-252: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.246 P-0-1311[263], Pressure feedback value B, signal range limitation, max.

The maximum value from the PLC variable "iPressureFeedbackValueB" is configured in this list element. If this value is exceeded, warning "B50D0" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-253: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.247 P-0-1311[264], Pressure feedback value B, value range, min.

This list element is used to specify the lower value range limit of pressure feedback value B. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-254: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.248 P-0-1311[265], Pressure feedback value B, value range, max.

This list element is used to specify the upper value range limit of pressure feedback value B. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-255: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.249 P-0-1311[266], Pressure feedback value B, signal range, min.

This list element is used to specify the lower signal range limit of pressure feedback value B. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-256: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.250 P-0-1311[267], Pressure feedback value B, signal range, max.

This list element is used to specify the upper signal range limit of pressure feedback value B. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-257: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.251 P-0-1311[268], Pressure feedback value B, filter time

This list element is used to specify the filter time of pressure feedback value B. Filtering is active, if the value "6" has been selected in "P-0-1311[261], Pressure feedback value B, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-258: Parameter attributes

8.2.252 P-0-1311[269], Pressure feedback value C, signal selection

This list element is used to select the signal source for "P-0-1282, Pressure feedback value C".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iPressureFeedbackValueC"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4

Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-259: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.253 P-0-1311[270], Pressure feedback value C, signal range limitation, min.

The minimum value from the PLC variable "iPressureFeedbackValueC" is configured in this list element. If the value falls below this minimum, warning "B50D6" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-260: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.254 P-0-1311[271], Pressure feedback value C, signal range limitation, max.

The maximum value from the PLC variable "iPressureFeedbackValueC" is configured in this list element. If this value is exceeded, warning "B50D6" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-261: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.255 P-0-1311[272], Pressure feedback value C, value range, min.

This list element is used to specify the lower value range limit of pressure feedback value C. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-262: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.256 P-0-1311[273], Pressure feedback value C, value range, max.

This list element is used to specify the upper value range limit of pressure feedback value C. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-263: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.257 P-0-1311[274], Pressure feedback value C, signal range, min.

This list element is used to specify the lower signal range limit of pressure feedback value C. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-264: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.258 P-0-1311[275], Pressure feedback value C, signal range, max.

This list element is used to specify the upper signal range limit of pressure feedback value C. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-265: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.259 P-0-1311[276], Pressure feedback value C, filter time

This list element is used to specify the filter time of pressure feedback value C. Filtering is active, if the value "6" has been selected in "P-0-1311[261], Pressure feedback value C, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-266: Parameter attributes

8.2.260 P-0-1311[277], Tank pressure, signal selection

This list element is used to select the signal source for "S-0-0814, Tank pressure".

0:	External assignment to the parameter (assignments of the IndraDrive firmware, master communication, ...)
1:	Analog input 1 (P-0-0210)
2:	Analog input 2 (P-0-0211)
3:	Analog input 3 (P-0-0228)
4:	Analog input 1, DA (P-0-0229)
5:	Analog input 2, DA (P-0-0208)
6:	Analog value from PLC variable "iTankPressure"

Min./max. value	0/6
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-267: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.261 P-0-1311[278], Tank pressure, signal range limitation, min.

The minimum value from the PLC variable "iTankPressure" is configured in this list element. If the value falls below this minimum, warning "B50DC" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-268: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.262 P-0-1311[279], Tank pressure, signal range limitation, max.

The maximum value from the PLC variable "iTankPressure" is configured in this list element. If this value is exceeded, warning "B50DC" is generated. This monitoring function is only active, if the value "6" has been configured in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-269: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.263 P-0-1311[280], Tank pressure, value range, min.

This list element is used to specify the lower value range limit of the tank pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-270: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.264 P-0-1311[281], Tank pressure, value range, max.

This list element is used to specify the upper value range limit of the tank pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-271: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.265 P-0-1311[282], Tank pressure, signal range, min.

This list element is used to specify the lower value range limit of the tank pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-272: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.266 P-0-1311[283], Tank pressure, signal range, max.

This list element is used to specify the upper value range limit of the tank pressure. This parameter is used for calculating scaling of the analog input signal in the technology function. Scaling is active, when a value from "1" to "6" has been selected in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	V, mA, -
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-273: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.267 P-0-1311[284], Tank pressure, filter time

This list element is used to specify the filter time of the tank pressure. Filtering is active, if the value "6" has been selected in "P-0-1311[277], Tank pressure, signal selection".

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-274: Parameter attributes

8.2.268 P-0-1311[285], Monitoring for pressure feedback value C too high: Debounce time

This list element is used to set the minimum duration of the threshold value violation for overpressure monitoring in chamber C. A warning or an error is generated after this time.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-275: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.269 P-0-1311[286], Monitoring for pressure feedback value C too high: Warning threshold

This list element is used to set the threshold for overpressure monitoring in chamber C. Warning "B50B3" is generated if the value exceeds this threshold. The diagnosis is delayed by the value set in "P-0-1311[285], Monitoring for pressure feedback value C too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-276: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.270 P-0-1311[287], Monitoring for pressure feedback value C too high: Alarm threshold

This list element is used to set the threshold for overpressure monitoring in chamber C. Error "D50B2" is generated if this threshold is exceeded. The diagnosis is delayed by the value set in "P-0-1311[285], Monitoring for pressure feedback value C too high: Debounce time".

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-277: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.271 P-0-1311[288], Swivel angle generator: Filter time of current motor torque

This list element is used to specify the filter time for the torque/force feedback value (S-0-0084). The filter function is a moving average filter. The filtered value is made available to the swivel angle generator.

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-278: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.272 P-0-1311[289], Swivel angle generator: Reduction factor [0..1] for static torque

This list element specifies the reduction factor for the static torque of the T0 criterion for the swivel angle generator. The reduction factor can be used to adjust the nominal torque and thus allowing the stationary load of the motor/pump group to be influenced.

Min./max. value	0/1
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-279: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.273 P-0-1311[290], Swivel angle generator: Reduction factor [0..1] for peak torque

This list element specifies the reduction factor for the peak torque of the Tmax criterion for the swivel angle generator. The reduction factor can be used to adjust the peak torque, thus allowing the peak load of the motor/pump group to be influenced.

Min./max. value	0/1
Format	DEC_MV
Unit	-
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-280: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.274 P-0-1311[291], Swivel angle generator: Mode selection of swivel angle generation

This list element is used to configure the generation of the active command value for the swivel angle controller by the swivel angle generator. Three modes have to be differentiated:

P-0-1311[291]	Formation of the active command value for the swivel angle controller
0	Command value = min {command value T0 criterion, command value Tmax criterion}
1	Command value = min {command value T0 criterion, command value Tmax criterion, external swivel angle input (S-0-0880)}
2	Command value = external swivel angle command value provision

Tab. 8-281: Swivel angle generator: Mode of active command value generation

Min./max. value	0/2
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-282: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.275 P-0-1311[292], Swivel angle controller: Proportional gain

This list element is used to set the proportional gain for swivel angle control.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	1000/min
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-283: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.276 P-0-1311[293], Swivel angle controller: Valve standard velocity

This list element is used to specify the valve standard velocity. The valve standard velocity represents the maximum actuating velocity of the valve in the case of a command value jump.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	%/s
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-284: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.277 P-0-1311[295], Swivel angle controller: Valve offset

This list element is used to specify the offset for the valve for swivel angle adjustment.

Min./max. value	-100/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-285: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.278 P-0-1311[296], Swivel angle controller: Valve substitute value while function is deactivated

This list element is used to specify the valve substitute value when swivel angle control is deactivated. This allows the pump to be moved to a defined limit stop with the help of the control output when swivel angle control is deactivated.

Min./max. value	-100/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-286: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.279 P-0-1311[297], Swivel angle generator: Factor for pressure differential-related friction losses in the pump

This list element specifies the factor for calculating the pressure differential-related friction losses of the pump for the swivel angle generator. The losses are read as pressure differential (pressure in cylinder chamber A - pressure in cylinder chamber B) multiplied by the factor P-0-1311[297]. The factor is provided within the range of 0..1.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-287: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.280 P-0-1311[300], Valve switching sequence, module 0 (default): Switching time 0

This list element is used to enter the switching time for which the valve status set in "P-0-1311[301], Valve switching sequence, module 0 (default): Valve status 0" is activated. Together they form the sequence pair "0". The switching process to the valve state of the sequence module "default" is configured with a total of up to 15 sequence pairs (0...14). Other sequence pairs for this module are set in the list elements P-0-1311[302] to P-0-1311[329].

☞ The value "-1" closes the sequence.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-288: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.281 P-0-1311[301], Valve switching sequence, module 0 (default): Valve status 0

This list element is used to enter the valve status that is controlled for the duration set in "P-0-1311[300], Valve switching sequence, module 0 (default): Switching time 0". Together they form the sequence pair "0". The switching process to the valve state of the sequence module "default" is configured with a total of up to 15 sequence pairs (0...14). Other sequence pairs for this module are set in the list elements P-0-1311[302] to P-0-1311[329].

☞ The valve status set in the sequence pair that closes the sequence is no longer activated. The valve status previously set is maintained.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-289: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.282 P-0-1311[330], Pulsation compensation: Activation of velocity threshold

Amount of maximum speed, up to which pulsation compensation is enabled.

Min./max. value	0/200
Format	DEC_MV
Unit	rpm
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-290: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.283 P-0-1311[331], Pulsation compensation: Activation of relative force threshold value

Relative force threshold value that the force feedback value S-0-0552 has to exceed in order that pulsation compensation is enabled. The value is a percentage value referred to "P-0-1271, Effective pressure/force command value".

The relative force threshold value is active with P-0-1372 bit 17/16 = 01.

Min./max. value	-100/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-291: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.284 P-0-1311[332], Pulsation compensation: Activation of absolute force threshold value

Absolute force threshold value that the force feedback value S-0-0552 has to exceed in order that pulsation compensation is enabled.

The absolute force threshold value is active with P-0-1372 bit 17/16 = 10.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-292: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.285 P-0-1311[333], Pulsation compensation: Activation of debounce time

Debounce time which must have fallen below the velocity threshold (P-0-1311[330]) and exceeded an activated force threshold (P-0-1311[331] or P-0-1311[332]) in order to enable pulsation compensation.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-293: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.286 P-0-1311[334], Pulsation compensation: Number of pump pistons

Number of pistons of the axial piston pump.

Min./max. value	1/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-294: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.287 P-0-1311[335], Pulsation compensation: Angular displacement of motor to transition region B -> A

Value of "P-0-0111, Actual position value of motor" at the beginning of the first transition region from the B-side of the pump to the A-side of the pump.

Min./max. value	0/360
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-295: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.288 P-0-1311[336], Pulsation compensation: Angular displacement of motor to transition region A -> B

Value of "P-0-0111, Actual position value of motor" at the beginning of the first transition region from the A-side of the pump to the B-side of the pump.

Min./max. value	0/360
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-296: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.289 P-0-1311[337], Pulsation compensation: Angular displacement offset of transition region B -> A

Offset for optimizing "P-0-1311[335], Pulsation compensation: Angular displacement of motor to transition region B -> A".

Min./max. value	-180/180
Format	DEC_MV
Unit	°
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-297: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.290 P-0-1311[338], Pulsation compensation: Angular displacement offset of transition region A -> B

Offset for optimizing "P-0-1311[336], Pulsation compensation: Angular displacement of motor to transition region A -> B".

Min./max. value	-180/180
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-298: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.291 P-0-1311[339], Pulsation compensation: Angle of transition region B -> A

Angle of transition region B → A, at which the pump sides are short-circuited.

Min./max. value	0/(360/P-0-1311[334])
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-299: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.292 P-0-1311[340], Pulsation compensation: Angle of transition region A -> B

Angle of transition region A → B, at which the pump sides are short-circuited.

Min./max. value	0/(360/P-0-1311[334])
Format	DEC_MV
Unit	°
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-300: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.293 P-0-1311[341], Pulsation compensation: Factor of angle of transition region B -> A

Percentage of "P-0-1311[339], Pulsation compensation: Angle of transition region B -> A", at which the compensation speed is to be fed forward.

Min./max. value	0/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-301: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.294 P-0-1311[342], Pulsation compensation: Factor of angle of transition region A -> B

Percentage of "P-0-1311[340], Pulsation compensation: Angle of transition region A -> B", at which the compensation speed is to be fed forward.

Min./max. value	0/100
Format	DEC_MV
Unit	%
Type	Input register

Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-302: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.295 P-0-1311[343], Pulsation compensation: Additive motor speed B -> A

This parameter contains the additive motor speed for compensating pulsation of axial piston pumps. It has an additive effect on the command speed of the motor, if a pump piston is within the transition region from the B-side of the pump to the A-side of the pump.

This parameter is evaluated only, if the value 01 has been set in P-0-1370, bit 29/28.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-303: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.296 P-0-1311[344], Pulsation compensation: Additive motor speed A -> B

This parameter contains the additive motor speed for compensating the pulsation of axial piston pumps. It acts additively on the command speed of the motor, when a pump piston is within the transition region from the A-side of the pump to the B-side of the pump.

This parameter is evaluated only, if the value 01 has been set in P-0-1370, bit 29/28.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-304: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.297 P-0-1311[350], Valve switching sequence, module 1 (rapid mode): Switching time 0

This list element is used to enter the switching time for which the valve status set in "P-0-1311[351], Valve switching sequence, module 1 (rapid mode): Valve status 0" is activated. Together they form the sequence pair "0". The switching process to the valve state of the sequence module "rapid mode" is configured with a total of up to 15 sequence pairs (0...14). Further sequence pairs for this module are set in the list elements P-0-1311[352] to P-0-1311[379].

☞ The value "-1" closes the sequence.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-305: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.298 P-0-1311[351], Valve switching sequence, module 1 (rapid mode): Valve status 0

This list element is used to enter the valve status that is controlled for the duration set in "P-0-1311[350], Valve switching sequence, module 1 (rapid mode): Switching time 0". Together they form the sequence pair "0". The switching process to the valve state of the sequence module "rapid mode" is configured with a total of up to 15 sequence pairs (0...14). Further sequence pairs for this module are set in the list elements P-0-1311[352] to P-0-1311[379].

☞ The valve status set in the sequence pair that closes the sequence is no longer activated. The valve status previously set is maintained.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-

Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-306: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.299 P-0-1311[380], Selection of variable for symbol-based patch function 1

The PLC variable of the technology function, which is to be displayed in symbol-based patch function 1, is selected in this list element. The instance path of the variable is entered in "P-0-0492, Symbol-based patch function 1, data source" and its value is output in "P-0-0493, Symbol-based patch function 1, display". In this way, the value of internal variables can be analyzed in the parameter editor or in the oscilloscope.

If the list element takes the value 0, the symbol-based patch function 1 is not influenced and it may be used for applicative PLC variables, for example.

Min./max. value	0/16
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-307: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.300 P-0-1311[381], Selection of variable for symbol-based patch function 2

The PLC variable of the technology function, which is to be displayed in the symbol-based patch function 2, is selected in this list element. The instance path of the variable is entered in "P-0-0494, Symbol-based patch function 2, data source" and its value is output in "P-0-0495, Symbol-based patch function 2, display". In this way, the value of internal variables can be analyzed in the parameter editor or in the oscilloscope.

If the list element takes the value 0, the symbol-based patch function 2 is not influenced and it may be used for applicative PLC variables, for example.

Min./max. value	0/16
Format	DEC_MV

Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-308: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.301 P-0-1311[382], Selection of variable for symbol-based patch function 3

The PLC variable of the technology function, which is to be displayed in the symbol-based patch function 3, is selected in this list element. The instance path of the variable is entered in "P-0-0496, Symbol-based patch function 3, data source" and its value is output in "P-0-0497, Symbol-based patch function 3, display". In this way, the value of internal variables can be analyzed in the parameter editor or in the oscilloscope.

If the list element takes the value 0, the symbol-based patch function 3 is not influenced and it may be used for applicative PLC variables, for example.

Min./max. value	0/16
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-309: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.302 P-0-1311[383], Selection of variable for symbol-based patch function 4

The PLC variable of the technology function, which is to be displayed in the symbol-based patch function 4, is selected in this list element. The instance path of the variable is entered in "P-0-0498, Symbol-based patch function 4, data source" and its value is output in "P-0-0499, Symbol-based patch function 4, display". In this way, the value of internal variables can be analyzed in the parameter editor or in the oscilloscope.

If the list element takes the value 0, the symbol-based patch function 4 is not influenced and it may be used for applicative PLC variables, for example.

Min./max. value	0/16
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-310: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.303 P-0-1311[384], System pressure increase - debounce time

This list element is used to specify the debounce time, for which the system pressure has to be below the switch-on threshold before a pressure increase is carried out, or for which the system pressure has to be above a switch-off threshold before a pressure increase is switched off.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-311: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.304 P-0-1311[385], System pressure increase - switch-on threshold

This list element is used to specify the switch-on threshold for increasing the system pressure; that is, when the pressure is below the switch-on threshold after the debounce time, the system pressure is increased.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-312: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.305 P-0-1311[386], System pressure increase - switch-off threshold

This list element is used to specify the switch-off threshold for increasing the system pressure; that is, when the pressure is above the switch-off threshold after the debounce time, the system pressure increase is stopped.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-313: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.306 P-0-1311[387], System pressure increase - speed command value

This list element is used to specify the speed command value of a slave drive, which is used to increase the system pressure.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0044 of the slave
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-314: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.307 P-0-1311[388], System pressure increase - acceleration

This list element is used to specify the acceleration of a slave drive, at which the speed of a slave drive is increased when system pressure is being built up. Specifying the acceleration serves to prevent cavitation on the suction side of the pump.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0160 of the slave
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-315: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.308 P-0-1311[389], System pressure increase - deceleration

This list element is used to specify the deceleration of a slave drive, at which the speed of a slave drive is lowered when system pressure is being built up.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0160 of the slave
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-316: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.309 P-0-1311[390], System pressure increase - delay for "drive ready" upon enable

This list element is used to specify the delay time, during which the slave axis has to be in the error-free state "drive ready" in the case of an external enable request or request from PFC. If this is not the case, the error "B507E" is displayed.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	s
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-317: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.310 P-0-1311[401], Valve switching sequence, module 2 (press mode): Valve status 0

This list element is used to enter the valve status that is activated for the duration set in "P-0-1311[400], Valve switching sequence, module 2 (press mode): Switching time 0". Together they form the sequence pair "0". The switching process to the valve state of the sequence module "press mode" is configured with a total of up to 15 sequence pairs (0...14). Further sequence pairs for this module are set in the list elements P-0-1311[402] to P-0-1311[429].

☞ The valve status set in the sequence pair that closes the sequence is no longer activated. The valve status previously set is maintained.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-318: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.311 P-0-1311[430], Holding function: Force accuracy window

This list element is used to specify the force accuracy window ($F_{Accuracy}$) for the holding function, within which automatic isolation is carried out.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-319: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.312 P-0-1311[431], Holding function: Force hysteresis

This list element is used to specify the force hysteresis (F_{Hyst}) for the holding function, at which the holding function is resumed in the automatic mode. The resumption threshold is calculated from F_{cmd}±($F_{Accuracy}$+F_{Hyst}).

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-320: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.313 P-0-1311[432], Holding function: Torque threshold

This list element is used to specify the torque threshold for the holding function, at which automatic isolation is carried out.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-321: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.314 P-0-1311[433], Debounce time for detecting isolation

This list element is used to set the debounce time for the isolation condition.

Min./max. value	0/2147483647
Format	DEC_MV

Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-322: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.315 P-0-1311[434], Closing time of shut-off valve

This list element is used to set the closing time of the shut-off valve(s) used for the holding function. The closing time to be entered is the time until a functional isolation of the hydraulically loaded chamber is ensured.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-323: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.316 P-0-1311[435], Delay time

This list element is used to set a delay time after ramping up the torque when the holding function is resumed.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-324: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.317 P-0-1311[436], Opening time of shut-off valve

This list element is used to set the opening time of the shut-off valve(s) used for the holding function. The opening time to be entered is the time until a functional connection to the hydraulically loaded chamber is established.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-325: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.318 P-0-1311[437], Descending torque slope

This list element is used to enter the slope for the torque for load reduction when isolating in the holding function.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086/s
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-326: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.319 P-0-1311[438], Ascending torque slope

This list element is used to enter the slope for the torque for load increase when resuming in the holding function.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086/s
Type	Input register
Editable	++
Decimal places	4

Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-327: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.320 P-0-1311[439], Holding function: Filter time for determining actual torque value

This list element is used to specify the filter time for a PT1 filter for filtering the "S-0-0084, Torque/force feedback value" in the holding function.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	10 ms
Refresh time	~50 ms

Tab. 8-328: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.321 P-0-1311[440], Holding function: Gain (Kp) of torque controller

This list element is used to specify the gain (Kp) for the torque controller of the holding function.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	rps
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	rps
Refresh time	~50 ms

Tab. 8-329: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.322 P-0-1311[441], Holding function: Position control window for isolating

This list element is used to specify the position accuracy window ($x_{Accuracy}$) for the holding function, in which automatic isolation is carried out.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-330: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.323 P-0-1311[442], Holding function: Position hysteresis for unlocking

This list element is used to specify the position hysteresis (x_{Hyst}) for the holding function, at which the holding function is resumed in the automatic mode. The resumption threshold is calculated from x_{cmd}±($x_{Accuracy}$+x_{Hyst}).

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-331: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.324 P-0-1312, Diagnostic logbook TF

The list elements of this parameter are used to output log data for diagnostic purposes. The individual elements are described below.

☞ The individual data are output in various units. The respective attributes are specified with the corresponding list element.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	-
Type	Output register
Editable	++
Decimal places	0

Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-332: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.325 P-0-1312[100], Filter ok time stamp

This list elements outputs the time stamp, when the state "filter ok" occurred last.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-333: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.326 P-0-1312[101], Filter warning time stamp

This list elements outputs the time stamp, when the state "filter warning" occurred last.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-334: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.327 P-0-1312[102], Filter alarm time stamp

This list elements outputs the time stamp, when the state "filter alarm" occurred last.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-335: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.328 P-0-1312[103], Filter ok operating time

This list element indicates the period of time, in which the state "filter ok" was active altogether.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-336: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.329 P-0-1312[104], Filter warning operating time

This list element indicates the period of time, in which the state "filter warning" was active altogether.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-337: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.330 P-0-1312[105], Filter alarm operating time

This list element indicates the period of time, in which the state "filter alarm" was active altogether.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	sec
Type	Output register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-338: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.331 P-0-1312[702], Activation of field data acquisition

P-0-1311[702] is used for activating and deactivating field data acquisition.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	-
Type	Input register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-339: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.332 P-0-1316, Acceleration controller smoothing time constant

The output of the acceleration controller is filtered using P-0-1316.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-340: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.333 P-0-1326, PLC Global Register G26

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.334 P-0-1327, PLC Global Register G27

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.335 P-0-1328, PLC Global Register G28

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.336 P-0-1329, PLC Global Register G29

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.337 P-0-1330, PLC Global Register G30

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.338 P-0-1331, PLC Global Register G31

See P-0-1326.

See chapter 8.1 "Relevant parameters" on page 261.

8.2.339 P-0-1370, Axis structure configuration

P-0-1370, Axis structure configuration

P-0-1370 is used to configure the PFC system function.

Structure of P-0-1370 and significance of the bits:

Bit	Designation/function	Comment
0	**Holding function, activation** 0: Deactivated 1: Activated	As of PFC03V04
1	**Holding function, configuration: Restarting behavior**, only relevant for activation (bit 0 = 1) 0: Reactivation without automatic movement 1: Reactivation with automatic movement, coordinated via Feedrate Override (S-0-0108)	As of PFC03V04

Bit	Designation/function	Comment
4-2	**Cylinder type** **000:** Not defined **001:** Single rod cylinder **010:** Double rod cylinder **101:** Single rod cylinder with area switching **110:** Double rod cylinder with area switching	Can be changed in PM
6/5	**Swivel angle control, configuration**, relevant only in case of variable displacement (bit 12/11 = 11) **00:** External swivel angle control activated, "P-0-1275, Effective displacement" can be cyclically written for calculating the advance **01:** PFC-internal closed-loop swivel angle control activated, "P-0-1275, Effective displaced volume"	Can be changed in PM
7	**Direction of motion of cylinder** **0:** Implemented by the pump (4-quadrant pump) **1:** Implemented by means of valves (2-quadrant pump) **Reserved**	Can be changed in PM
9/8	**Valve control, direction input** (bit 7 = 1) **00:** External via switching control word P-0-1283 (switching retracting/extending) **01:** Automatic valve control **10:** External via switching control word P-0-1283 (switching retracting/extending) with automatic validation	Can be changed in PM
10	**Direction of displacement of pump** with pos. motor speed (P-0-0112 > 0) **0:** Pressure build-up in cylinder chamber A **1:** Pressure build-up in cylinder chamber B	Can be changed in PM
12/11	**Pump type** **00:** Fixed displacement **10:** Two-point control (for rapid mode/press mode switching) **11:** Variable displacement (externally controlled)	Can be changed in PM
14/13	**Pump displacement control** (digital with two-point; analog with continuously variable) **00:** External via switching control word P-0-1283 (rapid mode/press mode switching) or via effective displacement P-0-1275 (profile) **01:** Automatic **10:** External via P-0-1283 or P-0-1275 with automatic validation	Can be changed in PM

Bit	Designation/function	Comment
15	**Process control variable** **0:** Pressure **1:** Force	Can be changed in PM
17/16	**System pressure increase, activation** **00:** Deactivated **01:** External provision of system pressure (S-0-0813) **10:** Provision of system pressure via secondary axis **11:** Reserved	As of PFC03V04 Can be changed in PM
18	**System pressure, configuration: Enable**, relevant only for provision via secondary axis (bit 17/16 = 10) **0:** Automatic enable of secondary axis in OM **1:** External enable via control word P-0-1283 bit 12	As of PFC03V04 Can be changed in PM
21-19	**Configuration of parameter set selection** **000:** No set switching **001:** Set switching via control word (P-0-1283.10...8) **010:** Set switching linked to rapid mode/press mode (set 1 & 2 only)	Can be changed if drive enable has not been set
24-22	**Source for actual acceleration value** **000:** None **001:** Acceleration sensor (P-0-1277) **010:** Differentiated from position feedback value (d^2 S-0-0386/dt^2) **011:** From force feedback value (S-0-0552, see bits 18-16) with acceleration observer **100:** From force feedback value (S-0-0552, see bits 18-16) with moving mass and DT1 model	Can be changed if drive enable has not been set
25	**Hydraulic circuit** **0:** Firmly configured hydraulic circuit depending on cylinder type and directional valve (default) **1:** Freely configurable hydraulic circuit; not released in standard setting, not documented	Can be changed in PM
26	**Valve/switching sequence** **0:** Internally preset (default) **1:** User-defined setting via P-0-1311 (starting from element #300)	Can be changed in PM

Bit	Designation/function	Comment
27	**Manual valve setting-up mode** **0:** Off; valves are switched according to configuration **1:** Valve control word (P-0-1410/P-0-1411) is not written and can be manually controlled via P-0-1390/P-0-1391	Can be changed in PM
29/28	**Pulsation compensation, activation** **00:** Deactivated **01:** Activated, with fixed input of compensation speed **10:** Activated, with cyclic input of compensation speed	Can be changed in PM
30	**Reserved**	
31	**Open PFC position/force control loop** **0:** PFC position/force loop closed **1:** PFC position/force loop closed	Can be changed in PM

Tab. 8-341: Structure of P-0-1370 and significance of the bits

Min./max. value	-/-
Format	BIN
Unit	-
Type	Input register
Editable	PM/not_AF
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-342: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.340 P-0-1371, Minimum pump displacement

This parameter specifies the smaller displacement of a pump with variable displacement. The effective value is displayed in "P-0-1275, Effective displacement".

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	cm^3
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓

Default value	-
Refresh time	~50 ms

Tab. 8-343: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.341 P-0-1372, Configuration, axis controllers/functions

P-0-1372 is used to set the operation modes of the controllers and various functions.

Structure of P-0-1372 and significance of the bits:

Bit	Designation/function	Comment
1-0	Reserved	
2	Activate decompression with pulling load 0: Decompression function deactivated 1: Decompression function activated	Always editable
3	Activate decompression with pushing load 0: Decompression function deactivated 1: Decompression function activated	Always editable Always deactivated with electromechanical system (simple actuator)
4	Velocity control command value path 0: Active 1: Not active, negative feedback value addition only	Always editable
5	Acceleration control command value path 0: Active 1: Not active, negative feedback value addition only	Always editable
6	Command values for rapid mode/press mode automatism 0: Only velocity command value taken into account for switching automatism 1: Velocity command value and pressure/force command value (P-0-1371) taken into account for switching automatism	Always editable
8/7	Advance switching, actuator (P-0-1370 bit 4 = 1) 00: External via switching control word (P-0-1283) 01: Automatic 10: External via switching control word (P-0-1283) with automatic check	Always editable

Bit	Designation/function	Comment
10/9	**Selection of active areas of a single rod cylinder** **00:** PFC02V02 behavior; active area is selected according to the controller output (position/force) **01:** Active area is selected depending on the load (chamber pressures) **10:** Active area is selected depending on the load (chamber pressures), the differential area is selected via control word P-0-1283, bit 4...7. **11:** The active area is selected exclusively via control word P-0-1283, bit 4...7	Always editable
11	**Holding function, configuration: Mode**, only relevant for activation (P-0-1370, bit 0 = 1) **0:** Automatic recognition of isolation/reactivation **1:** Manual commanding of isolation/reactivation via control word P-0-1283, bit 13	As of PFC03V04 Always editable
12	**Change back lock** of alternating control **0:** Not active **1:** Active; no change back from pressure/force control to position control	Always editable
13	**Enable condition for pressure/force control** of alternating control **0:** Relative pressure/force window around the command value (P-0-1311 [124]) **1:** Absolute pressure/force threshold (P-0-1311 [123])	Always editable
14	**Switching in pos. travel direction** of alternating control **0:** Not enabled **1:** Enabled	Always editable
15	**Switching in neg. travel direction** of alternating control **0:** Not enabled **1:** Enabled	Always editable
18-16	**Pulsation compensation, configuration** consideration of actual force value **00:** No consideration of the actual force value **01:** Use of the relative force threshold **10:** Use of the absolute force threshold **11:** Reserved	Always editable
19	**Monitoring for summated pressure too high, deactivation** **0:** Activated **1:** Deactivated	Always editable

Bit	Designation/function	Comment
20	Filter monitoring, configuration: Warning signal (75 %) 0: Normally open 1: Normally closed	Always editable
21	Filter monitoring, configuration: Alarm signal (100 %) 0: Normally open 1: Normally closed	Always editable
22	Filter monitoring, deactivation 0: Active 1: Not active	Always editable
23	Monitoring for oil temperature too high, deactivation 0: Activated 1: Deactivated	Always editable
24	Encoder jump monitoring: Deactivation with tolerance cycles 0: Activated 1: Deactivated	Always editable
25	Monitoring for accumulator pressure too high or too low, deactivation 0: Activated 1: Deactivated	Always editable
27/26	Lag error monitoring, activation 00: Not active 01: Model comparison 10: Velocity-dependent threshold value	Always editable
28	Monitoring for process pressure too high, deactivation (pressure A, pressure B) 0: Activated 1: Deactivated	Always editable
29	Monitoring of lowering speed, deactivation 0: Activated 1: Deactivated	Always editable
30	Field data acquisition, deactivation 0: Activated 1: Deactivated	Always editable
31	Monitoring of operating points of an A10 pump, deactivation 0: Activated 1: Deactivated	As of PFC03V04 Always editable

Tab. 8-344: Structure of P-0-1372 and significance of the bits

Min./max. value	-/-
Format	BIN
Unit	-
Type	Input register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-345: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.342 P-0-1373, Pressure/force controller, proportional gain

P-0-1373 is used to set the proportional gain of the process variable lag error.

Min./max. value	0 / 2147483647
Format	DEC_MV
Unit	rps
Type	Input register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-346: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.343 P-0-1374, Pressure/force loop integral action time

P-0-1374 is used to set the integral time for the lag error of the process variable. The variable to be integrated already contains the amplification of the proportional gain (P-0-1373).

Min./max. value	0 / 2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-347: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.344 P-0-1375, Pressure/force controller, Kd-factor

P-0-1375 is used to set the gain of the differentiated process variable lag error.

Min./max. value	0 / 2147483647
Format	DEC_MV
Unit	mm/N; mm/Nm; mm/bar
Type	Input register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-348: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.345 P-0-1376, Cylinder volume in force control

P-0-1376 is used to input the volume of the oil that is typically contained in the cylinder in the pressing cycles. It is taken into account for the gain factors of the force controller.

Min./max. value	0.001/2147483647
Format	DEC_MV
Unit	cm^3
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-349: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.346 P-0-1377, Moving mass

P-0-1377 is used to specify the moving mass on the actuator side (cylinder piston and tool) for forming the actual acceleration value.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	kg
Type	Input register
Editable	++

Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-350: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.347 P-0-1378, Gain factor for pressure/force controller velocity feedforward

It is possible to activate a velocity addition by writing a constant or writing dynamically to the parameter. P-0-1378 is used to set a factor with which the current actual velocity is weighted and added to the controller output of the pressure/force controller.

This functionality is used, for example, if an axis is moved but is not allowed to exceed a specific force limitation value. The dynamic velocity addition relieves the I-term of the force controller and increases the control quality. If the velocity feedforward is not active in this situation, the actual force value overshoots the command value, since the I-term has to be reduced. When the function is active, the force feedback value does not overshoot and the I-term only compensates small differences.

Min./max. value	0/1
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	4
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-351: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.348 P-0-1379, Acceleration controller load, Kp

P-0-1379 is used to set the proportional gain of the acceleration path in the optional state controller.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓

Default value	-
Refresh time	20 ms

Tab. 8-352: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.349 P-0-1380, Velocity controller load, Kp

P-0-1380 is used to set the proportional gain of the velocity path in the optional state controller.

Min./max. value	-2147483647/2147483647
Format	DEC_MV
Unit	-
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-353: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.350 P-0-1381, TechFunc identifier

The loaded and started technology function identifies via P-0-1381 so that, for example, IndraWorks recognizes the correct version and displays the appropriate dialogs.

Min./max. value	00000000 / FFFFFFFF
Format	HEX
Unit	-
Type	Output register
Editable	--
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-354: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.351 P-0-1382, Locking of safety configuration

The parameters for deactivating and configuring safety functions (e.g. monitoring of the restraint valves) can be protected by this lock parameter against unintentional changes (e.g. when loading a parameter file).

The lock parameter is locked by default and has to be unlocked by entering the value "23". This is acknowledged by setting the lock parameter to the value "4711". When the parameter is unlocked, it can be re-locked by entering the value "42". This is acknowledged by setting the lock parameter to the value "815".

See also chapter 6.20.10 "Monitoring of restraint valves" on page 94

Initial state →	Input →	Acknowledgement/target state
815: locked	23: unlock	4711: unlocked
4711: unlocked	42: lock	815: locked

Tab. 8-355: Procedure for unlocking and locking the safety configuration via P-0-1382

Configurations affected by the lock:

- P-0-1311[208], Monitoring of restraint valves: Deactivation
- P-0-1311[209], Monitoring of restraint valves: Max. time overlap of NO and NC contacts
- P-0-1311[210], Monitoring of restraint valves: Max. valve closing time
- P-0-1311[211], Monitoring of restraint valves: Max. valve opening time
- P-0-1311[212], Monitoring of restraint valves: Pilot oil pressure for opening safety valves
- P-0-1311[213], Monitoring of restraint valves: Permissible time interval between 2 tests (warning)
- P-0-1311[214], Monitoring of restraint valves: Permissible time interval between 2 tests (error)

Min./max. value	0 / 2147483647
Format	DEC_OV
Unit	-
Type	Input/output register
Editable	OM
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	200 ms

Tab. 8-356: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.352 P-0-1383, Monitoring configuration

Monitoring and the characteristics of associated digital signals are configured via P-0-1383.

Structure of P-0-1383 and significance of the bits

Bit	Designation/function	Comment
0	Monitoring for system pressure too high, deactivation 0: Active 1: Inactive	Always editable

1	Monitoring for system pressure too low, deactivation 0: Active, when drive in AF 1: Inactive	Always editable
2	Monitoring for system pressure too high, warning signal 0: Normally open 1: Normally closed	Always editable
3	Monitoring for system pressure too high, alarm signal 0: Normally open 1: Normally closed	Always editable
4	Monitoring for system pressure too low, warning signal 0: Normally open 1: Normally closed	Always editable
5	Monitoring for system pressure too low, alarm signal 0: Normally open 1: Normally closed	Always editable
6	Monitoring for pilot pressure too high, deactivation 0: Active 1: Inactive	Always editable
7	Monitoring for pilot oil pressure too low, deactivation 0: Active, when drive in AF 1: Inactive	Always editable
8	Monitoring for pilot oil pressure too high, warning signal 0: Normally open 1: Normally closed	Always editable
9	Monitoring for pilot oil pressure too high, alarm signal 0: Normally open 1: Normally closed	Always editable
10	Monitoring for pilot oil pressure too low, warning signal 0: Normally open 1: Normally closed	Always editable
11	Monitoring for pilot oil pressure too low, alarm signal 0: Normally open 1: Normally closed	Always editable
12	Reserved	Always editable
13	Monitoring for oil temperature too low, deactivation 0: Active, when drive in AF 1: Inactive	Always editable
14	Monitoring for oil temperature too high, warning signal 0: Normally open 1: Normally closed	Always editable

15	**Monitoring for oil temperature too high, alarm signal** 0: Normally open 1: Normally closed	Always editable
16	**Monitoring for oil temperature too low, warning signal** 0: Normally open 1: Normally closed	Always editable
17	**Monitoring for oil temperature too low, alarm signal** 0: Normally open 1: Normally closed	Always editable
31-18	**Reserved**	Always editable

Tab. 8-357: Structure of P-0-1383 and significance of the bits

Min./max. value	-/-
Format	BIN
Unit	-
Type	Input register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-358: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.353 P-0-1384, Acceleration feedforward

P-0-1384 is used to set the acceleration feedforward in parallel with position control. The interpolated command acceleration is weighted with the acceleration feedforward. This reduces the lag error during the acceleration phase.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	-
Refresh time	200 ms

Tab. 8-359: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.354 P-0-1385, Velocity controller smoothing time constant

The output of the velocity controller is filtered using P-0-1385. In addition, the input signals of command and actual velocity are filtered with this time constant for the switching logic, if the switching I-term in the position controller is used.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	ms
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-360: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.355 P-0-1387, TF diagnostic text

P-0-1387 displays the text of a diagnostic message, if present. See also description of diagnostic messages.

Min./max. value	-/-
Format	STRING
Unit	-
Type	Output register
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-361: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.356 P-0-1390, Input valve switching word 1

PLC input (%IW0)

In the manual valve control mode (P-0-1370 bit 27), the valves can be directly controlled via P-0-1390 and P-0-1391.

Bit	Designation/function	Comment
0	Enabling chamber A	
1	Enabling chamber B	
2	Rapid mode, cylinder	

3	**Press mode**, cylinder	
15-4	**Reserved**	

Tab. 8-362: Bit assignment P-0-1390, Input valve switching word 1

⚠ WARNING

As soon as the manual valve mode is used, the technology function can in no way intervene in the control of any valves. Inadvertent operation under drive enable can cause high pressures and might damage hydraulic components.

Use manual valve control with extreme caution and, if possible, without drive enable.

Only use manual valve control for commissioning purposes. Do not use manual valve control during operation. After the wiring has been checked, the manual valve switching mode has to be deactivated.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-363: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.357 P-0-1391, Input valve switching word 2

PLC input (%IW2)

In the manual valve control mode (P-0-1370 bit 27), the valves can be directly controlled via P-0-1390 and P-0-1391.

Bit	Designation/function	Comment
0	**Extending** cylinder	
1	**Retracting** cylinder	
2	**Rapid mode**, pump	
3	**Press mode**, pump	
15-4	**Reserved**	

Tab. 8-364: Bit assignment P-0-1391, Input valve switching word 2

⚠ WARNING

As soon as the manual valve mode is used, the technology function can in no way intervene in the control of any valves. Inadvertent operation under drive enable can cause high pressures and might damage hydraulic components.

Use manual valve control with extreme caution and, if possible, without drive enable.

☞ Only use manual valve control for commissioning purposes. Do not use manual valve control during operation. After the wiring has been checked, the manual valve switching mode has to be deactivated.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-365: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.358 P-0-1392, Input word for digital signals

PLC input (%IW4)

This PLC input can be used to receive digital signals of various monitoring functions.

Bit	Designation/function	Comment
0	Filter clogging ≥ 75 %	
1	Filter clogging ≥ 100 %	
2	Monitoring for system pressure too high, warning signal	
3	Monitoring for system pressure too high, alarm signal	
4	Monitoring for system pressure too low, warning signal	
5	Monitoring for system pressure too low, alarm signal	
6	Monitoring for pilot oil pressure too high, warning signal	

7	Monitoring for pilot oil pressure too high, alarm signal	
8	Monitoring for pilot oil pressure too low, warning signal	
9	Monitoring for pilot oil pressure too low, alarm signal	
10	Monitoring for oil temperature too high, warning signal	
11	Monitoring for oil temperature too high, alarm signal	
12	Monitoring for oil temperature too low, warning signal	
13	Monitoring for oil temperature too low, alarm signal	
15/14	Unassigned	

Tab. 8-366: Bit assignment P-0-1392, Input word for digital signals

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-367: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.359 P-0-1393, Valve feedback status word

PLC input (%IW6)

This PLC input can be used to receive digital signals of restraint valves.

Bit	Designation/function	Comment
0	Valve 1 NC	
1	Valve 1 NO	
2	Valve 2 NC	
3	Valve 2 NO	
15-4	Reserved	

Tab. 8-368: Bit assignment P-0-1392, Input word for digital signals

Min./max. value	-/-
Format	DEC_MV

Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	2 ms

Tab. 8-369: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.360 P-0-1404, PLC input WORD14 (%IB28)

P-0-1404 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-370: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.361 P-0-1405, PLC input WORD15 (%IB30)

P-0-1405 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-371: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.362 P-0-1406, PLC input WORD16 (%IB32)

P-0-1406 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-372: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.363 P-0-1407, PLC input WORD17 (%IB34)

P-0-1407 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-373: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.364 P-0-1408, PLC input WORD18 (%IB36)

P-0-1408 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-

Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-374: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.365 P-0-1409, PLC input WORD19 (%IB38)

P-0-1409 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-375: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.366 P-0-1410, Valve switching word 1

PLC output (%QW0)

P-0-1410 and P-0-1411 are used to set the bits for controlling the appropriate valves from the technology function. This interface is intended for direct assignment to digital outputs.

In the case of a PLC runtime error, the content of the parameter is set to zero.

Bit	Designation/function	Comment
0	Enabling chamber A	
1	Enabling chamber B	
2	Rapid mode, cylinder	
3	Press mode, cylinder	
15-4	Reserved	

Tab. 8-376: Bit assignment P-0-1410, Valve switching word 1

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-377: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.367 P-0-1411, Valve switching word 2

PLC output (%QW2)

P-0-1410 and P-0-1411 are used to set the bits for controlling the appropriate valves from the technology function. This interface is intended for direct assignment to digital outputs.

In the case of a PLC runtime error, the content of the parameter is set to zero.

Bit	Designation/function	Comment
0	**Extending** cylinder	
1	**Retracting** cylinder	
2	**Rapid mode**, pump	
3	**Press mode**, pump	
4	**Decompression** on B-side of pump	As of PFC02V06.
5	**Decompression** on A-side of pump	As of PFC02V08
6-15	**Reserved**	

Tab. 8-378: Bit assignment P-0-1411, Valve switching word 2

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-379: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.368 P-0-1412, Activation of special functions

PLC output (%QW4)

P-0-1412 is used to set the bits for controlling special functions from the technology function. This interface is intended for direct assignment to digital outputs.

In the case of a PLC runtime error, the content of the parameter is set to zero.

Bit	Designation/function	Comment
0	LED activation: Red	
1	LED activation: Green	
2	LED activation: Blue	
3-15	Reserved	

Tab. 8-380: Bit assignment P-0-1412, Activation of special functions

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	200 ms

Tab. 8-381: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.369 P-0-1413, Feedback of digital input signals

PLC output (%QW4)

The current state of digital signals for various monitoring functions is displayed in this PLC output. The current state is generated from "P-0-1392, Input word for digital signals" or from the associated PLC structures according to the signal selection of the relevant variable when monitoring is activated.

Bit	Designation/function	Comment
0	Filter clogging ≥ 75 %	
1	Filter clogging ≥ 100 %	
2	Monitoring for system pressure too high, warning signal	
3	Monitoring for system pressure too high, alarm signal	
4	Monitoring for system pressure too low, warning signal	

5	Monitoring for system pressure too low, alarm signal	
6	Monitoring for pilot oil pressure too high, warning signal	
7	Monitoring for pilot oil pressure too high, alarm signal	
8	Monitoring for pilot oil pressure too low, warning signal	
9	Monitoring for pilot oil pressure too low, alarm signal	
10	Monitoring for oil temperature too high, warning signal	
11	Monitoring for oil temperature too high, alarm signal	
12	Monitoring for oil temperature too low, warning signal	
13	Monitoring for oil temperature too low, alarm signal	
15/14	Unassigned	

Tab. 8-382: Bit assignment P-0-1413, Input word for digital signals

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-383: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.370 P-0-1424, PLC output WORD 14 (%QB28)

P-0-1424 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--

Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-384: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.371 P-0-1425, PLC output WORD 15 (%QB30)

P-0-1425 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-385: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.372 P-0-1426, PLC output WORD 16 (%QB32)

P-0-1426 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-386: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.373 P-0-1427, PLC output WORD 17 (%QB34)

P-0-1427 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-387: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.374 P-0-1428, PLC output WORD 18 (%QB36)

P-0-1428 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output
Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-388: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.375 P-0-1429, PLC output WORD 19 (%QB38)

P-0-1429 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC output

Editable	--
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-389: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.376 P-0-1440, PLC input DWORD 25 (%IB100)

P-0-1440 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-390: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.377 P-0-1441, PLC input DWORD 26 (%IB104)

P-0-1441 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-391: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.378 P-0-1442, PLC input DWORD 27 (%IB108)

P-0-1442 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-392: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.379 P-0-1443, PLC input DWORD 28 (%IB112)

P-0-1443 is reserved for user applications. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-393: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.380 P-0-1444, PLC input DWORD 29 (%IB116)

P-0-1444 is reserved for applications of the user. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input

Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-394: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.381 P-0-1445, PLC input DWORD 30 (%IB120)

P-0-1445 is reserved for user applications. It can be used as an interface for the input of information for an additional MLD program part. Its format and its decimal places cannot be set.

Min./max. value	-/-
Format	DEC_MV
Unit	-
Type	PLC input
Editable	++
Decimal places	0
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-395: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.382 P-0-2831.0.1, Output position controller Kv-part

Function The parameter displays the interim value (Kv component) of the position controller. The value is calculated from the current "S–0–0189, Following distance" and "S–0–0104, Position loop Kv-factor".

Use The parameter can be used to separately view the respective component of the control signal or the position controller output "P–0–2831.0.4".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-396: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.383 P-0-2831.0.3, Output position controller I-part

Function The parameter displays the interim value (I component) of the position controller.

Use The parameter can be used to separately view the respective component of the control signal or the position controller output "P–0–2831.0.4".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-397: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.384 P-0-2831.0.4, Output of position controller

Function This parameter displays the output value of the complete position controller.

Use The output of the position controller results from the sum of

- Output position controller Kv-part "P–0–2831.0.1"
- Output position controller I-part "P–0–2831.0.3"
- Correction value: velocity feedforward control "P–0–2831.0.5"
- The correction value of acceleration feedforward (no parameter)
- The correction value of velocity feedback (no parameter)
- The correction value of acceleration feedback (no parameter)

The output of the position controller is, at the same time, the input variable of alternating control.

Use

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-398: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.385 P-0-2831.0.5, Correction value: velocity feedforward control

Function The parameter displays the interim value of the velocity feedforward control of the position controller.

Use The parameter can be used to separately view the respective component of the control signal or the position controller output "P–0–2831.0.4".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-399: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.386 P-0-2842, Force control deviation

Function The force control deviation indicates the current control quality and thus the difference between P-0-1271 (Effective pressure/force command value) and S-0-0552 (Torque/force feedback value 2).

Use The control quality can be checked with the help of this parameter: This means, how precise is controlling or how fast is a disturbance corrected.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Type	Output register
Editable	--
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-400: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.387 P-0-2843, Output of force controller

Function The output of the force controller is the sum of the force controller terms. The terms of force control are: P-term P-0-2846.0.1, I-part P-0-2846.0.2 and feed-forward part (no parameter).

Use The output of the force controller is used in alternating control. On the basis of various switching criteria, checks are carried out to determine whether the output of the position controller or the force controller is to be passed on to the controlled system adjustment.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-401: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.388 P-0-2844, Velocity feedforward

Function It is possible to activate a velocity addition by writing a constant or writing dynamically to the parameter.

Use This functionality is used, for example, when an axis is moved but must not exceed a certain force limit value. The dynamic velocity addition relieves the I-term of the force controller and increases the control quality. If the velocity feedforward is not active in this situation, the actual force value overshoots the command value, since the I-term has to be reduced. When the function is active, the force feedback value does not overshoot and the I-term only compensates small differences.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Input register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-402: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.389 P-0-2845.0.8, Force controller velocity feedforward weighting

Function The portion of velocity feedforward of the force controller is determined by multiplying this parameter by the velocity feedforward of the force controller, P-0-2844.

Use This is applied for drives that are displaced at a measurable, impressed velocity. Here, the measured velocity value is cyclically assigned to the force controller velocity feedforward P-0-2844. The resulting velocity feedforward is added to the force controller output.

Min./max. value	-/-
Format	DEC_MV
Unit	%
Type	Input register
Editable	--
Decimal places	2
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-403: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.390 P-0-2846.0.1, Output force controller P-part

Function The force controller P-term is the product of force controller P-gain P-0-1373 and force control deviation P-0-2842.

Use The force controller P-term is part of the force controller output and is required for force control.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	20 ms

Tab. 8-404: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.391 P-0-2846.0.2, Output force controller I-part

Function The interim value (I component) of the force controller is in this parameter.

Use The parameter can be used to separately view the respective component of the control signal or the force controller output "P–0–2843".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–

Default value	-
Refresh time	20 ms

Tab. 8-405: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.392 P-0-2846.0.3, Term of force controller velocity feedforward

Function Velocity feedforward can be activated by writing a constant or dynamically to P-02844. Alternatively, the own actual velocity value can be added as feed-forward via P-0-1276.

Use This functionality is used, for example, when an axis is moved but must not exceed a certain force limit value. The dynamic velocity addition relieves the I-term of the force controller and increases the control quality. If the velocity feedforward is not active in this situation, the actual force value oscillates above the command value, since the I-term has to be reduced. If the function is active, the force feedback value does not overshoot and the I-term only compensates small differences.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0044
Type	Output register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	2 ms

Tab. 8-406: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.393 P-0-2853, Alternating control, control word 1

This parameter contains control word 1 for alternating control.

Bit	Designation/function	Comment
0	**Enable alternating control** 0: Do not enable 1: Enable	
2,1	Not used	No intervention possible in the interpolator of the IndraDrive firmware
4,3	Not used	No intervention possible in the interpolator of the IndraDrive firmware

Tab. 8-407: Bit assignment, P-0-2853, Alternating control, control word 1

Min./max. value	-/-
Format	BIN

Unit	-
Type	Input parameter
Editable	++
Decimal places	-
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-408: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.394 P-0-2855, Alternating control, status word

Function

This parameter contains the status word of the changeover logic.

See also Functional Description "Alternating control"

Structure

Bit	Designation/function	Comment
0	Force controller active 0: Not active 1: Active	
1	Delay time inactive/active 0: Inactive 1: Active	If 1, then delay time is active. See also "P–0–2856.0.4".
2	Alternating control in positive direction active 0: Not active 1: Active	
3	Alternating control in negative direction active 0: Not active 1: Active	
4-15	Reserved	

Tab. 8-409: Relevant bits of the status word of the force controller changeover logic

As of PFC02V04 and MPx20V14.

Delay, see P-0-1311[125].

Min./max. value	-/-
Format	BIN
Unit	-
Type	Display parameter
Editable	--
Decimal places	-
Buffered parameter	–

Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-410: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.395 P-0-2873.0.3, Control variable inversion

This parameter can be used to activate inverting of the valve control variable of swivel angle control.

If this parameter = -1, inverting is active.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Type	Input parameter
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-411: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.396 P-0-2914, Effective valve command value

This parameter displays the current valve command value of swivel angle control.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Type	Input parameter
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-412: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.397 P-0-2937.0.1, Force acquisition, control word

Function

Control word for configuring force acquisition

The type of force acquisition has to be selected in dependence on the encoder configuration.

Structure

Bit	Description/function
0 - 3	**Force acquisition**, selection **0x00:** Differential pressure A-B **0x01:** Pressure A **0x10:** Pressure B **0011:** Input of force feedback value **0111:** Input of force feedback value, inverted **1000:** Differential pressure A-B-C **1001 - 1000:** Reserved (deactivated)
4 - 14	**Reserved**
15	**Force acquisition**, deactivation **0:** Force acquisition after bit 0 - 3 **1:** No force acquisition

Tab. 8-413: Bit assignment P-0-2937.0.1, Force acquisition control word

Min./max. value	-/-
Format	BIN
Unit	-
Type	Input parameter
Editable	++
Decimal places	-
Buffered parameter	–
Default value	-
Refresh time	~50 ms

Tab. 8-414: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.398 P-0-2937.0.3, Input of force feedback value

This parameter is an intermediate value of actual force value acquisition. Offset and inversion have already been taken into account. The force input value is used only, if force acquisition was actually activated via the force acquisition control word (P-0-2937.0.1).

The parameter can be assigned to an analog input or it can be written via master communication.

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Type	Input parameter
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–

Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-415: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.399 P-0-2943, Pump displacement

Function

Parameter "P-0-2943, Pump displacement volume" indicates the displacement of the pump in the unit cm³.

Min./max. value	0.1/6553.5
Format	DEC_OV
Unit	cm³
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-416: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.400 S-0-0084, Torque/force feedback value

Function

Parameter displaying the currently effective actual torque/force value.

Calculation of the actual torque/force value

$$\text{actual torque/force value} = \text{torque-generating current, actual value } (P\ 0\ 0043) \cdot \text{torque factor}$$

Fig. 8-1: Relation for calculating the actual torque/force value

☞ The value shown in "S-0-0084" is only an approximation of the actually generated torque or force of the motor!

See also Functional Description "Current and Torque/Force Limitation"

Use

Torque factor

The torque factor mentioned in the calculation formula depends on the functional principle of the motor and the motor type:

- Synchronous motor: The torque factor corresponds to the torque/force constant (P-0-0051) irrespective of whether or not the motor is in field weakening mode.
- Asynchronous motor: In the basic speed range, the torque factor corresponds to the torque/force constant (P-0-0051); in the field weakening range, it is calculated in the firmware based on "P-0-0051" and depending on the speed.

The unit for the values of this parameter depends on the scaling that has been set (S-0-0086, Torque/force data scaling type).

Min./max. value	−32768/32767
Format	DEC_MV
Unit	S-0-0086
Type	Display register
Editable	--
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–
Default value	-
Refresh time	~50 ms

Tab. 8-417: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.401 S-0-0104, Position controller, Kv-factor

Function

Parameter "S-0-0104, Position loop Kv-factor" contains the value for the proportional gain of the position controller.

See also functional description “Open and closed-loop drive control“

Use

The unit of “S-0-0104, Position loop Kv-factor” is “1000 1/min”.

Example conversion

$$S\text{-}0\text{-}0104 = 1{,}0\,\frac{1000}{min} = 1{,}0 \cdot \frac{1000}{60}\,\frac{1}{s} = 16{,}67\,\frac{1}{s}$$

Fig. 8-2: S-0-0104, Position loop Kv-factor

Min./max. value	0/2147483647
Format	DEC_OV
Unit	1000/min
Type	Input register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	1
Refresh time	Current control clock cycle

Tab. 8-418: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.402 S-0-0105, Position controller integral action time

Function

Parameter "S-0-0105" defines the value of the I factor of the PI position controller.

The drive controller has a cascade structure, i.e., the velocity controller is superimposed on the current controller, and the position controller is superimposed on the velocity controller.

See also functional description "Axis control (closed-loop operation)"

Use
The I factor is defined by the reciprocal value of the integral action time referred to the position controller cycle time. For the I controller output, the I factor is applied on the P controller output and summed up.

☞ The PI controller is only to be used in special cases. In normal operation, the integral action time is set to zero.

Min./max. value	0/2147483647
Format	DEC_OV
Unit	ms
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓
Default value	0
Refresh time	~50 ms

Tab. 8-419: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.403 S-0-0108, Feedrate override

Function
Parameter "S-0-0108" is used for variable adjustment of a predefined command velocity.

For this purpose, the effective command velocity "S-0-0041, Homing velocity" is generated by multiplication with the value of "S-0-0108, Feedrate Override".

- S-0-0259, Positioning velocity
- P-0-4007, Positioning block velocity

  See also Functional Description "Positioning block mode"

See also Functional Description "Drive-controlled positioning"

Use
The feedrate override is effective in all interpolating operation modes and/or commands, such as:

- Drive-internal interpolation
- Drive-controlled positioning (jog)
- Commands initiating interpolating movements of the drive (S-0-0148, C0600 Drive-controlled homing procedure command)
- Positioning block mode

☞ Parameter "S-0-0108" can be configured cyclically and also be assigned to an analog input so that it can be perfectly used for what is called setting-up mode.

Min./max. value	0/600
Format	DEC_OV
Unit	%

Type	Input register
Editable	++
Decimal places	2
Buffered parameter	✓
Default value	100
Refresh time	2ms

Tab. 8-420: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.404 S-0-0124, Standstill window

Function

To recognize the standstill of the motor or axis, a threshold value for the velocity can be entered in this parameter. If the actual velocity value falls below this threshold, standstill is recognized by the controller. In case of standstill, bit 1 of "S-0-0013, Class 3 diagnostics" and message "S-0-0331, Status "n_feedback = 0"" are set.

See also Functional Description "Drive Halt"

Use

The standstill window is also "effective" at:

- Cancellation or interruption of a drive control command. Cancellation of interruption are acknowledged if the drive is at a standstill.
- Drive-controlled homing. The actual and command values are not switched before the drive is at a standstill.
- Command value processing. Command value processing is initialized on switchover of operating modes to velocity = 0 if the drive is at a standstill.
- "C1300 Positive stop drive procedure command". The value of "S-0-0124" is a criterion for acknowledging "C1300".
- Axis error correction. The value serves as criterion for recognizing the positive or negative direction of motion of the axis.

8.2.405 S-0-0386, Active position feedback value

Function

The value of parameter "S-0-0386" always displays the current position of the encoder which is set in the currently active operation mode.

Depending on the active operating mode and parameter "S-0-0520, Axis control word", the active position feedback value either corresponds to parameter "S-0-0051, Position feedback value of encoder 1" or parameter "S-0-0053, Position feedback value of encoder 2" or the hybrid position feedback value.

Min./max. value	--/--
Format	DEC_MV
Unit	S-0-0076
Type	Display register
Editable	--
Decimal places	S-0-0077 / S-0-0078
Buffered parameter	–

Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-421: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.406 S-0-0430, Effective target position

Function In this parameter, the current target position (absolute position) in operating modes:

- Drive-controlled positioning
- Drive-internal interpolation
- Positioning block mode

can be read out.

See also Functional Description "Drive-controlled positioning"

Use At "drive-controlled positioning", depending on the modalities defined in "S-0-0346, Position command value acceptance" and after change of the edge of the positioning command value acceptance bit, the value in "S-0-0430" corresponds to:

- the value of "S-0-0282, Positioning command value" if it was defined as absolute target position,
- the total from the previous value of "S-0-0430" and "S-0-0282" if the new target position refers to the previous target position (→ S-0-0346; bit 4 = 0),
- the total of the actual position value "S-0-0051" and "S-0-0282" at the time of toggling if the target position refers to the current actual position value (→ S-0-0346; bit 4 = 1).

☞ If residual path processing at repeated activation of operating mode "drive-controlled positioning" is possible, e.g. after reconnection of control voltage at axes with absolute measuring system, the effective target position is still specified in "S-0-0430" (non-volatile parameter).

Min./max. value	-2147483647 / 2147483647
Format	DEC_MV
Unit	S-0-0076
Type	Display register
Editable	--
Decimal places	S-0-0077 / S-0-0078
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-422: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.407 S-0-0550, Torque/force command value, positive 2

Force command value for alternating control in positive direction of force.

The parameter only takes effect in conjunction with P-0-1372, Configuration, axis controllers/functions, bit 14 "alternating control in positive direction of force allowed" and "P-0-2853, Alternating control, control word 1".

Min./max. value	-2147483647 / 2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	✓
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-423: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.408 S-0-0551, Torque/force command value, negative 2

Force command value for alternating control in negative direction of force.

The parameter only takes effect in conjunction with P-0-1372, Configuration, axis controllers/functions, bit 15 "alternating control in negative direction of force allowed" and "P-0-2853, Alternating control, control word 1".

Min./max. value	-2147483647 / 2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	✓
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-424: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.409 S-0-0552, Torque/force feedback value 2

The respective current actual torque/force value is displayed. This may differ due to the measuring method and/or configuration of the axis.

In the case of differential pressure measurement, the current actual torque/force value is calculated using the following formula:

$$F = p_A * A_A - p_B * A_B$$

Fig. 8-3: Calculation of the actual torque/force value

The actual pressure value can also be measured directly by means of a load cell.

The measuring method can be selected via the configuration of the force feedback value source in P-0-2937.0.1.

☞ The value is updated in parameter S-0-0084. S-0-0084 can, however, only display values with 2 bytes. S-0-0084 is limited accordingly.

Min./max. value	-214748364 / 2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Output register
Editable	--
Decimal places	S-0-0093/S-0-0094
Buffered parameter	–
Default value	-
Refresh time	~50 ms

Tab. 8-425: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.410 S-0-0553, Torque/force command value 2 ramp

Function Ramp slope for parameters "S-0-0550, Torque/force command value, positive" and "S-0-0551, Torque/force command value, negative".

Use When a new value is entered, the value can be cross-faded from "S-0-0550, Torque/force command value, positive" and from "S-0-0551, Torque/force command value, negative" with the help of a ramp.

With a ramp of “0”, the change takes place abruptly.

The time base is second; thus, the unit is, for example, N/s.

Min./max. value	0/2147483647
Format	DEC_MV
Unit	S-0-0086
Type	Input register
Editable	++
Decimal places	S-0-0093/S-0-0094
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-426: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.411 S-0-0800, Pressure command value

Function In the "pressure control" operation mode the command value is generated directly by the control unit and entered in this parameter.

Use A further value (S-0-0801, Additive Pressure command value) can be added to the pressure command value (S-0-0800). Before the sum of both values is transmitted to the pressure controller, several limit values act on it. The unit of the parameter depends on the settings in parameter "S-0-0806, Pressure data scaling type".

Min./max. value	- P-0-2875.0.4 / P-0-2875.0.4
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-427: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.412 S-0-0803, Pressure feedback value A

Function

This parameter contains the current actual pressure value of chamber A.

The unit for the values of this parameter depends on the scaling that has been set in "S-0-0806, Pressure data scaling type".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-428: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.413 S-0-0804, Pressure feedback value B

Function

This parameter contains the current actual pressure value of chamber B.

The unit for the values of this parameter depends on the scaling that has been set in "S-0-0806, Pressure data scaling type".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++

Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-429: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.414 S-0-0809, Pressure feedback value

Function Parameter displaying the currently effective pressure feedback value. The pressure feedback value is calculated from actual pressure value A and B. If actual pressure value B is the reference, the feedback pressure value (S-0-0809) has a negative sign.

The unit for the values of this parameter depends on the scaling that has been set (S-0-0806, Pressure data scaling type).

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0806
Type	Output register
Editable	--
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-430: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.415 S-0-0810, Pressure ramp time

Function The pressure ramp time is the reference time for the pressure ramp. In the "pressure control" operation mode this parameter defines a slope for the pressure command value.

The ramp time can be entered in steps of 0.1 ms.

Min./max. value	-/-
Format	DEC_OV
Unit	ms
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-431: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.416 S-0-0811, Pressure ramp reference

Function

In "pressure control" operation mode, the value of this parameter and the pressure ramp time (S-0-0810) serve for calculation of the ramp for the pressure command value. The value of "S-0-0811" is scaled according to the settings for pressure data scaling "S-0-0806, Pressure data scaling type".

Min./max. value	0 / P-0-2875.0.4
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	✓
Default value	-
Refresh time	~50 ms

Tab. 8-432: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.417 S-0-0813, System pressure

Function

The parameter outputs the current actual value of the system pressure (also referred to as low pressure). It can be monitored for too high and too low values by means of threshold values.

The unit of the parameter depends on the settings in parameter "S-0-0806, Pressure data scaling type".

Min./max. value	0 / P-0-2875.0.4
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-433: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.418 S-0-0814, Tank pressure

Function

The parameter shows the current pressure of the hydraulic tank.

The unit of the parameter depends on the settings in parameter "S-0-0806, Pressure data scaling type".

The parameter is alternatively used for the current pressure of a hydraulic accumulator.

Min./max. value	0 / P-0-2875.0.4
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	✓
Default value	-
Refresh time	20 ms

Tab. 8-434: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.419 S-0-0820, Piston area A

Piston area A of the hydraulic cylinder is the reference value for pressure feedback value A when calculating the force feedback value on the A-side of the cylinder.

The calculation of the resulting force feedback value depends on the effective areas that are multiplied by the relevant pressures. For example, the cylinder area varies in the case of multiple-area cylinders with rapid mode/press mode switching for calculating the force on the A-side of the cylinder. Cf. "P-0-1311[138], Cylinder area 3 (press mode, extending)".

Min./max. value	0.000 / 4000000.000
Format	DEC_OV
Unit	mm²
Type	Input register
Editable	PM
Decimal places	3
Buffered parameter	✓
Default value	1000.000
Refresh time	~50 ms

Tab. 8-435: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.420 S-0-0821, Piston area B

Piston area B of the hydraulic cylinder is the reference value for the pressure feedback value when calculating the force feedback value on the B-side of the cylinder.

The calculation of the resulting force feedback value depends on the effective areas that are multiplied by the relevant pressures. For example, the cylinder area varies in the case of multiple-area cylinders with rapid mode/press mode switching for calculating the force on the B-side of the cylinder. Cf. "P-0-1311[139], Cylinder area 4 (press mode, retracting)".

Min./max. value	0.000 / 4000000.000
Format	DEC_OV
Unit	mm²
Type	Input register
Editable	PM
Decimal places	3
Buffered parameter	✓
Default value	1000.000
Refresh time	~50 ms

Tab. 8-436: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.421 S-0-0827, Pressure control deviation

Function Parameter "S-0-0827" indicates the difference between pressure command value and pressure feedback value in the pressure control loop.

The unit of the parameter depends on the settings in parameter "S-0-0806, Pressure data scaling type".

Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0806
Type	Output register
Editable	--
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	PFC controller clock cycle

Tab. 8-437: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.422 S-0-0828, Positive pressure limit value

This parameter allows determining a pressure limit value for positive pressure command values of the pressure controller.

The unit for the values of this parameter depends on the scaling that has been set (S-0-0806, Pressure data scaling type).

Min./max. value	0 / P-0-2875.0.4
Format	DEC_MV
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808

Buffered parameter	✓
Default value	0
Refresh time	~50 ms

Tab. 8-438: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.423 S-0-0865, Positive spool limit value

This parameter allows determining a valve limit value for positive valve command values of the swivel angle control.

This limit value has a unipolar effect. A bipolar limit value is not provided.

Min./max. value	0/100
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0
Refresh time	~50 ms

Tab. 8-439: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.424 S-0-0866, Negative spool limit value

This parameter allows determining a valve limit value for negative valve command values of the swivel angle control.

This limit value has a unipolar effect. A bipolar limit value is not provided.

Min./max. value	-100/0
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0
Refresh time	~50 ms

Tab. 8-440: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.2.425 S-0-0880, Swivel angle command value

This parameter allows a swivel angle command value to be input.

The validity of this swivel angle command value depends on "P-0-1311[291], Swivel angle generator: Mode selection of swivel angle generation"

Min./max. value	-/-
Format	DEC_MV
Unit	%
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	–
Default value	0
Refresh time	PFC controller clock cycle

Tab. 8-441: Parameter attributes

See chapter 8.1 "Relevant parameters" on page 261.

8.3 Error and warning messages for position/force control x/F control (PFC)

8.3.1 General

All diagnostic messages related to the technology function are displayed with the diagnostic code (P-0-1300) and the diagnostic text (P-0-1387).

The various diagnostic messages are subdivided into four categories, which are an integral part of the relevant diagnostic code. Errors and warnings generate the corresponding diagnoses in IndraDrive, whereas messages are diagnosed using only the parameters of the technology function.

- Stop_0, critical error (D5xxx): F2017
- Stop_1, non-critical error (D4xxx): F2016
- Warning (B5xxx): E2015
- Message (B4xxx): -

8.3.2 Diagnostic messages

Error Stop0, F2017

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Error, diagnostic code: Text	Cause	Remedy
F2017, D500D: Pos. loops of PFC and drive cannot both be enabled	The control loops of the IndraDrive firmware and of PFC must not be closed at the same time.	Open the position control loop of the drive firmware by setting P-0-0556.8 to the value 1, or open the PFC position/force control loop by setting P-0-1370.31 to the value 1.
F2017, D5025: Actual velocity exceeds valid range	Encoder jump monitoring has not recognized valid position signals for more cycles than specified in the number of suppression cycles and signals an encoder error.	Check encoder signals. If necessary, increase number of suppression cycles in P-0-1311[175].
F2017, D502C: Position lag exceeds alarm level	Lag error monitoring signals an error.	Check setting of position controller. If necessary, increase alarm threshold of lag error monitoring via: • P-0-1311[118] or P-0-1311[119], if velocity-dependent • P-0-1311[122], if model-based
F2017, D504E: Oil temperature exceeds alarm level	Oil temperature monitoring signals an error.	Take thermal corrective measures. If necessary, increase alarm threshold via P-0-1311[174] or extend debounce time P-0-1311[172].
F2017, D5051: Tank pressure exceeds upper alarm level	Accumulator overpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, increase alarm threshold via P-0-1311[168] or extend debounce time P-0-1311[163].
F2017, D5055: Tank pressure falls below lower alarm level	Accumulator underpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, increase alarm threshold via P-0-1311[166] or extend debounce time P-0-1311[164].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Error, diagnostic code: Text	Cause	Remedy
F2017, D5057: Pressure chamber A exceeds upper alarm level	Process pressure monitoring of chamber A signals an error.	Take hydraulic corrective measures. If necessary, increase alarm threshold via P-0-1311[171] or extend debounce time P-0-1311[169].
F2017, D5059: Pressure chamber B exceeds upper alarm level	Process pressure monitoring of chamber B signals an error.	Take hydraulic corrective measures. If necessary, increase alarm threshold via P-0-1311[171] or extend debounce time P-0-1311[169].
F2017, D5062: Config err, axis type sel. not feasible P-0-1370.2	Invalid selection of cylinder type	Enter the value 001, 010, 101 or 110 in bits 4..2 in P-0-1370.
F2017, D5063: Config error, no pos./vel. operation mode active	The operation mode selected in IndraDrive is not supported by the technology function.	Select a positioning/position control mode or velocity control.
F2017, D5064: Acc. FF not supported -> set S-0-0348 =0!	Acceleration feedforward control of the IndraDrive firmware has not been switched off.	In S-0-0348 the value 0 has to be entered.
F2017, D5065: Drive loop cannot be enabled in pos. control	The control loop of the IndraDrive firmware has not been opened in position control.	Select the operation mode of closed-loop velocity control or open the control loop of the IndraDrive firmware by setting P-0-0556.8 to the value 1.
F2017, D5066: Firmware control deviation mon active->set S-0-0159=0	Lag error monitoring of the IndraDrive firmware has been activated.	Enter the value 0 in S-0-0159. The technology function provides its own lag error monitoring.
F2017, D5067: Function package SYX not selected -> set P-0-2003.7	The functional package SYTRONIX has not been selected.	Enter the value 1 in P-0-2003.7 and restart; where applicable, additional licensing required.
F2017, D5068: Torque/force unit cannot be [%] -> set in S-0-0086	Scaling of torque/force data incorrectly configured; percentage-based scaling is not allowed.	Enter the value 001 or 010 in S-0-0086.2..0.
F2017, D406A: Config error, axis control word -> reset S-0-0520.0	Actual position value via axis controller control word from encoder 2 is selected.	S-0-0520 has to be set to the value “0”.
F2017, D406B: Config error, axis control word -> set S-0-0520.0	Actual position value via axis controller control word from encoder 1 is selected.	S-0-0520 has to be set to the value “0”.
F2017, D5075: Init not completed, check config data	Enabling with torque of the IndraDrive is prevented by the technology function, since the technology function has not yet been initialized or still is incorrectly configured.	Complete the initialization of the technology function or correct the configuration.
F2017, D507F: Config of AH not supported, set P-0-0558.4/2	The configuration of Drive Halt (AH) is not supported.	The configuration of Drive Halt (AH) has to be adjusted (P-0-0558; bit 4 = 1, bit 0 = 1).
F2017, D5084: Sum pressure of pump exceeds alarm level	Summated pressure monitoring signals an excessive summated pressure.	Check the cycle for correct decompression. Plausibility check of cylinder chamber pressures (S-0-0803 and S-0-0804) and status of decompression valves (P-0-1280, bits 16..15).

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Error, diagnostic code: Text	Cause	Remedy
F2017, D508B: Cycle time not feasible	The configured cycle time of the fast task (CyclicFast) is invalid or has the wrong priority.	A cycle time of greater than or equal to 1 ms and priority 0 have to be set in the task configuration.
F2017, D5090: Actor cannot be hyd. motor -> change in P-0-0560	Actuator type is incorrectly configured.	Enter the value 4 in P-0-0560.
F2017, D509A: Rotatory scaling is not supported	A rotary scaling type has been configured for at least one scaling variable.	Linear scaling has to be configured for the scaling variables of position, velocity, acceleration and torque/force.
F2017, D509C: A holding brake has to be configured P-0-0525	With a hydraulic actuator the function of the electrical brake is not activated.	The function of the holding brake has to be activated by writing the value 1 to bit 2 of P-0-0525.
F2017, D50A6: System pressure exceeds upper alarm level	System overpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, adjust system pressure control; alternatively, increase alarm threshold via P-0-1311[235] or extend debounce time P-0-1311[233].
F2017, D50A9: System pressure falls below lower alarm level	System underpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, adjust system pressure control; alternatively, reduce alarm threshold via P-0-1311[238] or extend debounce time P-0-1311[236].
F2017, D50AC: Pilot oil pressure exceeds upper alarm level	Pilot oil overpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, adjust pilot oil pressure control; alternatively, increase alarm threshold via P-0-1311[249] or extend debounce time P-0-1311[247].
F2017, D50AF: Pilot oil pressure falls below lower alarm level	Pilot oil underpressure monitoring signals an error.	Take hydraulic corrective measures. If necessary, adjust pilot oil pressure control; alternatively, reduce alarm threshold via P-0-1311[252] or extend debounce time P-0-1311[250].
F2017, D50B2: Pressure chamber C exceeds upper alarm level	Overpressure monitoring of pressure feedback value C signals an error.	Take hydraulic corrective measures. If necessary, increase alarm threshold via P-0-1311[287] or extend debounce time P-0-1311[285].
F2017, D50B6: Oil temperature exceeds alarm level	Oil temperature monitoring for too low values signals an error.	Take hydraulic corrective measures. If necessary, reduce alarm threshold via P-0-1311[154] or extend debounce time P-0-1311[152]
F2017, D57D4: Safety vlv mon: Antivalence check Vlv1 failed	Feedback of the NC and the NO contact of valve 1 provided the same potential after the debounce time has elapsed.	Check P-0-1393, bits 0 and 1 If necessary, increase debounce time in P-0-1311[209].
F2017, D57D5: Safety vlv mon: Antivalence check Vlv2 failed	Feedbacks of the NC and the NO contact of valve 2 provided the same potential after the debounce time has elapsed.	Check P-0-1393, bits 2 and 3 If necessary, increase debounce time in P-0-1311[209].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Error, diagnostic code: Text	Cause	Remedy
F2017, D57D6: Safety vlv mon: Opening Vlv1 failed	While an enable was present (mode AF), safety valve 1 has not opened within the debounce time.	Check P-0-1393, bits 0 and 1 If necessary, increase debounce time in P-0-1311[211].
F2017, D57D7: Safety vlv mon: Opening Vlv2 failed	While an enable was present (mode AF), safety valve 2 has not opened within the debounce time.	Check P-0-1393, bits 2 and 3 If necessary, increase debounce time in P-0-1311[211].
F2017, D57D8: Safety vlv mon: Closing Vlv1 failed	While drive enable (mode Ab) was not granted safety valve 1 has not closed within the debounce time.	Check P-0-1393, bits 0 and 1 If necessary, increase debounce time in P-0-1311[210].
F2017, D57D9: Safety vlv mon: Closing Vlv2 failed	While drive enable (mode Ab) was not granted safety valve 2 has not closed within the debounce time.	Check P-0-1393, bits 2 and 3 If necessary, increase debounce time in P-0-1311[210].
F2017, D57DA: Safety vlv mon: Test time Vlv1	The last test of safety valve 1 took place too long ago. Operation without testing is not permitted.	Carry out testing. Where appropriate, extend test interval in P-0-1311[214].
F2017, D57DB: Safety vlv mon: Test time Vlv2	The last test of safety valve 2 took place too long ago. Operation without testing is not permitted.	Carry out testing. Where appropriate, extend test interval in P-0-1311[214].
F2017, D57DE: Position drift exceeds alarm level	Monitoring of drift rate signals an error. The cause is drift of the axis or excessive noise in the position signal.	Test for leakage. Extend cycle time of the monitoring interval P-0-1311[216] to suppress signal noise. Where appropriate, raise alarm threshold via P-0-1311[218].
F2017, D5FFE: Internal error: could not get valid semaphore handle	Internal handling error.	Reset COLD of MLD and restart. Get latest released PFC version. Get in touch with Rexroth Service.
F2017, D5FFF: Internal error: event number not valid	Internal handling error.	Reset COLD of MLD and restart. Get latest released PFC version. Get in touch with Rexroth Service.

Tab. 8-442: Error Stop0, F2017

Warning E2015,

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5000: Cyl. area less or equal zero, check S-0-0820	The required cylinder area 1 (rapid mode, extending) has been incorrectly configured.	Enter a value greater than 0 in S-0-0820.
E2015, B5001: Cylinder areas fast/slow not feasible P-0-1311[138]	The required cylinder area 3 (press mode, extending) has been configured smaller than the corresponding cylinder area 1 (rapid mode, extending).	The value entered in P-0-1311[138] has to be higher than the value in S-0-0820.
E2015, B5002: Cyl. area less or equal zero, check S-0-0821	The required cylinder area 2 (rapid mode, retracting) has been incorrectly configured.	A value greater than 0 has to be entered in S-0-0821.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5003: Cyl. areas fast>slow, check that S-0-0821<=S-0-0820	The required cylinder area 2 (rapid mode, retracting) has been configured greater than the corresponding cylinder area 1 (rapid mode, extending).	The maximum value in S-0-0821 must not be higher than the value in S-0-0820.
E2015, B5004: Cylinder areas fast/slow not feasible P-0-1311[139]	The required cylinder area 4 (press mode, retracting) has been configured smaller than the corresponding cylinder area 2 (rapid mode, retracting).	The value in P-0-1311[139] has to be at least the same as the value in S-0-0821.
E2015, B5005: Config data exceeds valid range P-0-1311[131]	The required switching factor for rapid mode/press mode switching has been incorrectly configured.	Enter a value between 0 and 2 in P-0-1311[131].
E2015, B5006: Force command value exceeds valid range	The specified force command value is smaller than its lower limit value or greater than its upper limit value.	The specified force command value, S-0-0550 or S-0-0551, has to be between the values of P-0-1311[102] and P-0-1311[103].
E2015, B5007: Pressure command value exceeds valid range	The given pressure command value is smaller than its lower limit value or greater than its upper limit value.	The specified pressure command value S-0-0800 has to be between the values of P-0-1311[101] and S-0-0828.
E2015, B5008: Cycle time not feasible P-0-1311[177]	The required cycle time of the fast task has been incorrectly configured.	A value greater than or equal to the call time of the fast task (1 ms by default) has to be entered in P-0-1311[177].
E2015, B5009: Areas switch coordination not feasible P-0-1372.7	Invalid selection of valve control, actuator.	Enter the value 00, 01 or 10 in bits 8/7 in P-0-1372.
E2015, B500A: Config data exceeds valid range P-0-1371	The required pump displacement (Vg) 2 has been incorrectly configured.	Enter a value greater than 0 in P-0-1371.
E2015, B500B: Config data exceeds valid range P-0-2943	The required pump displacement (Vg) 1 has been incorrectly configured.	Enter a value greater than 0 in P-0-2943.
E2015, B500C: Config data not feasible P-0-1371	The required pump displacement (Vg) 2 has been configured greater than the corresponding pump displacement (Vg) 1.	The maximum value in P-0-1371 must not be higher than the value in P-0-2943.
E2015, B500E: Speed limitation NOT feasible: P-0-0113	The required maximum pump speed has been incorrectly configured.	Enter a value greater than 0 in P-0-0113.
E2015, B500F: Config data exceeds valid range P-0-1311[137]	The required maximum process pressure has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[137].
E2015, B5010: Config data exceeds valid range P-0-1311[134]	The required allowed pressure differential for switching the directional valves has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[134].
E2015, B5011: Directional valve coord. not feasible P-0-1370.8	Invalid selection of valve control, direction input.	Enter the value 00, 01 or 10 in bits 9/8 in P-0-1370.
E2015, B5012: Swivel angle actuat. coord. not feasible P-0-1370.13	Invalid selection of pump displacement control.	Enter the value 00, 01 or 10 in bits 14/13 in P-0-1370.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5013: Actuation of directional valve not possible	Directional valve cannot be controlled, because no valve has been configured.	The direction input via valve can be configured by setting bit 7 in P-0-1370.
E2015, B5014: Actual pump displacement volume exceeds valid range	The specified effective displacement of the pump is smaller than the minimum displacement or greater than the maximum displacement.	The specified effective displacement, P-0-1275, has to be between the values of P-0-2943 and P-0-1371.
E2015, B5015: Pump displacement volume can not be modified	The variable input of the effective displacement is impossible, because a pump with a fixed displacement has been configured.	A variable displacement can be configured by inputting the value 01 for bits 12/11 in P-0-1370.
E2015, B5016: Actual cylinder volume <=0	The required cylinder volume in force control has been incorrectly configured.	Enter a value greater than 0 in P-0-1376.
E2015, B5017: Actual bulk modulus <= 0	At least one factor for internally calculating the controller output adjustment for force control has been incorrectly specified. This can be the effective displacement of the pump or the elastic modulus.	Specify a value greater than 0 for the effective displacement, P-0-1275, and the elastic modulus, P-0-1311[141].
E2015, B5018: Config data not feasible P-0-1311[104]	The accuracy window is invalid for force control.	A value greater than/equal to 0 has to be entered in P-0-1311[104].
E2015, B5019: Swivel angle mode config not feasible P-0-1370.5	The configuration of the swivel angle adjustment mode is invalid.	For the mode of swivel angle adjustment, only the values 00 and 01 are permitted for bit 6..5.
E2015, B501A: Config data exceeds valid range P-0-1385	The required velocity controller smoothing time constant has been incorrectly configured.	The value in P-0-1385 has to be at least the same as the value in P-0-1311[177].
E2015, B501B: Config data exceeds valid range P-0-1311[113]	The required change threshold for command values in the I-logic of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[113].
E2015, B501C: Config data exceeds valid range P-0-1311[114]	The required change threshold for actual values in the I-logic of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[114].
E2015, B501D: Config data exceeds valid range S-0-0057	The required fine positioning window in the I-logic of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in S-0-0057.
E2015, B501E: Config data not feasible P-0-1311[106]	The accuracy window is invalid for pressure control.	A value greater than/equal to 0 has to be entered in P-0-1311[106].
E2015, B501F: Config data exceeds valid range P-0-1311[107]	The required filter time in the I-logic of the pressure/force controller has been incorrectly configured.	The value in P-0-1311[107] has to be at least the same as the value in P-0-1311[177].
E2015, B5020: Config data exceeds valid range P-0-1311[108]	The required change threshold for command values in the I-logic of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[108].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5021: Config data exceeds valid range P-0-1311[109]	The required change threshold for actual values in the I-logic of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[109].
E2015, B5022: Config data exceeds valid range P-0-1311[110]	The required fine positioning window in the I-logic of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[110].
E2015, B5023: Cylinder areas can not be switched	The changeover of cylinder areas cannot be activated, because no cylinder with switching of effective area has been configured.	Switching of the effective area of the cylinder can be configured by setting bit 4 in P-0-1370.
E2015, B5024: Change rate pos./neg. not feasible	The effective upper or the effective lower velocity limit for encoder jump monitoring has been incorrectly configured.	Enter values greater than or equal to 0 in S-0-0038, S-0-0091, S-0-0113 and P-0-0113, and enter a value smaller than or equal to 0 in S-0-0039.
E2015, B5026: Config data exceeds valid range P-0-1311[116]	The reference velocity of lag error monitoring has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[116].
E2015, B5027: Config data exceeds valid range P-0-1311[116]	The reference velocity of lag error monitoring has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[116].
E2015, B5028: Config data exceeds valid range P-0-1311[118]	The max. lag error (at max. command velocity) of lag error monitoring has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[118].
E2015, B5029: Config data exceeds valid range P-0-1311[119]	The max. lag error (in standstill) of lag error monitoring has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[119].
E2015, B502A: Config data exceeds valid range P-0-1311[120]	The warning threshold of lag error monitoring has been incorrectly configured.	Enter a value between 0 and 0.9999 in P-0-1311[120].
E2015, B502B: Position lag exceeds warning level	Lag error monitoring signals a warning.	Check setting of position controller. If necessary, increase warning threshold of lag error monitoring via: • P-0-1311[120], if velocity-dependent • S-0-0057, if model-based
E2015, B502D: Invalid return value of check method	Internal handling error.	Reset COLD of MLD and restart. Get latest released PFC version. Get in touch with Rexroth Service.
E2015, B502E: Config data exceeds valid range S-0-0104	The proportional gain of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in S-0-0104.
E2015, B502F: Config data exceeds valid range S-0-0105	The integral action time of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in S-0-0105.
E2015, B5030: Config data exceeds valid range	Reserved	Reserved

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5031: Pos. vel. lim. < neg. vel. lim.: S-0-0038/0039/0113	The configured positive velocity limit value is smaller than the negative velocity limit value.	Enter valid values in S-0-0038 and in S-0-0039.
E2015, B5032: Config not feasible: P-0-2937.0.1 P-0-1372.15	Activating alternating control in the negative direction is not permitted with actual value source “pressure A” and when the force sensor is not inverted.	Deactivating alternating control in negative direction: Enter the value 0 in P-0-1372 bit 15! Select other actual value source in P-0-2937.0.1.
E2015, B5033: Control command for integral part not feasible	Invalid selection of switch-off behavior for I-term of controller.	Select the “reset” (0), “freeze” (1) or “take down” (2) mode. Internal error!
E2015, B5036: Config not feasible: P-0-2937.0.1 P-0-1372.14	Activating alternating control in the positive direction is not permitted with actual value source “pressure B” and with inverted force sensor.	Deactivate alternating control in positive direction: Enter the value 0 in P-0-1372 bit 14! Select other actual value source in P-0-2937.0.1.
E2015, B5037: Config not feasible: P-0-2937.0.1 P-0-2853.0	Alternating control cannot be enabled due to the selected source for pressure/force feedback values.	For alternating control a valid signal source for actual force value acquisition has to be configured in P-0-2937.0.1.
E2015, B5038: Block mode not feasible	The selected block operation mode is not useful due to active force-holding function.	Terminate the force-holding function.
E2015, B5039: Config data exceeds valid range P-0-1373	The proportional gain of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1373.
E2015, B503A: Config data exceeds valid range P-0-1374	The integral action time of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1374.
E2015, B503B: Config data exceeds valid range P-0-1375	Reserved	Reserved
E2015, B503C: Config data exceeds valid range P-0-1311[135]	The required switching factor for rapid mode/press mode switching has been incorrectly configured.	Enter a value between 0 and 2 in P-0-1311[135].
E2015, B503D: Invalid value for data type of	The entered value is invalid for this data type. For example, a negative value has been entered for a time parameter.	Enter a permissible value for the relevant data type, e.g. a positive value for a time parameter.
E2015, B503E: Control command for integral part not feasible	Invalid selection of switch-off behavior for I-term of controller.	Select the “reset” (0), “freeze” (1) or “take down” (2) mode. Internal error!
E2015, B5041: Controller config. is out of range P-0-1378	The weighting of velocity feedforward control of the force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1378.
E2015, B5042: S-0-0123 adjusted to set force/torque to scale	The feed constant (S-0-0123) was written by the technology function so that values in torque scaling [Nm] are equal to the values in force scaling [N].	No action required. Torque limit values [Nm] can be entered directly as force values [N]; e.g. 50 Nm = 50 N.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5043: Resetting invalid value not possible for	An invalid machine datum could not be reset to the valid value.	Check whether the parameter is a cyclic one. Get in touch with Rexroth Service.
E2015, B5044: Config data exceeds valid range P-0-1311[130]	The mounting angle for generating the acceleration feedback value has been incorrectly configured.	Enter a value between 0 and 360 in P-0-1311[130].
E2015, B5045: Config data not feasible P-0-1372.10	The selection of feed determination is not permitted for single-rod cylinders.	Enter the value 0 in P-0-1372, bit 10.
E2015, B5046: Config data exceeds valid range P-0-1311[129]	The P-gain for the acceleration observer has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[129].
E2015, B5047: Config data exceeds valid range P-0-1377	The moving mass for generating the acceleration feedback value has been incorrectly configured.	Enter a value greater than 0 in P-0-1377.
E2015, B5048: Config data exceeds valid range P-0-1311[124]	The relative switching window for alternating control has been incorrectly configured.	Enter a value between -100 and 100 in P-0-1311[124].
E2015, B5049: Config data exceeds valid range P-0-1311[125]	The debounce time of the switching condition for alternating control has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[125].
E2015, B504A: Config data exceeds valid range P-0-1311[151]	The factor for reducing the commanded Vg with reference to the critical Vg is outside the valid range of values.	A value from 0 to 1 has to be entered in P-0-1311[151].
E2015, B504B: Config data exceeds valid range P-0-1311[126]	The ramp time of the switching condition for alternating control has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[126].
E2015, B504C: Velocity limit not feasible: S-0-0038/0039/0091	The maximum velocity for alternating control has been incorrectly configured.	A value greater than 0 has to be entered in S-0-0091, and the values in S-0-0038 and S-0-0039 have to be valid.
E2015, B504D: Config data not feasible P-0-1311[173]	The configured warning threshold of oil temperature monitoring is greater than the corresponding alarm threshold.	The maximum value in P-0-1311[173] must not be higher than the value in P-0-1311[174].
E2015, B504F: Oil temperature exceeds warning level	Oil temperature monitoring signals a warning.	Take thermal corrective measures. If necessary, increase warning threshold via P-0-1311[173].
E2015, B5050: Config data not feasible P-0-1311[167]	The configured warning threshold of accumulator overpressure monitoring is greater than the corresponding alarm threshold.	The maximum value in P-0-1311[167] must not be higher than the value in P-0-1311[168].
E2015, B5052: Tank pressure exceeds upper warning level	Accumulator overpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, increase warning threshold via P-0-1311[167] or extend debounce time P-0-1311[163].
E2015, B5053: Config data not feasible P-0-1311[165]	The configured warning threshold of accumulator underpressure monitoring is smaller than the corresponding alarm threshold.	The value in P-0-1311[165] has to be at least equal to the value in P-0-1311[166].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5054: Tank pressure falls below lower warning level	Accumulator underpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, reduce warning threshold via P-0-1311[165] or extend debounce time P-0-1311[164].
E2015, B5056: Config data not feasible P-0-1311[170]	The configured warning threshold of process pressure monitoring is greater than the corresponding alarm threshold.	The maximum value in P-0-1311[170] must not be higher than the value in P-0-1311[171].
E2015, B5058: Pressure chamber A exceeds upper warning level	Process pressure monitoring of chamber A signals a warning.	Take hydraulic corrective measures. If necessary, increase warning threshold via P-0-1311[170] or extend debounce time P-0-1311[169].
E2015, B505A: Pressure chamber B exceeds upper warning level	Process pressure monitoring of chamber B signals a warning.	Take hydraulic corrective measures. If necessary, increase warning threshold via P-0-1311[170] or extend debounce time P-0-1311[169].
E2015, B505B: Config data not feasible P-0-1311[206]	Entering a negative threshold value for the pressure differential for detecting refilling is not permitted.	Enter a value greater than or equal to 0 in P-0-1311[206].
E2015, B505C: Config data exceeds valid range P-0-1311[157]	The configured lower limit of the value range for scaling the oil temperature is greater than or equal to the corresponding upper limit.	The value in P-0-01311[158] has to be higher than the value in P-0-01311[157].
E2015, B505D: Config data exceeds valid range P-0-1311[159]	The configured lower limit of the signal range for scaling the oil temperature is greater than or equal to the corresponding upper limit.	The value in P-0-01311[160] has to be higher than the value in P-0-01311[159].
E2015, B505E: Feed constant, S-0-0123 must be >0	The feed constant entered is not permitted.	Enter a value greater than 0 in S-0-0123.
E2015, B505F: Mechanical stiffness, P-0-1311[198] must be >0	The specified mechanical stiffness is not permissible.	A value greater than 0 has to be entered in P-0-1311[198].
E2015, B5060: Force sensor is needed -> set P-0-2937.0.1.1..0 = 11	The selection of the force determination for the mechanical axis is not permissible.	A force sensor has to be selected: Up to and including PFC02V04: Enter the value 010 in P-0-1370.18..16. PFC02V05 or higher: Enter the value 11 in P-0-2937.0.1..0.
E2015, B5061: Pressure control not feasible for electromechanics	The selection of the process variable for the mechanical axis is not permissible.	Force control has to be selected: Up to and including PFC02V04 enter the value 1 in P-0-1370.15. PFC02V05 or higher: Enter the value 11 in P-0-2937.0.1..0.
E2015, B5069: Automatic not possible in cyclic pos ctrl P-0-1372	Automatic control or control of area switching with plausibility check is not possible in cyclic position control.	Activation of area switching via the control word (P-0-1372.8..7 = 00) or use of interpolation in the drive (e.g. drive-controlled interpolation).

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B506C: Config data not feasible P-0-1311[117]	The input for the tolerance window of the actual displacement value is invalid.	Enter a valid value from 0 to 100 % in P-0-1311[117].
E2015, B506D: Scaling of slave axis is invalid	The scaling settings of the secondary axis are invalid.	In the secondary axis, rpm has to be set for velocity scaling and rad/s^2 for acceleration scaling, each in preferred scaling with reference to the motor shaft.
E2015, B506E: Config data not feasible P-0-1311[194]	The decompression switch-on threshold is lower than the switch-off threshold.	Enter at least the value from P-0-1311[195] in P-0-1311[194].
E2015, B506F: Config data exceeds valid range P-0-1311[101]	The required lower limit value for pressure command values has been incorrectly configured.	Enter a value greater than 0 in P-0-1311[101].
E2015, B5070: Config error: max cmd pressure <= min cmd pressure	The required upper limit value for pressure command values has been configured smaller than the corresponding lower limit value.	Enter a value greater than or equal to P-0-01311[101] in S-0-0828.
E2015, B5071: Config data exceeds valid range P-0-1311[102]	The required upper limit value for force command values has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[102].
E2015, B5072: Config data exceeds valid range P-0-1311[103]	The required lower limit value for force command values has been incorrectly configured.	Enter a value less than or equal to 0 in P-0-1311[103].
E2015, B5073: FDA with cycle time of 1 ms not possible P-0-1372.30	Using the FDA functionality with a PFC cycle time of 1 ms is not possible.	FDA has to be deactivated by means of P-0-1372 bit 30 = 1 or a PFC cycle time greater than/equal to 2 ms has to be selected in P-0-1311[177]
E2015, B5074: Axis conf. must not be changed P-0-1370	The desired change in the configuration can only be made in the parameter mode.	Switch IndraDrive to the parameter mode. Then adjust the configuration in P-0-1370 as desired.
E2015, B5076: Oil filter clogging >75%	Oil filter monitoring signals clogging of more than 75 %. Filter	Change filter. Check plausibility of the signal in P-0-1392, bit 0. If necessary, increase temperature threshold value in P-0-1311[178]. If necessary, increase debounce time in P-0-1311[179].
E2015, B5077: Oil filter clogging 100%	Oil filter monitoring signals clogging of 100 %.	Change filter. Check plausibility of the signal in P-0-1392, bit 1. If necessary, increase temperature threshold value in P-0-1311[178]. If necessary, increase debounce time in P-0-1311[179].
E2015, B5078: IPO impact not possible P-0-2853	Activating the intervention in the interpolation of the position command value while switching to force control is not permitted by IndraDrive.	Enter the value 0000 in P-0-2853, bits 4..1.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5079: Controller config. is out of range P-0-2845.0.8	The weighting of velocity feedforward control of the force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-2845.0.8.
E2015, B507A: Config data not feasible P-0-1311[195]	The decompression switch-off threshold is less than 0.	Enter a value greater than or equal to 0 in P-0-1311[195].
E2015, B507B: Config data exceeds valid range P-0-1311[122]	The lag error model monitoring window has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[122].
E2015, B507C: Config data not feasible P-0-1372.3	Impermissible configuration: Decompression and direction input via valves	Deactivate decompression (P-0-1372; bit 3 = 0).
E2015, B507D: Config data not feasible P-0-1311[384]	The switch-on threshold of system pressure control is greater than the switch-off threshold of system pressure control.	A value less than/equal to P-0-1311[386] has to be entered in P-0-1311[385].
E2015, B507E: Slave not ready for control	The slave drive for increasing the system pressure is to be activated, but it is not in Ab.	Switch drive to OM and switch on power.
E2015, B5081: Config data not feasible P-0-1372.3	The configuration of the decompression valves is not permitted for the selected cylinder type.	For single-rod cylinders, the decompression configuration must be identical for cylinder sides A and B. That is, the values in P-0-1372 bit 3 and bit 2 have to be identical.
E2015, B5082: Config data not feasible P-0-1311[396]	The required smoothing time constant for the optional velocity controller has been incorrectly configured.	The value in P-0-1385 has to be at least the same as the value in P-0-1311[177].
E2015, B5083: Config data not feasible P-0-1311[223]	The configured warning threshold of summated pressure monitoring is greater than the corresponding alarm threshold.	The value in P-0-1311[223] must not be higher than the value in P-0-1311[224].
E2015, B5085: Sum pressure of pump exceeds warning level	Summated pressure monitoring signals a high total pressure.	Check the cycle for correct decompression. Plausibility check of cylinder chamber pressures (S-0-0803 and S-0-0804) and status of decompression valves (P-0-1280, bits 16..15).
E2015, B5086: Config data exceeds valid range P-0-1316	The required smoothing time constant for the optional acceleration controller has been incorrectly configured.	The value in P-0-1316 has to be at least equal to the value in P-0-1311[177].
E2015, B5089: Config data exceeds valid range P-0-1311[115]	The required down ramp for the I-term of the position controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[115].
E2015, B508A: Config data exceeds valid range P-0-1311[111]	The required down ramp for the I-term of the pressure/force controller has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[111].
E2015, B508C: Config data exceeds valid range P-0-1377	The moving mass has been incorrectly configured.	Enter a value greater than 0 in P-0-1377.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B508D: Config data exceeds valid range P-0-1311[128]	The required filter time for generating the acceleration feedback value has been incorrectly configured.	The value in P-0-1311[128] has to be at least the same as the value in P-0-1311[177].
E2015, B5091: Oil filter feedback fail, reset feedback signal	Filter monitoring responded during an emergency stop. This response is likely to be incorrect.	Reset filter monitoring on the filter and repeat the cycle to verify whether the filter is clogged.
E2015, B5093: Parameter set no. 1 invalid, P-0-1311[0...6]	At least one list element of parameter set 1 has been incorrectly configured.	Enter values greater than or equal to 0 in P-0-1311[0], P-0-1311[1], P-0-1311[2], P-0-1311[4], P-0-1311[5], and P-0-1311[6].
E2015, B5094: Parameter set no. 2 invalid, P-0-1311[25...31]	At least one list element of parameter set 2 has been incorrectly configured.	Enter values greater than or equal to 0 in P-0-1311[25], P-0-1311[26], P-0-1311[27], P-0-1311[29], P-0-1311[30], and P-0-1311[31].
E2015, B5095: Parameter set no. 3 invalid, P-0-1311[50...56]	At least one list element of parameter set 3 has been incorrectly configured.	Enter values greater than or equal to 0 in P-0-1311[50], P-0-1311[51], P-0-1311[52], P-0-1311[54], P-0-1311[55] and P-0-1311[56].
E2015, B5096: Parameter set no. 4 invalid, P-0-1311[75...81]	At least one list element of parameter set 4 has been incorrectly configured.	Enter values greater than or equal to 0 in P-0-1311[75], P-0-1311[76], P-0-1311[77], P-0-1311[79], P-0-1311[80], and P-0-1311[81].
E2015, B5099: Pressure difference controlling not allowed P-0-1370	Alternating pressure control is not possible for the selected signal source.	Use alternating force control (P-0-1370 bit 15 = 1) or select pressure A (= 1) or pressure B (= 2) as signal source in P-0-2937.0.1.
E2015, B509B: Config data exceeds valid range P-0-1311[176]	The weighting of the maximum allowed velocity for encoder jump monitoring has been incorrectly configured.	Enter a value between 100 and 200 percent in P-0-1311[176].
E2015, B509D: Config data exceeds valid range S-0-0077	The specified scaling factor of position data is not permissible.	Enter the value 1 in S-0-0077.
E2015, B509E: Config data exceeds valid range S-0-0045	The specified scaling factor of velocity data is not permissible.	Enter the value 1 in S-0-0045.
E2015, B509F: Config data exceeds valid range S-0-0161	The specified scaling factor of acceleration data is not permissible.	Enter the value 1 in S-0-0161.
E2015, B50A0: Config data exceeds valid range S-0-0093	The specified scaling factor of torque/force data is not permissible.	Enter the value 1 in S-0-0093.
E2015, B50A1: Config data exceeds valid range S-0-0846	The specified scaling factor of flow data is not permissible.	Enter the value 1 in S-0-0846.
E2015, B50A2: Config data exceeds valid range S-0-0806	The specified scaling factor of pressure data is not permissible.	Enter the value 1 in S-0-0807.
E2015, B50A3: Config of system pressure rising invalid P-0-1370.16	The configuration of the system pressure increase is invalid.	A valid configuration has to be set for system pressure increase. P-0-1370 bit 17..16 unequal to 11.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50A5: Config data not feasible P-0-1311[234]	The configured warning threshold of system overpressure monitoring is greater than the corresponding alarm threshold.	The value in P-0-1311[234] must not be higher than the value in P-0-1311[235].
E2015, B50A7: System pressure exceeds upper warning level	System overpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, adjust system pressure control; alternatively, increase alarm threshold via P-0-1311[234] or extend debounce time P-0-1311[233].
E2015, B50A8: Config data not feasible P-0-1311[237]	The configured warning threshold of system underpressure monitoring is smaller than the corresponding alarm threshold.	The value in P-0-1311[237] has to be at least the same as the value in P-0-1311[238].
E2015, B50AA: System pressure falls below lower warning level	System underpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, adjust system pressure control; alternatively, reduce alarm threshold via P-0-1311[237] or extend debounce time P-0-1311[236].
E2015, B50AB: Config data not feasible P-0-1311[248]	The configured warning threshold of pilot oil overpressure monitoring is greater than the corresponding alarm threshold.	The value in P-0-1311[248] must not be higher than the value in P-0-1311[249].
E2015, B50AD: Control pressure exceeds upper warning level	Pilot oil overpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, adjust pilot oil pressure control; alternatively, increase warning threshold via P-0-1311[248] or extend debounce time P-0-1311[247].
E2015, B50AE: Config data not feasible P-0-1311[251]	The configured warning threshold of pilot oil underpressure monitoring is smaller than the corresponding alarm threshold.	The value in P-0-1311[251] has to be at least the same as the value in P-0-1311[252].
E2015, B50B0: Control pressure falls below lower warning level	Pilot oil underpressure monitoring signals a warning.	Take hydraulic corrective measures. If necessary, adjust pilot oil pressure control; alternatively, reduce alarm threshold via P-0-1311[251] or extend debounce time P-0-1311[250].
E2015, B50B1: Config data not feasible P-0-1311[286]	The configured warning threshold of overpressure monitoring for pressure feedback value C is smaller than the corresponding alarm threshold.	The value in P-0-1311[286] must not be higher than the value in P-0-1311[287].
E2015, B50B3: Pressure chamber C exceeds upper warning level	Overpressure monitoring of pressure feedback value C signals a warning.	Take hydraulic corrective measures. When appropriate, increase warning threshold via P-0-1311[286] or extend debounce time P-0-1311[285].
E2015, B50B4: Force calculation and cylinder config not feasible	Calculating the force from the pressure differential A-B-C is only possible for double rod cylinders with area switching.	Change cylinder type in P-0-1370 bit 2-4 or signal source for force calculation in P-0-2937.0.1.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50B5: Config data not feasible P-0-1311[153]	The configured warning threshold of oil temperature monitoring is smaller than the corresponding alarm threshold.	The value in P-0-1311[153] has to be at least the same as the value in P-0-1311[154].
E2015, B50B7: Oil temperature exceeds warning level	Oil temperature monitoring for too low values signals a warning.	Take hydraulic corrective measures. If necessary, reduce alarm threshold via P-0-1311[153] or extend debounce time P-0-1311[152]
E2015, B50B8: Config data not feasible P-0-1311[225]	The selection of the signal source for the system pressure is invalid	A value from 0 to 8 has to be entered in P-0-1311[225].
E2015, B50B9: Config data not feasible P-0-1311[226]	The limit values for the analog value of the system pressure are invalid.	In P-0-1311[226] a value of less than P-0-1311[227] has to be entered.
E2015, B50BA: System pressure: analog value exceeds range limit	The limit values of the analog value of the system pressure are exceeded	Inspect the sensor used, the analog terminal and wiring.
E2015, B50BB: Config data not feasible P-0-1311[228]	The configured lower limit of the value range for scaling the oil temperature is greater than or equal to the corresponding upper limit.	In P-0-1311[228] a value unequal to P-0-1311[229] has to be entered.
E2015, B50BC: Config data not feasible P-0-1311[230]	The configured lower limit of the signal range for scaling the system pressure is greater than or equal to the corresponding upper limit.	In P-0-1311[230] a value unequal to P-0-1311[231] has to be entered.
E2015, B50BD: Config data not feasible P-0-1311[232]	The filter time of system pressure is invalid	In P-0-1311[232] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50BE: Config data not feasible P-0-1311[239]	The selection of the signal source for pilot oil pressure is invalid.	A value from 0 to 8 has to be entered in P-0-1311[239].
E2015, B50BF: Config data not feasible P-0-1311[240]	The limit values for the analog value of the pilot oil pressure are invalid.	In P-0-1311[240] a value of less than P-0-1311[241] has to be entered.
E2015, B50C0: Control pressure: analog value exceeds range limit	The limit values for the analog value of the pilot oil pressure are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50C1: Config data not feasible P-0-1311[242]	The configured lower limit of the value range for scaling the pilot oil pressure is greater than or equal to the corresponding upper limit.	In P-0-1311[242] a value unequal to P-0-1311[243] has to be entered.
E2015, B50C2: Config data not feasible P-0-1311[244]	The configured lower limit of the signal range for scaling the pilot oil pressure is greater than or equal to the corresponding upper limit.	In P-0-1311[244] a value unequal to P-0-1311[245] has to be entered.
E2015, B50C3: Config data not feasible P-0-1311[246]	The filter time of pilot oil pressure is invalid.	In P-0-1311[246] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50C4: Config data not feasible P-0-1311[162]	The selection of the signal source for the oil temperature is invalid.	A value from 0 to 8 has to be entered in P-0-1311[162].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50C5: Config data not feasible P-0-1311[155]	The limit values for the analog value of the oil temperature are invalid.	In P-0-1311[155] a value of less than P-0-1311[156] has to be entered.
E2015, B50C6: Oil temperature: analog value exceeds range limit	The limit values for the analog value of the oil temperature are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50C7: Config data not feasible P-0-1311[161]	The filter time of the oil temperature is invalid.	In P-0-1311[161] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50C8: Config data not feasible P-0-1311[253]	The selection of the signal source for pressure feedback value A is invalid.	A value from 0 to 6 has to be entered in P-0-1311[253].
E2015, B50C9: Config data not feasible P-0-1311[254]	The limit values for the analog value of pressure feedback value A are invalid.	In P-0-1311[254] a value of less than P-0-1311[255] has to be entered.
E2015, B50CA: Pressure A: analog value exceeds range limit	The limit values for the analog value of pressure feedback value A are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50CB: Config data not feasible P-0-1311[256]	The configured lower limit of the value range for scaling pressure feedback value A is greater than or equal to the corresponding upper limit.	In P-0-1311[256] a value unequal to P-0-1311[257] has to be entered.
E2015, B50CC: Config data not feasible P-0-1311[258]	The configured lower limit of the signal range for scaling pressure feedback value A is greater than or equal to the corresponding upper limit.	In P-0-1311[258] a value unequal to P-0-1311[259] has to be entered.
E2015, B50CD: Config data not feasible P-0-1311[260]	The filter time of pressure feedback value A is invalid.	In P-0-1311[260] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50CE: Config data not feasible P-0-1311[261]	The selection of the signal source for pressure feedback value B is invalid.	A value from 0 to 6 has to be entered in P-0-1311[261].
E2015, B50CF: Config data not feasible P-0-1311[262]	The limit values for the analog value of pressure feedback value B are invalid.	In P-0-1311[262] a value of less than P-0-1311[263] has to be entered.
E2015, B50D0: Pressure B: analog value exceeds range limit	The limit values for the analog value of pressure feedback value B are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50D1: Config data not feasible P-0-1311[264]	The configured lower limit of the value range for scaling pressure feedback value B is greater than or equal to the corresponding upper limit.	In P-0-1311[264] a value unequal to P-0-1311[265] has to be entered.
E2015, B50D2: Config data not feasible P-0-1311[266]	The configured lower limit of the signal range for scaling pressure feedback value B is greater than or equal to the corresponding upper limit.	In P-0-1311[266] a value unequal to P-0-1311[267] has to be entered.
E2015, B50D3: Config data not feasible P-0-1311[268]	The filter time of pressure feedback value B is invalid.	In P-0-1311[268] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50D4: Config data not feasible P-0-1311[269]	The selection of the signal source for pressure feedback value C is invalid.	A value from 0 to 6 has to be entered in P-0-1311[269].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50D5: Config data not feasible P-0-1311[270]	The limit values for the analog value of pressure feedback value C are invalid.	In P-0-1311[270] a value of less than P-0-1311[271] has to be entered.
E2015, B50D6: Pressure C: analog value exceeds range limit	The limit values for the analog value of pressure feedback value C are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50D7: Config data not feasible P-0-1311[272]	The configured lower limit of the value range for scaling pressure feedback value C is greater than or equal to the corresponding upper limit.	In P-0-1311[272] a value unequal to P-0-1311[273] has to be entered.
E2015, B50D8: Config data not feasible P-0-1311[274]	The configured lower limit of the signal range for scaling pressure feedback value C is greater than or equal to the corresponding upper limit.	In P-0-1311[274] a value unequal to P-0-1311[275] has to be entered.
E2015, B50D9: Config data not feasible P-0-1311[276]	The filter time of pressure feedback value C is invalid.	In P-0-1311[276] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50DA: Config data not feasible P-0-1311[277]	The selection of the signal source for accumulator pressure is invalid.	A value from 0 to 6 has to be entered in P-0-1311[277].
E2015, B50DB: Config data not feasible P-0-1311[278]	The limit values of the analog value of the accumulator pressure are invalid.	In P-0-1311[278] a value of less than P-0-1311[279] has to be entered.
E2015, B50DC: Tank pressure: analog value exceeds range limit	The limit values for the analog value of the accumulator pressure are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50DD: Config data not feasible P-0-1311[280]	The configured lower limit of the value range for scaling the accumulator pressure is greater than or equal to the corresponding upper limit.	In P-0-1311[280] a value unequal to P-0-1311[281] has to be entered.
E2015, B50DE: Config data not feasible P-0-1311[282]	The configured lower limit of the signal range for scaling the accumulator pressure is greater than or equal to the corresponding upper limit.	In P-0-1311[282] a value unequal to P-0-1311[283] has to be entered.
E2015, B50DF: Config data not feasible P-0-1311[284]	The filter time of the accumulator pressure is invalid	In P-0-1311[284] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50E0: Config data not feasible P-0-1311[17]	The selection of the signal source for the swivel angle is invalid.	A value from 0 to 6 has to be entered in P-0-1311[17].
E2015, B50E1: Config data not feasible P-0-1311[18]	The limit values for the analog value of the swivel angle are invalid.	In P-0-1311[18] a value of less than P-0-1311[279] has to be entered.
E2015, B50E2: Swivel angle act: analog value exceeds range limit	The limit values for the analog value of the swivel angle are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50E3: Config data not feasible P-0-1311[20]	The configured lower limit of the value range for scaling the swivel angle is greater than or equal to the corresponding upper limit.	In P-0-1311[20] a value unequal to P-0-1311[21] has to be entered.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50E4: Config data not feasible P-0-1311[22]	The configured lower limit of the signal range for scaling the swivel angle is greater than or equal to the corresponding upper limit.	In P-0-1311[22] a value unequal to P-0-1311[23] has to be entered.
E2015, B50E5: Config data not feasible P-0-1311[24]	The filter time of swivel angle is invalid.	In P-0-1311[24] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50E6: Config data not feasible P-0-1311[200]	In P-0-1311[200] a value greater than/equal to P-0-1311[177] has to be entered.	
E2015, B50E7: Config data not feasible P-0-1311[288]	The filter time of motor torque is invalid.	In P-0-1311[288] a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50E8: Config data not feasible P-0-1311[202]	The target dynamics of swivel angle control is invalid.	In P-0-1311[202] a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50E9: Config data not feasible P-0-1311[203]	The time constant of swivel angle control is invalid.	In P-0-1311[203] a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50EA: Config data not feasible P-0-1311[289]	The reduction factor for the static torque is invalid.	In P-0-1311[289] a value greater than 0 and less than/equal to 1 has to be entered.
E2015, B50EB: Config data not feasible P-0-1311[290]	The reduction factor for the peak torque is invalid.	In P-0-1311[290] a value greater than 0 and less than/equal to 1 has to be entered.
E2015, B50EC: Config data not feasible P-0-2873.0.3	Controller output inversion is invalid.	In P-0-2873.0.3 a value greater than/equal to -1 and less than/equal to 1 has to be entered.
E2015, B50ED: Config data not feasible P-0-1311[295]	The valve offset is invalid.	In P-0-1311[295] a value greater than/equal to -100 and less than/equal to 100 has to be entered.
E2015, B50EE: Config data not feasible P-0-1311[296]	The valve substitute value is invalid.	In P-0-1311[296] a value greater than/equal to -100 and less than/equal to 100 has to be entered.
E2015, B50EF: Config data not feasible S-0-0865	The positive valve control variable limitation is invalid.	In S-0-0865 a value greater than/equal to -100 and less than/equal to 100 has to be entered.
E2015, B50F0: Config data not feasible S-0-0866	The negative valve control variable limitation is invalid.	In S-0-0866 a value greater than/equal to -100 and less than/equal to 100 has to be entered and the value must not be greater than S-0-0865.
E2015, B50F1: Config data not feasible P-0-1311[291]	The selected criterion for the command value generator of the swivel angle is invalid.	A value from 0 to 2 has to be entered in P-0-1311[291].
E2015, B50F2: Config data not feasible P-0-1311[201]	The integration time constant is invalid.	In P-0-1311[201] a value greater than/equal to P-0-1311[177] has to be entered.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B50F3: Config data not feasible P-0-1311[293]	The valve standard velocity is invalid.	In P-0-1311[293] a value greater than/equal to 0 has to be entered.
E2015, B50F4: Config data not feasible P-0-1311[204]	The max. controller output correction is invalid.	In P-0-1311[204] a value greater than/equal to 0 and less than/equal to 100 has to be entered.
E2015, B50F5: Config data not feasible P-0-1311[42]	The selection of the signal source for manual swivel angle input is invalid.	A value from 0 to 6 has to be entered in P-0-1311[42].
E2015, B50F6: Config data not feasible P-0-1311[43]	The limit values of the analog value for manual swivel angle input are invalid.	In P-0-1311[43] a value of less than P-0-1311[279] has to be entered.
E2015, B50F7: Manual swivel cmd: analog value exceeds range limit	The limit values of the analog value for manual swivel angle input are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B50F8: Config data not feasible P-0-1311[45]	The configured lower limit of the value range for scaling the manual swivel angle input is greater than or equal to the corresponding upper limit.	In P-0-1311[45] a value unequal to P-0-1311[46] has to be entered.
E2015, B50F9: Config data not feasible P-0-1311[47]	The configured lower limit of the signal range for scaling the manual swivel angle input is greater than or equal to the corresponding upper limit.	In P-0-1311[47] a value unequal to P-0-1311[48] has to be entered.
E2015, B50FA: Config data not feasible P-0-1311[49]	The filter time for manual swivel angle input is invalid.	In P-0-1311[49] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B50FB: Config data exceeds valid range P-0-1311[330]	The velocity threshold value for activating the pulsation compensation is invalid.	In P-0-1311[330] a value greater than 0 rpm and less than/equal to 500 rpm has to be entered.
E2015, B50FC: Config data exceeds valid range P-0-1311[331]	The relative force threshold value for activating the pulsation compensation is invalid.	In P-0-1311[331] a value greater than -1 and less than 1 has to be entered.
E2015, B50FD: Config data not feasible P-0-1311[332]	The absolute for threshold value for activating pulsation compensation is invalid.	In P-0-1311[332] a value unequal to 0 has to be entered.
E2015, B50FE: Config data not feasible P-0-1311[334]	The number of pump pistons is invalid.	In P-0-1311[334] a value greater than 0 has to be entered.
E2015, B50FF: Config data exceeds valid range P-0-1311[335]	The rotation angle of the motor at the beginning of the transition region from the B-side to the A-side is invalid.	In P-0-1311[335] a value greater than/equal to 0° and less than/equal to 360° has to be entered.
E2015, B5100: Config data exceeds valid range P-0-1311[336]	The rotation angle of the motor at the beginning of the transition region from the A-side to the B-side is invalid.	In P-0-1311[336] a value greater than/equal to 0° and less than/equal to 360° has to be entered.
E2015, B5101: Config data exceeds valid range P-0-1311[337]	The offset for the beginning of the transition region from the B-side to the A-side is invalid.	In P-0-1311[337] a value greater than/equal to -180° and less than/equal to 180° has to be entered.
E2015, B5102: Config data exceeds valid range P-0-1311[338]	The offset for the beginning of the transition region from the A-side to the B-side is invalid.	In P-0-1311[338] a value greater than/equal to -180° and less than/equal to 180° has to be entered.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5103: Config data exceeds valid range P-0-1311[339]	The angle of the transition region from B-side to A-side is invalid.	In P-0-1311[339] a value greater than 0° and less than 360°/ P-0-1311[334] has to be entered.
E2015, B5104: Config data exceeds valid range P-0-1311[340]	The angle of the transition region from the A-side to the B-side is invalid.	In P-0-1311[340] a value greater than 0° and less than 360°/ P-0-1311[334] has to be entered.
E2015, B5105: Config data exceeds valid range P-0-1311[341]	The portion of the transition region from B-side to A-side, in which compensating takes place, is invalid.	In P-0-1311[341] a value greater than 0 % and less than/equal to 100 % has to be entered.
E2015, B5106: Config data exceeds valid range P-0-1311[342]	The portion of the transition region from B-side to A-side, in which compensating takes place, is invalid.	In P-0-1311[342] a value greater than 0 % and less than/equal to 100 % has to be entered.
E2015, B5107: Config data not feasible P-0-1311[380]	The selection of symbol-based patch function 1 is invalid.	In P-0-1311[380] a number less than/ equal to 16 has to be entered.
E2015, B5108: Config data not feasible P-0-1311[381]	The selection of symbol-based patch function 2 is invalid.	In P-0-1311[381] a number less than/ equal to 16 has to be entered.
E2015, B5109: Config data not feasible P-0-1311[382]	The selection of symbol-based patch function 3 is invalid.	In P-0-1311[382] a number less than/ equal to 16 has to be entered.
E2015, B510A: Config data not feasible P-0-1311[383]	The selection of symbol-based patch function 4 is invalid.	In P-0-1311[383] a number less than/ equal to 16 has to be entered.
E2015, B510B: Config data not feasible P-0-1370.28	The configuration of the source of compensation speed is invalid.	In P-0-1370 bit 28 and bit 29 must not be set at the same time.
E2015, B510C: Config data not feasible P-0-1372.16	The configuration of the force threshold of pulsation compensation is invalid.	In P-0-1372 bit 16 and bit 17 must not be set at the same time.
E2015, B510D: Config data not feasible P-0-1311[67]	The selection of the signal source of the force feedback value input is invalid.	In P-0-1311[67] a value from 0 to 6 has to be entered.
E2015, B510E: Config data not feasible P-0-1311[68]	The limit values for the analog value of the swivel angle are invalid.	In P-0-1311[68] a value of less than P-0-1311[69] has to be entered.
E2015, B510F: Force feedback: analog value exceeds range limit	The limit values for the analog value of the force feedback value input are exceeded.	Inspect the sensor used, the analog terminal and wiring.
E2015, B5110: Config data not feasible P-0-1311[70]	The configured lower limit of the value range for scaling the force feedback value input is greater than or equal to the corresponding upper limit.	In P-0-1311[70] a value unequal to P-0-1311[71] has to be entered.
E2015, B5111: Config data not feasible P-0-1311[72]	The configured lower limit of the signal range for scaling the force feedback value input is greater than or equal to the corresponding upper limit.	In P-0-1311[72] a value unequal to P-0-1311[73] has to be entered.
E2015, B5112: Config data not feasible P-0-1311[74]	The filter time of the force feedback value input is invalid.	In P-0-1311[74] the value 0 or a value greater than/equal to P-0-1311[177] has to be entered.
E2015, B5113: A scaling type is invalid	The set scaling type is not supported.	Valid scaling types have to be set.

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B5114: A scaling factor is invalid	Invalid scaling factor.	All scaling factors have to have the value 1
E2015, B5115: Pump runs on low speed at high Vg	Impermissible operating point (low speed at high Vg).	Check rating and activation.
E2015, B5116: Pump is reversing at high Vg and high load	Impermissible operating point (reversing operation at high Vg).	Check rating and activation.
E2015, B5117: Config data exceeds valid range P-0-1311[150]	Manual Vg for the pump is less than minimum Vg.	P-0-1311[150] has to be greater than/equal to P-0-1371 when converted into percent, i.e. P-0-1371 * 100 / P-0-2943.
E2015, B5118: Config data exceeds valid range P-0-1311[439]	The filter time for torque is invalid.	A value greater than/equal to 0.0 has to be entered in P-0-1311[439].
E2015, B5119: Config data exceeds valid range P-0-1311[430]	The force window for recognizing isolating has an invalid value.	A value greater than/equal to 0.0 has to be entered in P-0-1311[430].
E2015, B511A: Config data exceeds valid range P-0-1311[431]	The hysteresis for the force window for recognizing isolating has an invalid value.	A value greater than/equal to 0.0 has to be entered in P-0-1311[431].
E2015, B511B: Config data exceeds valid range P-0-1311[432]	The torque threshold for recognizing isolating has an invalid value.	A value greater than/equal to 0.0 has to be entered in P-0-1311[432].
E2015, B511C: Config data exceeds valid range P-0-1311[440]	The gain factor for the torque controller of the isolation function has an invalid value.	A value greater than 0.0 has to be entered in P-0-1311[440].
E2015, B511D: Config data exceeds valid range P-0-1311[437]	The slope for torque reduction has an invalid value.	A value greater than 0.0 has to be entered in P-0-1311[437].
E2015, B511E: Config data exceeds valid range P-0-1311[438]	The slope for torque build-up has an invalid value.	A value greater than 0.0 has to be entered in P-0-1311[438].
E2015, B511F: Config data exceeds valid range P-0-1311[441]	The position window for recognizing isolating has an invalid value.	A value greater than/equal to 0.0 has to be entered in P-0-1311[441].
E2015, B5120: Config data exceeds valid range P-0-1311[442]	The hysteresis for the position window for recognizing isolating has an invalid value.	A value greater than/equal to 0.0 has to be entered in P-0-1311[442].
E2015, B57D2: Safety vlv mon: Test time Vlv1	The last test of the safety valve 1 took place too long ago, it has to be tested.	Carry out testing. Where appropriate, extend test interval in P-0-1311[213].
E2015, B57D3: Safety vlv mon: Test time Vlv2	The last test of safety valve 2 took place too long ago, it has to be tested.	Carry out testing. Where appropriate, extend test interval in P-0-1311[214].
E2015, B57DC: Safety config is locked	The safety configuration to be changed is locked.	The safety configuration can be unlocked via P-0-1382.
E2015, B57DD: Position drift exceeds warning level	Drift rate monitoring signals a warning - caused by lowering of the axis or excessive noise in the position signal.	Test for leakage. Extend cycle time of the monitoring interval P-0-1311[216] to suppress signal noise. Where appropriate, increase warning threshold via P-0-1311[217].

S-0-0095 (S-0-0390 + P-0-1387 incl. P-0-1300) Warning, diagnostic code: Text	Cause	Remedy
E2015, B57DF: Config data not feasible P-0-1311[217]	The required warning threshold for monitoring the lowering speed has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[217].
E2015, B57E0: Config data not feasible P-0-1311[218]	The required alarm threshold for monitoring the drift rate has been incorrectly configured.	Enter a value greater than or equal to 0 in P-0-1311[218].

Tab. 8-443: Warnings, E2015

Message

P-0-1387 incl. P-0-1300 Diagnostic code: Text	Cause	Remedy
B4034: Position controller, upper limitation active	The position controller output has reached its upper limit.	Check setting of position controller. If necessary, increase limit value using higher values in S-0-0038, S-0-0091, S-0-0113 or P-0-0113.
B4035: Position controller, lower limitation active	The position controller output has reached its lower limit.	Check setting of position controller. If necessary, reduce limit value using higher values in S-0-0091, S-0-0113 or P-0-0113, or lower value in S-0-0039.
B403F: Force controller, upper limitation active	The pressure/force controller output has reached its upper limit.	Check setting of pressure/force controller. If necessary, increase limit value using higher values in S-0-0038, S-0-0091, S-0-0113 or P-0-0113.
B4040: Force controller, lower limitation active	The pressure/force controller output has reached its lower limit.	Check setting of pressure/force controller. If necessary, reduce limit value using higher values in S-0-0091, S-0-0113 or P-0-0113, or lower value in S-0-0039.

Tab. 8-444: Messages

9 Annex

9.1 Documentations

9.1.1 Drive systems, system components

Drive systems with single-axis or double-axis drive controllers

Title	Type of documentation	Documentation type[1)]	Material number
Drive system – Rexroth IndraDrive Complete, intelligent and safe	Product catalog	R999000019	R999000019
Rexroth IndraDrive Cs Drive systems with HCS01	Project Planning Manual	DOK-INDRV*-HCS01******-PRxx-EN-P	R911322210
Rexroth IndraDrive Drive systems with HMV01/02, HMS01/02, HMD01, HCS02/03	Project Planning Manual	DOK-INDRV*-SYSTEM*****-PRxx-EN-P	R911309636
Rexroth IndraDrive Supply Units, Power Sections HMV, HMS, HMD, HCS02, HCS03	Project Planning Manual	DOK-INDRV*-HMV-S-D+HCS-PRxx-EN-P	R911318790
Rexroth IndraDrive Control sections CSE02, CSB02, CDB02, CSH02	Project Planning Manual	DOK-INDRV*-Cxx02******-PRxx-EN-P	R911338962
Rexroth IndraDrive Additional components and accessories	Project Planning Manual	DOK-INDRV*-ADDCOMP****-PRxx-EN-P	R911306140

1) In the documentation types, "xx" is a placeholder for the current documentation version (example: PR01 means the first edition of a project planning description)

Tab. 9-1: Documentation – Drive systems, system components

9.1.2 Firmware

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-…	Material number R911…
MPx-20 Functions	Application Manual	MP*-20VRS**-APxx-EN-P	345608
MPx-20 Version Notes	Release Notes	MP*-20VRS**-RNxx-EN-P	345606
Power Supply Basic PSB-20 Functions	Application Manual	PSB-20VRS**-APxx-EN-P	345610
Power Supply Basic PSB-19 Functions	Application Manual	PSB-19VRS**-APxx-EN-P	345602
MPx-18 Functions	Application Manual	MP*-18VRS**-APxx-EN-P	338673

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-…	Material number R911…
MPx-18 Version Notes	Release Notes	MP*-18VRS**-RNxx-EN-P	338658
MPx-17 Functions	Application Manual	MP*-17VRS**-APxx-EN-P	331236
MPx-17 Version Notes	Release Notes	MP*-17VRS**-RNxx-EN-P	331588
MPx-16 Functions	Application Manual	MP*-16VRS**-APxx-EN-P	326767
MPx-16 Version Notes	Release Notes	MP*-16VRS**-RNxx-EN-P	329272
MPx-16 to MPx-20 and PSB Parameters	Reference Book	GEN1-PARA**-RExx-EN-P	328651
MPx-16 to MPx-20 and PSB Diagnostic Messages	Reference Book	GEN1-DIAG**-RExx-EN-P	326738
Integrated Safety Technology "Safe Torque Off" (as of MPx-16)	Application Manual	SI3-**VRS**-APxx-EN-P	332634
Integrated Safety Technology "Safe Motion" (as of MPx-18)	Application Manual	SI3*SMO-VRS-APxx-EN-P	338920
Rexroth IndraMotion MLD Libraries as of MPx-17	Reference Book	MLD-SYSLIB2-RExx-EN-P	332627
Rexroth IndraMotion MLD Libraries as of MPx-18	Reference Book	MLD-SYSLIB3-RExx-EN-P	338916
Rexroth IndraMotion MLD as of MPx-17	Application Manual	MLD2-**VRS*-APxx-EN-P	334351
Rexroth IndraMotion MLD as of MPx-18	Application Manual	MLD3-**VRS*-APxx-EN-P	338914

1) In the document typecodes, "xx" is a placeholder for the current edition of the documentation (e.g.: RE02 is the second edition of a Reference Book)

Tab. 9-2: Documentations – Firmware

9.1.3 Motor/pump unit

Title	Type of documentation	Documentation type[1)]	Material number
Sytronix Variable-Speed Pump Drives	Product catalog	R999000332	R999000332
Rexroth Sytronix SvP 70xx Motor-Pump Unit MPA01	Operating Instructions	DOK-SYTROX-MPA01******-ITxx-xx-P	R911339824

Title	Type of documentation	Documentation type[1)]	Material number
Rexroth Sytronix SvP 70xx Motor-pump unit MPA02	Operating instructions	DOK-SYTROX-MPA02******-ITRS-EN-P	R911387041
Rexroth Sytronix SvP 7020 IMC Variable-Speed Pump Drives	Operating instructions	DOK-SYTROX-SVP7020-I*C-ITxx-EN-P	R911377189
Rexroth Sytronix SvP 7020 IMC Variable-Speed Pump Drives	Commissioning Manual	DOK-SYTROX-SVP7020-I*C-CO	RE 62311-IB
Rexroth Sytronix SvP 7020 PFC03 Variable-Speed Positioning of Hydraulic Axes	Operating instructions	DOK-SYTROX-SVP7020-PF*-ITxx-EN-P	RE 62314-B
Release Notes	Release Notes		RE 62313-RN

1) In the document type codes, "xx" is a placeholder for the current edition of the documentation (e.g.: IT01 is the first edition of Operating Instructions)

Tab. 9-3: Supplementary documentations

9.1.4 IT Security

Title	Type of documentation	Documentation type[1)]	Material number
Security Manual Electric Drives and Controls	Project planning manual	DOK-IWORKS-SECURITY***-PR	R911342562

Tab. 9-4: IT Security

9.2 Abbreviations

ADC	Analog-digital converter
AF	Drive enable
AT	Cyclic actual values
AU	Drive in automatic mode
DAC	Digital-analog converter
DFEn	Variable-speed drive using a pump with electronic pressure and flow rate control
DRn	Constant pressure system with hydromechanical pressure control
EMC	ElectroMagnetic Compatibility
F_act	Actual force value
F_cmd	Force command value
FcP	Frequency-controlled pump
FW	Drive firmware (e.g., MPx20VRS)
FOC mode	Field-oriented current control with motor encoder
FXC mode	Flux-controlled, sensorless motor operation
HW	Hardware

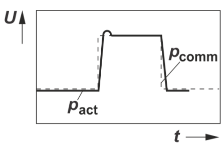
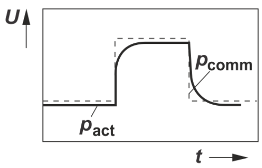
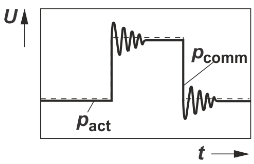
IMC	Injection Molding Control (p/Q control)
IW	IndraWorks
MDT	Cyclic command values
MLC	Motion Logic Control
MLD	Motion Logic Drive-based
MPx	Drive firmware
Decimal places	Decimal places
n_act	Actual speed value
P_act	Actual pressure value
P_cmd	Pressure command value
PFC	Position Force Control (x/F control)
Q_act	Actual flow value
Q_cmd	Flow command value
SvP	Servo-variable pump
SW	Software/parameter file (MLD program, FWS_MLDSYx_xxx_xxx)
SYX	SYTRONIX technology function
Vg	Displacement per revolution

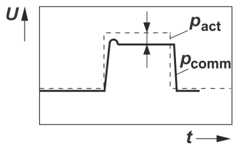
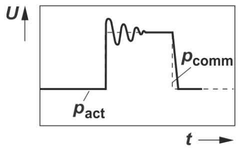
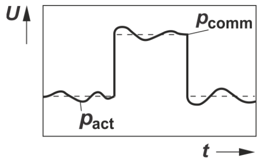
Tab. 9-5: Basic abbreviations

9.3 Controller optimization

9.3.1 General optimization of control parameters

Depending on the application, the parameters to be set for optimum controlling may vary. To achieve an ideal course, P-, I- and D-terms can be adjusted.

 DCH_Sytronix_idealeRegelung_EN.des	Ideal course
 DCH_Sytronix_P-Anteil_klein_EN.des	**Problem:** P-term too small **Solution:** Increase P-gain
 DCH_Sytronix_P-Anteil_gross_EN.des	**Problem:** P-term too large **Solution:** Reduce P-gain

 DCH_Sytronix_Regelabweichung_EN.des	**Problem:** P-term correct, excessive control deviation **Solution:** Increase I-gain component
 DCH_Sytronix_Zeitkonst_I-Anteil_EN.des	**Problem:** Time constant of I-term too small **Solution:** Optimize control deviation and oscillation If necessary, reduce P-term further
 DCH_Sytronix_D-Anteil_klein_EN.des	**Problem:** D-term too small **Solution:** Increase D-term

Tab. 9-6: Controller optimization

9.3.2 Setting rules for overshoot-free control behavior

For the application of a position-controlled axis (IT2 controlled system), the control parameters for an overshoot-free transient response can be determined.

P-controller, controller gain K_v

The stability limit of an axis with IT2 controlled system is reached with a controller gain of

$$K_v = 2D_0\omega_0$$

D_0 refers to damping and ω_0 to the natural angular frequency of the axis.

☞ Damping can be determined by means of a step response analysis for a stable system capable of oscillating:

$$D_0 = \frac{1}{\sqrt{1+\frac{\pi^2}{\left(\ln\frac{A1}{A2}\right)^2}}}$$

Where A 1 is the amplitude in the positive direction and A2 the amplitude in the negative direction of the first oscillation.

If D_0 is not known or cannot be determined, you should select D_0 = 0.1.

☞ The natural angular frequency can be determined using $\omega_0 = 2\pi f_0$. f_0 is the natural frequency of the axis.

In dependence on damping, K_v can be calculated as follows:

$$K_v = \begin{cases} \frac{1}{2} D_0 \omega_0, \text{ für } 0 < D_0 \leq 0,5 \\ \frac{1}{8} \frac{\omega_0}{D_0}, \text{ für } 0,5 < D_0 \end{cases}$$

☞ The controller gain is to be entered in "S-0-0104, Position loop Kv-factor". The correct unit has to be taken into account. For further information about the function, see chapter 7.4.7 "Position controller" on page 206.

P-controller with fine positioner (switching I-term), integral action time T_n

Here, it is assumed that the drive performs positioning in closed-loop position control against an external stiffness/load. Gain K_v is set as described in "P-controller, controller gain K_v" on page 509. The integral action time T_n depends on the stiffness of the hydraulic drive (cylinder), $c_{Öl,ges}$ and the static load stiffness of the controlled drive c_R. For this reason, we have to distinguish between the following cases for the integral action time:

$$T_n = \begin{cases} \frac{4}{K_v} \cdot \frac{2 \cdot c_{Öl,ges}}{c_R} \cdot \left(2 - \frac{2 \cdot c_{Öl,ges}}{c_R}\right) \text{ für } \frac{c_R}{c_{Öl,ges}} > 2 \\ \frac{4}{K_v} \text{ für } \frac{c_R}{c_{Öl,ges}} \leq 2 \end{cases}$$

In practice, the case $\frac{c_R}{c_{Öl,ges}} \leq 2$ is of greater relevance so that $T_n = \frac{4}{K_v}$ may be used as initial parameterization.

☞ Static load stiffness $c_R = \frac{\Delta F}{\Delta x}$ can be determined experimentally, if the load force can be varied:

- Perform positioning at position x_0 while load force $F_{L,0}$ develops
- Change load force by ΔF_L to $F_{L,1}$ and record position x_1
- $c_R = \frac{\Delta F_L}{\Delta x} = \frac{F_{L,1} - F_{L,0}}{x_1 - x_0}$

☞ The integral action time is to be entered in "S-0-0105, Position controller integral action time". The correct unit has to be taken into account. Further information about the function can be found in chapter 7.4.7 "Position controller" on page 206.

Acceleration feedback K_a with P-controller

For a deceleration-free control system, the following calculation rule is valid for acceleration feedback gain K_a, if no velocity feedback is used:

$$K_a = \frac{2 \cdot D_{soll}}{\omega_0}$$

Where D_{soll} is target damping and ω_0 the natural angular frequency of the axis.

In practice, control systems feature an intrinsic time delay, which has to be taken into account in parameterization and acceleration feedback. For this reason, the critical angular frequency $\omega_{krit,\ CS}$ has been introduced:

$$\omega_{krit,CS} = \frac{1}{\frac{2}{\pi}T_t + \frac{1}{\omega_{0,St}}}$$

Where

- T_t dead time of discrete-time signal processing, basically given by the sample time and phase shift of discrete filters or mathematical operations such as differentiation and
- $\omega_{0,St}$ of the natural angular frequency of the actuating system.

$\omega_{krit,\ CS}$ is the angular frequency at which a phase shift of 90° is reached due to the delay of the control system. The closer the natural angular frequency ω_0 of the drive comes to the critical angular frequency $\omega_{krit,\ CS}$, the lower is the damping effect of acceleration feedback. As the phase shift increases ($\omega_{krit,\ CS}$ decreases or tends towards ω_0), the acceleration feedback results in an increase in the natural frequency of the controlled drive, since it partially acts like a velocity feedback due to the phase shift. When $\omega_0 = \omega_{krit,\ CS}$ there is finally no more damping effect.

In dependence on n $\omega_{krit,\ CS}$ the realizable target damping D_{soll} and settings for the acceleration feedback gain K_a are as follows:

$$0 < \frac{\omega_0}{\omega_{krit,CS}} \le 0,25 \qquad D_{soll} = 0,6 \qquad K_a = \frac{1,2}{\omega_0}$$

$$0,25 < \frac{\omega_0}{\omega_{krit,CS}} \le 0,55 \qquad D_{soll} = 0,85 - \frac{\omega_0}{\omega_{krit,CS}} \qquad K_a = \frac{1,7}{\omega_0} - \frac{2}{\omega_{krit,CS}}$$

$$0,55 < \frac{\omega_0}{\omega_{krit,CS}} \le 1,0 \qquad D_{soll} = \frac{2}{3}\left(1 - \frac{\omega_0}{\omega_{krit,CS}}\right) \qquad K_a = \frac{4}{3}\left(\frac{1}{\omega_0} - \frac{1}{\omega_{krit,CS}}\right)$$

☞ When determining $\omega_{krit,\ CS}$ for a displacer-controlled hydraulic drive, one can usually neglect the delay by the dynamic behavior of the motor/pump unit as against the phase shift of signal processing.

Example:

A control system with a sample time of 2 ms is assumed and the acceleration is determined by twofold differentiation of the actual position. This results in the following realizable target damping of the hydraulic drive in dependence on the natural angular frequency ω_0 of the drive:

Delay T_t = 6 ms = sample time of the control system + 2 * sample time for differentiation

$$\omega_{krit,CS} = \frac{1}{\left(\frac{2}{\pi} \cdot 0,006s\right)} = 261,78\frac{rad}{s}$$

$$f_{krit,CS} = \frac{\omega_{krit,CS}}{2\pi} = \frac{261,78\frac{rad}{s}}{2\pi} = 41.\bar{6}Hz$$

ω_0 [rad/s] drive	Target damping D_{soll}	Acceleration feedback K_a [s]
6.28 <= ω_0 <= 65.54	0.60 <= D_{soll} <= 0.60	0.1910 <= K_a <= 0.0183
65.54 < ω_0 <= 144.00	0.60 < D_{soll} <= 0.30	0.0183 < K_a <= 0.0042
144.00 < ω_0 <= 261.80	0.30 < D_{soll} <= 0.00	0.0042 < K_a <= 0.000

Tab. 9-7: Realizable target damping and required gain in dependence on the natural frequency of the drive

☞ The acceleration feedback is to be entered in "S-0-0348, Acceleration feedforward gain". The correct unit has to be taken into account. For further information about the function, see chapter 7.4.7 "Position controller" on page 206.

Observer gain K_B for the acceleration observer

In the case of drives with a constant moving mass it may be advantageous to calculate an estimated value for the actual acceleration by mans of a reduced observer. For the observer gain, $\omega_B >= \omega_0$ has to be valid, with a natural angular frequency of ω_0 of the drive. Typically, $\omega_B >> \omega_0$ is selected so that the observer is clearly faster than the drive. Here, a compromise has to be found between the dynamics of the observer and excessively large gain of measurement noise. The observer gain K_B can then be formed as follows:

$K_B = \omega_B$ with $\omega_B \geq 2\pi f_0$

☞ The observer is entered in "P-0-1311[129], Acceleration observer: P-gain". The correct unit has to be taken into account. For further information about the function, see chapter 7.4.5 "Actual value acquisition" on page 199.

10 Service and support

Contact for repairs

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Preparation of information

We can help you in a fast and efficient way if you keep the following information available:

- Detailed description of the failure and the circumstances
- Information on the nameplate of the products concerned, particularly the type keys and serial numbers
- Parameter files of the relevant drive system with all parameters
- Your contact details (phone number, fax number, e-mail address)

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