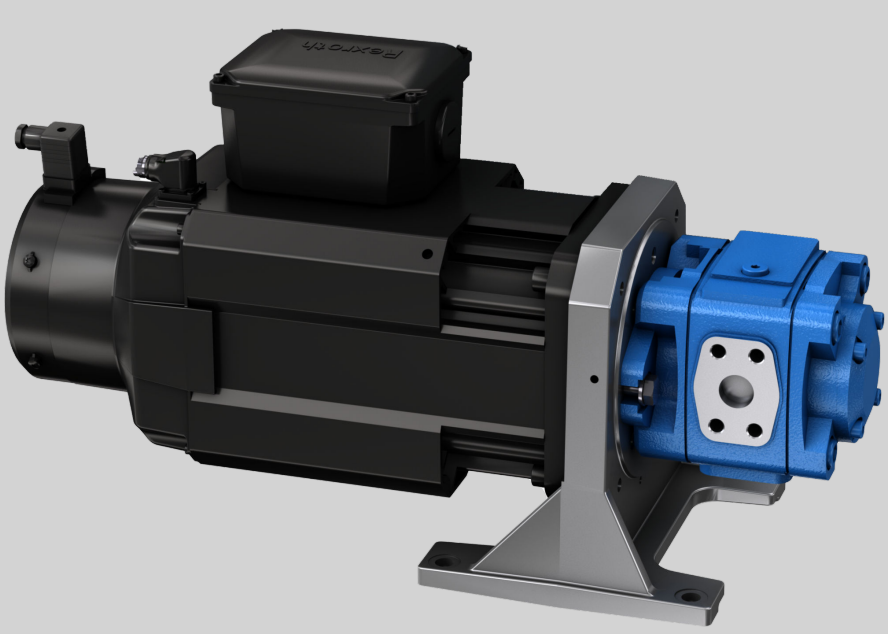
Sytronix

SvP 7030 IMC
Variable-Speed Pump Drives

Functional Description
RE 62312-FK/10.2022

Edition 01



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Title	Sytronix SvP 7030 IMC Variable-Speed Pump Drives
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Purpose of Documentation	This document describes the functions, features and commissioning of the variable-speed pump drive SvP 7030 IMC
Record of revisions	Edition 01, 2022-10 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	2022-10	First edition

Tab. 1-1: Record of revisions

This document describes the functions and features of the variable-speed pump drive SvP 7030 - Injection Molding Control (IMC). This drive solution can be used in applications for plastics machines or other pressure and flow control applications.

The main difference between the product ranges 7030 and 5020 lies in the drive units. Sytronix 7030 uses drive units of the ctrlX DRIVE product range, whereas Sytronix 5020 uses Rexroth frequency converters of type EFC. Besides, there are differences in terms of type and scope 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:

- Injection Molding Control (IMC): mainly for applications for plastics machines with alternating p/Q 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.

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⚠ 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

Introduction

The motor-pump units described in the product catalog (R999000332) can be used in combination with the drive units of the ctrlX DRIVE range. Drives with converters (ctrlX DRIVE XCS2) or inverters (ctrlX DRIVE XMS2) with the SvP 7030 solutions are suited for this purpose.

Further information on the drive units can be found in tab. 9-1 " Documentation – Drive systems, system components" on page 173 in the operating instructions.

Main features of ctrlX DRIVE units:

- Peak current up to 280 A
- High degree of overload capacity
- Compact design for applications with single axis
- Direct connection to three-phase current from 200 to 500 VAC (valid only for XCS2 devices)

1.4 Accessories

An extensive portfolio of accessories is available for Sytronix systems.

Mains filters 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 connect the motor to the drive unit.

Auxiliary components Accessories for connecting shielded cables and cables for commissioning.

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1.5 Software/parameter file packages

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

Hardware				Software/parameter file	
				IMC10Vxx	IMC02Vxx
				XCS2	CSH02.1 CSB02.1 HCS01.1
				Injection molding and blow molding applications, presses and other applications with alternating pressure and flow control.	Injection molding and blow molding applications, presses and other applications with alternating pressure and flow control.
System	**Drive**	**Motor**	**Pump**	**p/Q control**	**p/Q control**
SvP 7020	**HCS, HMS**	**MS2N, MSK**	**PGM, PGH, A4, A10**	**-**	X
SvP 7030	**XCS2, XMS2**	**MS2N, MSK**	**PGM, PGH, A4, A10**	**X**	-

X Available
- Not available

Tab. 1-2: Overview of the software/parameter file for SvP 7030

Commissioning tool The “IndraWorks Ds/MLD“ commissioning tool (version 15V18 and higher) is used to commission the variable-speed pump systems SvP 7030.

Important features This section lists the functions contained in the software/parameter file (IMC).

Functions	IMC
Pressure control	x
Pressure command value filter (PT1 for ascent/descent)	x
Unipolar speed limitation	x
Acceleration/deceleration limitation	x
Double pump operation/swivel angle switching (min.-max.) *In preparation*	-
p→Q switching/minimum value comparator	x
Master/slave function	x
Power limitation, pump	x
Parameter set switching - control (4 sets)	x
Cable break monitoring (firmware function)	x
Monitoring for inadmissible operating points	x
Pressure/speed range monitoring → function for pump protection	x
Model-based temperature monitoring, pump	x
Actual pressure value monitoring	x
Pressure/speed command value limitation	x

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Functions	IMC
Leakage compensation	x
Flow command value limitation (min, soft start)	x

x Available
- Not available

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

Type codes and overview of the software/parameter files

Additional FW component for product	FWS type	Technology function package	Technology function	FW version	Use of axis	Technology function Character	Technology function Version	Technology function Release	Design
CP-FWS-XD1-	**APP-**	**SVP_**	**IMC_**	**AX03-**	**NN-**	**V-**	**10**	**02-**	NN

CP-FWS-XD1 Additional firmware component for product CP-FWS-XD1
APP FWS type technology function
SVP SYTRONIX technology functional package
IMC Injection Molding Control technology function
AX03 Firmware version FWA-XD1-AXS-V-03VRS-NN
NN Axis assignment
V Firmware character (here: full version)
10 Technology function version
02 Technology function release
NN no other design

Tab. 1-4: Overview of types

Firmware requirements To use the Sytronix software, the following firmware has to be available for the drive:

Product name	Type	Type code	Brief description	Firmware
Injection Molding Control (IMC)	SvP 7030	CP-FWS-XD1-APP-SVP_IMC_AX03-NN-V-1002-NN	System function pressure/flow control (p/Q control)	AXS-V-0308.1 or higher

Tab. 1-5: Assignment of the Sytronix technology function to the drive firmware

See also chapter 5 "Introduction and basic principles of IMC" on page 17

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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 this documentation. This helps avoid personal hazards, 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 passing 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 alternating with flow adjustment.
- 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, speed and flow) 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 in the section “Intended use” is considered as improper and is therefore not permitted.

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

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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.
- Only use Rexroth products in technically perfect condition.
- Observe all information 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 accessory and spare parts approved by the manufacturer in order to rule out personnel hazards arising from 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 only commission the product when it has been established that the final product (for example, a machine or system), in which the Rexroth products have been installed, complies with national regulations, safety regulations and standards relevant to the application.

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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.

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⚠ 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.

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⚠ 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.

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☞ 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 have to 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.

Observe the regulations in the Security Guideline (R911342562).

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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.

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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.

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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.

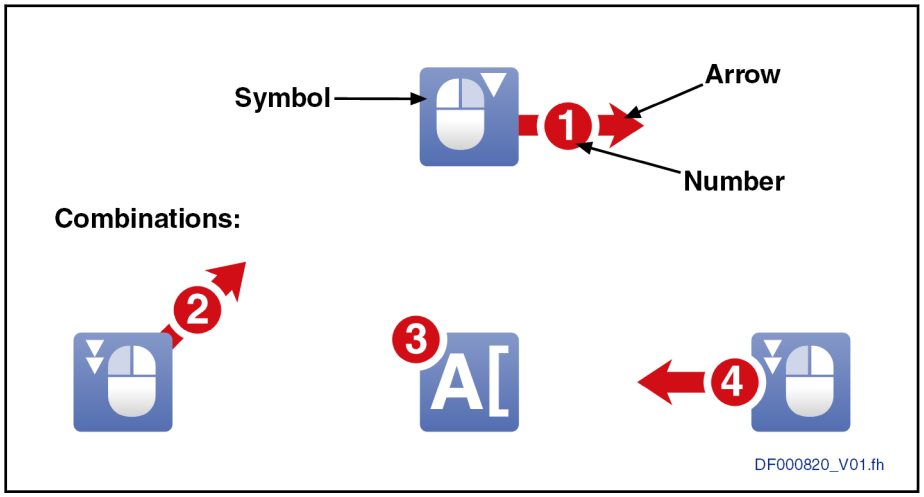

Fig. 4-1: Combinations of action symbols

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.

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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

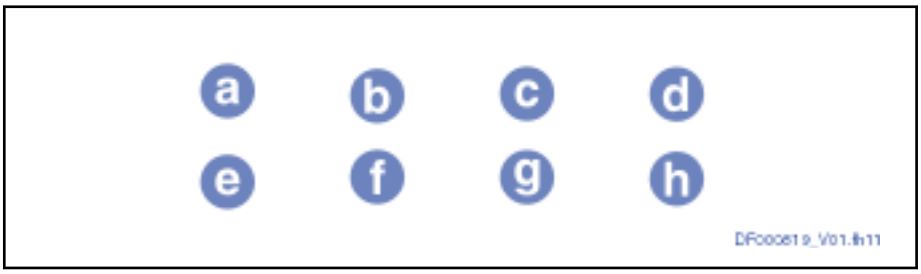

Fig. 4-2: Bullets

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

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

Tab. 4-3: Keyboard symbols

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5 Introduction and basic principles of IMC

5.1 Application type

The IMC software/parameter file is part of the SvP 7030 product family and is specifically designed for injection molding and blow molding applications, presses and other applications with alternating pressure and flow control.

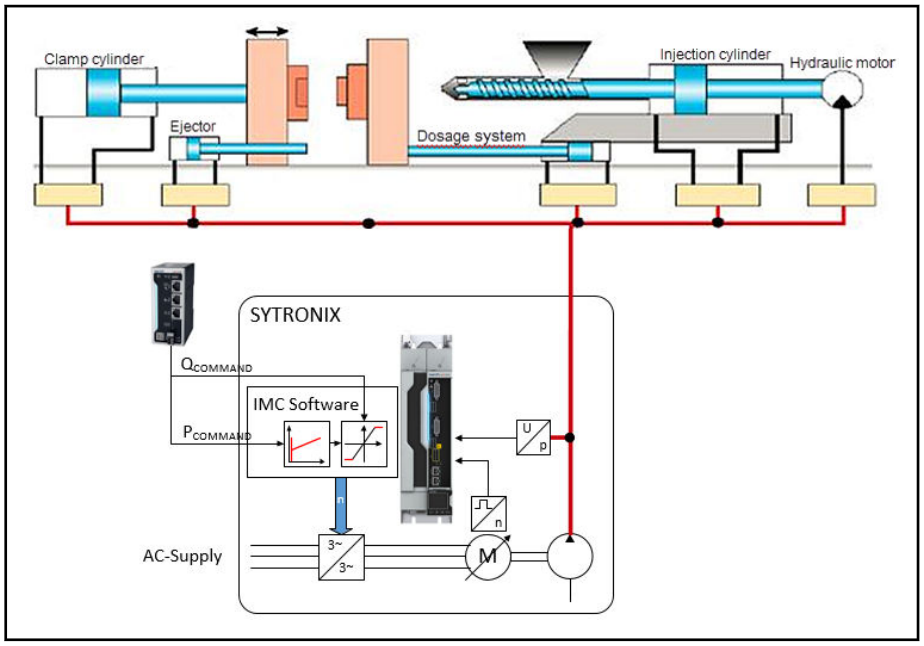

Fig. 5-1: Block diagram, p/Q control (IMC)

5.2 System requirements/components

Hardware

Sytronix unit (motor-pump group), hydraulic cylinder, drive controller (XCS2/XMS2), pressure sensor for pressure control.

- A positive motor speed has to result in an increase in pressure. Backgrounds and setting options can be found in chapter 6.3.1 "Assignment of direction of action" on page 23.
- Pressure values always refer to the atmospheric pressure. This applies to both pump data and sensor values.

Firmware

Required firmware:

FWA-XD1-AXS-V-03V08N-NN.01 or higher

Tools

IndraWorks Ds 15V18 or higher

Technology function/software

CP-FWS-XD1-APP-SVP_IMC_AX03-NN-V-1002-NN

Functional package/license for ctrlX DRIVE

To activate the firmware functions "ctrlX DRIVE Technology Function", "Parameter interface pressure, flow rate" and "Control the drive" you require the technology functions "TF1: Installing Technology Apps", the licensing option package "Runtime: Drive Runtime System Extension"". How to activate the firmware functions is shown in the following two figures.

The functional packages are subject to a charge and have to be included in the order. For this reason, the functional packages are already active at the time of delivery.

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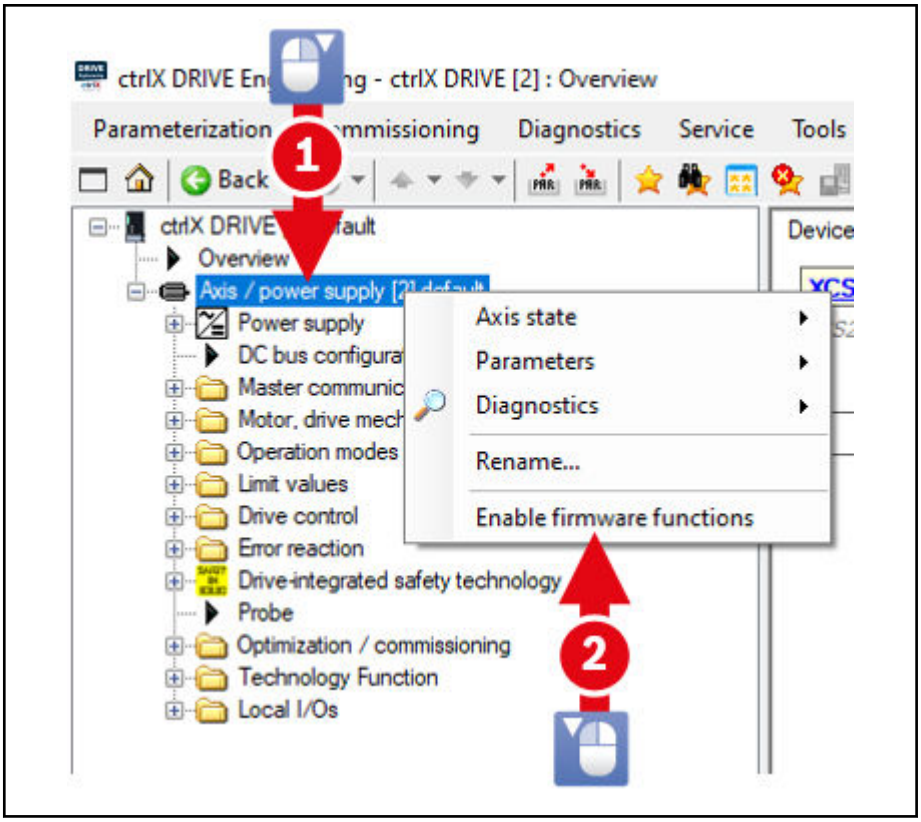

Fig. 5-2: Menu for enabling firmware functions

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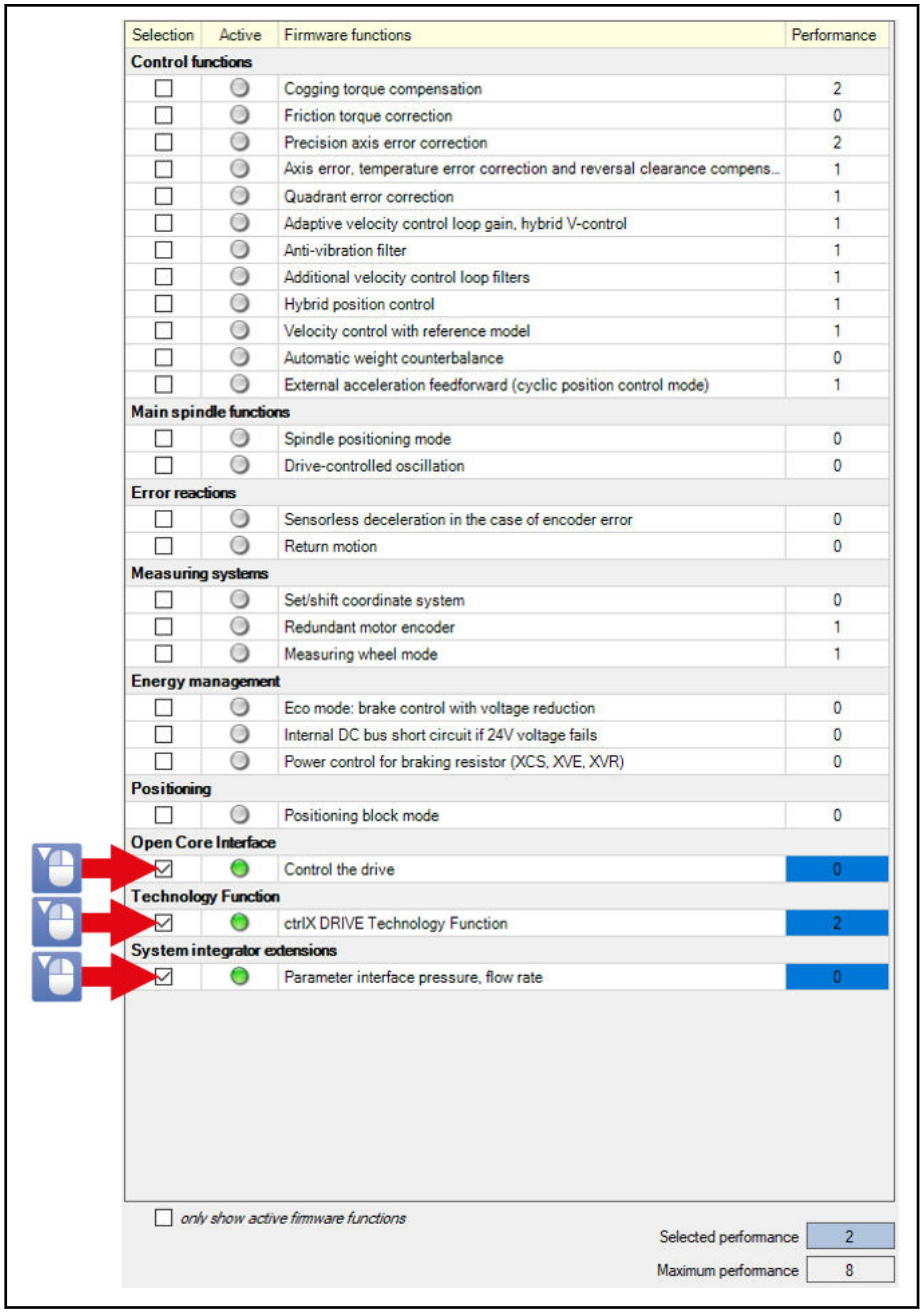

Fig. 5-3: Enabling of the firmware functions

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 available operation modes. Supported combinations are listed below:

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ctrlX DRIVE

Product	Power section	Control section						Firmware Runtime									Communication	Motor encoder (motor control)	Control
XCS2, XMS2	Wxxx xARN	02	N	ET	T0	EC	NN	S	03	RS	N	2	TF1	P	0	NN	Multi-Ethernet	Closed-loop recommended, open-loop possible (restricted dynamics)	p/Q
XCS2, XMS2	Wxxx xARN	02	N	ET	T0	EC	DA *	S	03	RS	N	2	TF1	P	0	NN	Multi-Ethernet / analog		

*	DA option card available on request
Product	
XCS2	ctrlX DRIVE, feeding converter, single axis, generation 2
XMS2	ctrlX DRIVE, inverter, single axis, generation 2
Power section	
W	Cooling type: air, internal
xxxx	Maximum current in Ampere
A	Protection class of input voltage IP20, 750 V DC
R or B	R = integrated braking transistor/braking resistor (XCS ≤ W0070) B = braking transistor (XCS ≥ W0100)
N	Without motor connector set
Control section	
02	ctrlX DRIVE^{PLUS}
N	Without panel
ET	Multi-Ethernet communication with RJ45
T0	Hardware option 1 - Safe Torque Off (STO)
EC	Hardware option 2 - multi-encoder interface
NN	Hardware option 3 - not equipped
DA	Hardware option 3 - I/O extension digital/analog
Firmware/Runtime	
S03RS	Standard runtime, version 03, latest release
N	Export license required: no (maximum output frequency < 599 Hz)
2	Protocol - communication, EtherCAT (SoE), for further protocols, see Project Planning Manual
TF1	Installing technology apps (XCS2)
P	Scope of functions, DRIVE runtime productivity
0	Scope of functions, SafeMotion not selected
NN	No other variant

Tab. 5-1: IMC device configuration

For a detailed description of the type code, see the Project Planning Manual in tab. 9-1 " Documentation – Drive systems, system components" on page 173.

5.4 Relevant parameters

See chapter 8 "Parameters and diagnostic messages" on page 109

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6 Description of IMC functions

6.1 Overview

The ctrlX DRIVE technology function Injection Molding Control (IMC) is used for closed-loop controlling with speed limitation. The control loop is closed via a systemic pressure sensor. The speed control variable of the pressure controller can be limited by a means of a speed command value, which results in the limitation of flow. This function is also referred to as p/Q control.

The transition between pressure controller output and flow limitation is realized according to the minimum value principle.

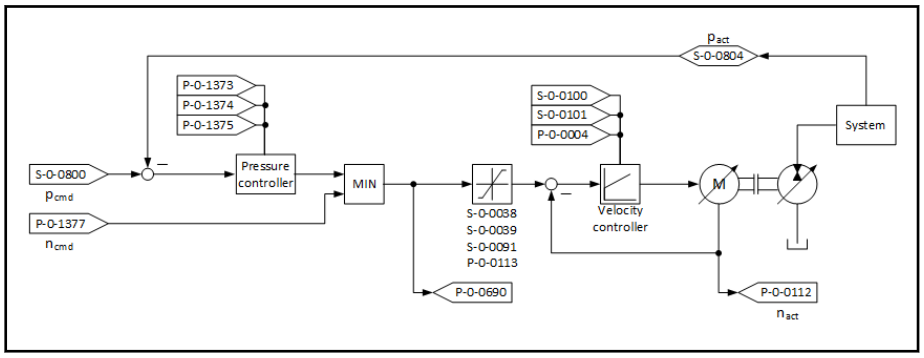

Fig. 6-1: Controller structure for p/Q control in the open circuit

System characteristics

The following system characteristics with rotary coupling between motor and pump are supported:

1. Hydraulic system:
   - Direction of flow via pump
2. Motor:
   - Without encoder
   - With encoder
3. Pump:
   - 2-quadrant operation; only positive pressure differential allowed
4. Pump volume:
   - Fixed displacement pump
5. Sensors:
   - Pressure sensor for system pressure

The sizing of components and the hydraulic design are limiting elements of the operating points and the dynamics of the motor-pump unit.

Supported functions

The following functions are available:

1. Communication interface and I/Os
   - Evaluation of pressure sensors via analog input
     - Freely scalable analog input weighting (bar/V, ...)
     - Signal filtering using PT1 filter
   - Easy Control state control chapter 6.6 on page 29
   - Fixed command value input for operating points (p_{cmd} and Q_{cmd}) chapter 6.7 on page 30
     - Four operating points

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  - Can be switched over at runtime
- Leakage compensation chapter 6.9 on page 32
- Cyclic transmission of command values (p_{cmd} and Q_{cmd}) via field bus or analog input
  - Command value filtering for ascent/descent (separate), PT1 filter
  - Command value limitation and soft start function chapter 6.10 on page 33

2. Pressure and flow control chapter 6.11 on page 35
   - Pressure control with $T_{controller}$ = 1 ms (pressure controller clock cycle)
   - Alternation of pressure controller output and speed command value (p/Q alternation) by means of minimum value comparator
   - Pressure-dependent switching of integral action time at pressure controller
   - Switching over of up to four controller parameter sets
   - Unipolar controller output limitation (n_{pos}, n_{neg})
   - Power limitation
   - Protection against cavitation
   - Freely definable ramp for limiting changes in the controller output (acceleration and deceleration limit value)
3. Master/slave operation chapter 6.12 on page 44
4. Protective functions chapter 6.13 on page 48
   - Pump pressure monitoring
   - Model-based temperature monitoring of the pump
   - Monitoring for inadmissible operating points
   - Active operation mode

Functions that are not supported

The following functions are not or not yet available:

- Swivel angle control
- Double pump control/2-point control
- Automatic controller parameter set switchover
- Automatic injection function

Requirements/restrictions

There are the following requirements/restrictions:

- The pressure control accuracy depends on:
  - Pressure sensor resolution
  - Pressure sensor precision/jitter
  - Freedom from interference in the pressure signal
  - Place of installation of the pressure sensor
  - Hydraulic capacitance of the system
  - Dynamic response of the motor-pump unit
- Open/closed-loop velocity control mode
  - Only the closed-loop velocity control mode is supported. The function of p/Q control is only possible in this operation mode.

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– The closed-loop velocity control mode controls the motor speed. The effective flow results from the coupling of speed with the pump and its displacement V_g.

6.2 Parameter handling

Reading of data

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

Process data contain values read in in a cyclic 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; this can be a displacement or a filter time, for example. The machine data are initially checked when switching to OM takes place. As long as the check has not been completed successfully, the drive must not be enabled. If the drive is nevertheless enabled, error message F2211 01890032 is generated. In this case, machine data are usually invalid, which is displayed by corresponding warning messages.

If the drive is in OM, the machine data 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.

Use of PLC registers

For the IMC-specific parameters, the PLC registers of the drive (P-0-1270 et seq.) are used. Their configuration has to be initialized after a PLC download or a PLC reset. For this purpose you have to switch the drive to the OM state.

Pertinent diagnostic messages

See also: chapter 8.1 "Parameters" on page 109

- E2211 0189000F: Drive has to be in CM for Register Config
- E2211 01890012: Invalid value for data type of
- F2211 01890032: Init not completed, check config data
- E2211 0189003A: Return value of mMD invalid
- E2211 01890052: Parameter cannot be read by Param-Handling
- E2211 01890053: Parameter cannot be written by Param-Handling

6.3 Motor-pump system

6.3.1 Assignment of direction of action

The characteristic of the motor-pump system has to be registered in the technology function. The actuator is a motor controlled by a controller. Due to the mechanical coupling with a pump (e.g. via a coupling), a flow is generated. To build up pressure in an application, a flow has to be fed into a system, and for active pressure reduction, a flow has to be displaced out of the system.

Definition

Positive flow is a flow into a system, as a result of which pressure is built up.

Negative flow is a flow out of a system, as a result of which pressure is reduced.

A **positive direction of rotation** is a clockwise direction of rotation viewed to the shaft.

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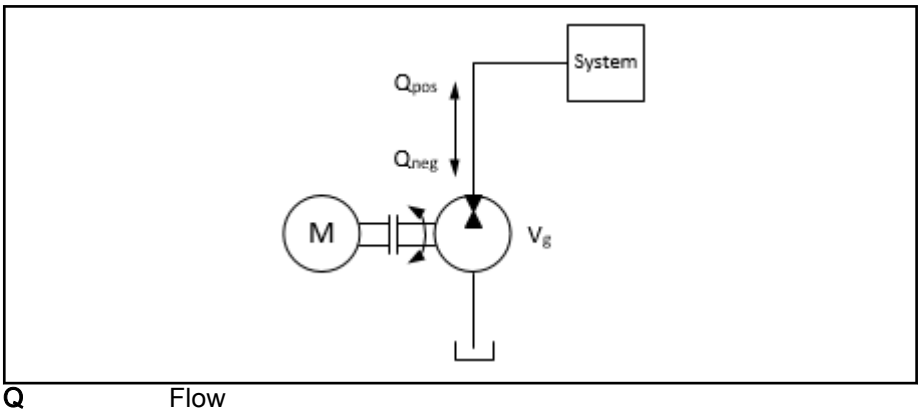
A **negative direction of rotation** is a counter-clockwise direction of rotation viewed to the shaft.

☞ A persisting negative flow can cause damage to hydraulic components.



Q Flow
V_g Displacement

Fig. 6-2: Assignment of direction of rotation of the motor to the direction of action of the pump

According to the mechanical coupling between motor and pump as well as the hydraulic connection of the pump, an assignment has to be made between the motor's direction of the rotation and the pump's direction of action. The assignment can be inverted by means of P-0-1370, bit 0. After a correct assignment was made in P-0-1278, the actual speed value is displayed in the direction of action.

P-0-1370 bit 0 = 1 is set by default, which is provided for operation of a clockwise rotating pump.

The following table shows, how the direction of action is determined and how the correct assignment can be set accordingly.

Direction of rotation of the motor (P-0-0112)	Pressure feedback value (S-0-0804)	Configuration of assignment (P-0-1370 bit 0)
P-0-0112 > 0	Increasing	0: A positive speed results in a positive flow
P-0-0112 < 0	Falling	
P-0-0112 < 0	Increasing	1: A negative speed results in a positive flow (default)
P-0-0112 > 0	Falling	

Tab. 6-1: Setting of the assignment between direction of rotation of the motor to the direction of action of the pump

Features

- Assignment of direction of rotation of the motor and direction of displacement of the pump
- Sensors:
  - Pressure sensor

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0804, Pressure feedback value
- P-0-0112, Actual speed value of motor
- P-0-1278, Actual speed value in the direction of pressure build-up
- P-0-1370, Config word

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Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 0189003F: Parameter cannot be changed in AF P-0-1370.0

6.3.2 Pump

Pumps have a geometric volume (V_g), 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

The mechanical structure (axial piston, internal/external gear, ...) is irrelevant. The pump has to support at least 2-quadrant operation as operating point.

Fixed displacement pump

Fixed displacement pumps have a fixed displacement per revolution.

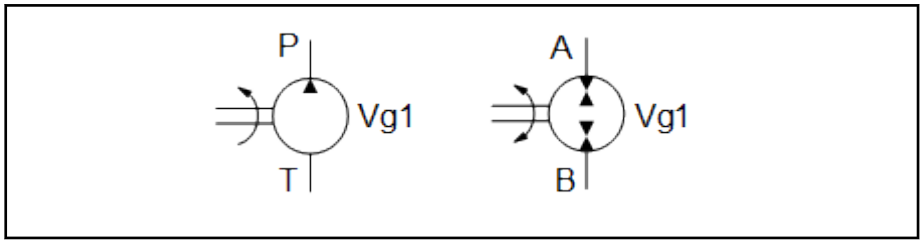

Fig. 6-3: Left: 2-quadrant pump with T/P ports; right: right: 4-quadrant pump with A/B ports; each with a fixed displacement Vg1

Pump data

For operating a motor-pump group correctly in accordance with its technical specification, it is required that the IMC function knows the pump type used. This information can be provided via P-0-1389[100] by entering a value (which corresponds to a pump type) in the parameter. A configuration can only be changed, when the drive is not in AF.

The following pump types with their data are supported:

Model	Pump type	Value in P-0-1389[100]
PGH4-3X/020	Internal gear pump	0
PGH2-2X/005	Internal gear pump	20
PGH2-2X/006	Internal gear pump	21
PGH2-2X/008	Internal gear pump	22
PGH3-2X/011	Internal gear pump	30
PGH3-2X/013	Internal gear pump	31
PGH3-2X/016	Internal gear pump	32
PGH4-3X/020	Internal gear pump	40
PGH4-3X/025	Internal gear pump	41
PGH4-3X/032	Internal gear pump	42
PGH4-3X/040	Internal gear pump	43
PGH4-3X/050	Internal gear pump	44
PGH4-3X/063	Internal gear pump	45
PGH5-3X/063	Internal gear pump	50
PGH5-3X/080	Internal gear pump	51
PGH5-3X/100	Internal gear pump	52

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Model	Pump type	Value in P-0-1389[100]
PGH5-3X/125	Internal gear pump	53
PGH5-3X/160	Internal gear pump	54
PGH5-3X/200	Internal gear pump	55
PGH5-3X/250	Internal gear pump	56
A10FZO/003	Axial piston pump	100
A10FZO/006	Axial piston pump	101
A10FZO/008	Axial piston pump	102
A10FZO/010	Axial piston pump	103
A10FZO/012	Axial piston pump	104
A10FZO/014	Axial piston pump	105
A10FZO/018	Axial piston pump	106
A10FZO/023	Axial piston pump	107
A10FZO/028	Axial piston pump	108
A10FZO/035	Axial piston pump	109
A10FZO/045	Axial piston pump	110
A10FZO/051	Axial piston pump	111
A10FZO/063	Axial piston pump	112
User-defined	-	200

Tab. 6-2: Supported pump types

When a pump has been selected, the key date are displayed within the range of P-0-1389[160..177] (see "Pertinent parameters" on page 26). If the selected pump is not stored in the technology function (possible software inconsistencies between technology function and IndraWorks Ds), warning “E2211 01890051” is issued. If a pump is not available with its data set, the pump data set can be activated freely configurable with P-0-1389[100] = 200. However, thermal monitoring of the pump on the basis of a temperature model is not possible for a user-defined pump (chapter 6.13.3 "Temperature monitoring" on page 50).

In the case of a user-defined pump, the pump data can be entered in parameters P-0-1389[160..177].

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- P-0-1275, Pump displacement
- P-0-1389[100], Pump type
- P-0-1389[160], Displacement 1
- P-0-1389[163], Maximum input power
- P-0-1389[164], Pump moment of inertia
- P-0-1389[165], Maximum speed in continuous operation, bipolar
- P-0-1389[166], Minimum speed in continuous operation, bipolar
- P-0-1389[168], Maximum acceleration, bipolar
- P-0-1389[175], Maximum critical pressure
- P-0-1389[176], Maximum pressure in continuous operation

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- P-0-1389[177], Minimum pressure

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890028: Config data exceeds valid range P-0-1389[160]
- E2211 01890029: Config data exceeds valid range P-0-1389[161]
- E2211 0189002A: Config data exceeds valid range P-0-1389[163]
- E2211 0189002B: Config data exceeds valid range P-0-1389[164]
- E2211 0189002C: Config data exceeds valid range P-0-1389[165]
- E2211 0189002D: Config data exceeds valid range P-0-1389[166]
- E2211 0189002E: Config data exceeds valid range P-0-1389[168]
- E2211 0189002F: Config data exceeds valid range P-0-1389[175]
- E2211 01890030: Config data exceeds valid range P-0-1389[176]
- E2211 01890031: Config data exceeds valid range P-0-1389[177]
- E2211 01890051: Config data exceeds valid range P-0-1389[100]
- E2211 01890054: Parameter cannot be changed in AF

6.4 Scaling

The scaling system of the firmware is supported. Since a rotary system is used and “position” scaling is not required, the following scaling settings are relevant:

Scaling variable	Scaling parameters	Supported scaling settings
Velocity	S-0-0044	rpm, rps, deg/min, deg/s
Acceleration	S-0-0160	rad/s^2
Torque/force data	S-0-0086	Nm, in lbf, %
Flow	S-0-0845	l/min, l/s, gal/min, gal/s, %
Pressure	S-0-0806	bar, psi, %

Tab. 6-3: Supported scaling settings

The number of decimal places and hence the resolution of parameters can be set for every scaling variable via the associated scaling exponent. A change of scaling factors is not supported; they always have to have the value “1”. It is possible to invert the scaling data, but the direction of action of the pump is set via P-0-1370 Bit 0 (see also chapter 6.3 "Motor-pump system" on page 23).

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- 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-0-0085, 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-0-0160, Acceleration data scaling type

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- S-0-0161, Acceleration data scaling factor
- S-0-0162, Acceleration 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-0-0845, Flow data scaling type
- S-0-0846, Flow data scaling factor
- S-0-0847, Flow data scaling exponent
- S-0-0848, Flow polarities

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890014: A scaling type is invalid
- E2211 01890039: A scaling factor is invalid

6.5 Operation modes

In order that the IMC technology function can be used, the ctrlX DRIVE has to be operated in the "closed-loop velocity control" mode.

The technology function has always to be in the RUN state, because with an open position control loop (P-0-0556 bit 8 = 1) the velocity command value path is opened as well, and the technology function has to copy the command value in "P-0-0690, Additive velocity command value, process controller". Here, the assignment of the motor's direction of rotation to the pump's direction of action is also taken into account.

Easy startup mode

For commissioning the motor-pump system the drive can be operated in the easy startup mode in closed-loop velocity control.

The following functions are not supported or switched off in the easy startup mode:

- Monitoring of actual pressure value
- Monitoring based on thermal pump model
- Monitoring for inadmissible operating point
- Command value limitations, soft start
- p/Q control

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- 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
- P-0-0115, Device control: Status word

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- P-0-0116, Device control: Control word
- P-0-0556, Config word of axis controller
- P-0-1411, Status word 2

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- F2211 01890027: Position loop closed, set P-0-0566.8
- F2211 01890038: Operation mode invalid, velocity control required

6.6 Easy Control state control

The function "Easy Control" is made available to simplify controlling of the ctrlX DRIVE with reduced interface. The standard interface of ctrlX DRIVE (control and status word) is not used for this. The ctrlX DRIVE is enabled or all errors are cleared irrespective of the current state by means of two binary signals for enable and reset.

Easy Control can optionally be used for commanding as alternative to the standard control and status word of the firmware. This function is selected via P-0-1370 bit 2:

P-0-1370 bit 2	Description
FALSE	State control of ctrlX DRIVE via standard control word and status word
TRUE	Status control via Easy Control using P-0-1390 bit 6/5

Tab. 6-4: Activation of Easy Control state control

When Easy Control state control is used, commanding is carried out via P-0-1390 bit 6/5.

P-0-1390	Description
Bit 5	Drive enable, behavior dependent on P-0-1370, bit 3
Bit 6	Error reset with positive edge

Tab. 6-5: Commanding of Easy Control state control

Enable function

The enable is commanded via P-0-1390, bit 5. P-0-1370, bit 3 can be used to determine whether the enable signal is to be interpreted as edge- or level-controlled.

P-0-1370 bit 3	Description
FALSE	Enabling edge-controlled
TRUE	Enabling level-controlled

Tab. 6-6: Interpretation of enable signal

When enabling is activated, the drive is to be switched to AF by executing commands, irrespective of the current state. Switching of the enable it to be carried out by write access to P-0-4028 bit 15/14/13. If this is impossible, the error F2211 0189005C is signaled.

Reset function

If an error occurs, the type of error is differentiated between encoder error and non-encoder error. In the case of an encoder error the drive is switched to CM in order to execute a reset there. Switching back to OM takes place as the drive enable is set. In the case of non-encoder errors the drive remains in the original operation mode. With a rising edge of the reset signal P-0-1390 bit 6, the error is reset by executing command C0500.

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To be able to use the Easy Control state control, the following requirements have to be met:

- Activated firmware function "Open Core Interface"
- Master communication with profile type analog (P-0-4084 = 0xFF00)
- Power switched on
- Velocity control configured as primary or secondary operation mode

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- P-0-1311[202], Delay time for switching Bb -> Ab
- P-0-1370, Config word
- P-0-1390, Control word
- P-0-4028, Device control word
- P-0-4084, Application: Profile type

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 0189005B: Switching to CM failed
- F2211 0189005C: Switching to OM failed
- F2211 0189005D: Internal command error
- E2211 0189005E: Time out by switching from bb to Ab
- E2211 0189005F: Not possible to enable parked axis
- E2211 01890060: Device control word cannot be written
- E2211 01890061: OpMode velocity control not configured

6.7 Fixed command value input

A function is provided that allows an operating point (p_{cmd} and Q_{cmd}) to be input via a cyclic process datum or alternatively via one of four machine data sets as fixed command value. The purpose of this function is a reduction of the analog interface while offering flexibility in the input of different operating points.

P-0-1370 bit 31 is used to select whether command values for pressure and flow are input via cyclic process data or firmly configurable machine data. If P-0-1370 bit 31 has the value 1, pressure and flow are provided from one set of machine data. The set is selected via P-0-1390 bit 4...3. Corresponding digital inputs can be assigned, for example, using P-0-1390 bit 4 and bit 3. With the binary selection of a set, the operating point is switched over at runtime without ramping or similar processing. It should be noted that the pressure command filter described in the following chapter (chapter 6.8 "Pressure command value filter" on page 31) may nevertheless have a smoothing effect on the switching of p_{cmd}.

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P-0-1370, bit 31	P-0-1390, bit 4..3	Source for command value input		Description
		p_{cmd}	Q_{cmd}	
0	xx	S-0-0800	P-0-1377	Cyclic process data
1	00	P-0-1311[80]	P-0-1311[81]	Manual set 1
	01	P-0-1311[82]	P-0-1311[83]	Manual set 2
	10	P-0-1311[84]	P-0-1311[85]	Manual set 3
	11	P-0-1311[86]	P-0-1311[87]	Manual set 4

Tab. 6-7: Selection of cyclic and manual command value input

Features

- Input of up to four operating points for p_{cmd} and Q_{cmd}
- Working points can be switched over using P-0-1390, bit 4..3

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0800, Pressure command value
- P-0-1311[80], Manual p_{cmd} Set 1
- P-0-1311[81], Manual Q_{cmd} Set 1
- P-0-1311[82], Manual p_{cmd} Set 2
- P-0-1311[83], Manual Q_{cmd} Set 2
- P-0-1311[84], Manual p_{cmd} Set 3
- P-0-1311[85], Manual Q_{cmd} Set 3
- P-0-1311[86], Manual p_{cmd} Set 4
- P-0-1311[87], Manual Q_{cmd} Set 4
- P-0-1370, Config word
- P-0-1377, Flow command value
- P-0-1390, Control word

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890007: Config data exceeds valid range P-0-1311[80]
- E2211 01890008: Config data exceeds valid range P-0-1311[82]
- E2211 01890009: Config data exceeds valid range P-0-1311[84]
- E2211 0189000A: Config data exceeds valid range P-0-1311[86]
- E2211 0189003B: Config data exceeds valid range P-0-1311[81]
- E2211 0189003C: Config data exceeds valid range P-0-1311[83]
- E2211 0189003D: Config data exceeds valid range P-0-1311[85]
- E2211 0189003E: Config data exceeds valid range P-0-1311[87]

6.8 Pressure command value filter

Pressure command value filtering contributes to smoothing abrupt pressure command value changes and avoiding controller oscillations caused by pressure command value step changes. "S-0-0800, Pressure command value" is filtered by means of a PT1 filter in this context.

Two filter times are provided, one for increasing command values, one for decreasing command values.

- P-0-1384, Command value filter, filter time for increasing values

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- P-0-1385, Command value filter, filter time decreasing values

The filtered pressure command value is output in parameter "P-0-1271, Effective pressure command value" and becomes active at the controller input.

The command value filter can be deactivated by setting both filter times (P-0-1384 and P-0-1385) to the value 0.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0800, Pressure command value
- P-0-1271, Effective pressure command value
- P-0-1384, Command value filter, filter time for increasing values
- P-0-1385, Command value filter, filter time decreasing values

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890046 Config data exceeds valid range P-0-1384
- E2211 01890047 Config data exceeds valid range P-0-1385

6.9 Leakage compensation

A function is provided for the pressure-related compensation of pump case drain and system leakage in the flow command value path.

The flow command value is entered in P-0-1377. To increase the accuracy of the given flow, the function of leakage compensation can be utilized. The function compensates leakage within the pump and that of the system in order to ensure more precise controlling of the actuator. Without leakage compensation, a difference between the required and the effective oil flow occurs within the system.

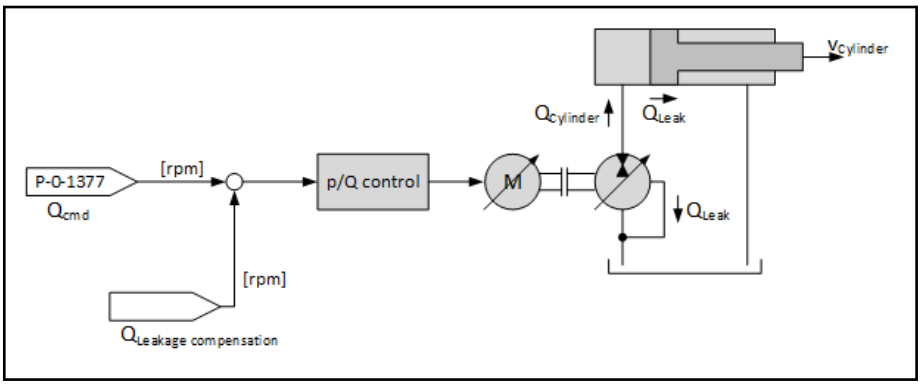

Fig. 6-4: Leakage compensation, speed command value feedforward

The leakage compensation speed is determined by linear interpolation or extrapolation. To this end, a supporting point has to be determined from a measurement. Based on the supporting point and in dependence on the system pressure, a corresponding compensation speed can be fed forward ($Q_{leakage\ compensation}$). fig. 6-5 "Leakage/speed characteristic curve with one supporting point" on page 33 shows the interpolated leakage/speed characteristic curve with one supporting point. P-0-1311[209] represents the pressure p_2, at which the measurement was taken, P-0-1311[208] the corresponding speed ($Q_{leakage}(p_2)$), which occurs as a result of the leakage.

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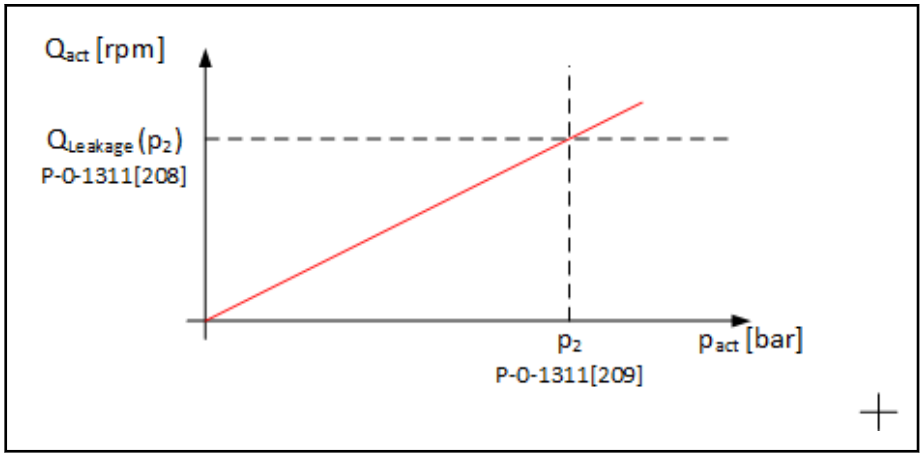

Fig. 6-5: Leakage/speed characteristic curve with one supporting point

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0804, Pressure feedback value
- P-0-1278, Actual speed value in the direction of action
- P-0-1311[208], Determined leakage speed at reference pressure P-0-1311[209]
- P-0-1311[209], Reference pressure when determining leakage
- P-0-1377, Flow command value

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890005: Config data exceeds valid range P-0-1311[208]
- E2211 01890006: Config data exceeds valid range P-0-1311[209]

6.10 Command value limitation

A function is provided for limiting pressure and flow command values. For the flow command value, a soft start function is provided additionally.

Limitation of pressure command value

The pressure command value is input via S-0-0800 or from the memory of fixed command values (see chapter 6.7 "Fixed command value input" on page 30). It is limited between "P-0-1389[101], Maximum pressure command value" and "P-0-1389[102], Minimum pressure command value". When the limitation of the pressure command value is active, this is indicated via a warning.

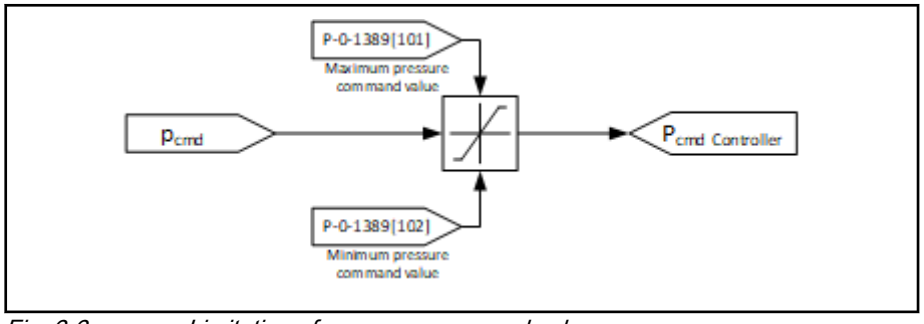

Fig. 6-6: Limitation of pressure command value

Limitation of flow command value

The flow command value is input via P-0-1377 or from the memory of fixed command values (see chapter 6.7 "Fixed command value input" on page 30). It is limited after leakage compensation (see chapter 6.9 "Leakage compensation" on page 32) between the maximum flow command value and "P-0-1389[111], Minimum flow command value". The maximum flow com-

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mand value corresponds to the active velocity limit value of the drive. It is determined as follows:

- At positive motor speed for pressure build-up (P-0-1370 bit 0 = 0)
  - S-0-0038 > 0: Minimum from "S-0-0038, Positive velocity limit value" and "S-0-0091, Bipolar velocity limit value"
  - S-0-0038 = 0: "S-0-0091, Bipolar velocity limit value"
- At negative motor speed for pressure build-up (P-0-1370 bit 0 = 1)
  - S-0-0039 < 0: Minimum from amount of "S-0-0039, Negative velocity limit value" and "S-0-0091, Bipolar velocity limit value"
  - S-0-0039 = 0: "S-0-0091, Bipolar velocity limit value"

The active flow command value is shown in P-0-1285. When the limitation of the flow command value is active, this is indicated by a warning.

Soft start

For the soft start function, when the drive enable is received, the flow command value is set to the minimum value in P-0-1389[111] until the pressure feedback value in S-0-0804 reaches the minimum pressure command value in P-0-1389[102] or the maximum duration for the soft start in P-0-1389[112] has elapsed.

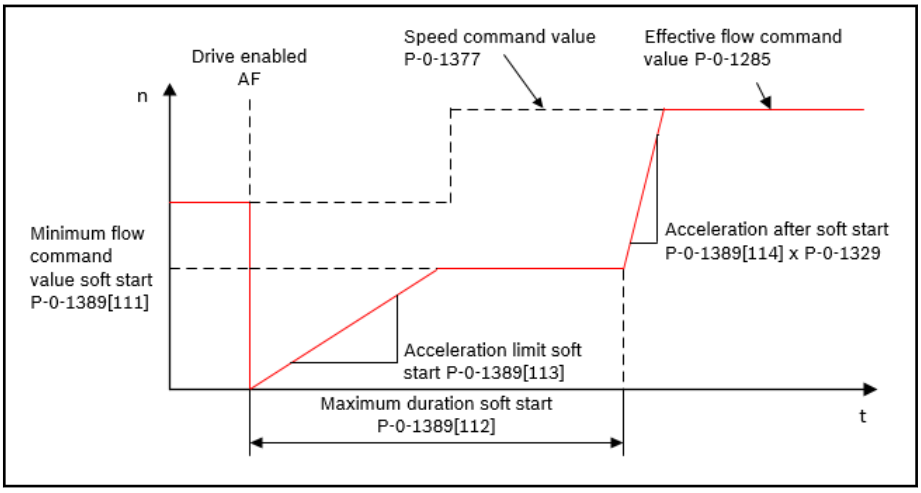

Fig. 6-7: Soft start sequence

By means of “P-0-1389[113], Acceleration limit soft start” it is possible to ramp "P-0-1285, Effective flow command value” at the beginning of the soft start. After the end of the soft start function the active flow command value is ramped to the current motor speed, but not to a speed higher than the maximum motor speed. The ramp can be configured with “P-0-1389[114], Acceleration factor after soft start“ as percentage value referred to “P-0-1329, Acceleration limitation of pump speed“ The soft start function is deactivated by a time of 0 s in P-1389[112] (default setting). During soft start there is no diagnosis that the command value is limited.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0038, Positive velocity limit value
- S-0-0039, Negative velocity limit value
- S-0-0091, Bipolar velocity limit value
- S-0-0800, Pressure command value
- S-0-0804, Pressure feedback value
- P-0-1285, Effective flow command value
- P-0-1370, Config word

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- P-0-1377, Speed command value
- P-0-1389[101], Maximum pressure command value
- P-0-1389[102], Minimum pressure command value
- P-0-1389[111], Minimum flow command value
- P-0-1389[112], Maximum duration of soft start
- P-0-1389[113], Acceleration limit for soft start
- P-0-1389[114], Acceleration factor after soft start

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 0189000B: Config data exceeds valid range P-0-1389[102]
- E2211 0189000C: Config data exceeds valid range P-0-1389[111]
- E2211 0189000D: Config data exceeds valid range P-0-1389[112]
- E2211 0189000E: Pressure command value limited
- E2211 01890013: Config data exceeds valid range P-0-1389[113]
- E2211 01890015: Flow rate command value limited
- E2211 01890040: Config data exceeds valid range P-0-1389[114]
- E2211 01890062: Config data exceeds valid range P-0-1389[177]

6.11 Pressure and flow control

6.11.1 Overview

The function of pressure/flow control is provided. Moreover, supplementary functions for limiting the pump speed and for improving the control result are made available.

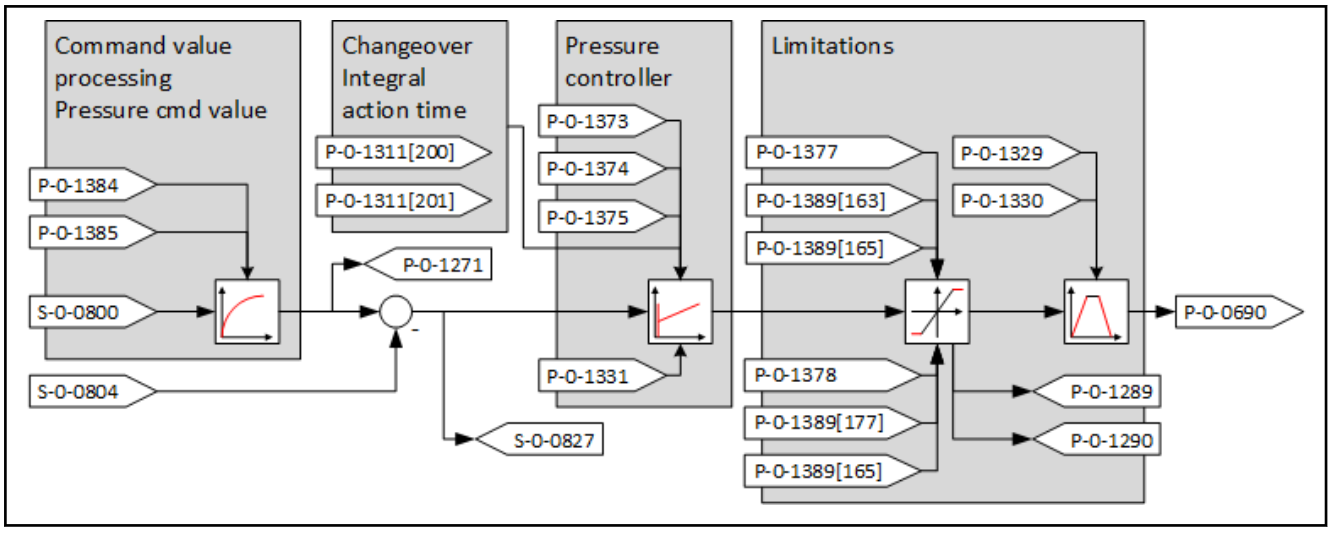

Fig. 6-8: Overview of pressure and flow controllers with parameter interfaces

The scope of functions of pressure and flow control can be categorized into the groups “controllers” and “limitations”. The following contents are dealt with in this chapter:

- Controllers
  - Pressure control
  - Open-loop flow control
  - Parameter set switching
  - Switching of integral action time

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- Limitations
  - Speed limitation
  - Protection against cavitation
  - Power limitation
  - Acceleration limitation

6.11.2 p/Q controller

Closed-loop pressure control

The closed-loop pressure control receives its pressure command value via parameter S-0-0800. The active command value is output in parameter P-0-1271 (see chapter 6.8 "Pressure command value filter" on page 31). The pressure feedback value is read via parameter S-0-0804. The current pressure control deviation is displayed in parameter S-0-0827.

The pressure controller is configured using the following parameters:

- P-0-1373, Kp, P-gain
- P-0-1374, Tn, integral action time
- P-0-1375, Kd, D-gain

A negative integrator term can be accepted for a dynamic pressure reduction of the pump and be limited to a maximum negative value via parameter "P-0-1331, Lower integrator term limitation, pressure controller". The output value of the controller is output in parameter "P-0-0690, Additive velocity command value, process controller".

With the help of parameter S-0-0832 a pressure window can be configured. If "S-0-0827, Pressure control deviation" is less than the pressure window, then bit 1 in parameter "P-0-1411 Status word 2" is set to 1 and thus it is fed back that the specified pressure command value has been reached.

P-0-1411, bit 1	Description
0	The pressure control deviation (S-0-0827) is greater than the pressure window (S-0-0832)
1	Pressure control deviation (S-0-0827) is less than/equal to the pressure window (S-0-0832)

Tab. 6-8: Status of pressure control deviation

Open-loop flow control

An open-loop flow control can be realized by limiting and overriding the pressure controller. The upper and lower limitations are determined by means of the following parameters.

- P-0-1377, Speed command value
- P-0-1378, Lower speed limit value

The speed values are calculated in the unit of velocity scaling. The two limit values restrict the output value of the controller, which is output in parameter "P-0-0690, Additive velocity command value, process controller". If the controller output value is limited by the speed command value (P-0-1410, bit 3 = 1), the system is in open-loop flow control (P-0-1410 bit 9 = 1). If the controller output value is less than the speed command value, the system is in closed-loop flow control (P-0-1410 bit 9 = 0). Parameter P-0-1378 can be used to limit the speed in the downward direction, e.g. for pressure reduction (P-0-1410 Bit 4 = 1).

Parameter set switching

A function is provided that allows the control parameters to be manually switched between up to four parameter sets alternatively to a cyclic input (e.g. over a field bus). The purpose of this function is the adjustment of the controller parameters to different hydraulic loads and oil volumes present dur-

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ing operation. An optimum parameter set for up to four different hydraulic loads can be defined and selected by the master communication or via digital inputs of the machine according to the current operating point. Alternatively, the control parameters can be cyclically corrected for a continuing adjustment to the operating point.

Switching between a cyclic input and fixed parameters can be changed over by means of "P-0-1370, Config word" bit 12:

P-0-1370, bit 12	Description
0	Cyclic input of control parameters
1	Input of control parameters from parameter sets

Tab. 6-9: Selection of source for control parameters

The following control parameters can be switched over:

- Speed controller K_P
- Speed controller T_N
- Pressure controller K_P, P-gain
- Pressure controller T_N, integral action time
- Pressure controller K_D, D-gain
- Pressure command value filter, filter time for increasing values
- Pressure command value filter, filter time for decreasing values

Cyclic input

The cyclic adaptation of control parameters is activated with "P-0-1370, Config word", bit 12 = 0. In this case, the control parameters are read cyclically from the parameters via the following interface:

Parameter	Unit	Description
S-0-0100	Nm/(rad/s)	Speed controller K_P
S-0-0101	ms	Speed controller T_N
P-0-1373	1/s	Pressure controller K_P, P-gain
P-0-1374	ms	Pressure controller T_N, integral action time
P-0-1375	-	Pressure controller K_D, D-gain
P-0-1384	ms	Pressure command value filter, filter time for increasing values
P-0-1385	ms	Pressure command value filter, filter time for decreasing values

Tab. 6-10: Cyclic input of control parameters

Input from parameter set

The input of control parameters is activated with "P-0-1370, Config word", bit 12 = 1. In this case it is possible to switch at runtime between four parameters sets by means of "P-0-1390, Control word", bit 15..14.

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P-0-1390, bit 15..14	P-0-1311[Index]	Unit	Description
00	0	Nm/(rad/s)	Speed controller K_P
	1	ms	Speed controller T_N
	2	1/s	Pressure controller K_P, P-gain
	3	ms	Pressure controller T_N, integral action time
	4	-	Pressure controller K_D, D-gain
	5	ms	Pressure command value filter, filter time for increasing values
	6	ms	Pressure command value filter, filter time for decreasing values
01	20	Nm/(rad/s)	Speed controller K_P
	21	ms	Speed controller T_N
	22	1/s	Pressure controller K_P, P-gain
	23	ms	Pressure controller T_N, integral action time
	24	-	Pressure controller K_D, D-gain
	25	ms	Pressure command value filter, filter time for increasing values
	26	ms	Pressure command value filter, filter time for decreasing values
10	40	Nm/(rad/s)	Speed controller K_P
	41	ms	Speed controller T_N
	42	1/s	Pressure controller K_P, P-gain
	43	ms	Pressure controller T_N, integral action time
	44	-	Pressure controller K_D, D-gain
	45	ms	Pressure command value filter, filter time for increasing values
	46	ms	Pressure command value filter, filter time for decreasing values
11	60	Nm/(rad/s)	Speed controller K_P
	61	ms	Speed controller T_N
	62	1/s	Pressure controller K_P, P-gain
	63	ms	Pressure controller T_N, integral action time
	64	-	Pressure controller K_D, D-gain
	65	ms	Pressure command value filter, filter time for increasing values
	66	ms	Pressure command value filter, filter time for decreasing values

Tab. 6-11: Input of control parameters from parameter sets

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If parameter input from parameter sets has been activated, the parameter currently active on the interface for the cyclic control parameter input (see tab. 6-10 "Cyclic input of control parameters" on page 37) is output as status information.

Features

- Control parameters can be selected from the following sources
  - Cyclic interface
  - Cyclically switchable parameter sets
- Four different parameter sets can be preconfigured
- Currently active values are displayed in the respective registers
- Switching between parameter sets without ramping

Switching of integral action time

Switching of integral action time is used for the fine optimization of the pressure controller. It reduces overshooting when pressure is build up. The functionality can be activated via "P-0-1370, Config word" bit 1 = 1.

P-0-1370 bit 1	Description
0	Switching of integral action time deactivated
1	Integral action time switching deactivated

Tab. 6-12: Configuration of integral action time switching

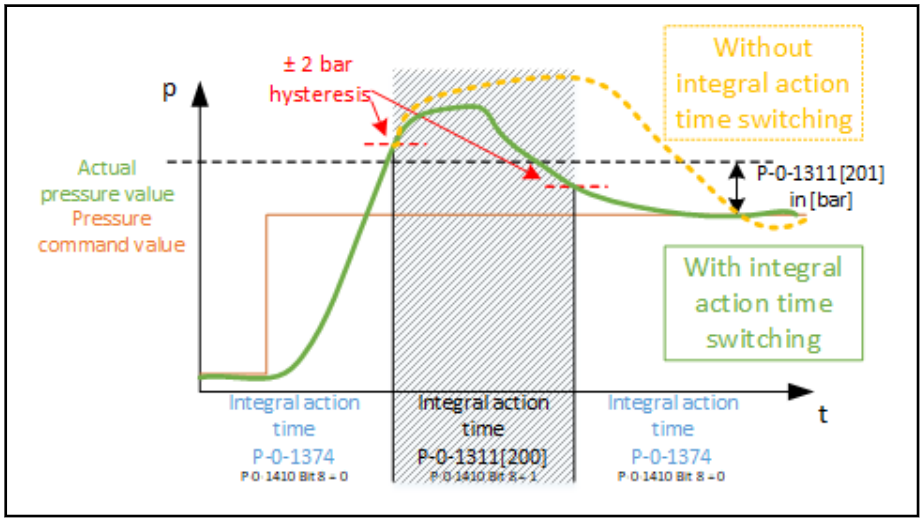

Fig. 6-9: Behavior of integral action time switching

The phase controller can be configured via the following parameters:

- P-0-1311[200], Integral action time upon switching
- P-0-1311[201], Pressure switching threshold for integral action time switching, additive to pressure command value

If the actual pressure value exceeds the relative pressure switching threshold in P-0-1311[201] + 2 bar hysteresis, the integral action time in the pressure controller is switched to the value in P-0-1311[200]. If the pressure feedback value falls again below the pressure switching threshold in P-0-1311[201] - 2 bar hysteresis, the integral action time in parameter P-0-1374, Tn, Integral action time (see "Closed-loop pressure control" on page 36) takes effect again in the controller.

The active integration time in the controller is displayed in "P-0-1410, Status word 1", bit 8. If the bit has the value “1”, the switching function is active and "P-0-1311[200], Integral action time for switching I-term when overshooting"

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is active in the pressure controller. If the bit has the value “0”, "P-0-1374, Tn, integral action time" is active again.

P-0-1410, bit 8	Description
0	Integral action time "P-0-1374, Tn, Integral action time" is active
1	Integral action time "P-0-1311[200], Integral action time for switching I-term when overshooting" is active

Tab. 6-13: Status of the pressure window

Limitation of the negative integrator term

Limiting "P-0-1331, Lower limit value of I-term, pressure controllers" allows an improved control behavior while pressure is being reduced. If the control difference is negative, the pressure controller computes a negative controller output to reduce the pressure. The limiting parameter P-0-1331 indicates how high the negative integrator term may become.

For a fast pressure reduction with subsequent pressure holding, a high negative integrator term is recommended. It should be noted that a high negative integrator term can promote pressure undershoots at certain operating points in the pressure reduction process.

Parameter P-0-1331 must not fall below the value in “P-0-1378, Lower speed limit value”, because the value determines the maximum negative controller output. An incorrect configuration is signaled by the warning “E2211 01890063 Config data exceeds valid range P-0-1331“.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0100, Speed controller K_P
- S-0-0101, Speed controller T_N
- S-0-0800, Pressure command value
- S-0-0804, Pressure feedback value
- S-0-0827, Pressure control deviation
- S-0-0832, Pressure window
- P-0-0690, Additive velocity command value, process controller
- P-0-1271, Effective pressure command value
- P-0-1276, Pressure controller P-term
- P-0-1277, Pressure controller D-term
- P-0-1311[0, Speed controller K_P
- P-0-1311[1], Speed controller T_N
- P-0-1311[2], Pressure controller K_P, P-gain
- P-0-1311[3], Pressure controller T_N, integral action time
- P-0-1311[4], Pressure controller K_D, D-gain
- P-0-1311[5], Pressure command value filter, filter time for increasing values
- P-0-1311[6], Pressure command value filter, filter time for decreasing values
- P-0-1311[20], Speed controller K_P
- P-0-1311[21], Speed controller T_N
- P-0-1311[22], Pressure controller K_P, P-gain
- P-0-1311[23], Pressure controller T_N, integral action time

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- P-0-1311[24], Pressure controller K_D, D-gain
- P-0-1311[25], Pressure command value filter, filter time for increasing values
- P-0-1311[26], Pressure command value filter, filter time for decreasing values
- P-0-1311[40], Speed controller K_P
- P-0-1311[41], Speed controller T_N
- P-0-1311[42], Pressure controller K_P, P-gain
- P-0-1311[43], Pressure controller T_N, integral action time
- P-0-1311[44], Pressure controller K_D, D-gain
- P-0-1311[45], Pressure command value filter, filter time for increasing values
- P-0-1311[46], Pressure command value filter, filter time for decreasing values
- P-0-1311[60], Speed controller K_P
- P-0-1311[61], Speed controller T_N
- P-0-1311[62], Pressure controller K_P, P-gain
- P-0-1311[63], Pressure controller T_N, Integral action time
- P-0-1311[64], Pressure controller K_D, D-gain
- P-0-1311[65], Pressure command value filter, filter time for increasing values
- P-0-1311[66], Pressure command value filter, filter time for decreasing values
- P-0-1311[200], Integral action time for switching I-term when overshooting
- P-0-1311[201], Switching threshold for switching I-term when overshooting
- P-0-1329, Pump acceleration limit
- P-0-1330, Pump deceleration limit
- P-0-1331, Lower limit value of I-term, pressure controller
- P-0-1370, Config word
- P-0-1373, Kp, P-gain
- P-0-1374, Tn, integral action time
- P-0-1375, Pressure controller K_D, D-gain
- P-0-1377, Speed command value
- P-0-1378, Lower speed limit value
- P-0-1384, Command value filter, filter time for increasing values
- P-0-1385, Command value filter, filter time for decreasing values
- P-0-1390, Control word
- P-0-1410, Status word 1
- P-0-1411, Status word 2
- P-0-2806.0.12, Output pump pressure controller I-part

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

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- E2211 01890001: Parameter set 1 out of range P-0-1311[0..6]
- E2211 01890002: Parameter set 2 out of range P-0-1311[20..26]
- E2211 01890003: Parameter set 3 out of range P-0-1311[40..46]
- E2211 01890004: Parameter set 4 out of range P-0-1311[60..66]
- E2211 01890041: Config data exceeds valid range P-0-1311[201]
- E2211 01890042: Config data exceeds valid range P-0-1311[200]
- E2211 01890043: Config data exceeds valid range P-0-1373
- E2211 01890044: Config data exceeds valid range P-0-1374
- E2211 01890045: Config data exceeds valid range P-0-1375
- E2211 01890048: Config data exceeds valid range P-0-1329
- E2211 01890049: Config data exceeds valid range P-0-1330
- E2211 01890050: Config data exceeds valid range S-0-0832
- E2211 01890063: Config data exceeds valid range P-0-1331
- E2211 01890064: lower speed limit is greater than zero P-0-1378

6.11.3 Limitations

Speed limitations

The active max. speed limit of the controller output in P-0-1289 corresponds to the lowest speed limit value from

- Maximum speed from power limitation
- P-0-1377, Speed command value
- P-0-1389[165], Configured maximum pump speed

The active min. speed limit of the controller output in P-0-1290 corresponds to the highest speed limit value from

- Protection against cavitation, permissible negative speed
- P-0-1378, Lower speed limit value
- P-0-1389[165], Configured maximum pump speed with negative sign

If the speed value is limited by the upper or lower active speed limit, this is indicated by the value 1 in the status word P-0-1410, bit 3 for the upper speed limit or bit 4 for the lower speed limit.

Protection against cavitation

The cavitation protection feature prevents an impermissible reverse direction of rotation of the pump. The pump is not allowed to rotate in reverse direction, if "S-0-0804, Pressure feedback value" is lower than parameter "P-0-1389[177], Permissible continuous minimum pump pressure". If this is the case, the active lower speed limit is set to 0 until the pressure feedback value rises again above the permissible continuous minimum pressure. This reduces wear of the pump caused by cavitation effects. The intervention of protection against cavitation is indicated in "P-0-1410, Status word 1" with bit 7 = 1, and warning "E2211 01890059: Cavitation protection blocks negative speed" is output.

Power limitation

The power limitation protects the pump against overloading.

The functionality is activated by default and can be deactivated via "P-0-1370, Config word", bit 25 = 1.

P-0-1370, bit 25	Description
0	Power limitation activated
1	Power limitation deactivated

Tab. 6-14: Configuration of integral action time switching

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When a predefined pump is selected, the maximum pump power and the displacement of the pump are set automatically. When a user-defined pump is to be configured, the maximum pump power has to be configured in P-0-1389[163] and the displacement in P-0-1389[160] (see also chapter 6.3.2 "Pump" on page 25). The currently active displacement is indicated in P-0-1275.

The permissible maximum limit speed $n_{Max\text{-}Power}$ is determined in dependence on pressure feedback value S-0-0804 in order not to exceed the permissible maximum power.

$$n_{Max-Power} = \frac{P_{Max}}{p_{act} \times V_g} = \frac{P-0-1389[163]}{S-0-0804 \times P-0-1275}$$

Fig. 6-10: Power limitation - calculation rule

If the controller provides a speed that exceeds this determined limit speed, the controller output is limited to the calculated value. This means that the limit speed becomes smaller as the pressure rises.

The intervention of power limitation is indicated in "P-0-1410, Status word 1" with bit 5 = 1, and warning "E2211 01890057: Max power limited" is output.

Acceleration limitation

The permissible maximum acceleration is to be entered in parameter P-0-1329, the permissible maximum deceleration in P-0-1330. The configured acceleration and deceleration values must not exceed the value of parameter "P-0-1389[168], Maximum bipolar pump acceleration".

If no pump acceleration has been defined (P-0-1389[168] = 0), there is no restriction.

The activation of acceleration and deceleration limits is indicated in "P-0-1410, Status word 1" with bit 6 = 1, and warning “E2211 01890058: Acceleration/Deceleration limited" is output.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0804, Pressure feedback value
- P-0-1275, Active pump displacement
- P-0-1289, Active max. speed limit
- P-0-1290, Active min. speed limit
- P-0-1329, Pump acceleration limit
- P-0-1330, Pump deceleration limit
- P-0-1370, Config word
- P-0-1377, Speed command value
- P-0-1378, Negative speed limit value
- P-0-1389[160], Displacement 1
- P-0-1389[163], Maximum mechanical pump power
- P-0-1389[165], Maximum pump speed
- P-0-1389[168], Maximum bipolar pump acceleration
- P-0-1389[177], Permissible continuous minimum pressure
- P-0-1410, Status word 1

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 0189004B: Config data exceeds valid range P-0-1389[163]
- E2211 0189004C: Config data exceeds valid range P-0-1389[165]

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- E2211 0189004D: Config data exceeds valid range P-0-1389[160]
- E2211 0189004E: Config data exceeds valid range P-0-1389[177]
- E2211 0189004F: Config data exceeds valid range P-0-1389[168]
- E2211 01890057: Max power limited
- E2211 01890058: Acceleration/Deceleration limited
- E2211 01890059: Cavitation protection blocks negative speed

6.12 Master/slave operation

6.12.1 Overview

To offer greater power with unchanged high dynamics of the motor-pump system, the so-called master/slave operation is provided. In master/slave operation, several motor-pump systems can be coupled via a speed command value input from master to slave and thus a system can be set up, which is cascadable in terms of power.

In a network with master/slave operation there is always one motor-pump system that is operated as master. The master runs in p/Q control. The n available slave systems are operated in speed control and follow the speed command value issued by the p/Q controller of the master system as control variable. The function of master/slave operation can be (de)activated. With "P-0-1370, Config word" bit 10 = 1 the unit is always in master operation and thus executes p/Q control according to the commanding.

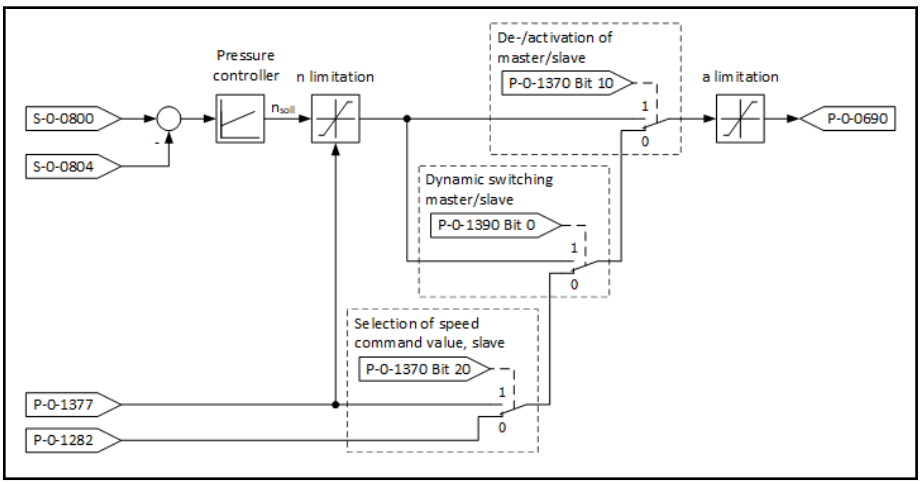

Fig. 6-11: Overview of master/slave switching

P-0-1370, bit 10	Description
0	Master/slave switching possible
1	Fixed master functionality

Tab. 6-15: (De)activation of master/slave operation

If the function of master/slave switching has been activated with P-0-1370, bit 10 = 0, the function can be switched as follows at runtime via the control word P-0-1390, bit 0:

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P-0-1390, bit 0	Description
0	Motor-pump system in slave operation
1	Motor-pump system in master operation

Tab. 6-16: Dynamic switching of master/slave function at runtime

If slave operation has been activated for the unit, the source of the speed command value can be configured by means of P-0-1370, bit 20. This offers high flexibility in the topology of a master/slave network. For the flow command value in master operation and for the speed command value provision (P-0-1377), the same interface may be used, or a register as separate interface (P-0-1282).

The speed command value received by the slave unit is limited by acceleration limitation in order to protect the motor-pump unit. The configuration interface for this can be found in the functional description of the p/Q controller, see "Acceleration limitation" on page 43. Unlike in master operation, the acceleration limitation in slave operation does not signal its activity status.

P-0-1370, bit 20	Description
0	P-0-1282 as speed command value for slave
1	P-0-1377 as speed command value for slave (in case of master operation, flow command value interface)

Tab. 6-17: Analog speed command value source for slave

In slave operation the speed is internally limited to a minimum speed P-0-1311[204]. If a check valve is used, the value “0” has to be entered for the minimum speed in order to protect the pump. The status of whether the unit is in the master or the slave mode, is indicated in P-0-1411, bit 2.

P-0-1411, bit 2	Description
0	Master operation active (p/Q control)
1	Slave operation active (speed control)

Tab. 6-18: Status of master/slave operation

☞ The following functions are not supported or switched off when a unit is in the slave mode:

- Monitoring of actual pressure value
- Monitoring based on thermal pump model
- Monitoring for inadmissible operating point
- Command value limitations, soft start
- p/Q control

6.12.2 Hydraulic setup

The following variants of hydraulic coupling of motor-pump groups are supported.

☞ The minimum speed in slave mode is defined in P-0-1311[204]. For hydraulic circuits with check valves the parameter must be set to 0!

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Circuit with check valve at the slave pump

All slave units operate commonly in the positive direction (flow into the system) to provide/increase the pressure in the system. The pressure is only reduced (flow out of the system) via the master unit.

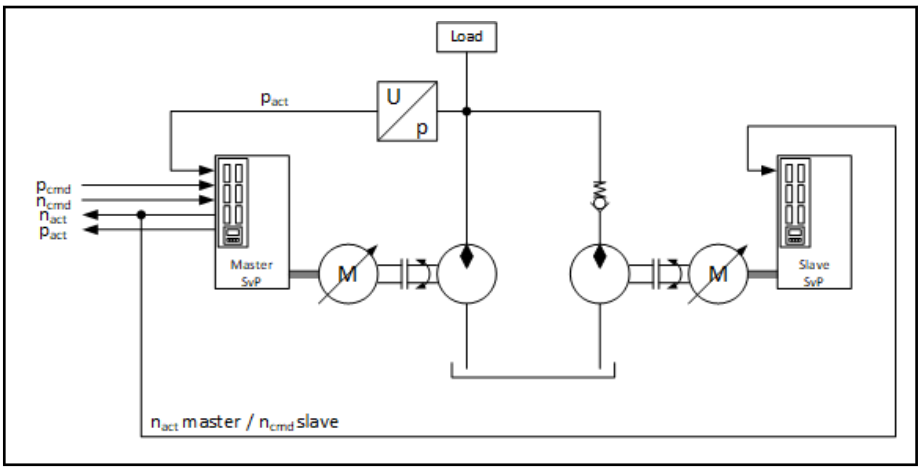

Fig. 6-12: Schematic circuit with check valve at the slave pump

Circuit without check valve at the slave pump

All pump outputs (master and slave units) are permanently interconnected.

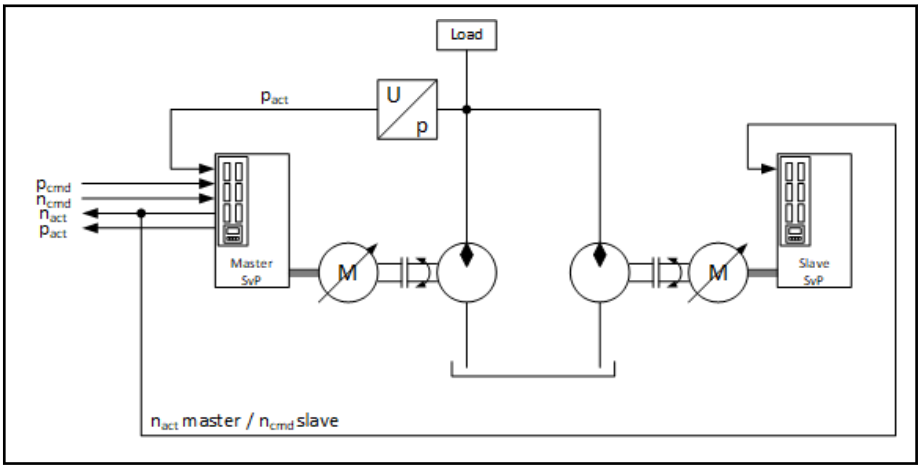

Fig. 6-13: Schematic circuit without check valve at the slave pump

Circuit with pilot operated check valve at the slave pump

Combined behavior of "Circuit with check valve at the slave pump" on page 46 and "Circuit without check valve at the slave pump" on page 46 according to the position of the pilot operated check valve.

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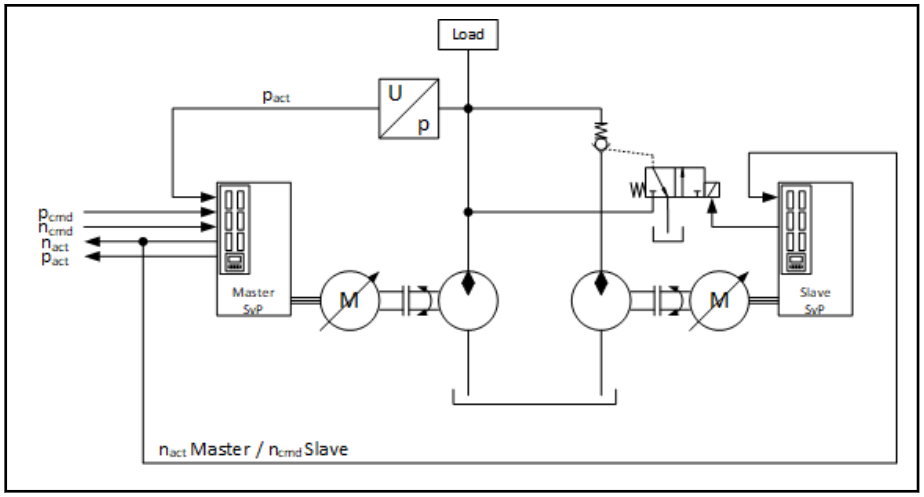

Fig. 6-14: Schematic circuit with pilot operated check valve at the slave pump

The following has to be noted when check valves are used:

- If the system comprises a check valve it has to be ensured that in case of performance reduction the master is not overloaded if all slave units are switched off.
- Without check valve, the system can only be set up with difficulties as all pumps are directly connected and have to be driven in parallel in order to maintain pressure in the system. If one slave unit fails, the machine control has to switch the system off in order to prevent damage to the system due to reversed direction of rotation.
- In case of a connection of the slave pump via a pilot operated check valve it can be ensured that the slave pump is decoupled as soon as the slave controller is switched off or has a fault.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- P-0-1282, Speed command value in slave operation
- P-0-1311[204], Minimum speed in slave operation
- P-0-1329, Pump acceleration limit
- P-0-1330, Pump deceleration limit
- P-0-1370, Config word
- P-0-1377, Flow command value in master operation/speed command value in slave operation
- P-0-1390, Control word
- P-0-1411, Status word

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890048: Config data exceeds valid range P-0-1329
- E2211 01890049: Config data exceeds valid rangeP-0-1330
- E2211 01890058: Acceleration/Deceleration limited

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6.13 Protective functions

6.13.1 Overview

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

Features

- Monitoring functions:
  - Pump pressure too high
  - Pump pressure too low
  - Pump temperature from model too high
  - Inadmissible operating points (n/M)
- Alarm threshold violations under drive enable will cause error reaction in ctrlX DRIVE.
- Monitoring functions can be deactivated to some extent via configurations.

6.13.2 Pump pressure monitoring

The function of monitoring the pressure of a pump is provided. If the permissible operating range of the pump is left, warnings and errors are generated.

The function monitors the actual pressure value of a pump. Monitoring is based on pump data, which are stored in the configuration when a pre-defined pump is selected and which have to be configured when a user-defined pump is used (see chapter 6.3.2 "Pump" on page 25). Apart from pump data, application-specific limit values can be configured to further restrict the operating range. This helps avoid overloading due to high pressures. The pressure feedback value is read via parameter S-0-0804.

Required pump data:

- Maximum pressure of the pump for brief overloading P-0-1389[175]
- Maximum pressure of the pump for continuous loading P-0-1389[176]
- Minimum pressure of the pump P-0-1389[177]

User-defined restrictions:

- User-defined maximum pressure P-0-1389[103]
- User-defined minimum pressure P-0-1389[104]

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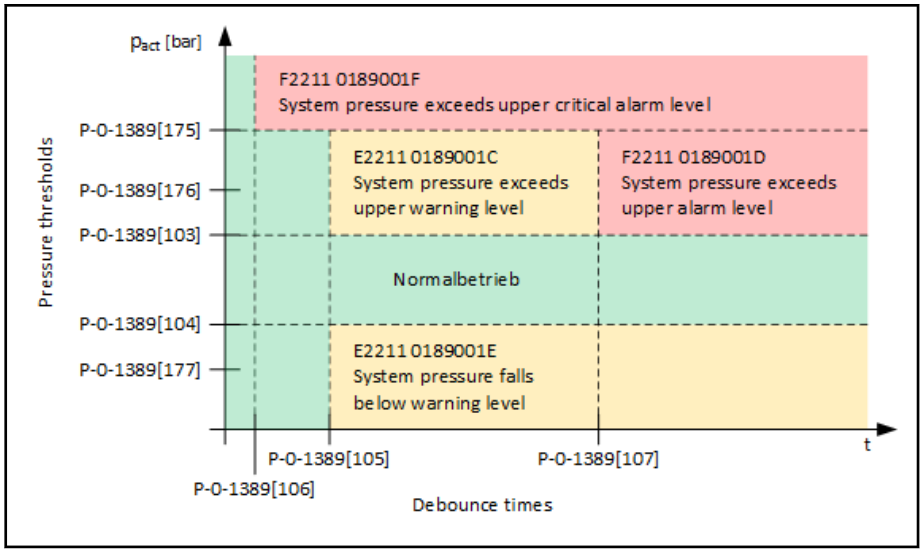

Fig. 6-15: Pump pressure monitoring

The pump data P-0-1389[176..177] can be used to define the normal operating range of the pump. By means of P-0-1389[103] the operating range can be further restricted. By means of P-0-01389[104] the lower operating range can be overwritten. If zero is entered for the adjustments of the operating range, it is deactivated.

Every warning and error message is subject to a debounce time. The time valid for this is shown in fig. 6-15 "Pump pressure monitoring" on page 49. The same time is applied to debounce the reset of the event.

Monitoring for low pressures

Low pressure warning:

- When the drive is enabled (AF) and pressure feedback value S-0-0804 is less than the threshold P-0-1389[177] (optionally P-0-1389[104]) for the duration specified in P-0-1389[105], the warning E2211 0189001E is issued.

Monitoring for high pressures

High pressure warning:

- When pressure feedback value S-0-0804 is higher than P-0-1389[176] (optionally P-0-1389[103]) for the time specified in P-0-1389[105], the warning E2211 0189001C is issued.

High pressure error

- When pressure feedback value S-0-0804 is higher than P-0-1389[176] (optionally P-0-1389[103]) for the time specified in P-0-1389[107], the error F2211 0189001D is issued.

Error of high/critical pressure:

- When pressure feedback value S-0-0804 is higher than P-0-1389[175] for the time specified in P-0-1389[106], the error F2211 0189001F is issued.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0804, Pressure feedback value
- P-0-1389[103], User-defined maximum pressure
- P-0-1389[104], User-defined minimum pressure
- P-0-1389[105], Debounce time for warning in inadmissible pressure range
- P-0-1389[106], Debounce time for error in critical pressure range

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- P-0-1389[107], Debounce time for error in invalid pressure range
- P-0-1389[175], Critical maximum pressure of pump
- P-0-1389[176], Maximum pump pressure in continuous operation
- P-0-1389[177], Minimum pump pressure

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890016: Config data exceeds valid range P-0-1389[177]
- E2211 01890017: Config data exceeds valid range P-0-1389[176]
- E2211 01890018: Config data exceeds valid range P-0-1389[104]
- E2211 01890019: Config data exceeds valid range P-0-1389[103]
- E2211 0189001A: Config data exceeds valid range P-0-1389[107]
- E2211 0189001B: Config data exceeds valid range P-0-1389[106]
- E2211 0189001C: System pressure exceeds upper warning level
- F2211 0189001D: System pressure exceeds upper alarm level
- E2211 0189001E: System pressure falls below lower warning level
- F2211 0189001F: System pressure exceeds upper critical alarm level

6.13.3 Temperature monitoring

The function of monitoring the temperature of a pump is provided. Heating up of the pump in the pressure holding operation is calculated with the help of a temperature model, and when a certain heat level is exceeded, a warning or an error is generated.

To be able to calculate the degree of heat of the pump, a pump of type PGH has to be selected in parameter P-0-1389[100], since the required model data are stored exclusively for this pump type (see also chapter 6.3.2 "Pump" on page 25). In addition, the thermal model is based on the use of the operating fluid HLP46 with an inlet temperature of 50 °C.

The thermal model monitors the speed feedback value, S-0-0040 as indicator for the thermal stability in relation to the pressure feedback value, S-0-0804. For calculating the temperature model, both values are filtered with a PT1 filter with a time constant of 200 ms. The software contains coefficients for all selectable pumps of type PGH, from which, among others, the characteristic curves n_{s1} and n_{s6} are calculated for evaluating the current operating point.

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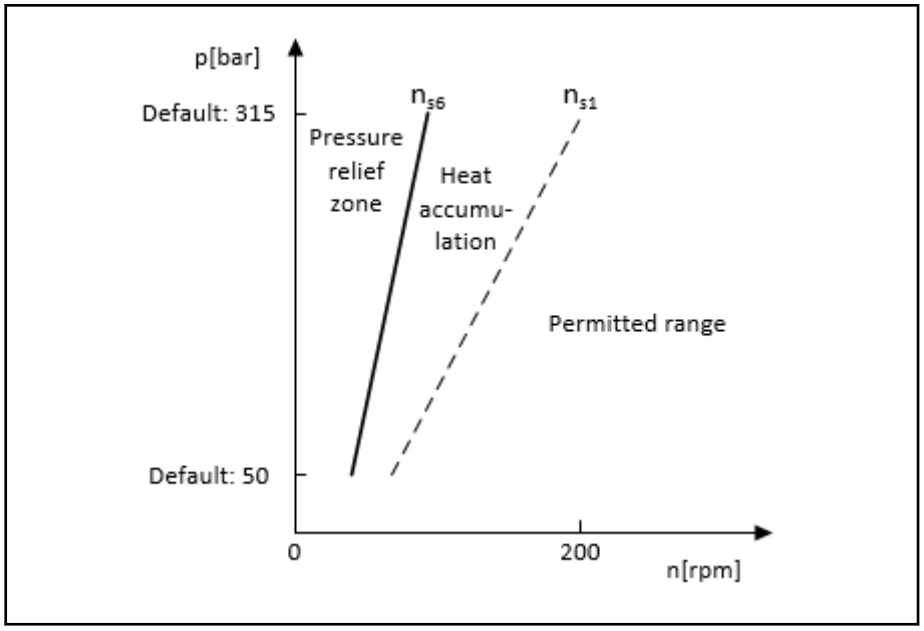

Fig. 6-16: p(n) diagram for the thermal classification of operating points

In case of operation at a speed below the n_{s1} line, there is a risk of heat accumulation. Within this range, the oil flow is not sufficient to cool the pump so that a thermal steady-state condition occurs. It is therefore recommended maintaining a speed greater than “P-0-1389 [166], Min. positive speed”. In some cases the system leakage is, however, too small to satisfy this condition so that the degree of heat rises in dependence on the operating point.

In case of continuous operation at a speed below the n_{s6} line, the displacement is not sufficient to compensate internal pump leakage. Consequently, the pump cannot maintain the system pressure, which results in a slow pressure reduction in the system.

Cooling down of the pump depends on the ambient conditions. The cooling factor in P-0-1389[124] in the order from 1 to 3 is a measure for the heat dissipation of the pump (in a thermally stable state). Factor 1 describes a pump, which cools down slowly (e.g. at high ambient temperature), factor 3 (default) a pump, which cools down faster (e.g. at room temperature). A higher cooling-down factor therefore means faster cooling down of the pump and thus a shorter recovery time between two high-pressure cycles.

The minimum speed n_{s1} (exchange rate of the liquid) required to avoid heat accumulation is output in P-0-1297. The “degree of heat” is output as value in % in P-01298.

Diagnostics

- If the degree of heat exceeds the value of 90 %, warning E2211 01890022 is issued.
- If the degree of heat exceeds the value of 98 %, error F2211 01890023 is issued. The generation of the error can be deactivated via “P-0-1370, Config word”, bit 18.
- If the speed falls below the n_{s6} line for the debounce time that can be configured in P-0-1389[131], warning E2211 01890021 is signaled.

If a pump was selected, for which no valid data are available in the temperature model, the warning E2211 01890055 is shown once for two seconds when the pump is selected as well as after a restart upon the first switching to OM.

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When the temperature model has been deactivated, the warning E2211 01890056 is output once after the configuration as well as after a restart upon first switching to OM.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0040, Velocity feedback value of encoder 1
- S-0-0804, Pressure feedback value B
- P-0-1297, Min. positive speed limitation
- P-0-1298, Degree of heat, thermal pump model
- P-0-1389[100], Pump type
- P-0-1389[124], Cooling factor
- P-0-1389[131], Debounce time of warning if actual speed is below n_{s6} line
- P-0-1389[166], Minimum speed in continuous operation

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890020: Config data exceeds valid range P-0-1389[124]
- E2211 01890021: Low positive speed
- E2211 01890022: Heat accumulation exceeds warning level
- F2211 01890023: Excessive heat accumulation
- E2211 01890055: Internal pump data is invalid
- E2211 01890056: Therm. pump model deactivated or not available

6.13.4 Inadmissible operating point

The function recognizes an inadmissible operating point on the basis of the motor speed (n) and motor torque (M). If the pressure-controlled system is in the motor operation mode with negative direction of rotation, an impermissible operating point is approached, which will result in a drive error after a debounce time. This state can be caused, for example, by a frozen pressure sensor signal. The function is activated by default and can be deactivated via "P-0-1370, Config word", bit 21 = 1.

Definition

An inadmissible operating point is present, if "S-0-0084, Torque feedback value" of the motor is below the torque threshold P-0-1389[141] and, at the same time, "P-0-1278, Actual speed value in the direction of action" of the motor is below the speed threshold P-0-1389[140]. If the system is in this operating point for longer than debounce time P-0-1389[142], error F2211 01890026 is triggered.

☞ In the case of a clockwise rotating pump, "S-0-0084, Torque feedback value" is positive.

The process values “speed feedback value” and “torque feedback value” of the motor are PT1-filtered before monitoring for inadmissible operating points.

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0084, Torque feedback value
- P-0-1278, Actual speed value in the direction of action
- P-0-1370, Config word
- P-0-1389[140], Speed threshold for inadmissible operating point
- P-0-1389[141], Torque threshold for inadmissible operating point

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- P-0-1389[142], Maximum admissible time at impermissible operating point

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- E2211 01890024: Config data exceeds valid range P-0-1389[140]
- E2211 01890025: Config data exceeds valid range P-0-1389[142]
- F2211 01890026: Invalid operation point detected

6.13.5 Wire break monitoring

The drive provides the function of monitoring the input value of the analog inputs for wire break. The message to be generated can be configured in the control word for the relevant analog input (P-0-2900.x.1) as warning or error. For further information, see functional description of firmware AXS-V-03 in chapter 9.2 "Firmware" on page 173.

6.14 Activation of required FW functional packages

The functionality indicates the status of required Sytronix packages. The list of active firmware functions P-0-2003.0.2 of the ctrlX DRIVE shows the packages, which were activated by the user, in the form of function codes. With the help of this list you can see whether all the firmware resources required for the Sytronix technology functionalities are available and whether the software can be run.

The following packages are required for the Sytronix technology functionalities:

Function	Function code
Parameter interface for pressure, flow	0x52120001
Controlling the drive	0x07200001

Tab. 6-19: Required FW functional packages

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- P-0-2003.0.2, Active firmware functions
- P-0-2003.0.3, Selectable firmware functions

Pertinent diagnostic messages

See also: chapter 8.2 "Errors and warning messages" on page 164

- F2211 01890033: Needed FW-Packages not available

6.15 Diagnostics/error handling

Warnings and errors of the technology function are recorded by the integrated generation of diagnostic messages and displayed via different output channels. We distinguish the following categories of events:

- **F8211**, fatal errors which do not allow a definable error reaction of the ctrlX DRIVE.
- **F2211**, non-fatal errors which allow a definable error reaction of the ctrlX DRIVE.
- **E8211**, fatal warnings which run a drive reaction of the ctrlX DRIVE.
- **E2211**, non-fatal warnings which do not run a drive reaction of the ctrlX DRIVE.

The event with the highest severity is displayed in the diagnostic message of the ctrlX DRIVE firmware (S-0-0095). It is composed as follows:

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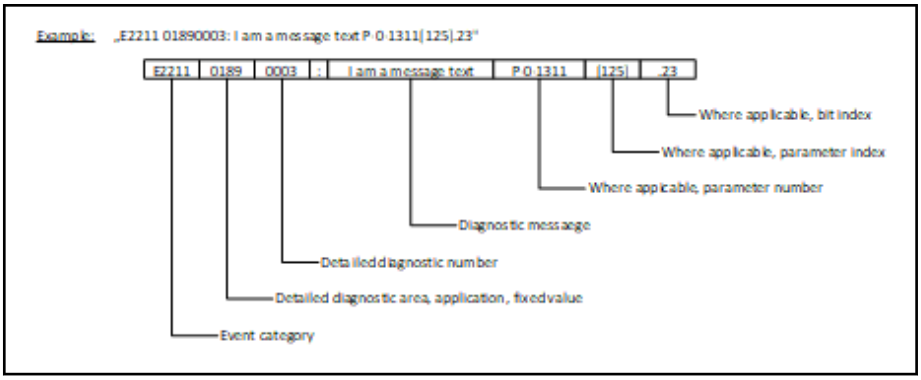

Fig. 6-17: S-0-0095, Diagnostic message

As shown in the example, apart from the event category, the detailed diagnostic message number as well as the corresponding text is displayed, which provides detailed information on the cause of the event. In addition to a diagnostic text, it can also contain notes on the relevant parameter or the list element concerned, whose entered value is the cause of the event. The detailed diagnostic message number is available separately in S-0-0390.0.136.

The information of diagnostic number and detailed diagnostics number is stored additionally in the diagnostic logbook of the ctrlX DRIVE.

See also description of diagnostic messages chapter 8.2 "Errors and warning messages" on page 164.

Features

- Events are classified into four categories according to their severity
- Unequivocal diagnostic message number with diagnostic text
- PLC errors/warning messages generated at the ctrlX DRIVE for the events: E/F2211, E/F8211
- Events are recorded with time stamps in the diagnostic logbook

Pertinent parameters

See also: chapter 8.1 "Parameters" on page 109

- S-0-0095, Diagnostic message
- S-0-0390, Diagnostic message number
- S-0-0390.0.136, Detailed diagnostics

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7 Commissioning

7.1 Establishing a connection to the drive

7.1.1 General

Use the IndraWorks Ds software to commission and diagnose ctrlX DRIVEs. This section describes the most common types of establishing a connection using **Network search** and **IP address search**.

☞ A guided alternative is the connection wizard. The connection wizard is always available and guides the customer step by step through the entire process of establishing a connection.

7.1.2 Establishing the connection

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

The IP address can be changed using the plug-in panel of the ctrlX DRIVE or IndraWorks Ds. The procedure is described in the following chapter and in section "IP setting using the panel" on page 59.

☞ 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 within the same network will be found, irrespective of their IP and computer configuration. Devices with an IP configuration outside the subnet used will also be found.

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

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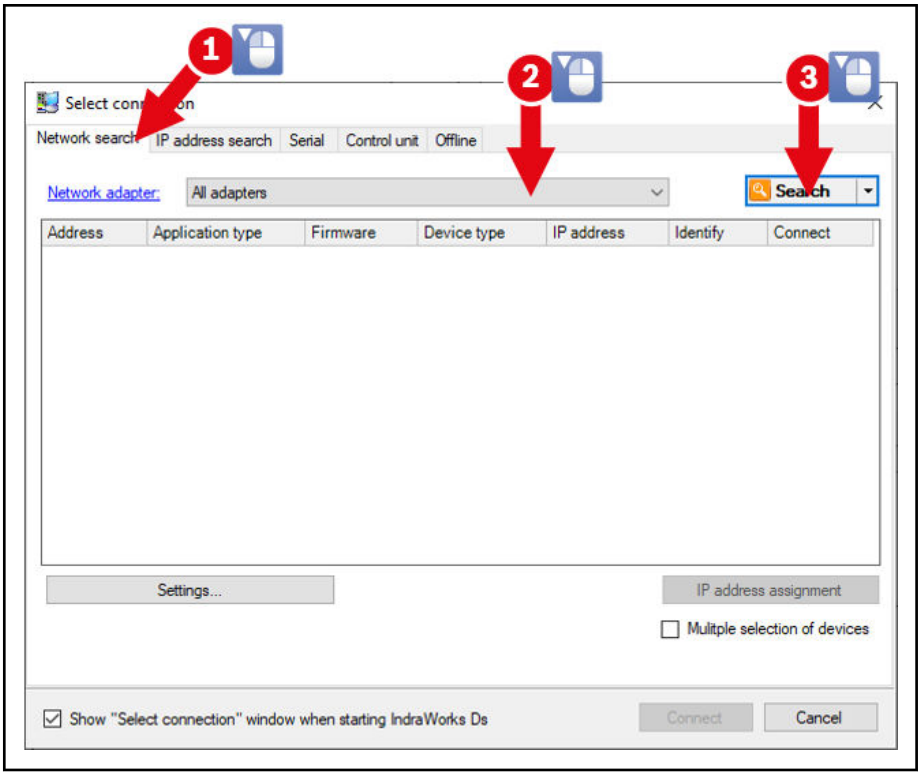

Fig. 7-1: Network search

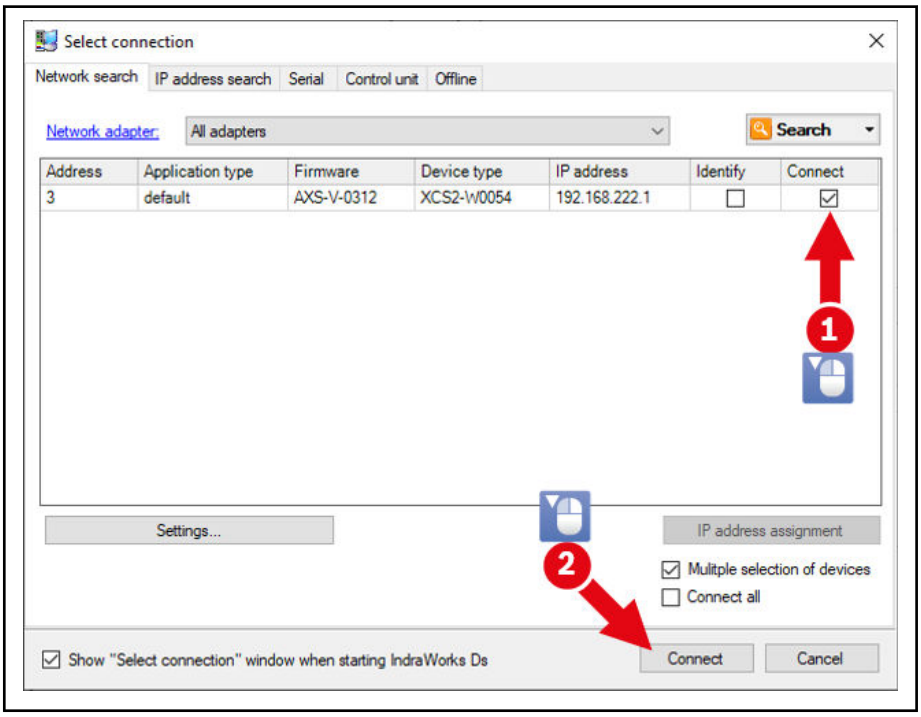

Fig. 7-2: Establishing the connection in the network search

☞ If you set a check mark in the column “Identify", the diagnostic LED of the ctrlX DRIVE blinks white.

If the network search was successful, but the IP address found is not in the network range of the adapter, communication is not readily possible.

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IndraWorks Ds shows the device found in red letters. In this case, there are two options after having clicked on “Connect”.

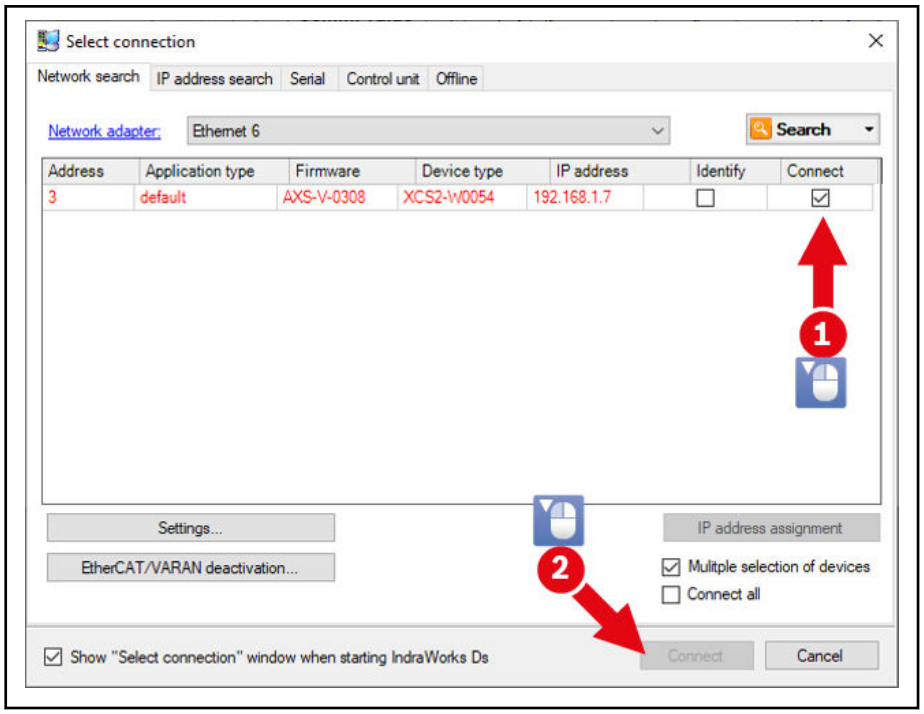

Fig. 7-3: The IP address is not within the valid range

1. **Extending the computer IP address** (e.g., in case servicing is required). IndraWorks Ds automatically adds a matching IP address in the computer to facilitate communication with the devices. The address will be automatically deleted again, if the check box for “Restore old settings” has been activated and IndraWorks Ds is closed, or when the ctrlX DRIVE reboots.

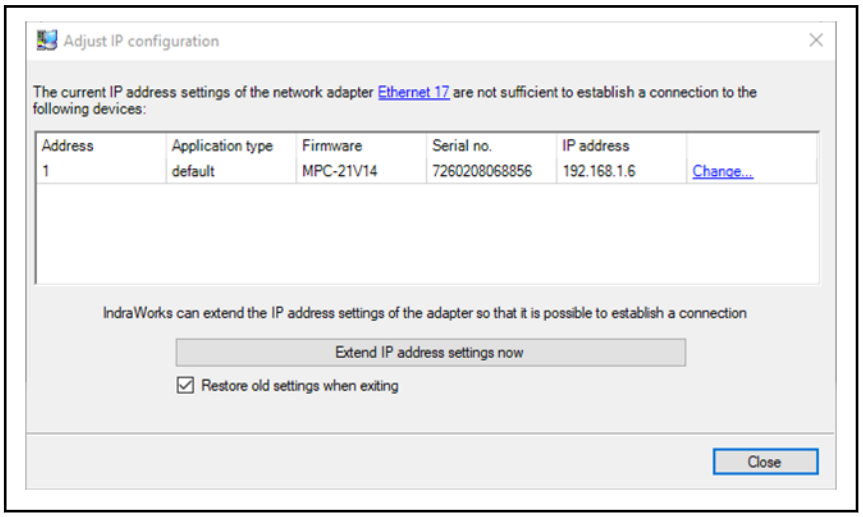

Fig. 7-4: Extending the IP address settings of the adapter

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 Ds suggests an IP address suitable for communication with the computer. Alternatively, a specific IP address can be assigned.

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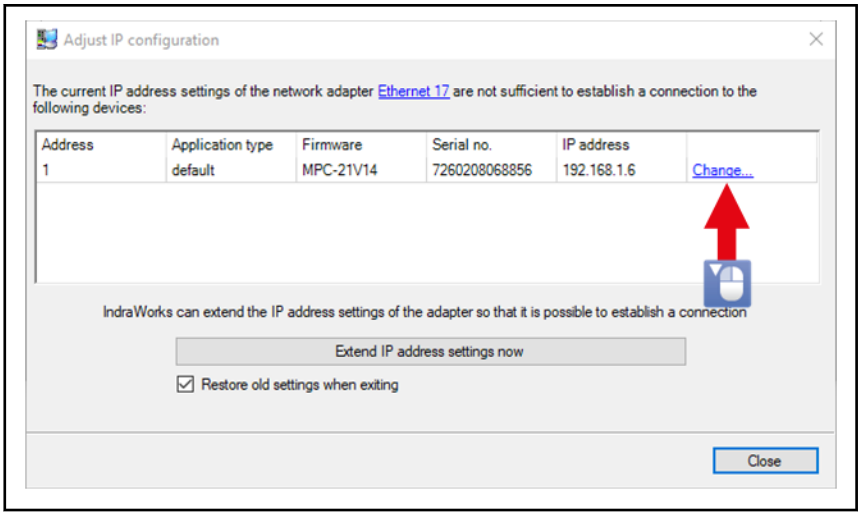

Fig. 7-5: Changing the IP settings of the ctrlX DRIVE

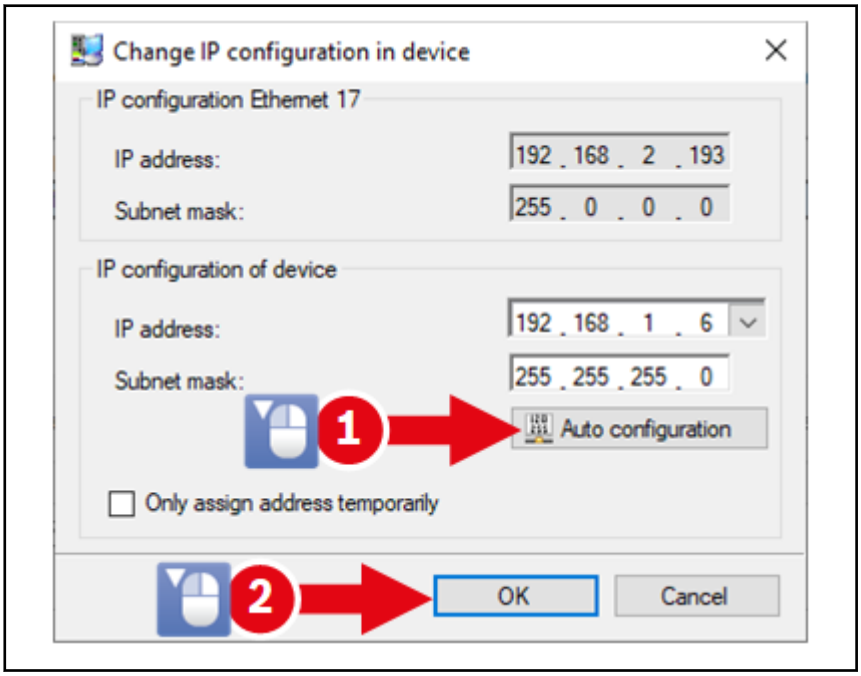

Fig. 7-6: Making new IP settings for the ctrlX DRIVE

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.

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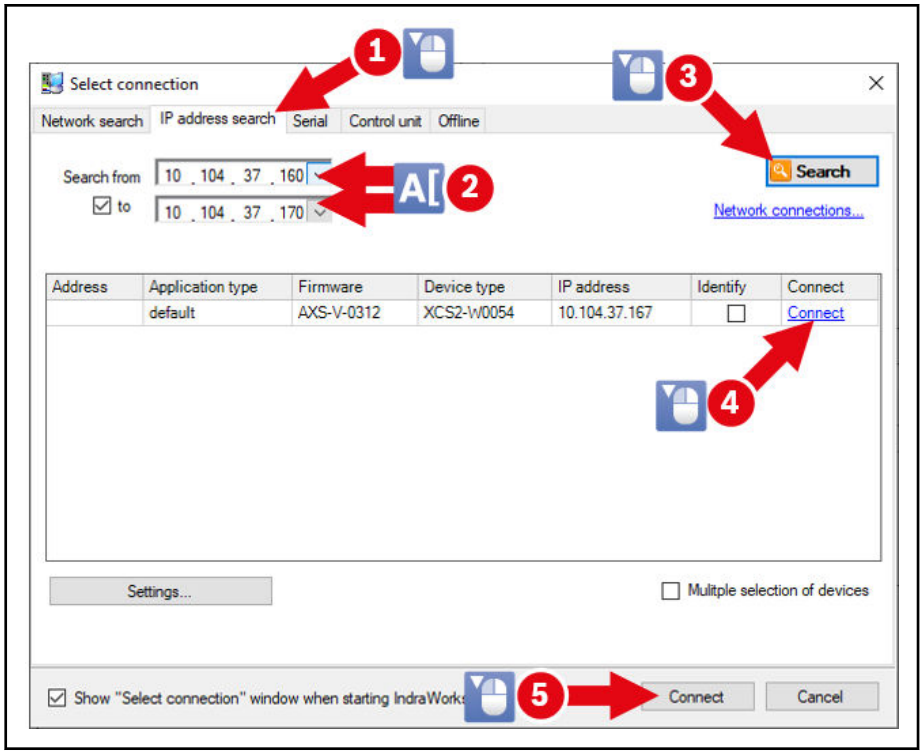

Fig. 7-7: Establishing the connection using the IP address search

IP setting using the panel

The current IP settings of the field bus interface of the ctrlX DRIVE can also be configured using the optional panel. To this end, proceed as follows on the panel, **press "Enter" ▸ select “Axis x" and confirm with "Enter" ▸ select “Network settings" and confirm with "Enter" ▸ select “Field bus XF21-XF22” and confirm with "Enter"**.

USB connection using the panel

The optional panel is plugged on the ctrlX DRIVE and connected to a Windows PC via a USB cable. This connection is independent of field bus interfaces. The DCHP server in the panel assigns a separate IP address which differs from the address of the Ethernet interface.

The DHCP server of the panel assigns addresses within the range of 192.168.yyy.1 ... 192,168.yyy.253. For "yyy" the range 222 ... 254 is valid.

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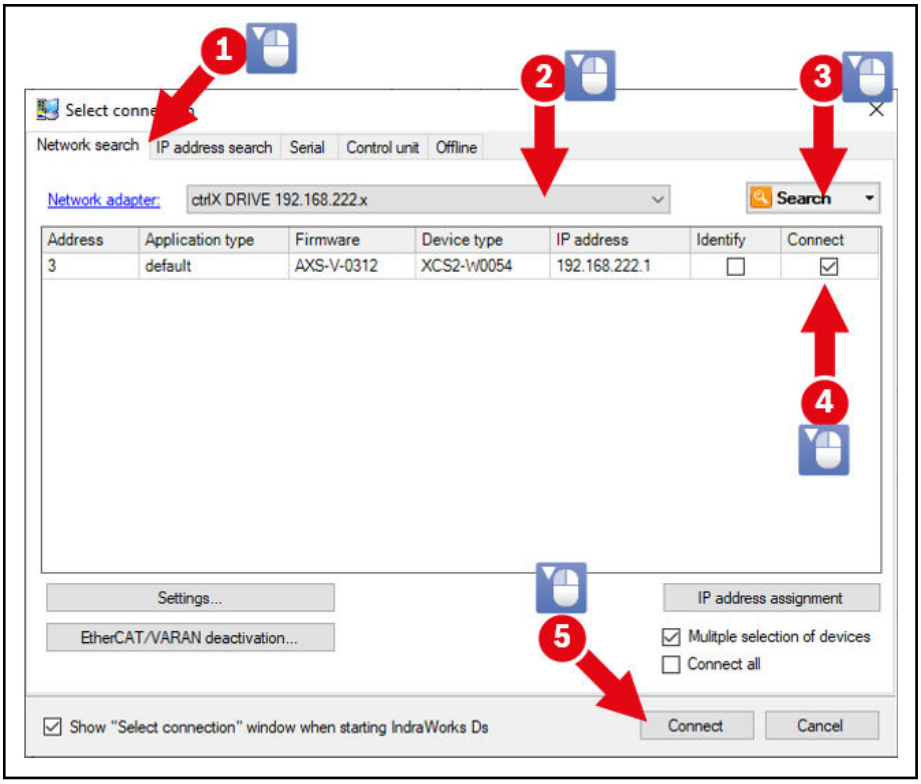

Fig. 7-8: Establishing the connection in the network search using the USB connection on the panel

☞ In the engineering network, no "Network Bridges" may be activated via USB.

☞ Parallel engineering of several drives via their USB interface on a PC is not permitted.

Another method of establishing a connection to the ctrlX DRIVE is the connection wizard. It is not explained in more detail at this point.

Further information on the establishment o the connection can be found in the Application Manual of the firmware. Please see the valid firmware application descriptions in the Annex in chapter 9.2 "Firmware" on page 173.

7.2 Loading the technology function

To be able to use the technology function, the software/parameter file has to be loaded first. In the condition as supplied, the software/parameter file has already been installed. In the case of updates, the technology function can be re-loaded in the form of a parameter file (loadable Technology Function Project).

No PLC programming knowledge is required, because the complete technology function can be operated via the dialogs in IndraWorks Ds.

To do this, the following steps have to be executed:

1. For displaying the active technology function and its status, select "PLC settings" under the node "Technology Function" in IndraWorks Ds.
2. Here, you can check, whether the IMC software is installed, and if so, with which release status. In addition, you see whether the software is actively running (RUN state).

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3. If necessary, a new program can be loaded (as a software/parameter file) via “Load project....”

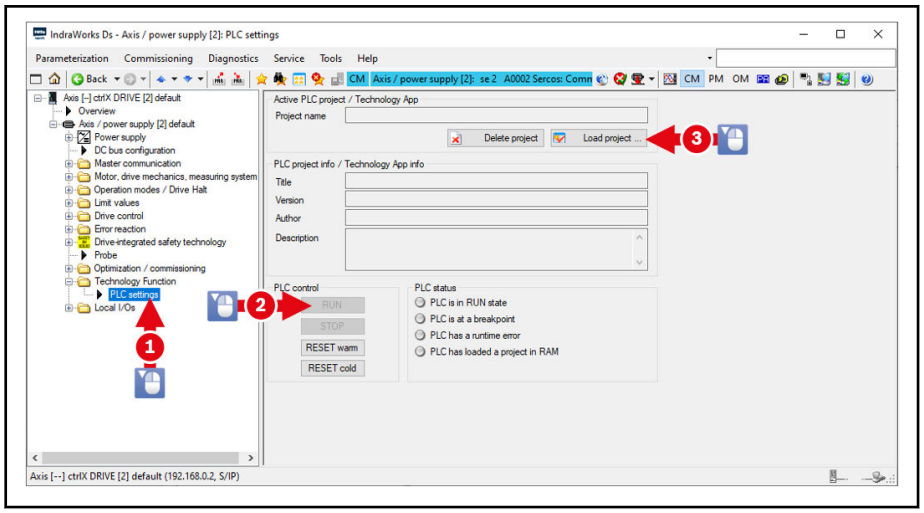

Fig. 7-9: PLC settings

7.3 Configuring the ctrlX DRIVE

7.3.1 Parameter access

In order to be able to configure all functions completely it is required to carry out parameterizing with the help of the parameter editor or the parameter group.

It is recommended that you store a parameter backup before changing parameter values. This allows you to restore previous settings in the case of problems. For further information, see application description of the firmware in the Annex.

The following sections describe the general handling if you wish to change parameter values that are not included in dialogs.

Parameter editor

You can view or change individual parameters with the help of the parameter editor. The parameter editor shows the name, the minimum and maximum possible value as well as the current value of the parameter.

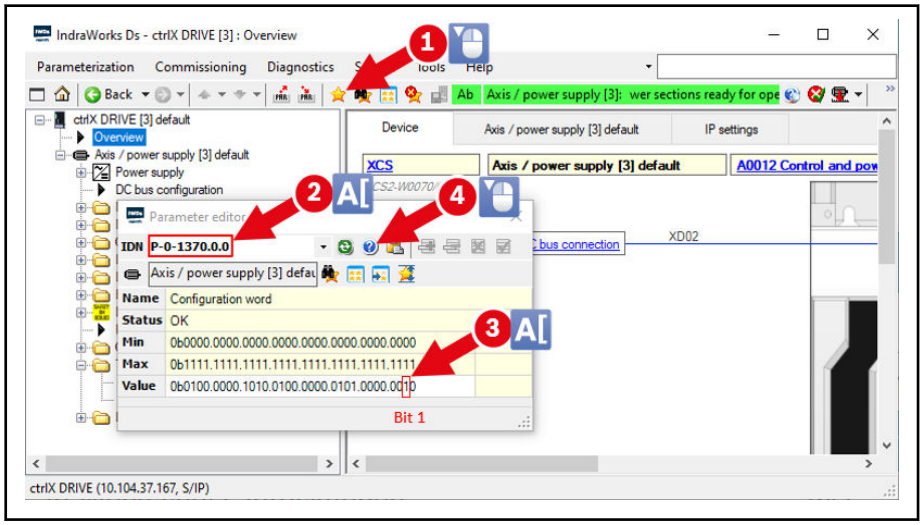

Fig. 7-10: Changing parameters in the parameter editor

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1. Call the parameter editor.
2. Select the parameter, the value of which is to be changed.
3. Change the value. In the example shown here, a bit is changed. All writable parameters can be changed.
4. The parameter help description (4) shows a more detailed description of the parameter.

The help button shows the required information for most of the parameters. If information on global PLC registers is displayed instead, refer to the description of this parameter in these commissioning instructions.

Parameter group

The parameter group is recommended, if several values are to be changed. The view below shows that comments may be updated, amongst others. The created parameter group can be saved by clicking the “Save” button and loaded at a later point in time.

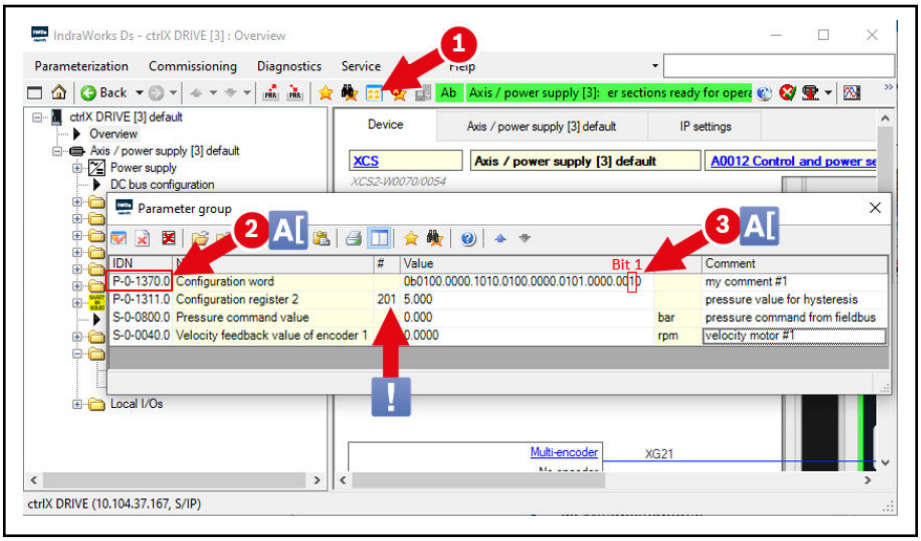

Fig. 7-11: Changing parameters via the parameter group

1. Call the parameter group.
2. Select the parameter, the value of which is to be changed.
3. Change the value. In the example shown here, a bit is changed. All writable parameters can be changed.

The graphic above shows that list elements (e.g. P-0-1311) have an additional column "#". The index of the list parameters can be entered via the field and, analogously to non-list parameters, the value can be changed. In this example, parameter P-0-1311[201] has been called and its value can now be changed.

For further information and limits regarding the writing of parameters, see application description of the firmware in the Annex.

7.3.2 Master communication

Connection to the control

- **Connection to the control** can be established via the communication interfaces available in the drive. The following interface types have to be distinguished:

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– **Analog/digital inputs and outputs**

  Command values and control signals are transmitted to the ctrlX DRIVE through analog and digital signals. This type of communication requires an I/O extension in the form of an optional card (DA). In this connection, see the hardware configuration of the device in chapter 5.3 "Electrical system characteristics" on page 19.

– **Multi-Ethernet field bus interface** (Sercos®, EtherCAT®, PROFINET®)

  Command values and control signals are transmitted to the ctrlX DRIVE over the field bus.

An exemplary assignment for the cyclic exchange of process data between master communication and the drive over the field bus interface is shown in fig. 7-14 "Exemplary assignment of the communication interface with external control via field bus" on page 64.

- The technology function is **configured** via the defined drive parameters, see: chapter 8.1.2 "Relevant parameters" on page 109

Multi-Ethernet field bus interface

The following figures show connection proposals for the ctrlX DRIVE with supported field buses:

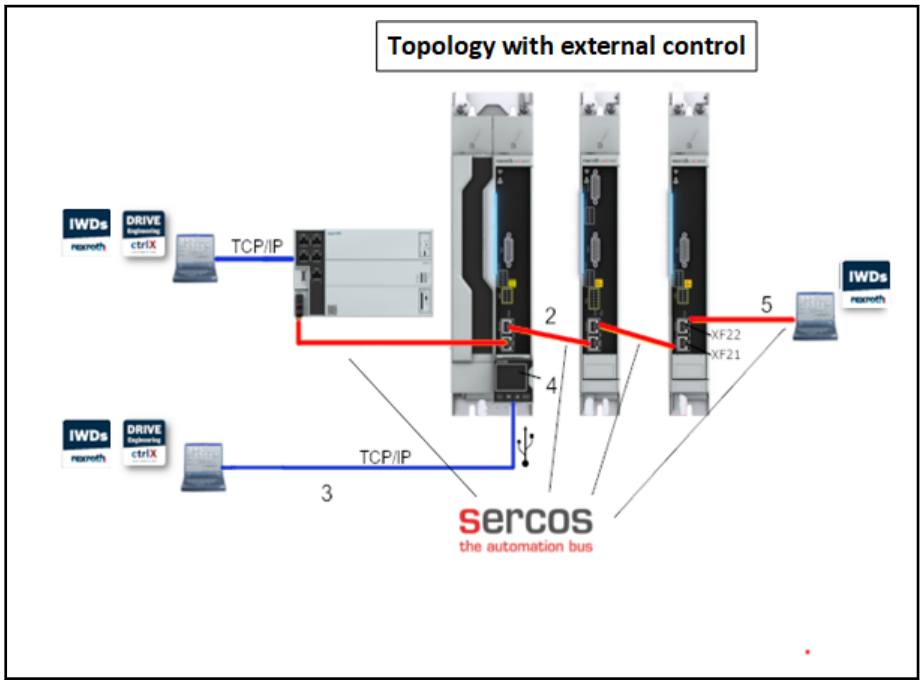

Fig. 7-12: Connection under Sercos topology with external control

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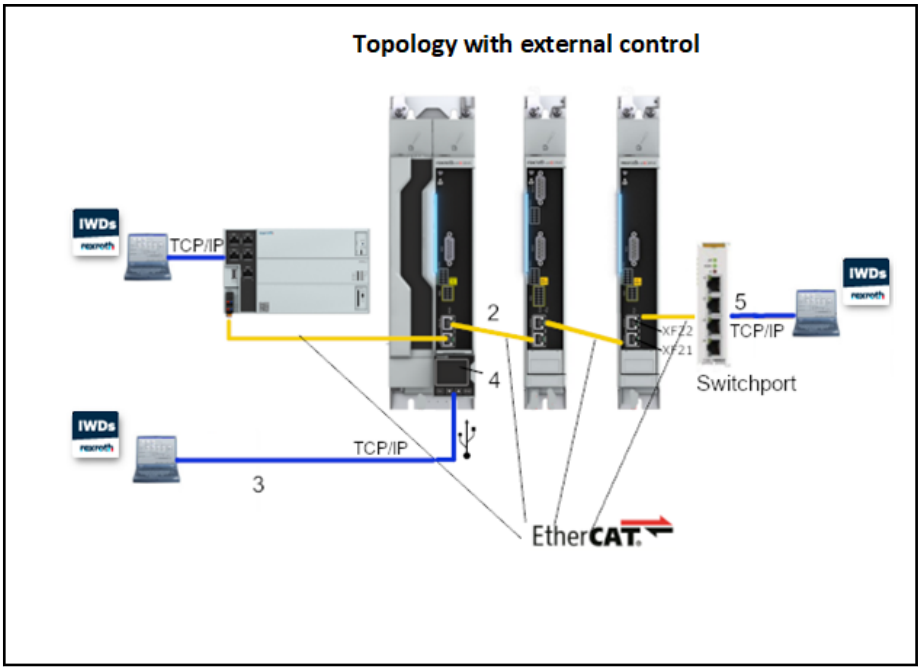

Fig. 7-13: Connection under EtherCAT topology with external control

It is recommended that the master communication be activated only after the ctrlX DRIVE and the technology function were configured. Repeated phase switching of the drive state machine, which is required for commissioning, causes delays in machine commissioning under an active field bus.

The master communication can be selected and set in IndraWorks directly in the project tree under the folder "Master communication", see chapter "Selecting and setting the master communication" on page 65 or in the dialog of initial parameterization, see "Analog initial parameterization" on page 77.

An example of process data for communication with an external control is displayed in the following figure:

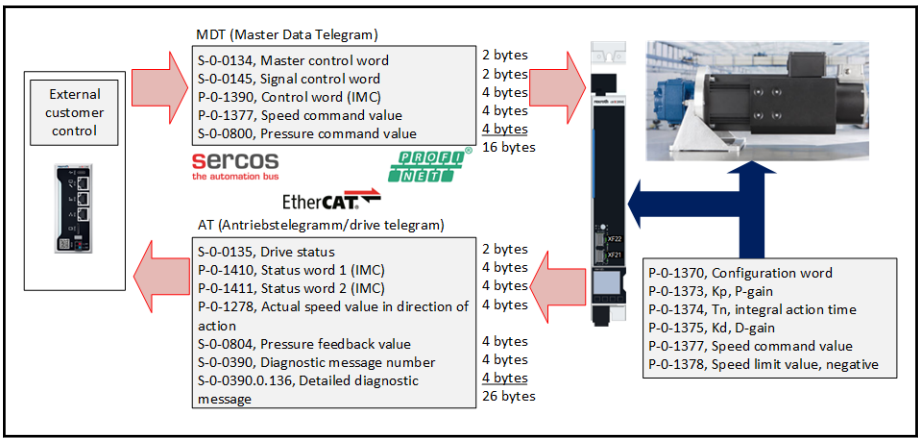

Fig. 7-14: Exemplary assignment of the communication interface with external control via field bus

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Selecting and setting the master communication

Activate EtherCAT® (SoE)

Since the configuration is carried out almost exclusively on the master communication side, on the ctrlX DRIVE only the master communication and the application profile need to be activated and the operation mode set.

1. Activate master communication and application profile type

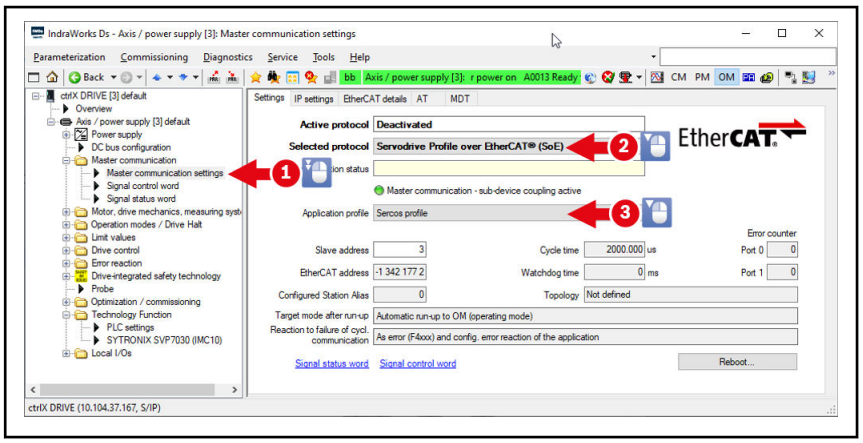

Fig. 7-15: Activating EtherCAT® (SoE)

☞ After a communication protocol or the profile type was changed, the device has to be restarted.

☞ Due to the selected application profile type, “S-0-0134, Master control word” is used for the controller enable (AF), etc. "S-0-0135, Drive status word" contains essential status information such as readiness for operation, drive error, etc. For further information, see application description of the firmware in the Annex.

2. Configure cyclic feedback values (AT) (on control side)
   - chapter "S-0-0135, Drive status word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1410, Status word 1" on page 158; length: 2 bytes
   - chapter "P-0-1411, Status word 2" on page 159; length: 2 bytes
   - chapter "P-0-1278, Actual speed value in direction of action" on page 115; length: 4 bytes
   - chapter "S-0-0804, Pressure feedback value" on page 163; length: 4 bytes
   - chapter "S-0-0390, Diagnostic message number" on page 162; length: 4 bytes; decimal places: 0; unit: -
   - chapter "S-0-0390.0.136, Detailed diagnostics" on page 162; length: 4 bytes; decimal places: 0; unit: -
3. Configure cyclic command values (MDT) (on control side)
   - chapter "S-0-0134, Master control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "S-0-0145, Signal control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1390, Control word" on page 157; length: 2 bytes

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- chapter "P-0-1377, Speed command value" on page 143; length: 4 bytes
- chapter "S-0-0800, Pressure command value" on page 162; length: 4 bytes

4. Configure operation modes (is already set by “loading basic settings”)
   - Primary operation mode: Velocity control; S-0-0032 = 0b0000.0000.0000.0010

     chapter "S-0-0032, Primary operation mode" on page 161

☞ The higher-level control might overwrite the setting of the operation mode when initializing the EtherCAT bus. If applicable, check the settings on the control unit.

Sercos®

Since the configuration is carried out almost exclusively on the control side, on the ctrlX DRIVE only the master communication and the application profile need to be activated and the operation mode set.

1. Activate master communication and application profile type

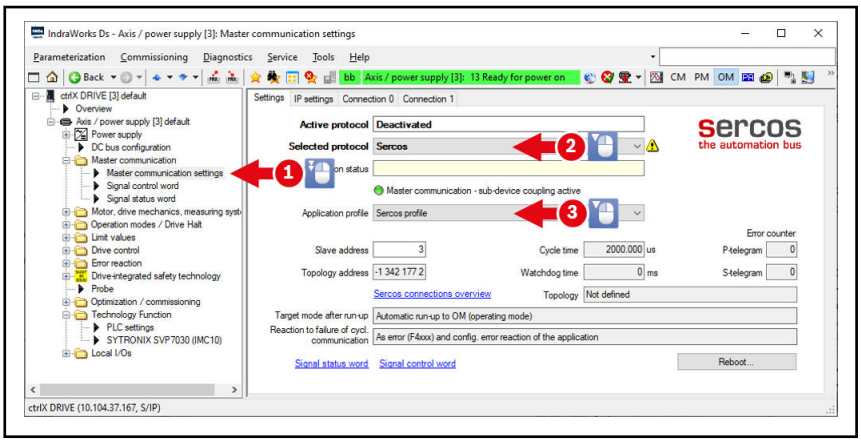

Fig. 7-16: Activate Sercos®

☞ After a communication protocol or the profile type was changed, the device has to be restarted.

☞ Due to the selected application profile type, “S-0-0134, Master control word” is used for the controller enable (AF), etc. "S-0-0135, Drive status word" contains essential status information such as readiness for operation, drive error, etc. For further information, see application description of the firmware in the Annex.

---

2. Configure cyclic feedback values (AT) (on control side)
   - chapter "S-0-0135, Drive status word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1410, Status word 1" on page 158; length: 2 bytes
   - chapter "P-0-1411, Status word 2" on page 159; length: 2 bytes
   - chapter "P-0-1278, Actual speed value in direction of action" on page 115; length: 4 bytes

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- chapter "S-0-0804, Pressure feedback value" on page 163; length: 4 bytes
- chapter "S-0-0390, Diagnostic message number" on page 162; length: 4 bytes; decimal places: 0; unit: -
- chapter "S-0-0390.0.136, Detailed diagnostics" on page 162; length: 4 bytes; decimal places: 0; unit: -

3. Configure cyclic command values (MDT) (on control side)
   - chapter "S-0-0134, Master control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "S-0-0145, Signal control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1390, Control word" on page 157; length: 2 bytes
   - chapter "P-0-1377, Speed command value" on page 143; length: 4 bytes
   - chapter "S-0-0800, Pressure command value" on page 162; length: 4 bytes
4. Configure operation modes (is already set by “loading basic settings”)
   - Primary operation mode: Velocity control; S-0-0032 = 0b0000.0000.0000.0010

     chapter "S-0-0032, Primary operation mode" on page 161

PROFINET®

To establish the communication, the master communication and the application profile have to be activated on the ctrlX DRIVE. In addition, process data and the operation modes have to be configured on the ctrlX DRIVE.

1. Activate master communication and application profile type

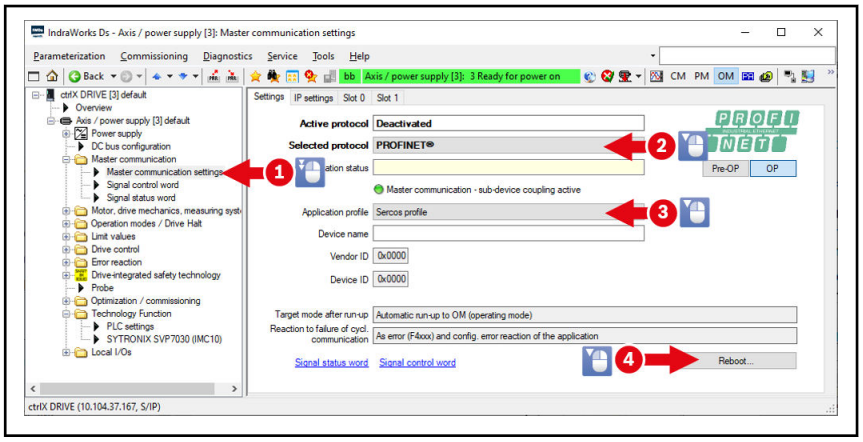

Fig. 7-17: Activating PROFINET®

The text field "Device name" contains the unequivocal device name that is used for master communication. A device can be identified by this name. For PROFINET® it is the "station name".

☞ After a communication protocol or the profile type was changed, the device has to be restarted.

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Due to the selected application profile type, “S-0-0134, Master control word” is used for the controller enable (AF), etc. "S-0-0135, Drive status word" contains essential status information such as readiness for operation, drive error, etc. For further information, see application description of the firmware in the Annex.

2. Configure cyclic feedback values (AT)
   - chapter "S-0-0135, Drive status word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1410, Status word 1" on page 158; length: 2 bytes
   - chapter "P-0-1411, Status word 2" on page 159; length: 2 bytes
   - chapter "P-0-1278, Actual speed value in direction of action" on page 115; length: 4 bytes
   - chapter "S-0-0804, Pressure feedback value" on page 163; length: 4 bytes
   - chapter "S-0-0390, Diagnostic message number" on page 162; length: 4 bytes; decimal places: 0; unit: -
   - chapter "S-0-0390.0.136, Detailed diagnostics" on page 162; length: 4 bytes; decimal places: 0; unit: -

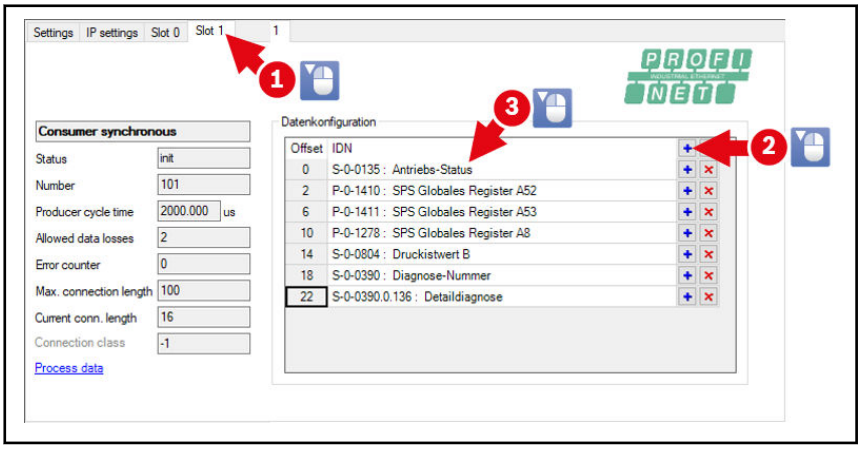

Fig. 7-18: Configuration of cyclic data in the dialog

3. Configuring cyclic command values (MDT)
   - chapter "S-0-0134, Master control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "S-0-0145, Signal control word" on page 162; length: 2 bytes; decimal places: 0; unit: -
   - chapter "P-0-1390, Control word" on page 157; length: 2 bytes
   - chapter "P-0-1377, Speed command value" on page 143; length: 4 bytes
   - chapter "S-0-0800, Pressure command value" on page 162; length: 4 bytes

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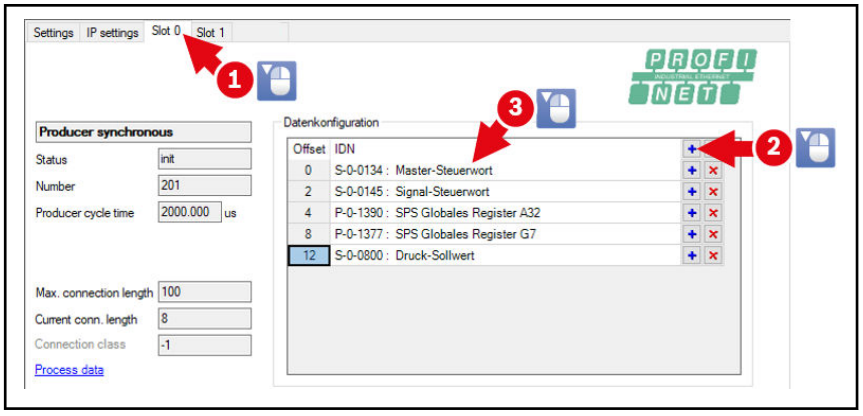

Fig. 7-19: Configuration of cyclic command values in the dialog

4. Configure operation modes (is already set by “loading basic settings”)
   - Primary operation mode: Velocity control; S-0-0032 = 0b0000.0000.0000.0010

     chapter "S-0-0032, Primary operation mode" on page 161

Error reset

If an error message is active in the ctrlX DRIVE and the error is no longer present, this error can be acknowledged directly on the device or also via the field bus communication. For acknowledging via field bus communication, “S-0-0145, Signal control word” is used. It is contained in the MDT data and is addressed via master communication. To be able to acknowledge a drive error with the “S-0-0145, Signal control word, it has first to be configured in the ctrlX DRIVE. The configuration for an error reset is shown in the figure below.

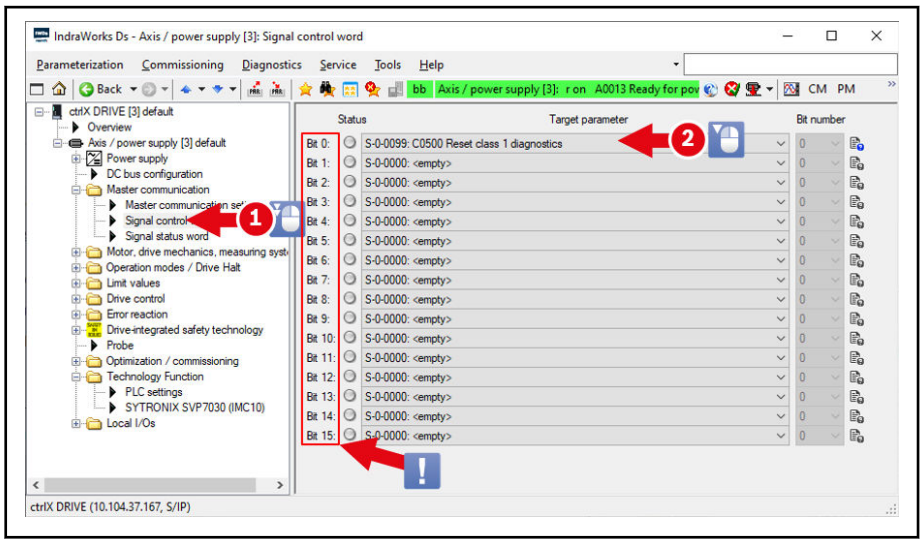

Fig. 7-20: Configuring the signal control word with the reset command to bit 0

The graphic above shows the configuration of the signal control word. The command "S-0-0099, C0500 Reset class 1 diagnostics" starts the error acknowledgement process and can now be started via "S-0-0145 bit 0, Signal control word". It is possible to enter further target parameters and address them with the corresponding bit.

Analog/digital interface

If no field bus is operated, the technology function can be operated and commanded via the analog/digital interface of the ctrlX DRIVE.

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Activating the analog/digital interface

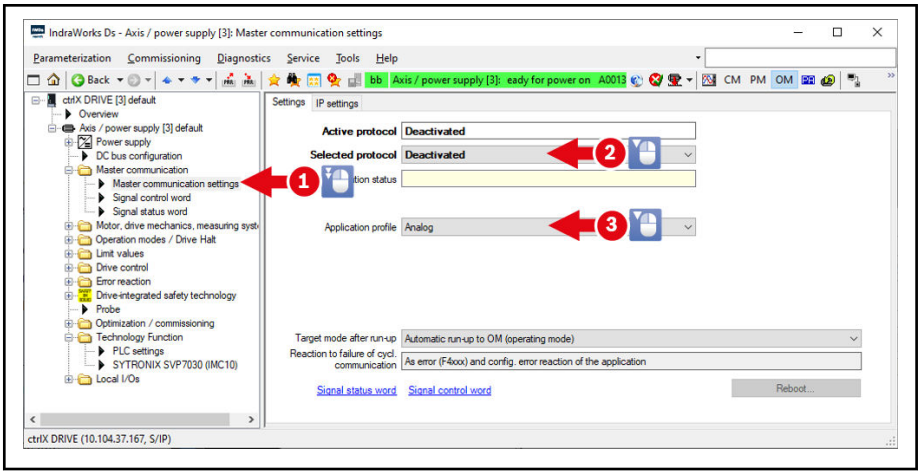

Fig. 7-21: Activating the analog/digital interface

After a communication protocol or the profile type was changed, the device has to be restarted.

Due to the selected application profile type, “P-0-4028, Device control word” is used for the controller enable (AF), etc. "P-0-0115, Device control: Status word" contains essential status information such as readiness for operation, drive error, etc. For further information, see application description of the firmware in the Annex.

Communication interfaces of the analog/digital interface

In the default configuration, the ctrlX DRIVE provides the following interfaces in the form of digital inputs and outputs as well as analog inputs and outputs.

XG31 connection	Signal name	Function	Default assignment	Ident number	Bit
1	I_1	Digital input	Drive enable	P-0-4028	15
2	I_2	Digital input	Parameter set selection	P-0-1390	14
3	I_3	Digital input	Parameter set selection	P-0-1390	15
4	0V	GND reference	-	-	-
5	0V_100	Analog input Connection for cable shield	-	-	-
6	I_4	Digital input	Master/slave operation	P-0-1390	0
7	I_5	Digital input	Clear error	S-0-0099	0
8	I_6/O_1	Digital input/output	Fault	P-0-0115	13
9	I_a_1+	Analog differential input	Pressure sensor	S-0-0804	-
10	I_a_1-				

Tab. 7-1: ctrlX DRIVE connection points XG31 with basic settings

The configurations listed in the table above can be made by selecting “Load basic setting” under “Basic configuration/interfaces”, see chapter 7.4.2 "Initial parameterization of the technology function" on page 74 .

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XG37 connection	Signal name	Function	Default assignment
1	IO_1	Digital input/output	Unassigned
2	IO_2	Digital input/output	Unassigned
3	I_5	Digital input	Unassigned
4	I_6	Digital input	Unassigned
5	I_7	Digital input	Unassigned
6	I_8	Digital input	Unassigned
7	24V_EA	Voltage supply inputs	-
8	IO_3	Digital input/output	Unassigned
9	IO_4	Digital input/output	Unassigned
10	O_5	Digital output	Unassigned
11	O_6	Digital output	Unassigned
12	O_7	Digital output	Unassigned
13	O_8	Digital output	Unassigned
14	0V_EA	0 V reference	-

Tab. 7-2: ctrlX DRIVE connection points XG37

XG38 connection	Signal name	Function	Default assignment
1	I_a_1+	Analog differential input	Flow command value
7	I_a_1-		
2	I_a_2+	Analog differential input	Pressure command value
8	I_a_2-		
3	I_a_3+	Analog differential input	Speed command value for slave operation
9	I_a_3-		
4	0V_EA_100_AnaOut	Shield of analog output	-
5	O_a_1	Analog output	Pressure feedback value B
6	0V_EA_Ana	0 V reference	-
10	0V_EA_100_AnaIn	Shield of analog input	-
11	O_a_2	Analog output	Speed in direction of action
12	0V_EA_Ana	0 V reference	-

Tab. 7-3: ctrlX DRIVE connection points XG38

7.3.3 Scaling

The supported scaling types are shown in chapter 6.4 "Scaling" on page 27.
The following figures show the dialogs for setting the scaling mechanism:

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Setting Scaling for velocity and acceleration has to be rotary. The figure below shows the setting in preferred scaling.

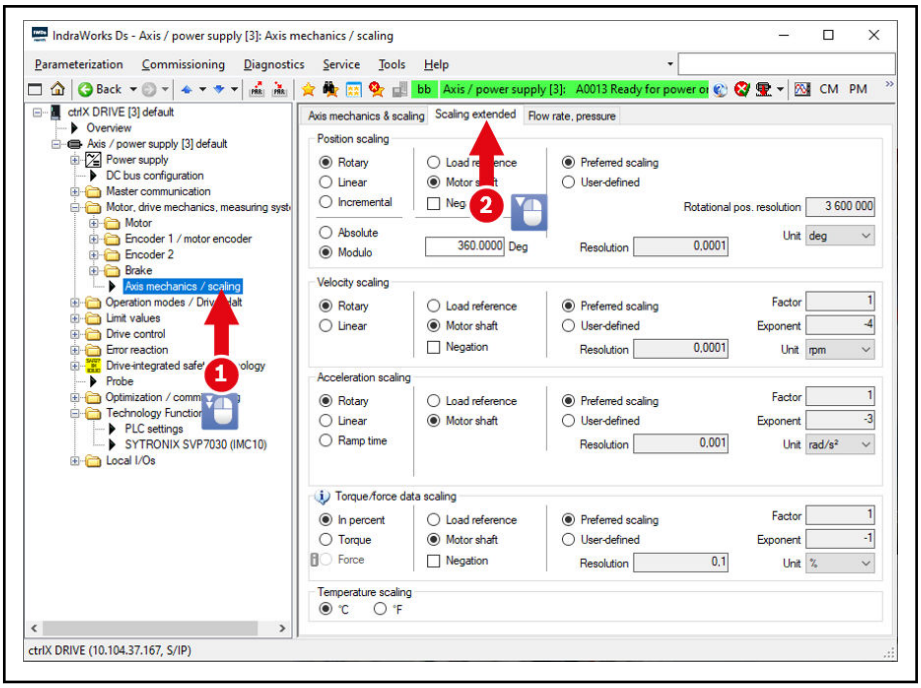

Fig. 7-22: Scaling of velocity, acceleration and torque data

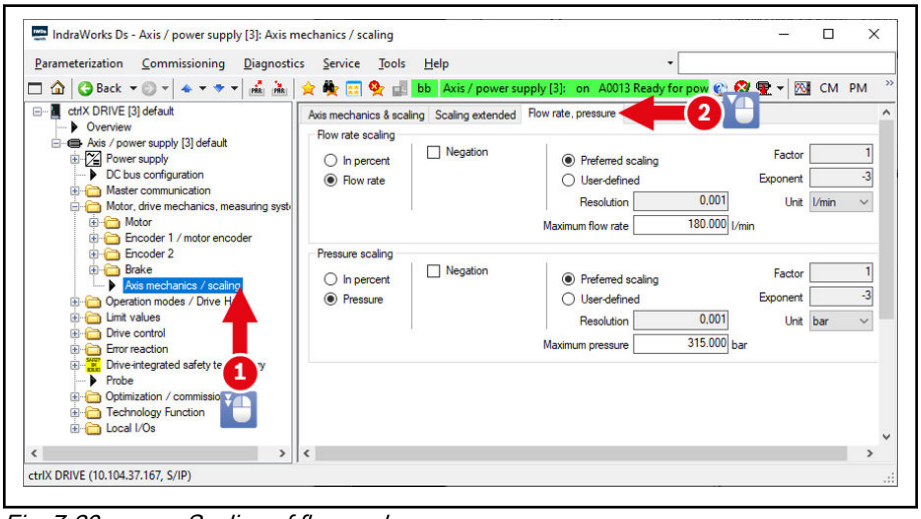

Fig. 7-23: Scaling of flow and pressure

☞ Due to the use of “Negation”, the sign of the parameters with the corresponding scaling is inverted at the interface. This applies to machine and process data.

☞ In contrast to the technology function SvP 7020 IMC02VRS, the direction of action of the pump has to be configured by means of "Configuration word, P-0-1370", bit 0 (see chapter 6.3.1 "Assignment of direction of action" on page 23).

7.3.4 Operation modes (ctrlX DRIVE)

Velocity control For the technology function, velocity control has to be selected as primary operation mode. Further operation modes are not supported.

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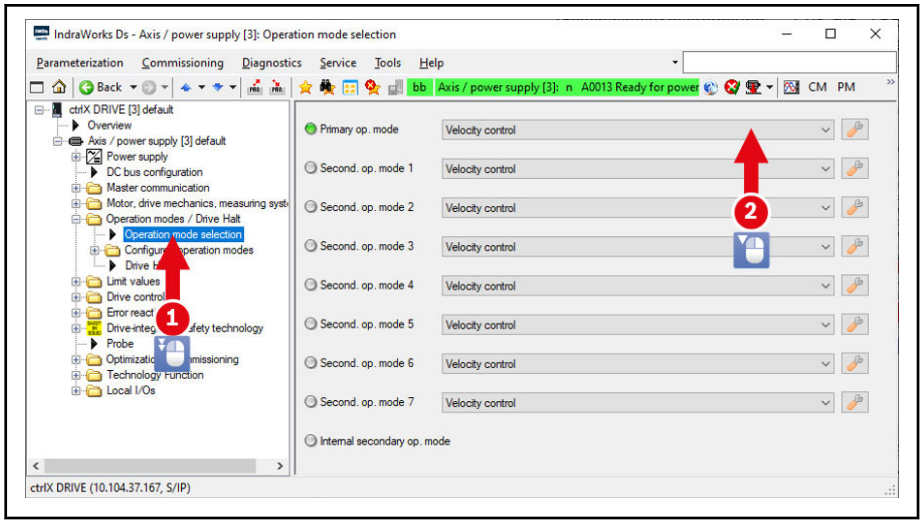

Fig. 7-24: Setting the primary operation mode

7.3.5 Interfaces

For external controlling of functionalities and external querying of states, values can be assigned to digital inputs and outputs or used in the field bus. The following listing shows interface parameters. The assignment of parameters can be seen in the referenced chapters.

Inputs

chapter "P-0-1390, Control word" on page 157
chapter "P-0-4028, Device control word" on page 160
chapter "S-0-0099, C0500 Reset class 1 diagnostics" on page 161
chapter "S-0-0134, Master control word" on page 162
chapter "S-0-0145, Signal control word" on page 162

Outputs

chapter "P-0-1410, Status word 1" on page 158
chapter "P-0-1411, Status word 2" on page 159
chapter "S-0-0135, Drive status word" on page 162

Configuration

The analog interfaces are configured in the folder "Local I/O" in the project tree. Via the following dialog you can map the required digital signals from the physical interface to the interface parameter.

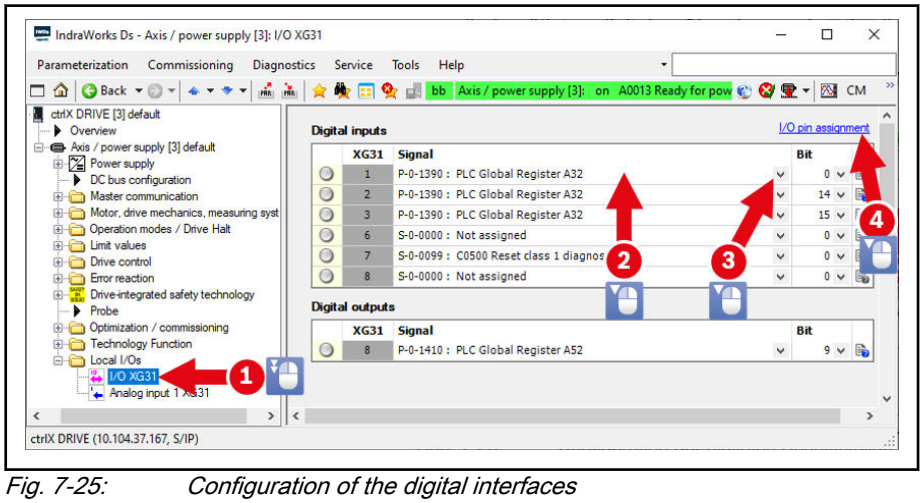

Fig. 7-25: Configuration of the digital interfaces

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The relevant interface parameter has to be selected from the drop-down menu in (2), whereas the associated bit can be selected in (3). By selecting (4) you can view the I/O pin assignment. This view shows the status of the analog and digital inputs and outputs.

7.4 IMC commissioning

7.4.1 Overview

To simplify commissioning, dialogs are provided which were specifically developed for the technology function. The introductory overview dialog is started using the "SYTRONIX 7030 (IMC10)" menu item under the "Technology Function" branch in the project tree:

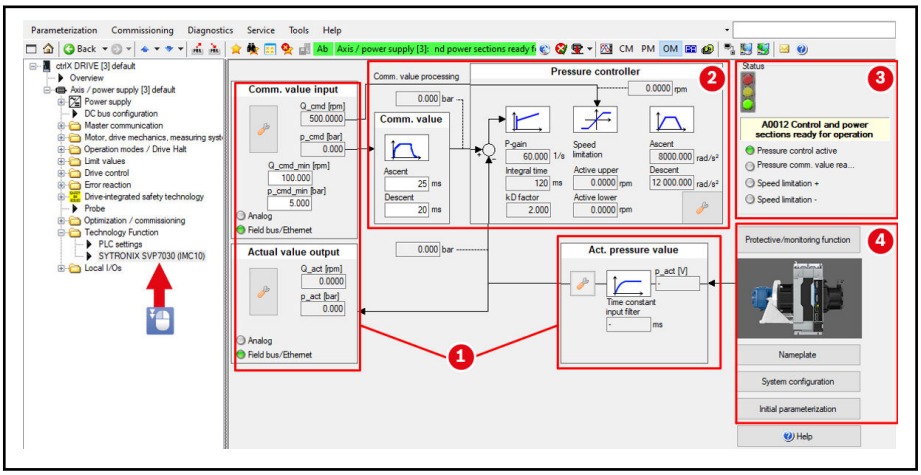

Fig. 7-26: Functional areas of the start dialog

The dialog comprises four functional areas which will be explained in the following:

1. I/O configuration:

   Configuration of the input and output signals for IndraDrive
2. p/Q controller:

   Configuration of the p/Q controller
3. Diagnostics:

   Status display and output of warnings/errors
4. Configuration:

   Information and settings of the complete system (hardware and software)

7.4.2 Initial parameterization of the technology function

The following points are to be considered/completed before operation:

- General drive commissioning (operation possible in velocity control)

⚠ WARNING

In order to prevent damage to the pump, it has to be checked before setting of the error reaction to torque disable in every individual case whether backward rotation of the pump is admissible. If not, mechanical precautions are to be taken in order to prevent it (check valve).

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⚠ WARNING **The direction of rotation causing the pressure to increase must always be positive in parameter P-0-1278. Otherwise, operation is not possible and/or the pump may be damaged.**

If the direction of rotation which causes the pressure increase is not positive in parameter P-0-1278, the configuration in “P-0-1370, Config word”, bit 0 has to be changed. The parameter “S-0-0040, Velocity feedback value” or” P-0-0112, Actual speed value of motor” may, under certain circumstances, have another orientation than “P-0-1278, Speed in direction of action”.

How parameters can be written is explained in detail in chapter 7.3.1 "Parameter access" on page 61.

Initial parameterization

The function for loading the IMC basic settings is called by clicking the “Initial parameterization” button.

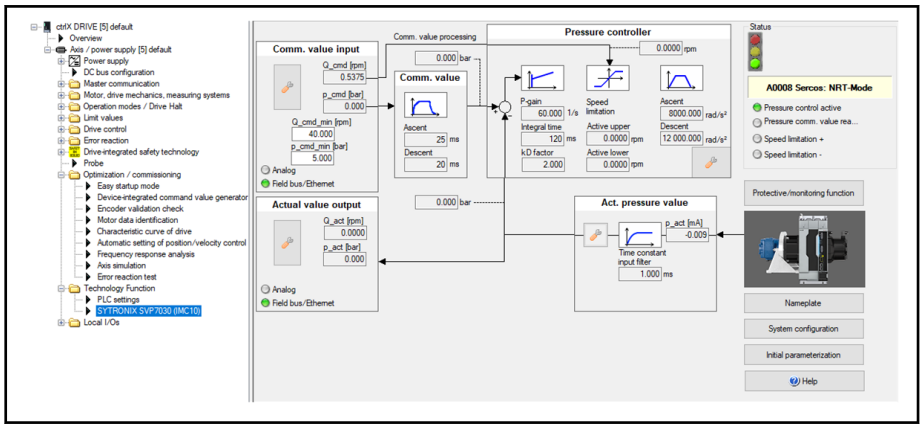

Fig. 7-27: Loading basic settings

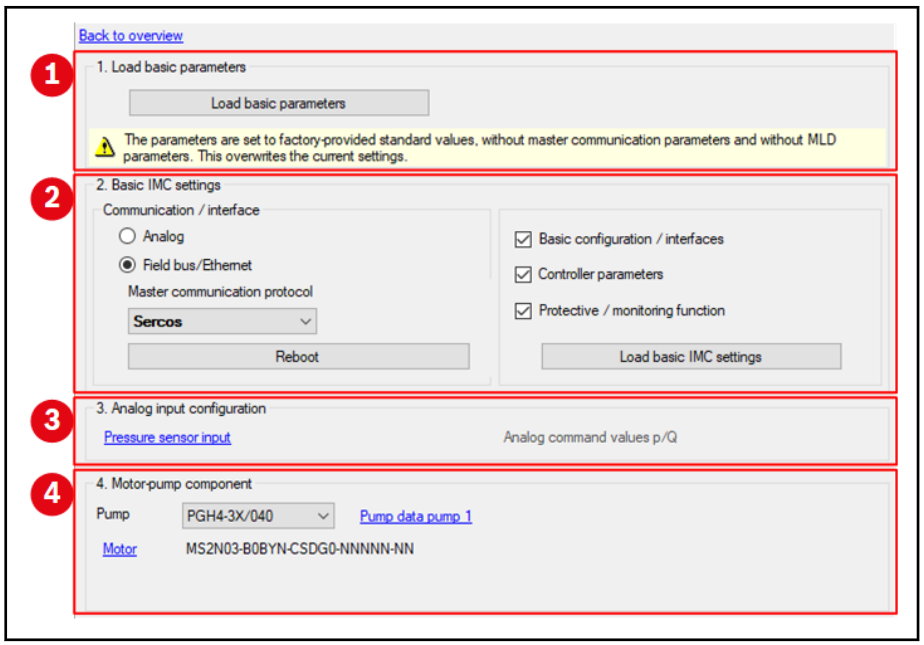

Fig. 7-28: Initial parameterization

The figure above illustrates the four sections of the dialog:

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1. **Load basic parameters**: Here, the drive parameters are set to factory default values, without master communication parameters and without MLD parameters.
2. **IMC basic settings**: Selection of the communication interface (analog or field bus).

☞ Use the correct hardware configuration/control unit!

Communication/interface

Depending on the hardware/control unit type, two types of interfaces (analog, field bus/Ethernet) are available. According to the recognized hardware, one of the following interfaces can be set:

- Analog
- Field bus/Ethernet
  - Sercos®
  - Servodrive Profile over EtherCAT® (SoE)
  - PROFINET®

For the related controller parameters such as velocity controller, p/Q control, default values are loaded using the “Load IMC basic settings” button. With these settings, the technology function usually runs smoothly for most hydraulic systems.

Basic configuration/interfaces

Basic configurations and interface configurations are loaded according to the selected communication/interface. For example, parameters for master communication, operation mode, assignment of digital inputs or analog inputs.

Controller parameters

Basic settings are loaded for the pressure controller parameter and parameter set switching.

Protective/monitoring function

Basic settings for protective and monitoring functions are loaded.

☞ If basic settings are loaded while the machine is active, it is recommended that you make a parameter backup of the initial configuration before.

3. **Analog input configuration**: Here, the pressure sensor input is configured For further information, see chapter 7.4.3 "Pressure sensor" on page 82.
4. Configuration of **motor/pump group**

   The selection of the pump type used provides the technology function with operating data and limit data. This will shorten commissioning times. The pump data are used for the following functions:

   - Pressure and flow control chapter 6.11.3 on page 42
   - Pump pressure monitoring chapter 6.13.2 on page 48
   - Pump pressure monitoring chapter 6.13.3 on page 50

   If no data for the pump used are available, you can enter individual pump data via the selection “Other pump”.

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Pump data of the selected type cannot be changed. In this case, select “other pump”.

The following two graphics show the required steps for configuring a user-defined pump (other pump) in the dialog “Initial parameterization”.

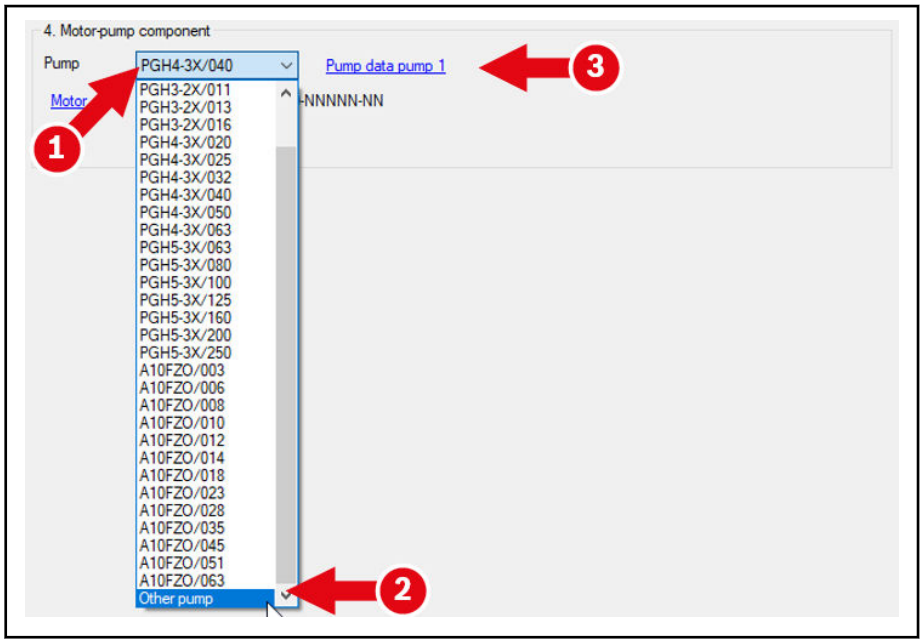

Fig. 7-29: Setting a user-defined pump

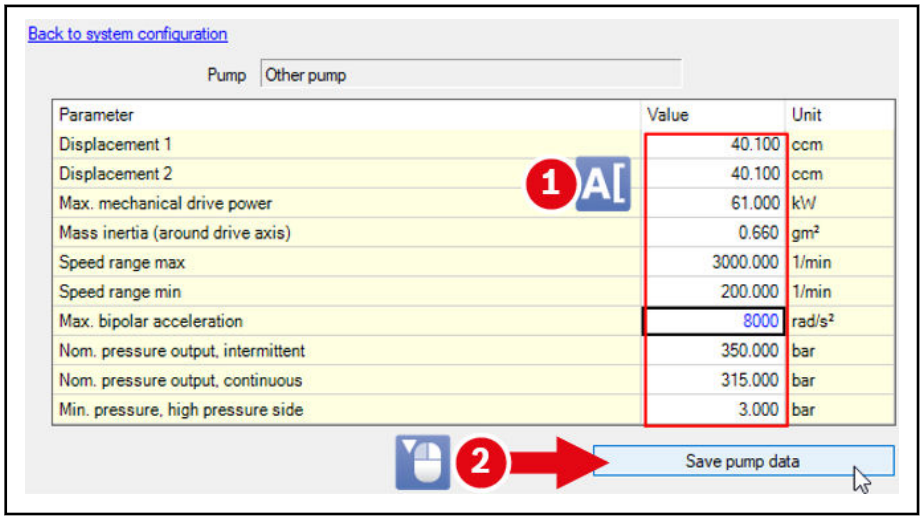

Fig. 7-30: Configuring pump data of a user-defined pump

Analog initial parameterization

For the functionality of p/Q control an input is required for the pressure and flow command values. One possible variant of doing this is via the analog interface. A selection is supported by the graphic user interface in IndraWorks Ds. For this purpose, the interface can be parameterized by selecting "Load basic setting":

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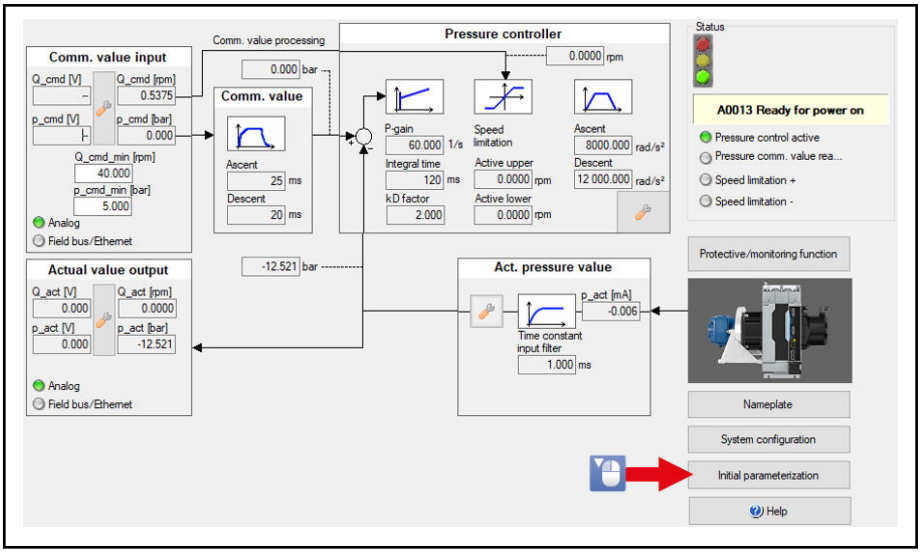

Fig. 7-31: Initial parameterization

By selecting analog communication and "Basic configuration / interfaces" as values to be loaded, the configuration of analog communication can be loaded by means of "Load IMC basic settings". As a result, a parameter file is loaded, which contains a suitable standard configuration according to the selection made.

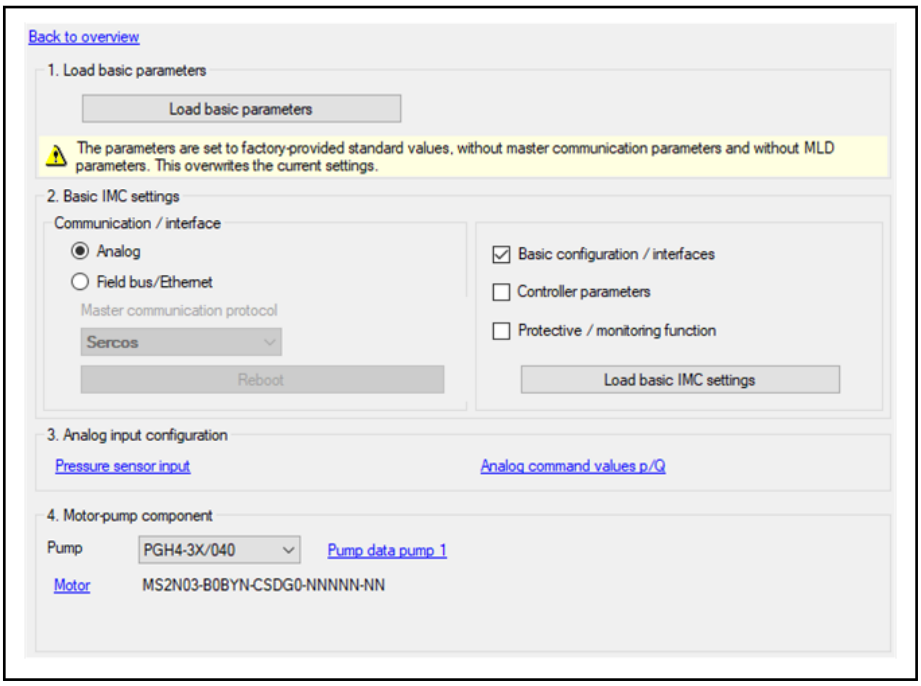

Fig. 7-32: Loading basic settings for analog interface

The correctness of the basic setting can be checked in the main screen. The analog input and output are displayed as active by LEDs.

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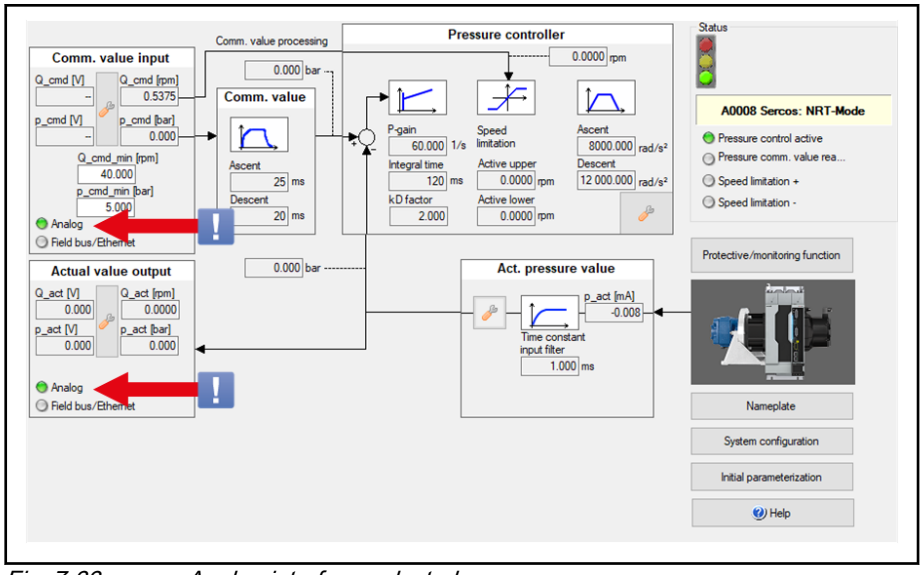

Fig. 7-33: Analog interface selected

Analog command value provision

The analog command values for pressure and flow can be assigned individually to the available analog inputs. For this purpose you have to open the configuration for command value processing:

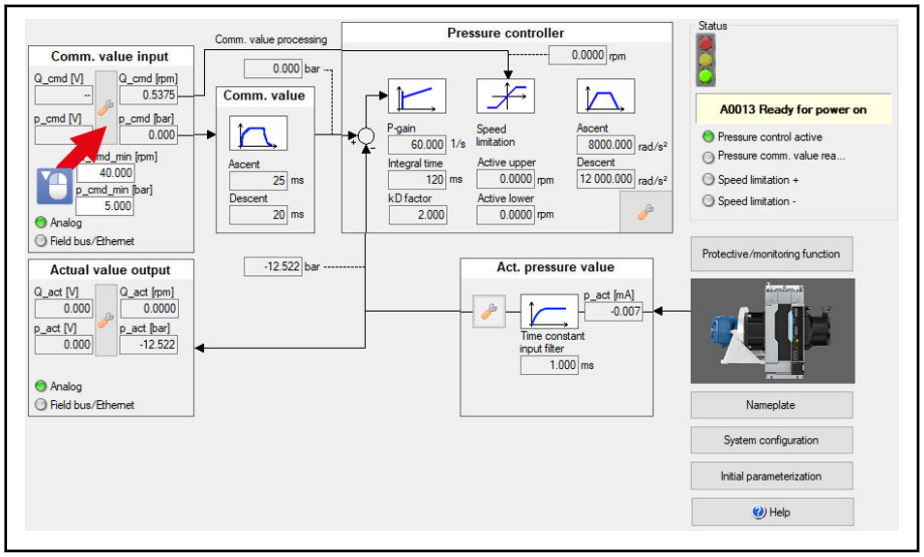

Fig. 7-34: Command value input

The available analog inputs are displayed via the drop-down menu for the input selection and can be selected directly. If supported by the input you can select between the interpretation as current input and as voltage input.

The signal range has to be assigned to the value range according to the commanding at the analog interface.

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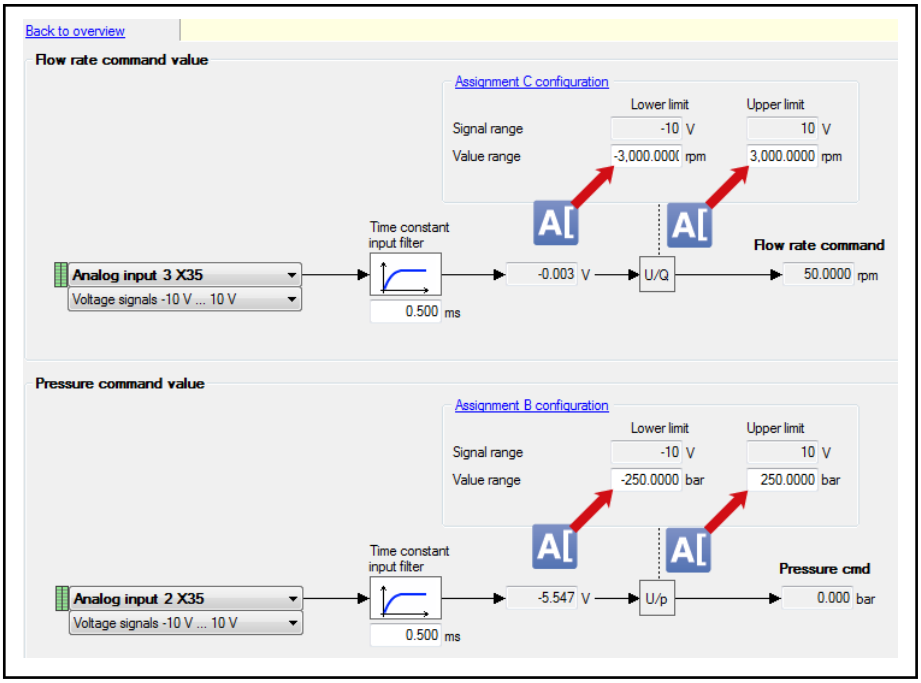

Fig. 7-35: Normalization of the command value input

Analog actual value output

Via the existing analog interfaces, the process data of actual pressure and flow data can be output, which can be processed further for diagnostics purposes in master communication. The configuration of the analog actual value output can be opened by selection in the graphic user interface:

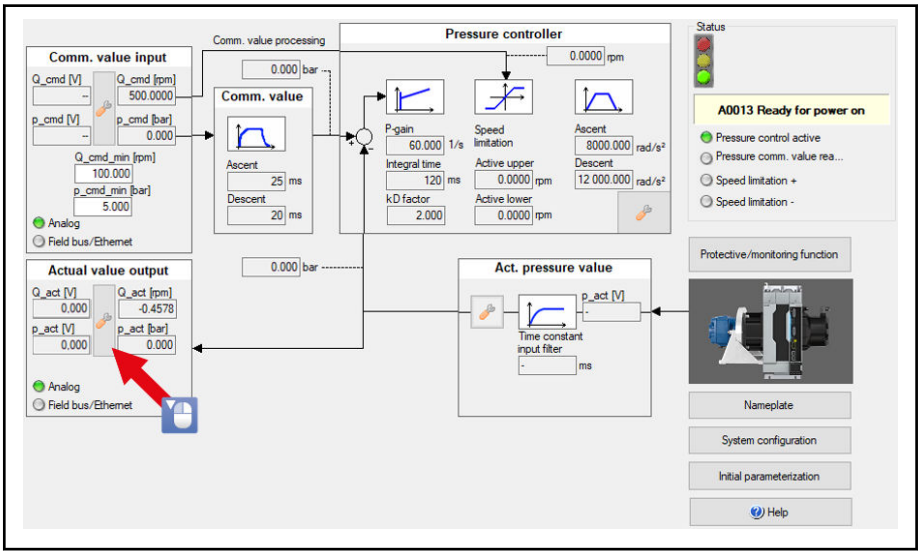

Fig. 7-36: Settings for actual value output

The actual values can be assigned to available analog outputs using the drop-down menu. The output is only possible as voltage output.

The value range has to be assigned to the signal range in accordance with the usage and the relevant value range.

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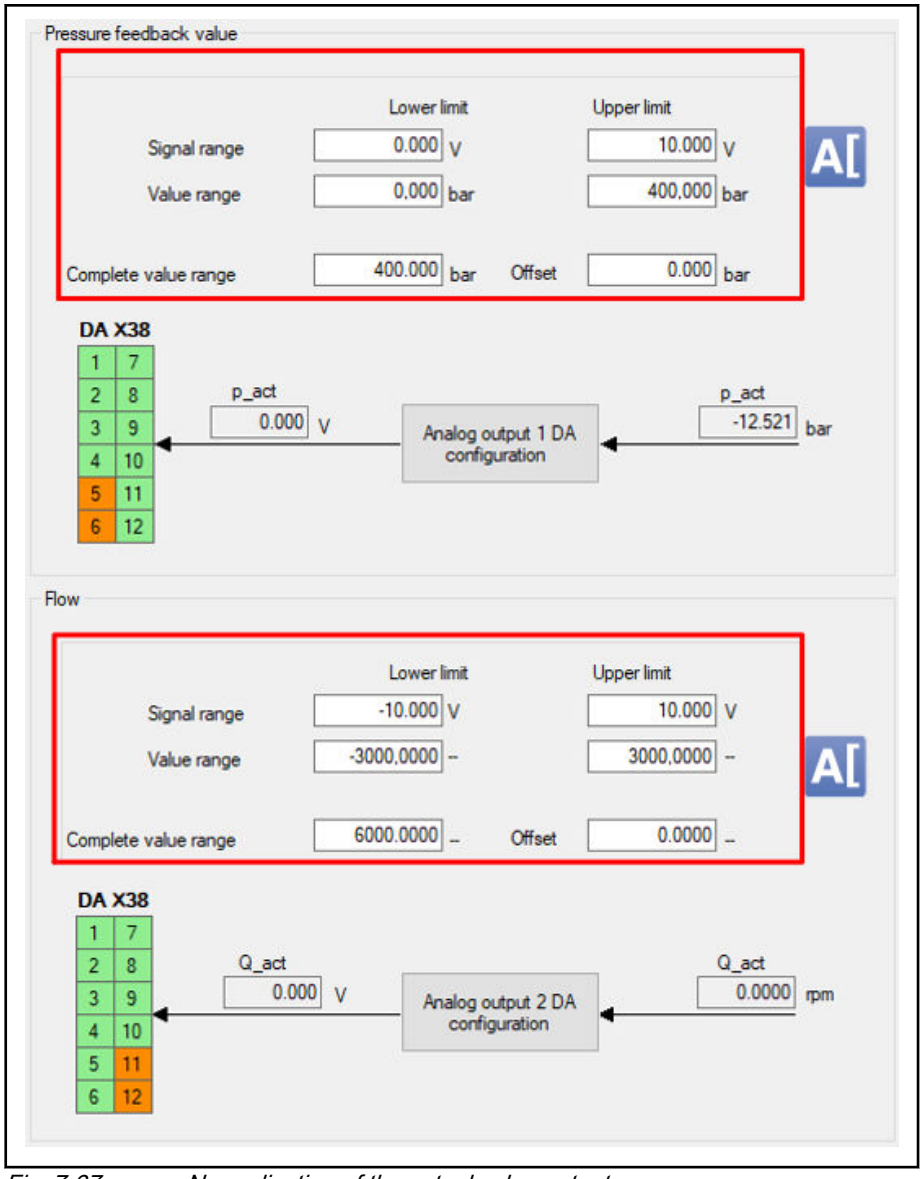

Fig. 7-37: Normalization of the actual value outputs

Basic setting for digital inputs and outputs

The digital inputs at the analog interface can be used for executing cyclic commanding and for providing status information in the form of digital outputs at the analog interface.

The active setting at the ctrlX DRIVE can be displayed in the configuration of the local I/Os and, if necessary, adapted to the application at hand.

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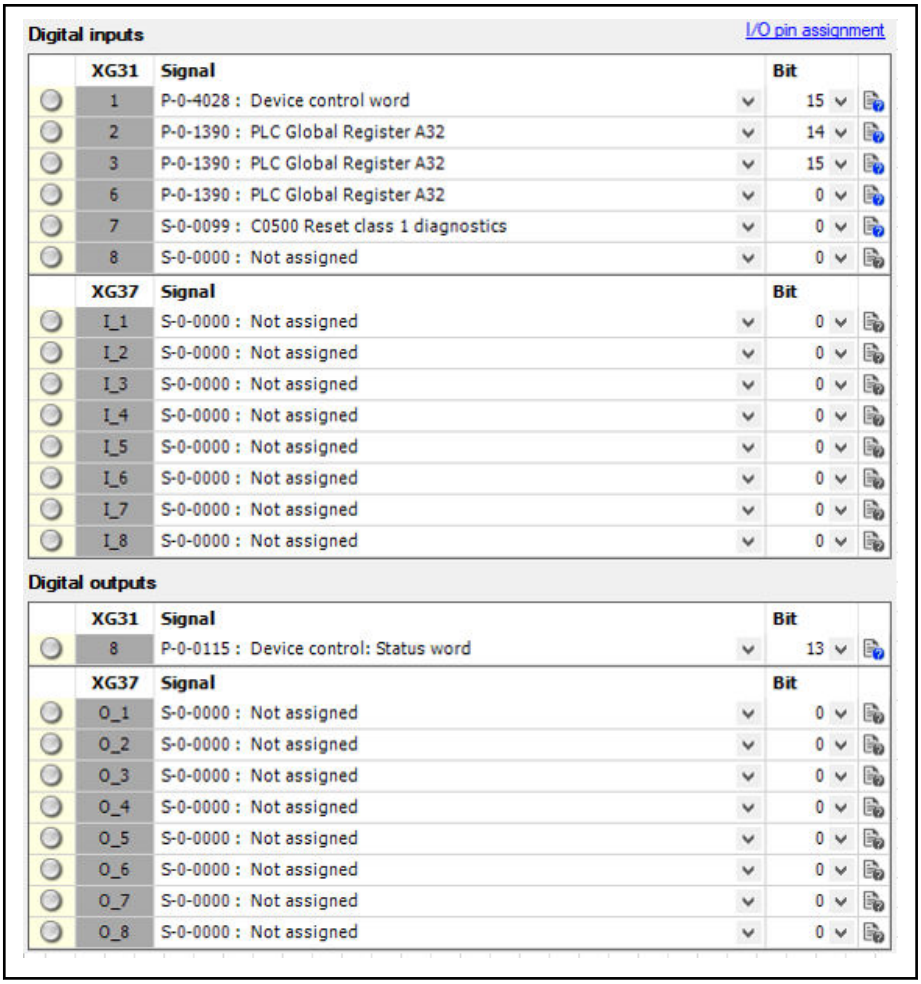

Fig. 7-38: Basic setting for digital inputs and outputs of the ctrlX DRIVE

7.4.3 Pressure sensor

In order to be able to close the pressure control loop, a pressure sensor for acquiring the pressure to be corrected has to be read in. It is recommended that pressure transducer HM20-2X be used (data sheet RE 30272). Use a pressure sensor with a voltage output within the range of 0 to 10 V or, depending on the control section variant, use a current sensor within the range of 4 mA to 20 mA to acquire the pressure.

☞ A voltage sensor with offset for the actual value acquisition or a current sensor is recommended in order that the cable break detection function can be used.

The pressure sensor is to be connected to XG31 or the DA option according to the table tab. 7-1 " ctrlX DRIVE connection points XG31 with basic settings" on page 70. The measuring cables are to be shielded together.

IndraWorks Ds provides a graphic user interface for configuring the pressure sensor.

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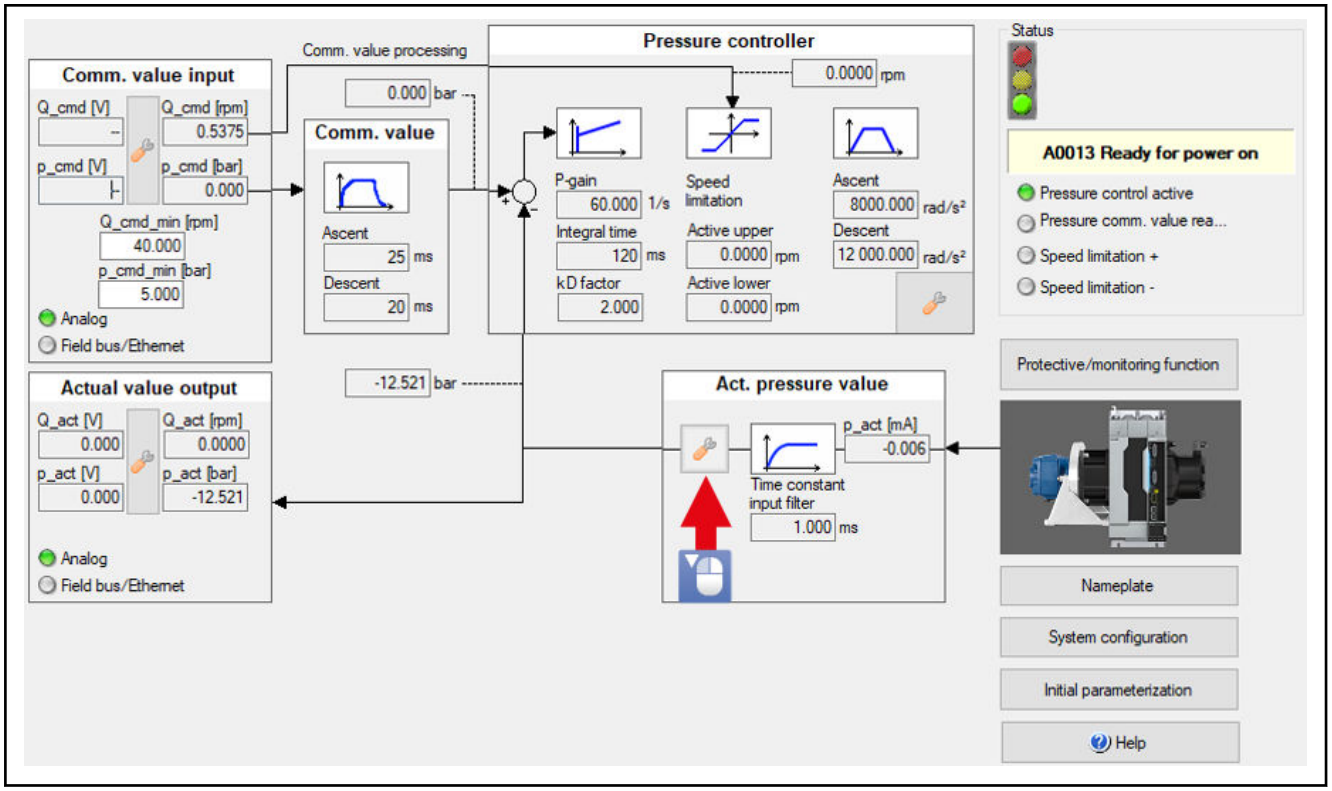

Fig. 7-39: Pressure sensor configuration

In the case of pressure transducers of series HM20-2X, the type used can be selected in the drop-down field (see pressure sensor data sheet, RE 30272).

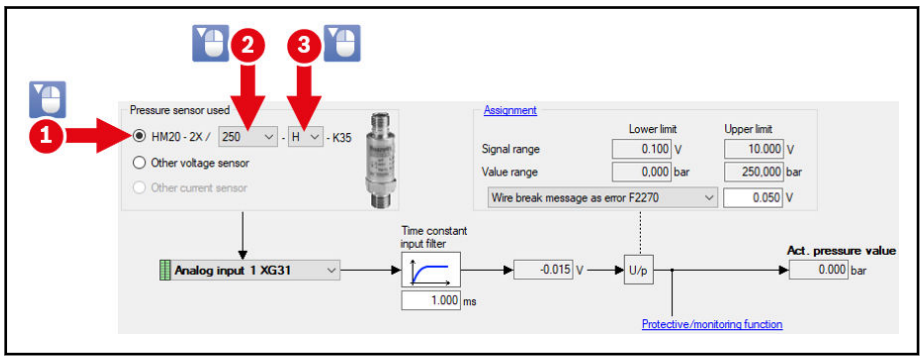

Fig. 7-40: Selection of the voltage sensor HM20-2X/...

If the type is not contained in the drop-down field, it has to be entered manually.

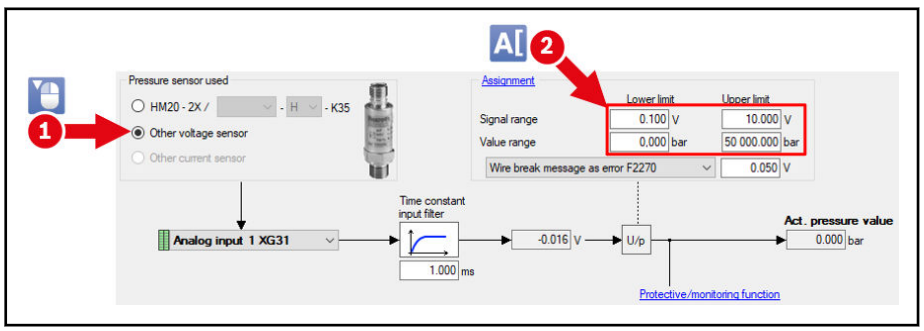

Fig. 7-41: Selection of another voltage sensor

7.4.4 Easy Control state control

The "Easy Control" state control is made available to simplify controlling of the ctrlX DRIVE with reduced interface. It can be activated by means of P-0-1370, bit 2. The Easy Control is particularly interesting for standalone applications, if no control is available as master communication. Thanks to the Easy Control, enabling of the ctrlX DRIVE (switching to AF) can be commanded from any current state using a bit (P-0-1390, bit 5). The signal can come from a digital input, for example. The Easy Control switches automatically to AF. Level- and edge-controlled commanding of the enable is supported.

Similar to enabling, for error acknowledgement, merely a bit (P-0-1390, bit 6) is required. The signal can come from a digital input, for example. The Easy Control automatically resets the corrected error with a rising edge, irrespective of the severity and type of error, and adjusts the operating state of ctrlX DRIVE, if required.

For more detailed information, see chapter 6.6 "Easy Control state control" on page 29.

7.4.5 Fixed command value input

With the fixed command value input function, up to four operating points can be firmly configured in so-called sets alternatively to an analog input of operating points for p_{cmd} and Q_{cmd}. It is possible to switch between the sets at runtime via two bits (P-0-1390, bit 4/3).

This function allows operating points to be activated without master communication, e.g. in the case of a self-contained power unit. As a result, a cyclic command value provision via two analog inputs is no longer required, switching can be performed via a maximum of two digital inputs. If only one fixed operating point is to be activated, no additional inputs are required.

More detailed information on the configuration can be found in chapter 6.7 "Fixed command value input" on page 30.

7.4.6 Pressure command value filter

For pressure command value p_{cmd}, filtering with a PT1 filter is provided with different filter times for increasing (P-0-1384) and decreasing (P-0-1385) values. The filter times can be entered in the GUI as shown in the following.

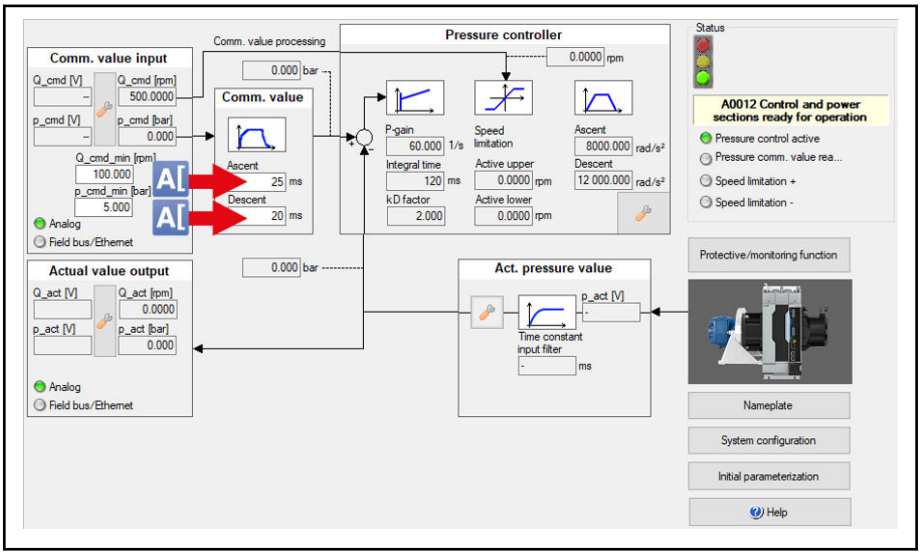

Fig. 7-42: Setting of filter times for the pressure command value

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The filter times can be changed at runtime. They are read every 16 ms. The filtered p_{cmd} is displayed for checking purposes in P-0-1271 (see chapter 6.8 "Pressure command value filter" on page 31).

Apart from entering the filter times directly, it is possible to switch between stored filter sets using parameter set switching (see "Parameter set switching" on page 36). In this case, up to four sets of filter times are supported for increasing and decreasing p_{cmd}. Switching always takes place together with the controller parameters. The function is supported by the GUI and is described in chapter "Parameter set switching" on page 96.

7.4.7 Leakage compensation

The leakage compensation serves to ensure an exact oil flow from the pump. This function allows leakage within a pump to be compensated in order that an actuator (e.g. cylinder) moves at constant velocity. Without leakage compensation, a difference between the commanded flow command value Q_{cmd} and the actual oil flow Q_{act} occurs in the system due to the pressure-related leakage.

Determination of leakage

The leakage compensation function adds leakage proportionally to the pressure as an offset. For this purpose, leakage has to be measured at a reference point (pressure) and entered. This can be carried out as follows:

1. Block the cylinder or close the valves.
2. Specify a fixed pressure for the system and start the pressure control of the technology function (pressure holding phase with minimum oil flow)
3. When the reference pressure value is reached, enter it in P-0-1311[209] and
4. enter the corresponding speed (leakage) of the pump (S-0-1278) in P-0-1311[208]

The GUI for configuring leakage compensation can be opened via the tab "System configuration" in the main dialog. See the following graphic:

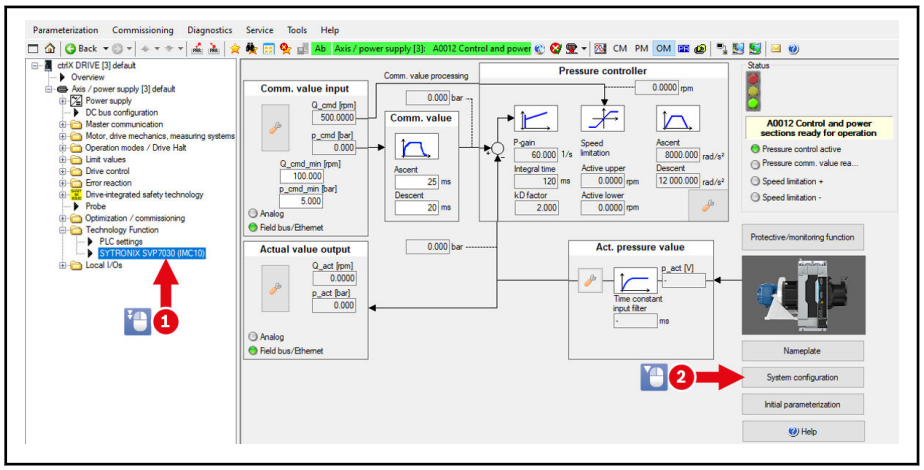

Fig. 7-43: System configuration

Then, the two parameters can be edited as shown in the following graphic.

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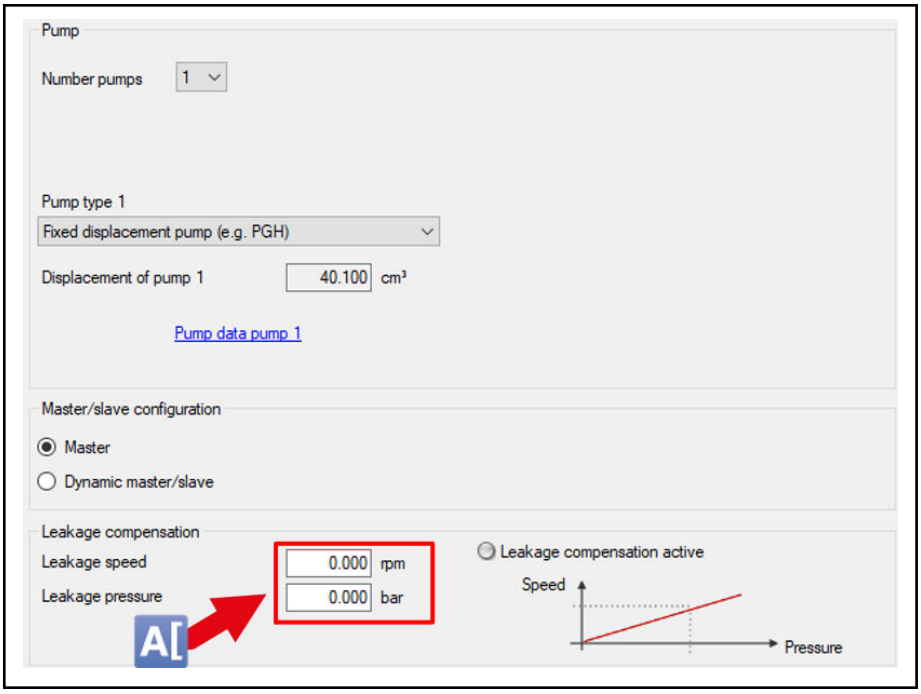

Fig. 7-44: Configuration of leakage compensation

If the value 0 is entered for "P-0-1311[208], Determined leakage speed at reference pressure P-0-1311[209]" or "P-0-1311[209], Reference pressure when determining leakage", the leakage compensation function is deactivated.

For more detailed information, see chapter 6.9 "Leakage compensation" on page 32.

7.4.8 Command value limitation

Limitation of pressure command value

The pressure command value p_{cmd} (P-0-1271) is limited to a minimum and a maximum pressure range as shown below. The resulting value $p_{cmd\ Controller}$ is handed over to the p/Q controller.

For additional information, see "Limitation of pressure command value" on page 33.

Limitation of flow command value

The flow command value Q_{cmd} is limited to a minimum flow (P-0-1389[111]) as shown below. In the positive direction, this minimum flow results from the unipolar and bipolar velocity limit value depending on the direction of action and is generated according to the minimum value principle (see "Limitation of flow command value" on page 33). The resulting flow command value is passed on to the soft start function.

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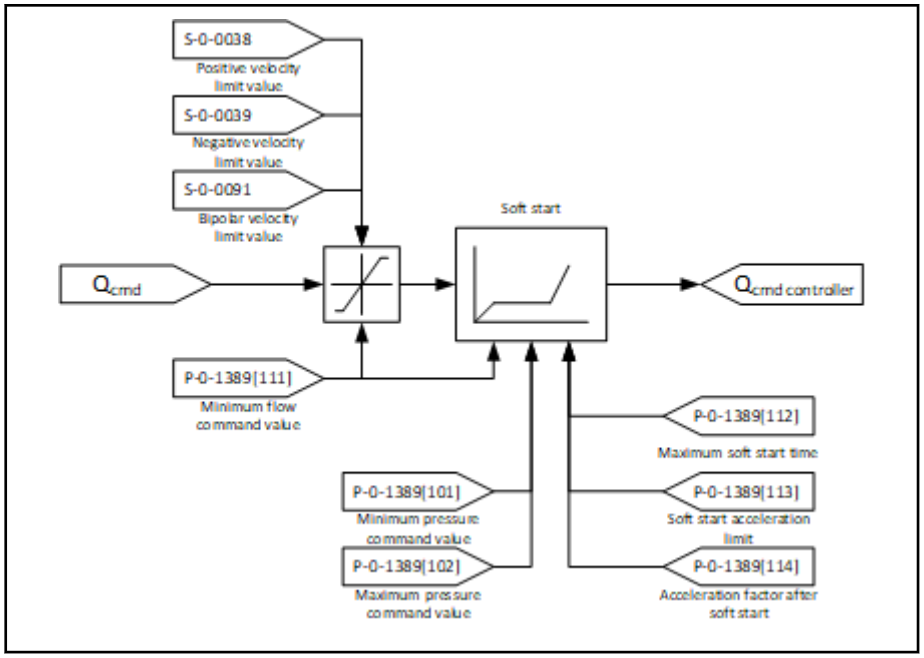

Fig. 7-45: Limitation of flow command value

☞ From the application's point of view, the limitation "P-0-1389[111], Minimum flow command value" usually serves to compensate continuous leakage and, in addition, prevents movements at a speed around 0 rpm.

Soft start

The soft start function receives the limited flow command value Q_{cmd} (see "Limitation of pressure command value" on page 86) and, when the function has been activated, accelerates starting from speed 0 via a defined ramp (P-0-1389[113]) to the minimum flow command value (P-0-1389[111]). When the minimum pressure (P-0-1389[101]) is reached or, at the latest, after the maximum duration (P-0-1389[112]) has elapsed, the soft start function is terminated and the flow command value is ramped to a limited flow command value. The resulting flow command value $Q_{cmd\ Controller}$ is passed on to the controller.

This function is used to a allow a soft start for example when the oil or the asynchronous motor is cold.

☞ The soft start function is switched off when 0 s is entered for "P-0-1389[112], Maximum duration of soft start".

For additional information, see "Soft start" on page 34.

7.4.9 p/Q controller – parameter setting

Overview

Activating the p/Q control

☞ Closed-loop pressure control and open-loop flow control are carried out exclusively in master operation (visible in P-0-1411, Status word 2, bit 2 = 0). For further information on the activation, see chapter 6.12 "Master/slave operation" on page 44.

The p/Q control is active when the drive is in the AF state. Switching to AF is possible as follows:

- Master communication over field bus chapter 7.3.2 on page 62

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- Analog master communication chapter 7.3.2 on page 62

If the drive is not in AF, no control is run and thus no active movement of the motor-pump unit.

The status of the active p/Q control is fed back in P-0-1410, Status word 1, with bit 0.

If the enable is granted via master communication, it is important that the operation mode “velocity control" has been selected. See also chapter 6.5 "Operation modes" on page 28.

Switching the p/Q control off

The p/Q control is deactivated when the drive state AF is exited or switching over to slave operation takes place.

Closed-loop pressure control

With closed-loop pressure control the "S-0-0827, Control difference" between "S-0-0800, Pressure command value" and "S-0-0804, Pressure feedback value" is corrected. The resulting controller output alternates with “P-0-1377, Flow command value” according to the minimum value principle. “P-0-0690, Active speed command value” is passed on as command value for the drive-integrated speed controller. For further information, see chapter 6.11.2 "p/Q controller" on page 36 and chapter 6.11.3 "Limitations" on page 42.

The function of the pressure controller is dealt with in chapter 6.11.2 "p/Q controller" on page 36.

Transition between closed-loop pressure control and open-loop flow control

Closed-loop flow control is realized by limiting the maximum pump speed. If the speed provided by the pump controller falls below the limit P-0-1377, flow control is deactivated and the pressure controller assumes controlling.

The function of the Q controller is dealt with in chapter 6.11.3 "Limitations" on page 42.

Controller structure

The figure below shows the principle of the controller structure from the command value input through to the controller output:

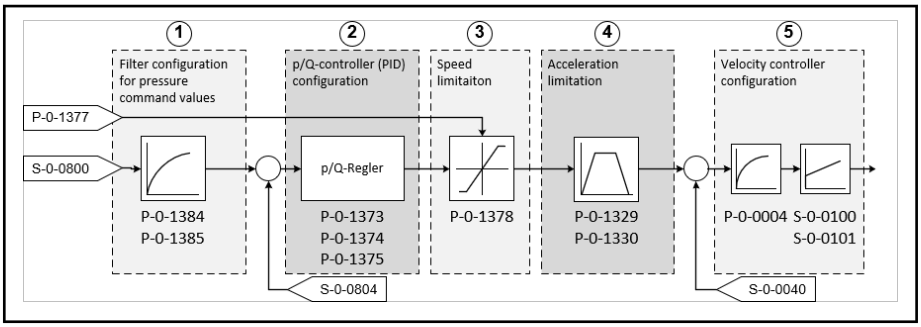

Fig. 7-46: Control structure of p/Q controller

The related dialog window for the controller:

1) On the input side, "S-0-0800, Pressure command value" can be filtered using a PT1-filter (chapter 7.4.6 "Pressure command value filter" on page 84).

2) From the "S-0-0827, Control difference" between "P-0-1271, Filtered pressure command value” and "S-0-0804, Pressure feedback value" the controller output is calculated with the p/Q controller.

3) The controller output of the p/Q controller alternates with “P-0-1377, Flow command value” according to the minimum value principle.

4) The controller output is limited with regard to possible changes in order to protect the pump against mechanical overloading.

5) The limited controller output is handed over via P-0-0690 as speed command value for the drive-integrated speed controller.

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p/Q controller - settings (PID)

The following parameters are relevant for the setting of the p/Q controller:

- P-0-1373, Kp, P-gain, [1/s]
- P-0-1374, Tn, integral action time, [ms]
- P-0-1375, Kd, D-gain [-]

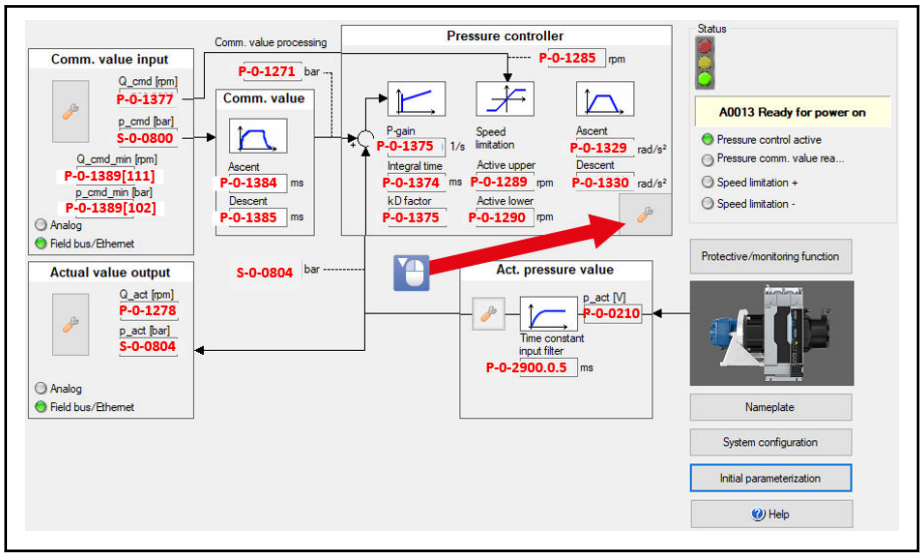

Fig. 7-47: p/Q controller settings

The dialog for setting the IMC controller can be called by clicking on the highlighted icon of the configuration tool.

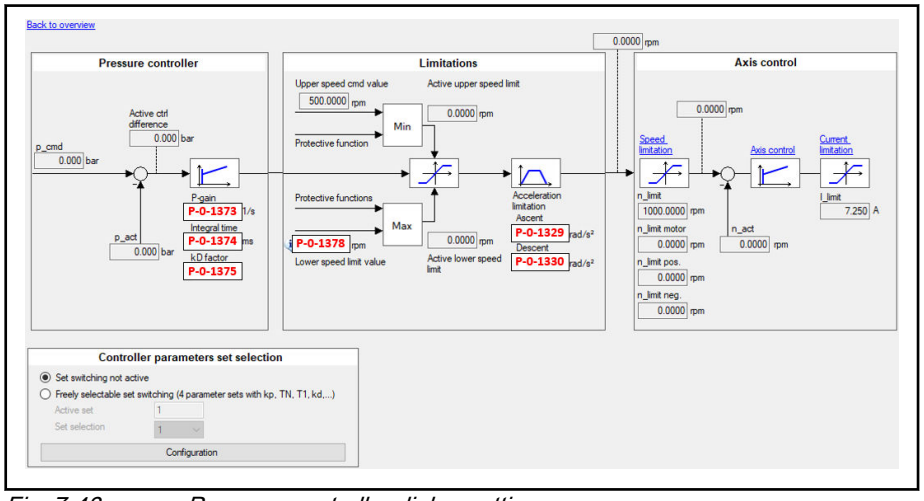

Fig. 7-48: Pressure controller dialog settings

Kp, P-gain (P-0-1373)

In general, the P-gain can be set to a value in the range from 40 to 80 [1/s], depending on the compression oil volume in the pipes and cylinders of the system.

With a small oil volume, only a small P-gain is possible! If the overshoot is too high or if vibrations occur, the P-gain must be reduced in increments of 5.

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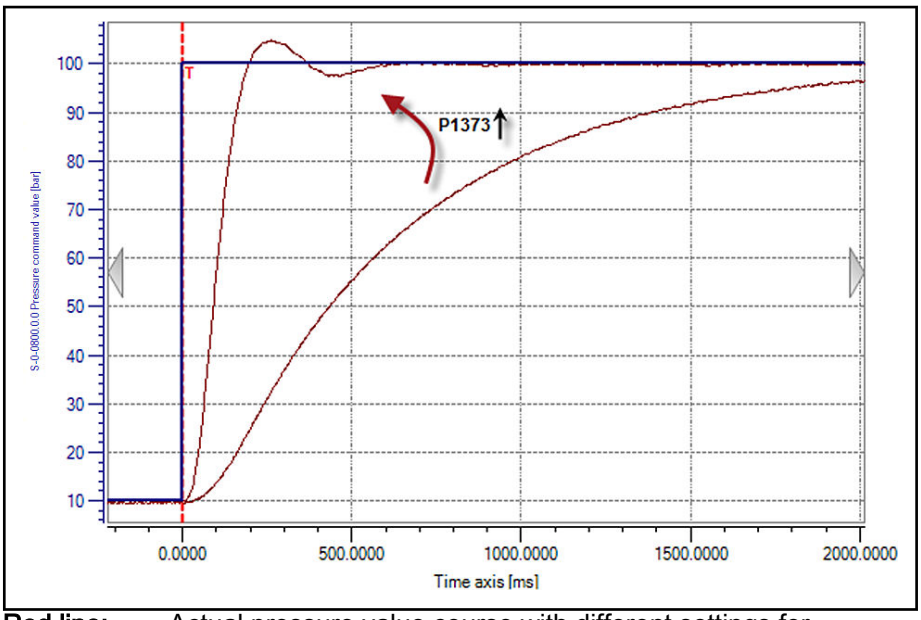

Red line: Actual pressure value course with different settings for P-0-1373

Blue line: Pressure command value course

Fig. 7-49: Effect of the adjustment of Kp, P-gain

Tn, integral action time (P-0-1374)

The value will usually lie within the range from 100 to 140 ms.

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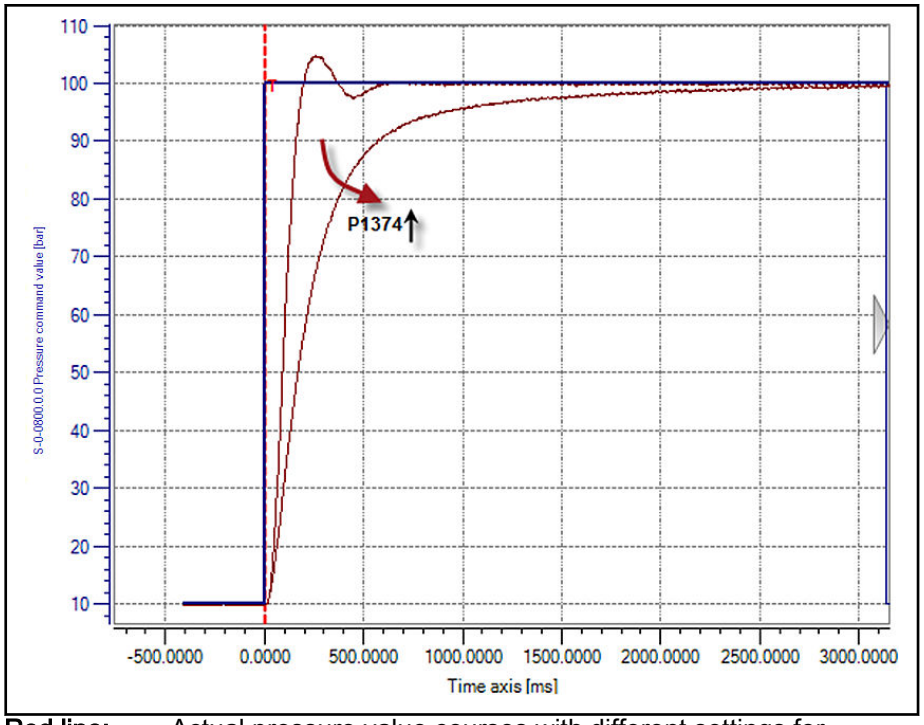

Red line: Actual pressure value courses with different settings for P-0-1374

Blue line: Pressure command value course

Fig. 7-50: Effect of the adjustment of Tn, integral action time

☞ If the actual pressure value (S-0-0804) shows excessive overshoots, P-0-1374 is to be increased in increments of 5 ms. If the increase in P-0-1374 does not sufficiently reduce the overshoots, additional measures are to be implemented, e.g. switching of the integral action time, see "Switching of integral action time" on page 39.

Kd, D-gain (P-0-1375)

A higher D-gain causes higher damping of the control behavior. As the D-gain increases, jumps in the command variable are attenuated to a greater extend, but disturbance jumps are corrected faster.

When setting parameter P-0-1375, a start value of 1.0 is suitable in most cases.

☞ If there are major overshoots in the system, this value is to be increased in increments of 1.0 to 2.0. If the oil volume in the system is very large, this value may also be greater.

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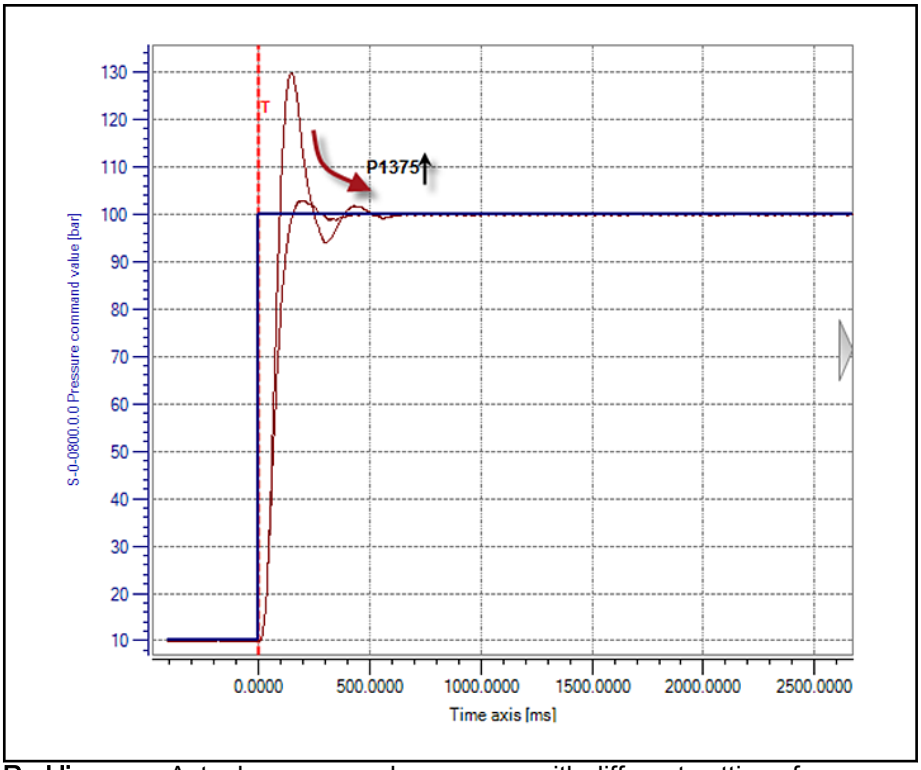

Red line: Actual pressure value courses with different settings for P-0-1375

Blue line: Pressure command value course

Fig. 7-51: Effect of the adjustment of Kd, D-gain

PID optimization

The following graphics show examples of possible pressure courses in the case of command value steps. With the help of the measures described below, the behavior shown can be counteracted.

☞ It is recommended that you use the PID parameters of the p/Q controller for optimizing. For subsequent fine-tuning of the control result, the PI parameters or the velocity controller are recommended.

Example 1: Overshoots

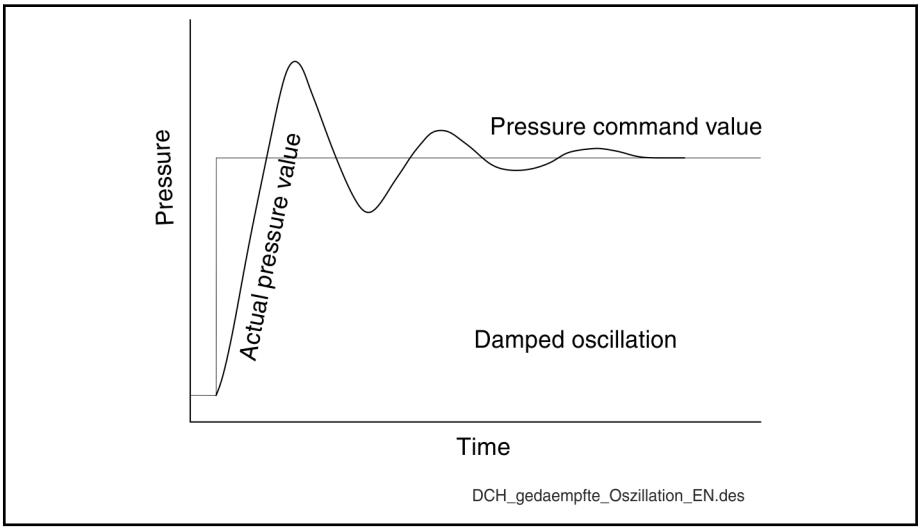

Fig. 7-52: Damped oscillation

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Step	Behavior / result	Measure
1	Overshoots (damped oscillation)	Increase D-gain (P-0-1375)
2	The actual pressure value still overshoots	Reduce P-gain (P-0-1373 or S-0-0100, respectively)
3	The actual pressure value still overshoots	Reduce integral action time (P-0-1374)

Tab. 7-4: Measures against overshoots

Example 2: Slow pressure increase

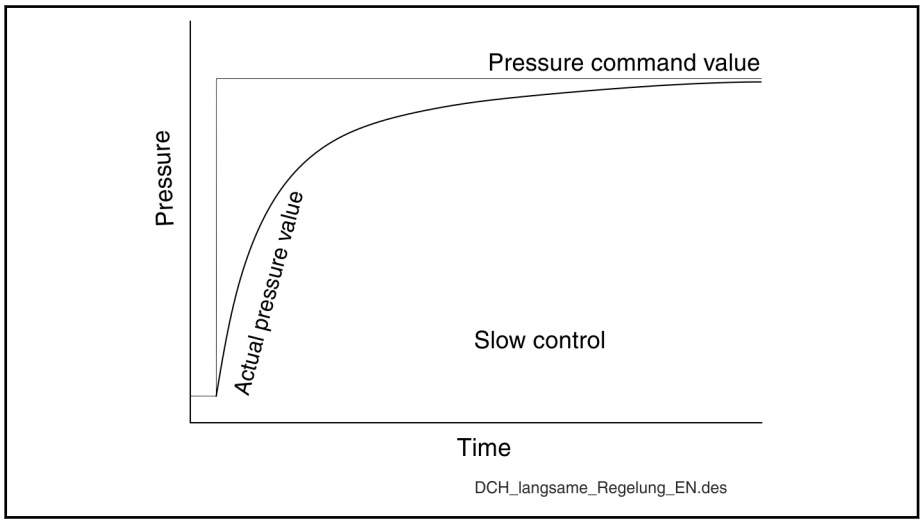

Fig. 7-53: Slow control

Step	Behavior / result	Measure
1	Slow reaction	Increase P-gain (P-0-1373 or S-0-0100, respectively)
2	Reaction still slow	Reduce D-gain (P-0-1375)
3	Reaction still slow	Reduce integral action time (P-0-1374)

Tab. 7-5: Measures against slow reaction

Example 3: Unstable pressure signal

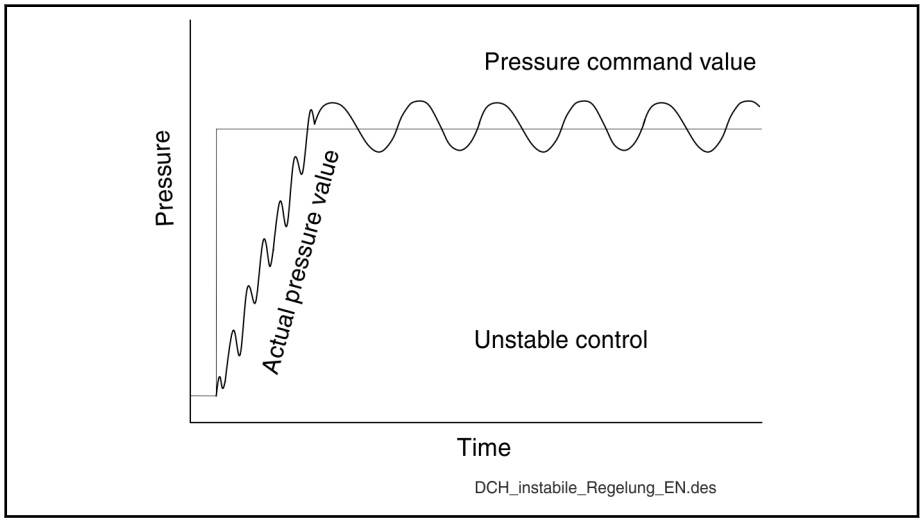

Fig. 7-54: Unstable control

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Step	Behavior / result	Measure
1	Fast, but unstable reaction	Reduce P-gain (P-0-1373 or, if applicable, S-0-0100)
2		Increase integral action time (P-0-1374 or, if applicable, S-0-0101)
3		Reduce D-term (P-0-1375)

Tab. 7-6: Measures against unstable reaction

Example 4: Optimum closed-loop pressure control

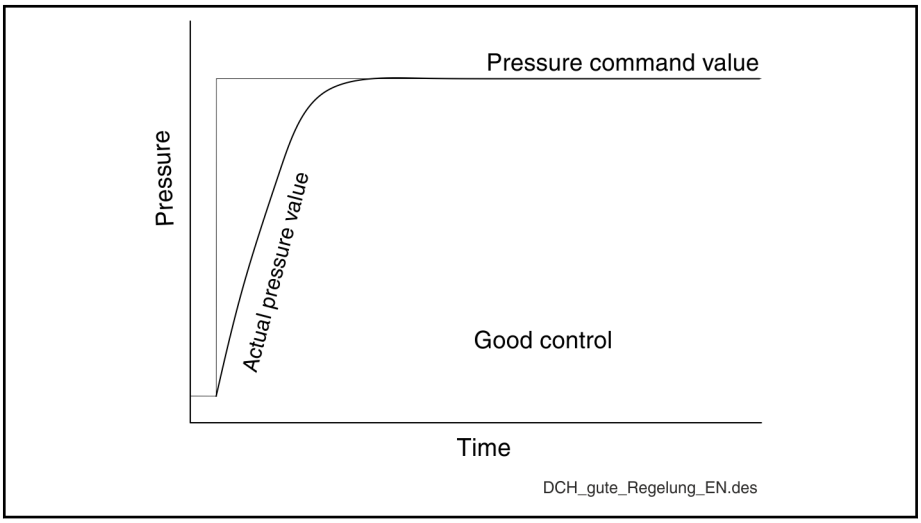

Fig. 7-55: Good control

If the control behavior is good, no measures need to be taken.

Settings of the acceleration and deceleration ramp

In some applications, it may be necessary to further restrict the acceleration/ deceleration rate of the pump in order to prevent mechanical damage to internal components.

On the suction side, high acceleration may cause the formation of a local vacuum in the hydraulic fluid as the oil is not able to follow the movement of the pump rotor in terms of dynamics. Thus, cavitation may be caused in the system.

☞ The positive and negative acceleration limits may have different values. Take account of the details in the data sheet of the pump as well of the specific installation situation.

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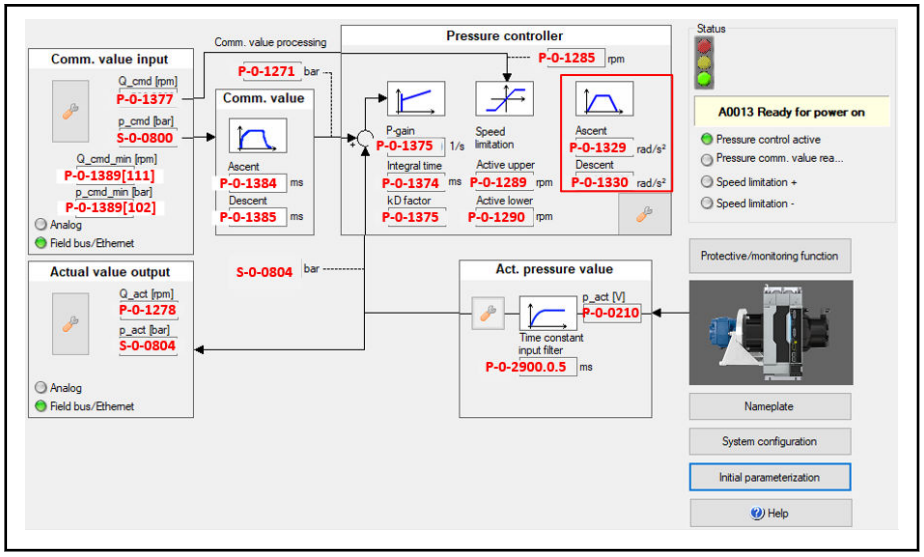

Fig. 7-56: Active acceleration and deceleration limit

The following parameters are used to set the acceleration limit:

- P-0-1329, Acceleration limit of pump speed
- P-0-1330, Deceleration limit of pump speed

The acceleration limit is deactivated by setting P-0-1329 to 0; the deceleration limit is deactivated by setting P-0-1330 to 0.

The function of acceleration and deceleration limitation is described in chapter "Acceleration limitation" on page 43.

Parameter setting for the velocity controller

The velocity controller is configured with the following settings:

- S-0-0100, Velocity controller proportional gain, [Nm/(rad/s)]
- S-0-0101, Velocity loop integral action time, [ms]
- P-0-0004, Speed controller smoothing time constant, [µs]

In the as-supplied condition, the speed controller is parameterized for a mechanical system. Due to the lower stiffness in a hydraulic system, as we have it in these applications, the control parameters have to be adjusted. The velocity controller can be set in IndraWorks via the screen for the axis control.

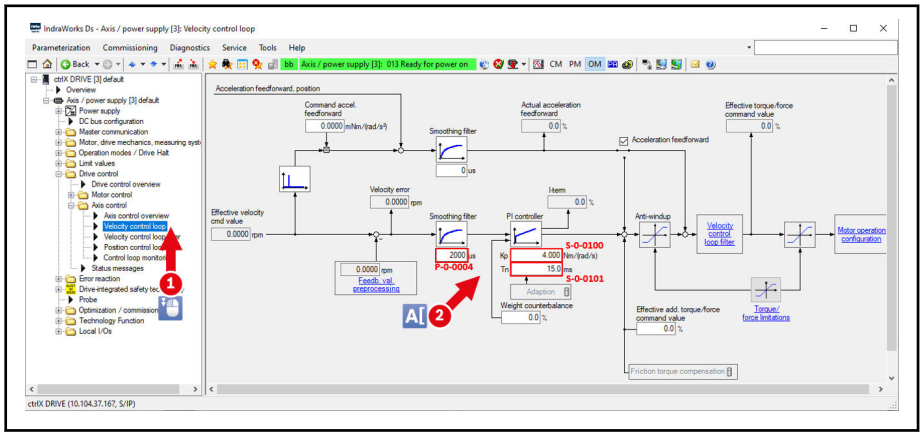

Fig. 7-57: Connection of S-0-0100, S-0-0101 and P-0-0004

For pressure control with the technology function, the following settings are generally recommended:

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☞ By loading IMC basic settings, useful values are configured for the parameters S-0-0100, S-0-0101 und P-0-0004. See "Initial parameterization" on page 75.

- S-0-0100 = P-0-0510 * 1000 * 0.4 [kgm^2]
  - P-0-0510, Rotor inertia
  - S-0-0100, Velocity controller proportional gain
- S-0-0101 = 10 ~ 15 ms
  - S-0-0101, Velocity loop integral action time
- P-0-0004 = 800 µs
  - P-0-0004, Speed controller smoothing time constant

☞ If humming or an unstable control response is recognized in static operating points, a band-stop filter (P-0-1122 und P-0-1123) may contribute to compensating this behavior. It can help to remove a resonance frequency in the high frequency range (approx. 800 Hz). By measuring the oscillation frequency or an FFT, critical frequencies can be recognized and integrated in the range of the band-stop filter. For configuration, the “Velocity control loop filter” has to be used.

☞ For the motor MS2N13 with reluctance torque, S-0-0100 has to be reduced further based on the value specified above. For a system with MSK133, a value of 10 to 20 is recommended for S-0-0100.

Further information on the velocity controller can be found in the firmware description AXS03. The material number of the description can be found in chapter 9.2 "Firmware" on page 173.

Parameter set switching

Parameter set switching allows switching between four parameter sets during operation, either manually or via a higher-level control. This ensures optimum operation of the pressure controller in the case of dynamic changes in hydraulic loads and oil volumes.

In this way, the following settings can be switched:

- Speed controller settings
- Pressure controller settings
- Pressure command value filter

For additional information, see "Parameter set switching" on page 36.

Enabling parameter set switching

If a further parameter set is to be used, the function has to be enabled in the dialog.

☞ In the basic setting of the IMC software, parameter set switching is not active.

The configuration of parameter set switching is part of the pressure controller dialog as shown below:

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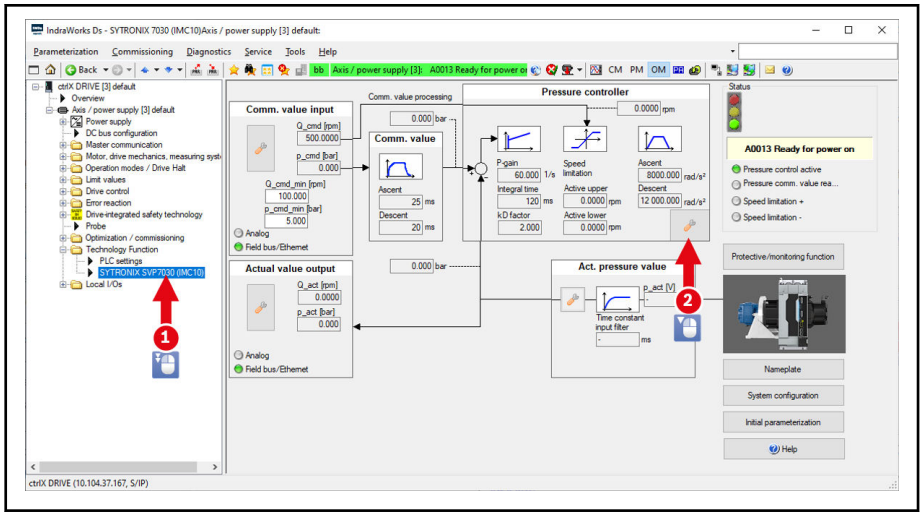

Fig. 7-58: Open the pressure controller dialog for activating parameter set switching

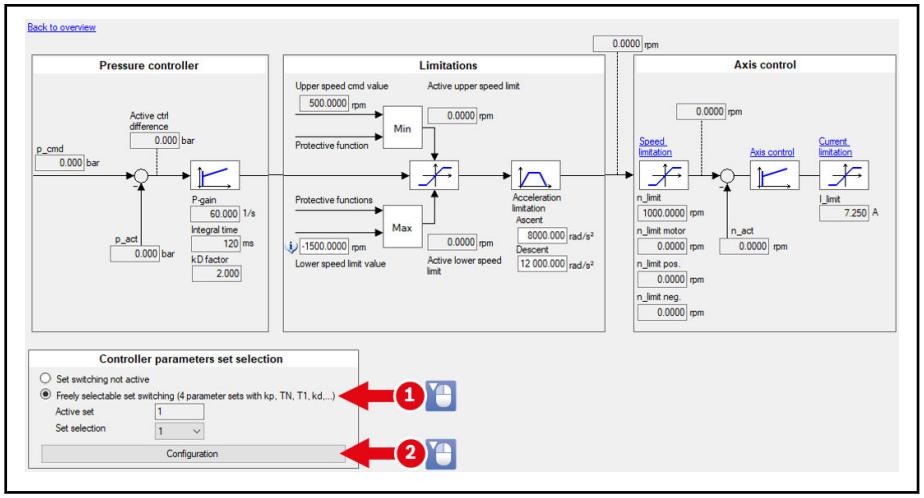

Fig. 7-59: (1) Activate parameter set switching and (2) open the dialog for configuring the 4 parameter sets

By enabling parameter set switching, the currently active controller settings (S-0-0100, S-0-0101, P-0-1373, P-0-1374, P-0-1375, P-0-1384, and P-0-1385) are overwritten with the values from parameter set switching.

Configuring the four parameter sets

The figure below shows the parameter set configuration of sets one to four. Double-click the value of the set to be changed and edit the value. Afterwards the input has to be activated by clicking the button "Save parameter sets".

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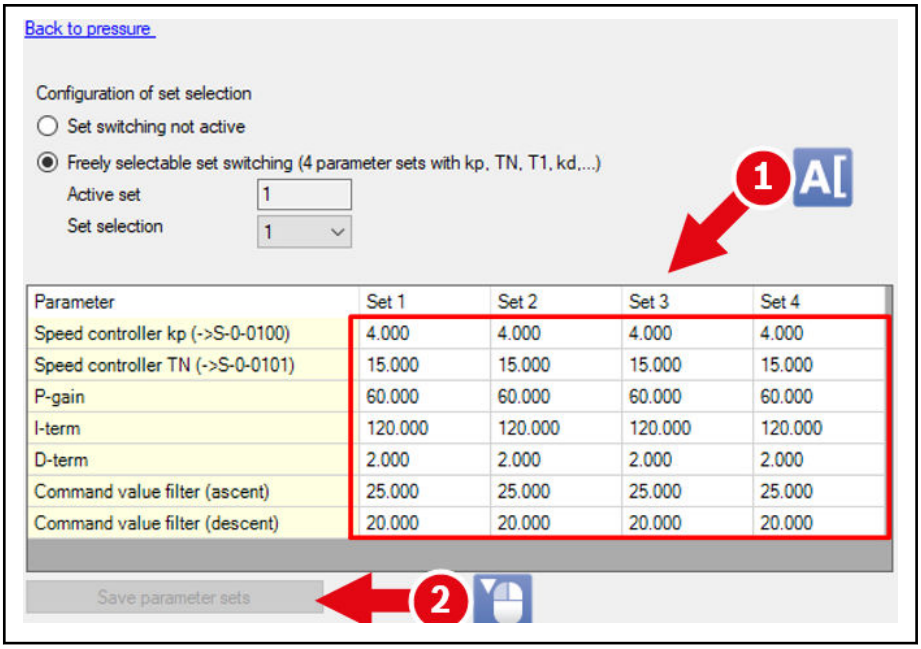

Fig. 7-60: Editing four switchable parameter sets and saving the values

The parameters behind the individual sets can be taken from the table of the functional description in chapter "Input from parameter set" on page 37.

Selecting the parameter set

There are three possibilities of selecting the set (1 to 4):

- Via master communication
- Via digital inputs
- Via the IndraWorks dialog (SYTRONIX 7030 (IMC10))

Selection of the parameter sets via master communication or via digital inputs

The 4 parameter sets can be selected via the bits of the control word P-0-1390, bit 14/15 by an external PLC or via the digital inputs of the ctrlX DRIVE. Switching takes place directly as P-0-1390 is selected.

P-0-1390, bit 15/14	Parameter set
0/0	1
0/1	2
1/0	3
1/1	4

Tab. 7-7: Parameter set selection

For more detailed information on the configuration of the master communication interface, see chapter 7.3.2 "Master communication" on page 62.

For more detailed information on the configuration of digital inputs, see chapter 7.3.5 "Interfaces" on page 73.

Selection of the parameter sets via the IndraWorks dialog

If controlling of the parameter sets is not configured via the master communication or the digital inputs, the parameter set can also be selected manually via the IndraWorks dialog as follows:

1. Parameter set switching has to be active.

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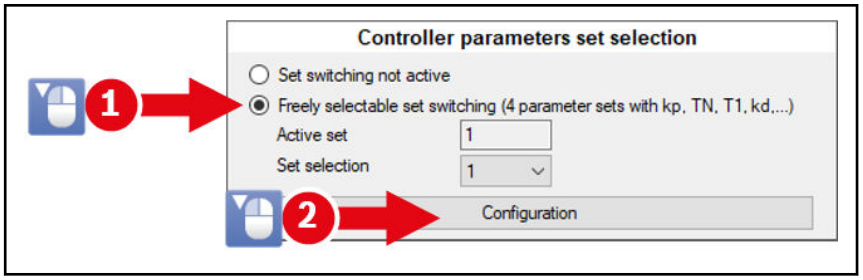

Fig. 7-61: Selection of the parameter set via the IndraWorks Ds dialog

2. In the “Set selection” field, choose the set to be used (P-0-1390; bit 14/15 is automatically set to the corresponding set). The active set is then superseded by the selected set.

☞ If P-0-1390 is set to cyclic, switching is not possible in the dialog.

Switching of integral action time

A function is provided for switching integral action time Tn in dependence on the pressure control difference. This function can be used to reduce pressure overshoots.

For additional information, see "Switching of integral action time" on page 39.

Principle of operation

The integral action time Tn of the pressure controller can be switched between two values in dependence on the pressure control difference. If the actual pressure value exceeds the pressure command value beyond a configured limit (large negative control difference), a smaller integral action time Tn is used for a faster pressure reduction until the actual pressure value falls below a hysteresis. For further information, see "Switching of integral action time" on page 39.

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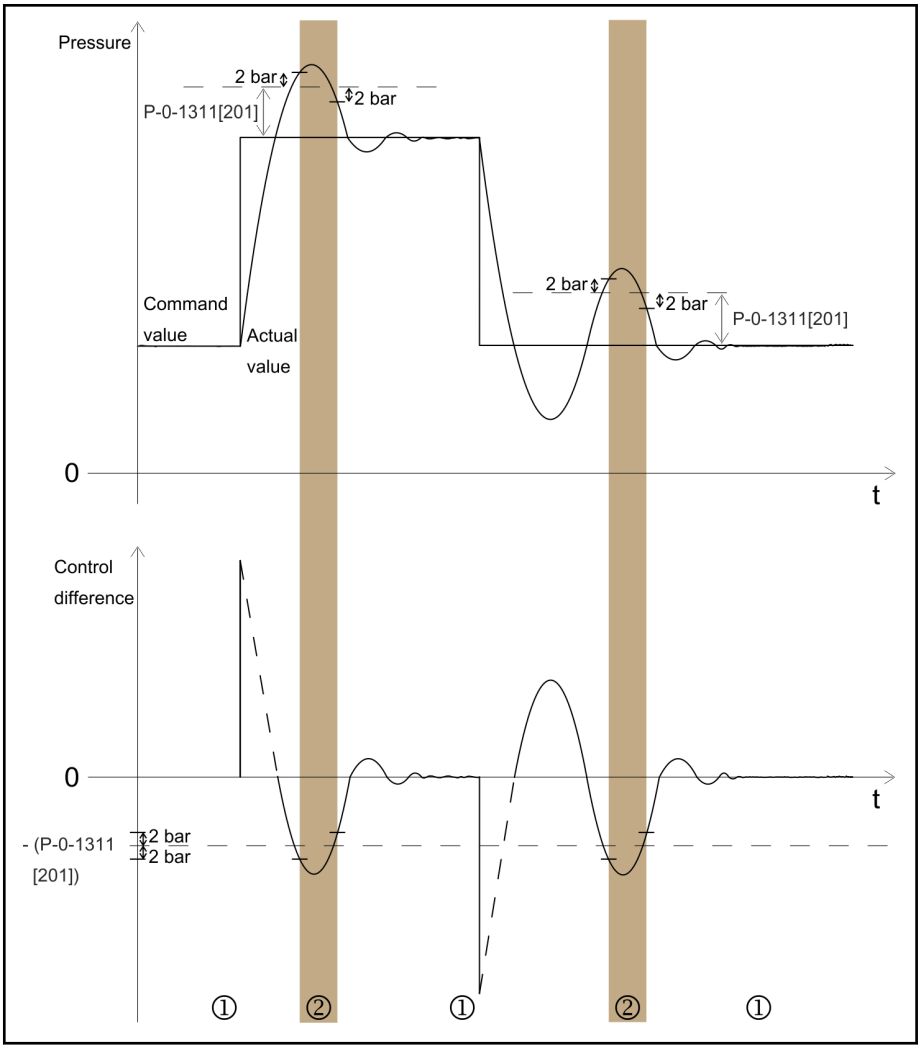

Fig. 7-62: Switching of integral action time Tn

The graphic above shows two pressure overshoots that are detected (range (2)). In (2), the shorter integral action time is active until the pressure overshoot falls below the hysteresis (range (1)). In (1), the configured integral action time of the pressure controller is active.

Activating integral action time switching

1. Open the parameter editor.
2. Search for parameter **P-0-1370** in the parameter search window.
3. Configure bit 1. Select value "1" to activate the function, and value "0" to deactivate it.

   When configuring the bit, take care not to change the other bits. If required, store the configuration of P-0-1370.

How parameters can be configured without the IMC dialog is described in chapter 7.3.1 "Parameter access" on page 61.

Setting instructions

First, enter in parameter P-0-1311[200] the integral action time to be switched for the pressure controller in the case of overshoots. To achieve a useful configuration, the value has to be **less than the value in "P-0-1374, Tn integral action time"**. A typical value for P-0-1311[200] is approximately 1/4 of the integral action time from the pressure controller, P-0-1374.

In parameter P-0-1311[201] you have to enter, at which level of positive pressure overshoots switching of the integral action time is to activated. For the

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actual switching criterion, a hysteresis of ±2 bar is added to the control difference set in P-0-1311[201]. A typical value for P-0-1311[201] is 5 bar.

Protection against cavitation

The function protects the pump against cavitation. This is accomplished by setting the setpoint speed to zero when the actual pressure value is less than the minimum pressure of the pump.

For further information, see chapter "Protection against cavitation" on page 42.

Activating the function

The function is continuously active and cannot be deactivated.

Configuring the cavitation protection

The minimum pressure for cavitation protection is taken from the configured pump. If a pump has been selected from the pump data, the minimum pressure of the pump is configured automatically. If an individual value is to be applied as minimum pressure, “other pump” has to be configured and the value "Min. pressure, high pressure side" has to be entered manually. How to change the configuration is described in fig. 7-30 "Configuring pump data of a user-defined pump" on page 77.

Power limitation

The function protects the pump against overloading. If the hydraulic power in the system comes close to the maximum power limit value of the pump, the pump speed is limited. The limitation of power is mapped in status word P-0-1410 bit 5.

For further information, see chapter "Power limitation" on page 42.

Activating the function

The functionality is activated by default and can be deactivated using “P-0-1370, Config word”, bit 25 = 1.

A detailed description of how to configure the configuration word in the parameter editor can be found in chapter 7.3.1 "Parameter access" on page 61.

Configuring the power limitation

The limit value for the power limitation is taken from the configured pump. If a pump has been selected from the pump data, the valid limit value is configured automatically. If an individual value is to be applied as power limit, “other pump” has to be configured and the value "Max. mechanical drive power" has to be entered manually. How to change the configuration is described in fig. 7-30 "Configuring pump data of a user-defined pump" on page 77.

Dialog for power limitation

To get to the dialog interfaces for power limitation click the button "Protective/monitoring function". The GUI shows the active pump limit values, including the maximum pump power.

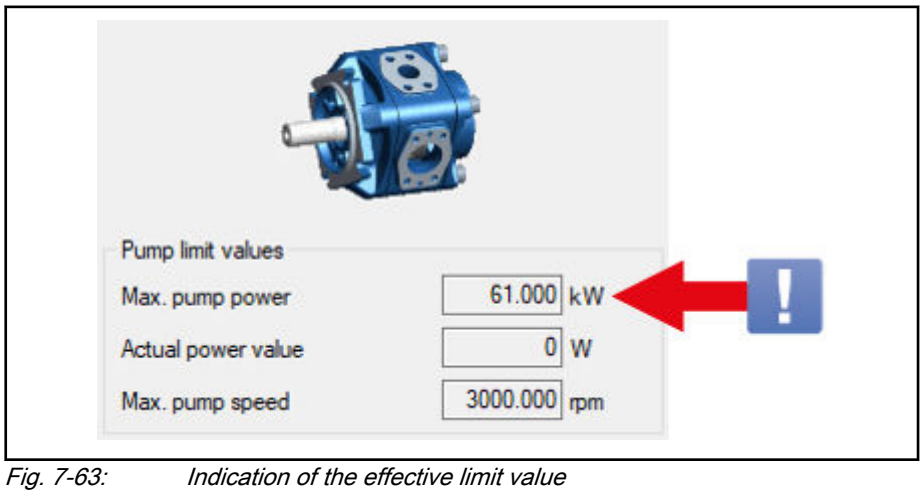

Fig. 7-63: Indication of the effective limit value

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7.4.10 Master/slave operation

In master/slave operation, several motor-pump systems are coupled via a speed command value input from the master to n slaves and thus a system can be set up, which is cascadable in terms of power.

Application

Master/slave operation is useful for the following applications:

- Increase in flow Q by parallel operation of several motor-pump units
- Increase in flow, if the motor-pump size required for the application is not available
- Reduction in the energy consumption by disabling a unit during long pressure holding times (depending on cycle); thus, individual units can be rated smaller with an unchanged, long pressure holding duration.

Coupling types between master and slave

This is configured in the sub-dialog "System configuration".

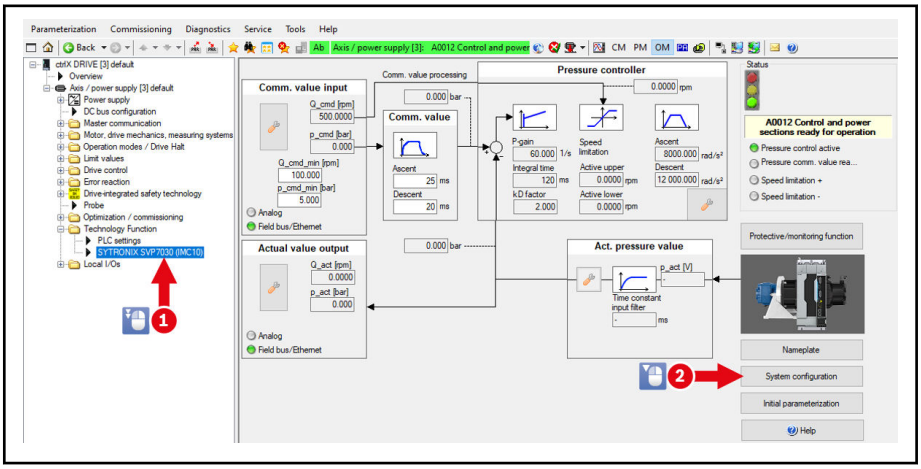

Fig. 7-64: Opening the system configuration

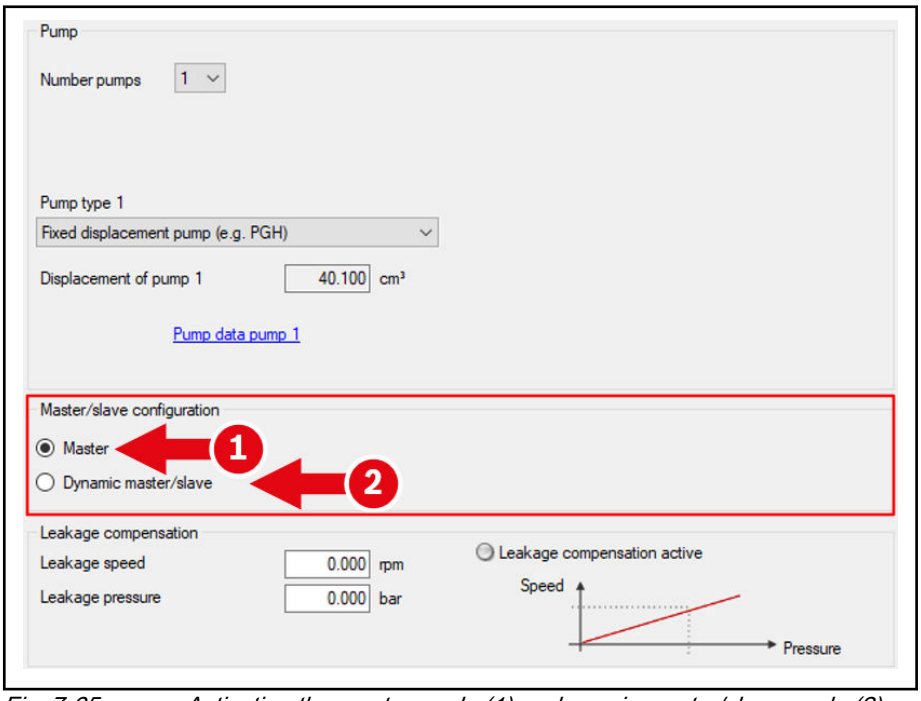

Fig. 7-65: Activating the master mode (1) or dynamic master/slave mode (2)

The graphic above shows coupling types that are supported between master and slave:

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- In **Master mode (1)** p/Q control is active. It is activated with P-0-1370, bit 10 = 1:
- The **dynamic master/slave mode (2)** is activated using P-0-1370 bit 10 = 0:

In the dynamic master/slave mode (2) it is possible to switch between the master and the slave operation mode at runtime (P-0-1390 bit 0). In the master mode, p/Q control is run whereas in the slave mode, speed control is applied.

When a master and a slave are coupled, the master transmits the output of its controller (P-0-0048) to the slave as speed command value (P-0-1377 or P-0-1282). The state of the master/slave mode is displayed in “P-0-1411, Status word 2” bit 2.

The acceleration and deceleration limit of the slave speed is configured with the same interface as the limitation in the master mode. How to configure the limitation is described in chapter chapter "Settings of the acceleration and deceleration ramp " on page 94.

For more detailed information on signal coupling and hydraulic coupling, see chapter 6.12 "Master/slave operation" on page 44

Error handling for the subsystem and a possibly required valve activation are to be handled via an external PLC of the machine.

Example:

Master/slave network with field bus control via EtherCAT

The following example shows a system network consisting of several IMC master and slave units. Primarily the signal flows for the master/slave function are shown here.

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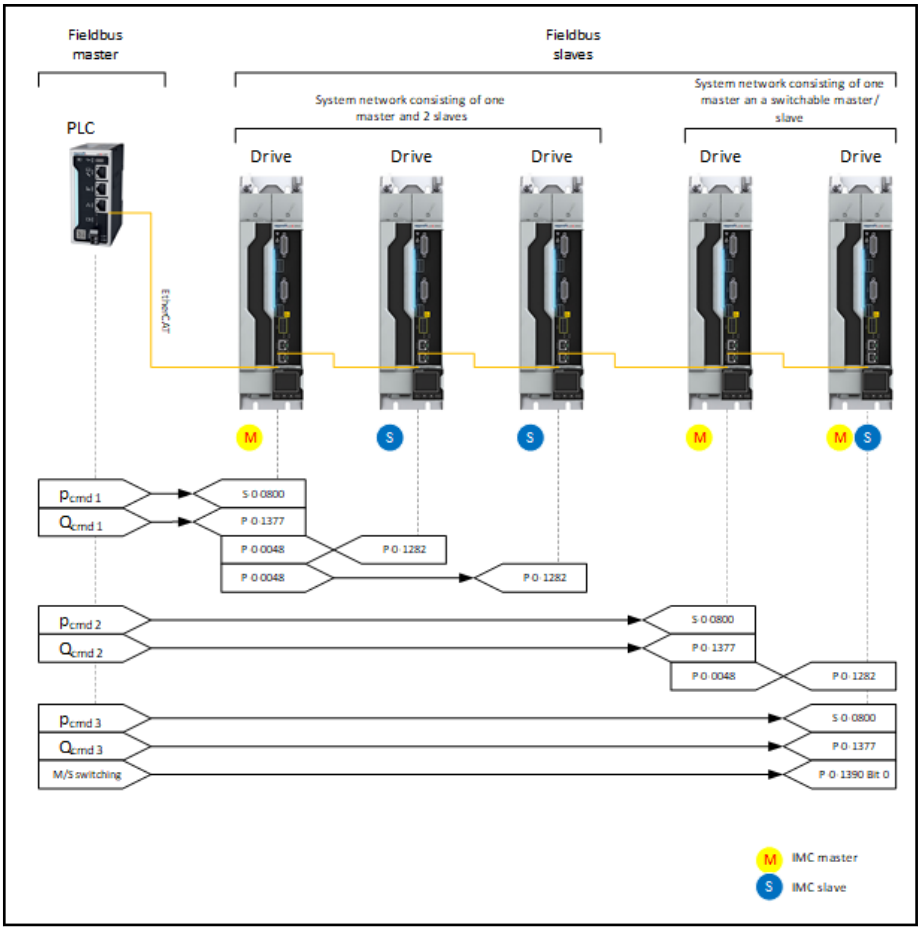

Fig. 7-66: Master/slave network

With another field bus communication the signal flow may differ. It is shown exemplarily in this diagram to illustrate a connection between source and sink.

In any case the data are exchanged between the device over the field bus master.

The example includes a PLC as master communication and n field bus slaves with IMC technology function. Two system networks are shown. A system network is characterized in that at least one master with p/Q control is included. p_{cmd} and Q_{cmd} have to be transmitted to each master. One master may have several slaves with the speed control function. The controller output of the p/Q control is transmitted from the master (P-0-0048) to the n slaves (P-0-1282).

If a network contains a switchable master/slave unit, p_{cmd} and Q_{cmd} as well as the speed (P-0-0048) have to be transmitted to this unit by an assigned master unit. In addition, switching between master and slave operation has to be handled via P-0-1390, bit 0.

7.4.11 Monitoring functions

The following monitoring functions are available:

- Actual pressure value
- Inadmissible operating point

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This is configured in the dialog “Protective/monitoring functions”.

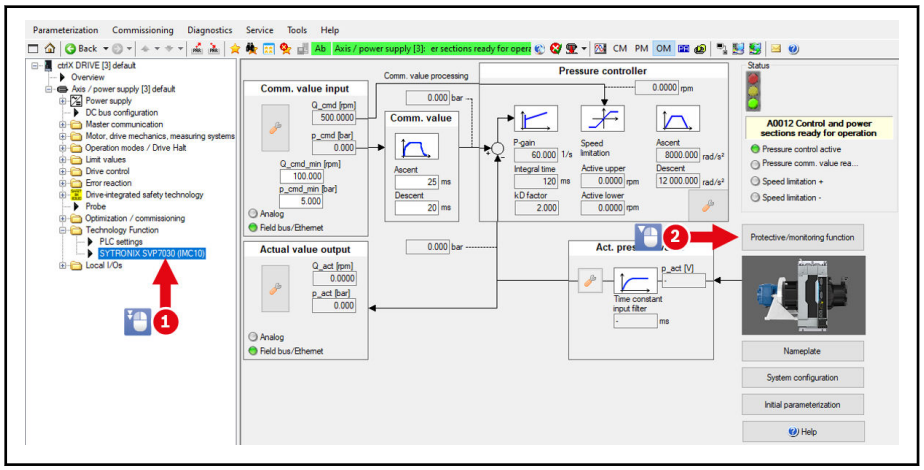

Fig. 7-67: Protective/monitoring functions

Pressure monitoring

The actual pressure value S-0-0804 is monitored for too high and too low values. Monitoring of the actual pressure value serves to protect the pump and optionally other system components. This is configured in the dialog “Protective/monitoring functions”.

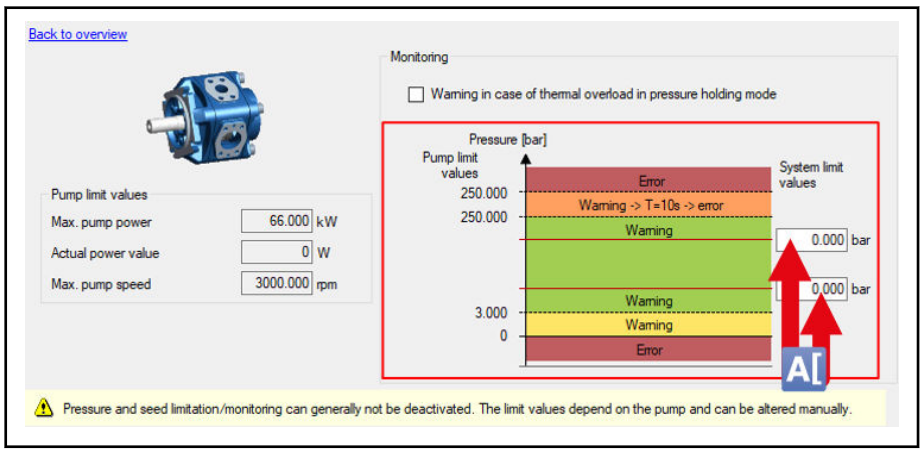

Fig. 7-68: Configuration of pressure monitoring

The pump limit values for minimum pressure in continuous operation, maximum pressure in continuous operation and the maximum critical pressure are configured via the pump data configuration (see also chapter 7.4.2 "Initial parameterization of the technology function" on page 74). For protecting other system component, system limit values can optionally be configured. The user-defined maximum pressure (P-0-1389[103]) and the user-defined minimum pressure (P-0-1389[104]) are available for this purpose.

Temperature monitoring

The degree of heat of the pump (P-0-1298) is calculated and monitored on the basis of a temperature model in dependence on speed and pressure. For all pumps of type PGH the data required for the temperature model are stored in the software. If a corresponding pump was selected and the temperature model activated, merely the cooling factor (P-0-1389[124]) has to be set to a value between 1 (slow cooling down of the pump, e.g. at high ambient temperature) and 3 (fast cooling down of the pump, e.g. at room temperature). If the temperature model is not to trigger a drive error, this can be suppressed.

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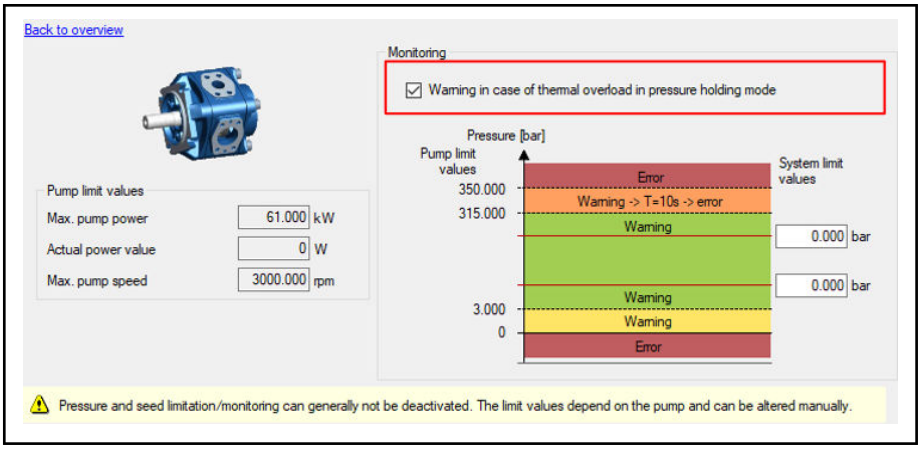

Fig. 7-69: Configuration of the reaction of the pump temperature model

For further information, see chapter 6.13.3 "Temperature monitoring" on page 50.

Inadmissible operating point

An inadmissible operating point is recognized on the basis of the motor speed (P-0-0112) and the motor torque (S-0-0084). If the pump rotates at negative speed and a torque below the minimum threshold for the duration of the debounce time (P-1389[142]), a drive error is triggered. For the speed threshold (P-0-1389[140]) a negative value has to be entered so that monitoring is not triggered by the noise of the encoder signal at a standstill. For the torque threshold (P-0-1389[141]) a positive value may be entered, too so that monitoring reliably responds even at a small negative torque.

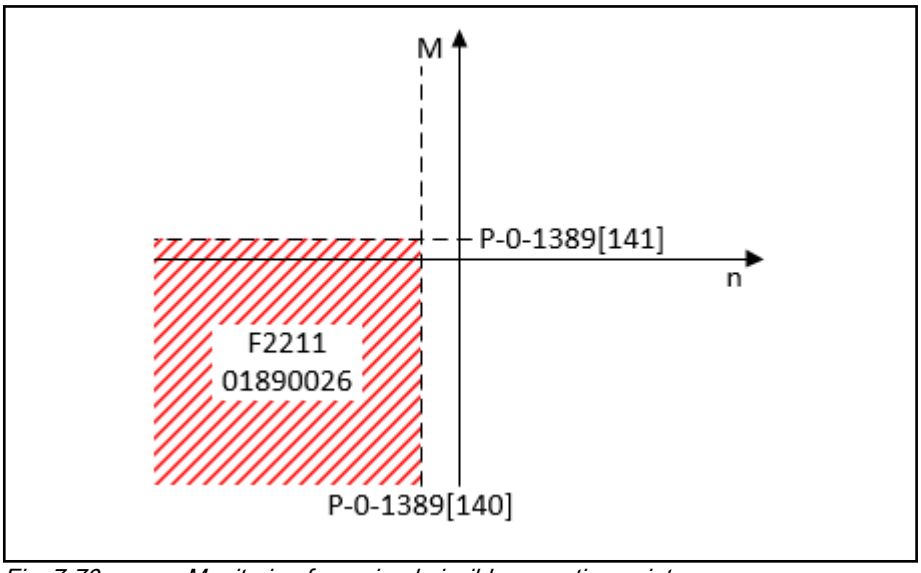

Fig. 7-70: Monitoring for an inadmissible operating point

For further information, see also chapter 6.13.4 "Inadmissible operating point" on page 52.

7.4.12 Diagnostics including logbook

Present diagnostic messages are shown in S-0-0095 (see chapter 6.15 "Diagnostics/error handling" on page 53). The diagnostic message contains the following information:

- Event category
- Detailed diagnostics number
- Diagnostic text

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- If applicable, parameter number with index

Diagnostic texts are displayed in English. The detailed diagnostic number is additionally shown in S-0-0390.0.136. If no diagnostic message is present, the value for the detailed diagnostic number is displayed as "0x00000000".

Additionally, certain states such as "Pressure control active" and different 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 warning or error
- Yellow: Warning
- Red: Error

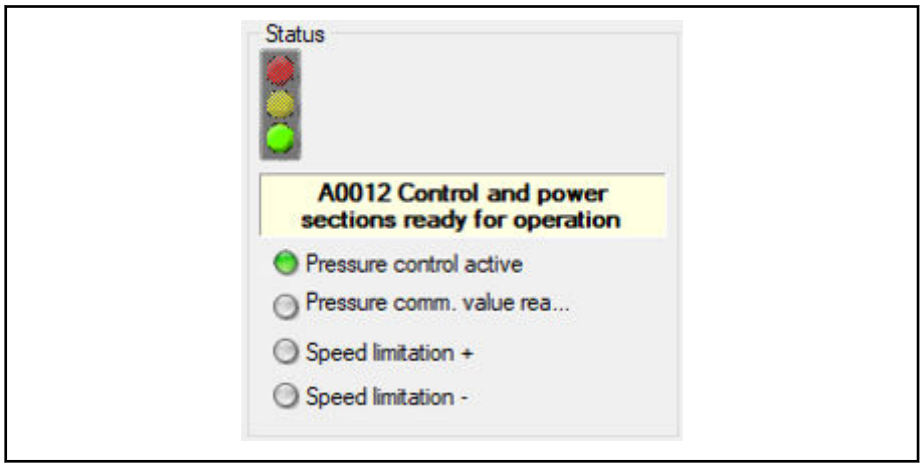

Fig. 7-71: Signal light with states of technology function

The diagnostic text is displayed not only in the overview dialog, but also in the menu bar of IndraWorks Ds.

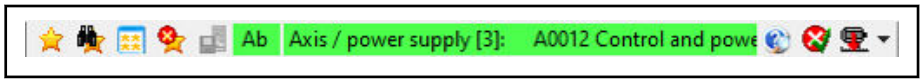

Fig. 7-72: Diagnostic text

The diagnostic logbook is displayed via the "Diagnostic memory" or by clicking on the message in the menu bar (see figure above). The last 128 diagnostic messages that were generated are displayed as event and detailed diagnostic (if available). At present, no descriptive text is supported for detailed diagnostics of the technology function. Diagnostic messages are stored together with the system time and time difference between the events.

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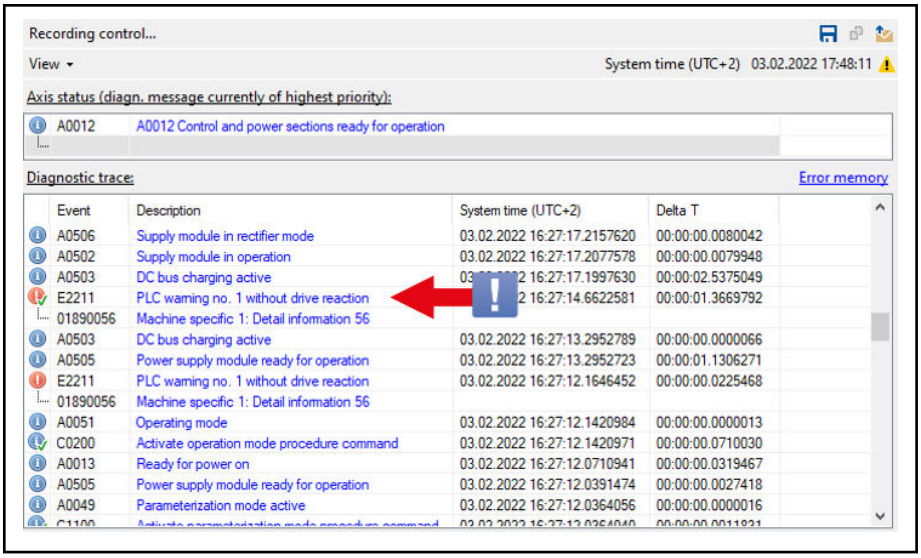

Fig. 7-73: Exemplary representation of a diagnostic message from the technology function in the diagnostic logbook

Events of the technology function can be recognized by the detailed diagnostics number 0189xxxx. If such a number is present, please refer to the cause and remedy documentation in chapter 8.2 "Errors and warning messages" on page 164.

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8 Parameters and diagnostic messages

8.1 Parameters

8.1.1 Overview

☞ **Damage to the internal memory (flash) caused by cyclic write access to the flash!**

On the main circuit board there is a non-volatile memory (flash) and a volatile memory (working memory). The flash memory contains the circuit board-specific operating data as well as machine data of the technology function.

A write access to the machine data requires writing to the internal memory (flash).

During the execution of some commands (see description of the respective diagnostic command message; e.g. C0500), data are written to the internal memory (flash), too.

Because only a limited number of write accesses are allowed, you should see to it that such write accesses are not carried out too often (maximum of approx. 100,000 writing cycles).

By changing the setting via “S-0-0269, Storage mode” you can reduce too frequent writing to the flash memory. A consequence is, however, that configurations are lost when the system is switched off. Saving the changes in the flash would be possible using the “S-0-0264, C2200, Backup working memory procedure command”.

8.1.2 Relevant parameters

Relevant parameters

Parameters and page in parameter description
chapter "P-0-0112, Actual velocity value of motor" on page 113
chapter "P-0-0690, Additive velocity command value, process loop" on page 113
chapter "P-0-1271, Effective pressure command value" on page 114
chapter "P-0-1275, Effective pump displacement" on page 114
chapter "P-0-1276, Pressure controller P-term" on page 114
chapter "P-0-1277, Pressure controller D-term" on page 115
chapter "P-0-1278, Actual speed value in direction of action" on page 115
chapter "P-0-1282, Speed command value for slave" on page 115
chapter "P-0-1285, Effective flow" on page 116
chapter "P-0-1289, Effective max. speed limit" on page 116
chapter "P-0-1290, Effective min. speed limit" on page 117
chapter "P-0-1297, Min. positive speed limitation" on page 117
chapter "P-0-1298, Degree of heat, thermal pump model" on page 117
chapter "P-0-1301, Reserved" on page 118
chapter "P-0-1311[0], Parameter set 1: Speed controller: Kp" on page 118

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Parameters and page in parameter description
chapter "P-0-1311[1], Parameter set 1: Speed controller: Tn" on page 119
chapter "P-0-1311[2], Parameter set 1: Pressure controller: Kp" on page 119
chapter "P-0-1311[3], Parameter set 1: Pressure controller: Tn" on page 120
chapter "P-0-1311[4], Parameter set 1: Pressure controller: Kd" on page 120
chapter "P-0-1311[5], Parameter set 1: Pressure command value filter for increasing values" on page 121
chapter "P-0-1311[6], Parameter set 1: Pressure command value filter for decreasing values" on page 121
chapter "P-0-1311[20], Parameter set 2: Speed controller: Kp" on page 122
chapter "P-0-1311[21], Parameter set 2: Speed controller: Tn" on page 122
chapter "P-0-1311[22], Parameter set 2: Pressure controller: Kp" on page 123
chapter "P-0-1311[23], Parameter set 2: Pressure controller: Tn" on page 123
chapter "P-0-1311[24], Parameter set 2: Pressure controller: Kd" on page 124
chapter "P-0-1311[25], Parameter set 2: Pressure command value filter for increasing values" on page 124
chapter "P-0-1311[26], Parameter set 2: Pressure command value filter for decreasing values" on page 125
chapter "P-0-1311[40], Parameter set 3: Speed controller: Kp" on page 125
chapter "P-0-1311[41], Parameter set 3: Speed controller: Tn" on page 126
chapter "P-0-1311[42], Parameter set 3: Pressure controller: Kp" on page 126
chapter "P-0-1311[43], Parameter set 3: Pressure controller: Tn" on page 127
chapter "P-0-1311[44], Parameter set 3: Pressure controller: Kd" on page 127
chapter "P-0-1311[45], Parameter set 3: Pressure command value filter for increasing values" on page 128
chapter "P-0-1311[46], Parameter set 3: Pressure command value filter for decreasing values" on page 128
chapter "P-0-1311[60], Parameter set 4: Speed controller: Kp" on page 129
chapter "P-0-1311[61], Parameter set 4: Speed controller: Tn" on page 129
chapter "P-0-1311[62], Parameter set 4: Pressure controller: Kp" on page 130
chapter "P-0-1311[63], Parameter set 4: Pressure controller: Tn" on page 130
chapter "P-0-1311[64], Parameter set 4: Pressure controller: Kd" on page 131
chapter "P-0-1311[65], Parameter set 4: Pressure command value filter for increasing values" on page 131
chapter "P-0-1311[66], Parameter set 4: Pressure command value filter for decreasing values" on page 132
chapter "P-0-1311[80], Operating point 1: Pressure command value" on page 132
chapter "P-0-1311[81], Operating point 1: Speed command value" on page 133
chapter "P-0-1311[82], Operating point 2: Pressure command value" on page 133
chapter "P-0-1311[83], Operating point 2: Speed command value" on page 134

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Parameters and page in parameter description
chapter "P-0-1311[84], Operating point 3: Pressure command value" on page 134
chapter "P-0-1311[85], Operating point 3: Speed command value" on page 135
chapter "P-0-1311[86], Operating point 4: Pressure command value" on page 135
chapter "P-0-1311[87], Operating point 4: Speed command value" on page 136
chapter "P-0-1311[200], Integral action time for switching I-term when overshooting" on page 136
chapter "P-0-1311[201], Switching threshold for switching I-term when overshooting" on page 137
chapter "P-0-1311[202], Delay time for switching bb ⇒ Ab" on page 137
chapter "P-0-1311[204], Minimum speed in slave operation" on page 138
chapter "P-0-1311[208], Leakage compensation, determination speed" on page 138
chapter "P-0-1311[209], Leakage compensation, determination pressure" on page 139
chapter "P-0-1329, Acceleration limit of pump" on page 139
chapter "P-0-1330, Deceleration limit of pump" on page 139
chapter "P-0-1370, Configuration word" on page 140
chapter "P-0-1373, Kp, P-gain" on page 142
chapter "P-0-1374, Tn, Integral action time" on page 142
chapter "P-0-1375, Kd, D-gain" on page 142
chapter "P-0-1377, Speed command value" on page 143
chapter "P-0-1378, Negative speed limit value" on page 143
chapter "P-0-1381, Technology function identifier" on page 144
chapter "P-0-1384, Command value filter, filter time for increasing values" on page 144
chapter "P-0-1385, Command value filter, filter time for decreasing values" on page 145
chapter "P-0-1389[100], Pump type" on page 145
chapter "P-0-1389[101], Maximum pressure command value" on page 145
chapter "P-0-1389[102], Minimum pressure command value" on page 146
chapter "P-0-1389[103], User-defined maximum pressure" on page 146
chapter "P-0-1389[104], User-defined minimum pressure" on page 147
chapter "P-0-1389[105], Debounce time for warning in invalid pressure range" on page 147
chapter "P-0-1389[106], Debounce time for error in critical pressure range" on page 147
chapter "P-0-1389[107], Debounce time for error in invalid pressure range" on page 148
chapter "P-0-1389[111], Minimum flow command value" on page 148
chapter "P-0-1389[112], Maximum duration of soft start" on page 149

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Parameters and page in parameter description
chapter "P-0-1389[113], Acceleration limit for soft start" on page 149
chapter "P-0-1389[114], Acceleration factor after soft start" on page 149
chapter "P-0-1389[124], Cooling factor" on page 150
chapter "P-0-1389[131], Debounce time of the actual speed value warning too short to optimize leakage" on page 150
chapter "P-0-1389[140], Monitoring of operating point: Speed threshold value" on page 151
chapter "P-0-1389[141], Monitoring of operating point: Torque threshold value" on page 151
chapter "P-0-1389[142], Monitoring of operating point: Debounce time" on page 152
chapter "P-0-1389[160], Displacement 1" on page 152
chapter "P-0-1389[163], Maximum input power" on page 153
chapter "P-0-1389[164], Pump moment of inertia" on page 153
chapter "P-0-1389[165], Maximum speed in continuous operation, bipolar" on page 154
chapter "P-0-1389[166], Minimum speed in continuous operation, bipolar" on page 154
chapter "P-0-1389[168], Maximum acceleration, bipolar" on page 155
chapter "P-0-1389[175], Maximum critical pressure" on page 155
chapter "P-0-1389[176], Maximum pressure in continuous operation" on page 156
chapter "P-0-1389[177], Minimum pressure in continuous operation" on page 156
chapter "P-0-1390, Control word" on page 157
chapter "P-0-1410, Status word 1" on page 158
chapter "P-0-1411, Status word 2" on page 159
chapter "P-0-1419, Patch function 1" on page 160
chapter "P-0-2806.0.12, Output pump pressure controller I-part" on page 160
chapter "P-0-4028, Device control word" on page 160
chapter "S-0-0032, Primary operation mode" on page 161
chapter "S-0-0099, C0500 Reset class 1 diagnostics" on page 161
chapter "S-0-0100, Velocity controller proportional gain" on page 161
chapter "S-0-0101, Velocity loop integral action time" on page 161
chapter "S-0-0134, Master control word" on page 162
chapter "S-0-0135, Drive status word" on page 162
chapter "S-0-0145, Signal control word" on page 162
chapter "S-0-0390, Diagnostic message number" on page 162
chapter "S-0-0390.0.136, Detailed diagnostics" on page 162
chapter "S-0-0800, Pressure command value" on page 162
chapter "S-0-0804, Pressure feedback value" on page 163

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Parameters and page in parameter description
chapter "S-0-0827, Pressure control deviation" on page 163
chapter "S-0-0832, Pressure window" on page 163
chapter "S-0-0842, Flow feedback value" on page 164

Tab. 8-1: Pertinent parameters

For further information, see documentation of firmware AXS03VRS.

8.1.3 Parameter description

P-0-0112, Actual velocity value of motor

Function The parameter indicates the motor speed irrespective of scaling.

Min./max. value	-/-
Format	DEC
Unit	rpm
Type	Display register
Editable	--
Decimal places	4
Buffered parameter	–
Default value	-
Refresh time	125 µs

Tab. 8-2: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-0690, Additive velocity command value, process loop

Function P-0-0690 serves apart from S-0-0037 for feedforwarding an additive velocity command value. P-0-0690 is used to feed the output of the p/Q controller to the speed controller.

Min./max. value	S-0-0044/S-0-0044
Format	DEC
Unit	S-0-0044
Type	Input register
Editable	++
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-3: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

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P-0-1271, Effective pressure command value

Function The parameter displays the effective pressure command value after command value limitation.

See also chapter 6.10 "Command value limitation" on page 33

Min./max. value	-/-
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	--
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-4: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1275, Effective pump displacement

Function The parameter displays the effective displacement of the pump V_g. The displacement is used for calculating the current output of the pump.

Min./max. value	-/-
Format	DEC
Unit	cm^3
Type	PLC Global Register
Editable	--
Decimal places	1
Buffered parameter	–
Default value	-
Refresh time	16 ms

Tab. 8-5: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1276, Pressure controller P-term

Function The parameter displays the current proportional term of the pressure controller.

Min./max. values	-/-
Format	DEC
Unit	l/min
Type	PLC Global Register
Editable	--
Decimal places	3

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Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-6: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1277, Pressure controller D-term

Function The parameter displays the current derivative term of the pressure controller.

Min./max. values	-/-
Format	DEC
Unit	l/min
Type	PLC Global Register
Editable	--
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-7: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1278, Actual speed value in direction of action

Function The parameter indicates the actual speed value in the direction of action of the drive.

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-8: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1282, Speed command value for slave

Function This parameter shows the speed command value for slave operation. The source of the speed command value can be switched by means of P-0-1370, bit 20.

Valid for the following configuration:

- Dynamic switching with master/slave operation, P-0-1370, bit 10 = 0, and cyclic selection of slave operation with P-0-1390, bit 0 = 0 and

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- source selection to P-0-1282, switched with P-0-1370, bit 20 = 0

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-9: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1285, Effective flow

Function In this parameter the effective flow is displayed with the sign of the direction for pressure buildup. The direction of action of the flow can be configured by means of P-0-1370, bit 0.

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	16 ms

Tab. 8-10: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1289, Effective max. speed limit

Function The maximum effective speed limit is displayed in this parameter. The effective limit results from limitations, e.g., max. permissible values from pump data or power limitation.

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–

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Default value	-
Refresh time	16 ms

Tab. 8-11: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1290, Effective min. speed limit

Function In this parameter, the minimum effective speed limit is displayed. The effective limit results from limitations, e.g. min. permissible values from pump data or cavitation protection function.

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	16 ms

Tab. 8-12: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1297, Min. positive speed limitation

Function This parameter outputs the minimal stable speed at which the pump can be operated at the current pressure operating point. This value limits the positive actuating variable.

Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	--
Decimal places	S-0-0045/S-0-0046
Buffered parameter	–
Default value	-
Refresh time	16 ms

Tab. 8-13: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1298, Degree of heat, thermal pump model

Function This parameter displays the current degree of heat of the pump from the thermal model.

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Min./max. values	-/-
Format	DEC
Unit	%
Type	PLC Global Register
Editable	--
Decimal places	2
Buffered parameter	–
Default value	-
Refresh time	16 ms

Tab. 8-14: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1301, Reserved

Function This parameter has been reserved for internal purposes and must not be overwritten.

Min./max. values	-/-
Format	BIN
Unit	-
Type	PLC Global Register
Editable	--
Decimal places	-
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-15: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[0], Parameter set 1: Speed controller: Kp

Function In this parameter you can set the proportional gain (K_p) of the speed controller when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “S-0-0100, Velocity controller proportional gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	Nm/(rad/s)
Type	PLC Global Register
Editable	++

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Decimal places	3
Buffered parameter	✓
Default value	4.000 Nm/(rad/s)
Refresh time	~32 ms

Tab. 8-16: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[1], Parameter set 1: Speed controller: Tn

Function

In this parameter the integral action time (K_p) of the speed controller is set when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “S-0-0101, Velocity controller integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	15.000 ms
Refresh time	~32 ms

Tab. 8-17: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[2], Parameter set 1: Pressure controller: Kp

Function

In this parameter you can set the proportional gain (K_p) of the pressure controller when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “P-0-1373, Kp, P-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3

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Buffered parameter	✓
Default value	60.000 1/s
Refresh time	~32 ms

Tab. 8-18: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[3], Parameter set 1: Pressure controller: Tn

Function

In this parameter the integral action time (K_p) of the pressure controller is set when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “P-0-1374, Tn, integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	120.000 ms
Refresh time	~32 ms

Tab. 8-19: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[4], Parameter set 1: Pressure controller: Kd

Function

In this parameter the D-gain (K_d) of the pressure controller is set when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “P-0-1375, Kp, D-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	1
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	2.000
Refresh time	~32 ms

Tab. 8-20: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[5], Parameter set 1: Pressure command value filter for increasing values

Function

In this parameter the filter time constant is set for PT1 filtering in pressure command value processing for increasing values when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “P-0-1384, Command value filter, filter time for increasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	25.000 ms
Refresh time	~32 ms

Tab. 8-21: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[6], Parameter set 1: Pressure command value filter for decreasing values

Function

In this parameter the filter time constant is set for PT1 filtering in pressure command value processing for decreasing values when parameter set 1 is selected. When parameter set 1 is selected, the parameter in “P-0-1385, Command value filter, filter time for decreasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 bit 15/14 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	20.000 ms
Refresh time	~32 ms

Tab. 8-22: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[20], Parameter set 2: Speed controller: Kp

Function

In this parameter the proportional gain (K_p) of the speed controller is set when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “S-0-0100, Velocity controller proportional gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	Nm/(rad/s)
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	4.000 Nm/(rad/s)
Refresh time	~32 ms

Tab. 8-23: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[21], Parameter set 2: Speed controller: Tn

Function

In this parameter the integral action time (K_p) of the speed controller is set when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “S-0-0101, Velocity controller integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	15.000 ms
Refresh time	~32 ms

Tab. 8-24: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[22], Parameter set 2: Pressure controller: Kp

Function

In this parameter the proportional gain (K_p) of the pressure controller is set when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “P-0-1373, Kp, P-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	60.000 1/s
Refresh time	~32 ms

Tab. 8-25: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[23], Parameter set 2: Pressure controller: Tn

Function

In this parameter the integral action time (T_n) of the pressure controller is set when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “P-0-1374, Tn, integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	120.000 ms
Refresh time	~32 ms

Tab. 8-26: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[24], Parameter set 2: Pressure controller: Kd

Function

In this parameter the D-gain (K_d) of the pressure controller is set when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “P-0-1375, Kp, D-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	1
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	2.000
Refresh time	~32 ms

Tab. 8-27: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[25], Parameter set 2: Pressure command value filter for increasing values

Function

In this parameter the filter time constant is set for PT1 filtering in pressure command value processing for increasing values when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “P-0-1384, Command value filter, filter time for increasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 2 P-0-1390 bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	25.000 ms
Refresh time	~32 ms

Tab. 8-28: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[26], Parameter set 2: Pressure command value filter for decreasing values

Function

In this parameter you can set the filter time constant for PT1 filtering in pressure command value processing for decreasing values when parameter set 2 is selected. When parameter set 2 is selected, the parameter in “P-0-1385, Command value filter, filter time for decreasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 Bit 15/14 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	20.000 ms
Refresh time	~32 ms

Tab. 8-29: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[40], Parameter set 3: Speed controller: Kp

Function

In this parameter you can set the proportional gain (K_p) of the speed controller when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “S-0-0100, Velocity controller proportional gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	Nm/(rad/s)
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	4.000 Nm/(rad/s)
Refresh time	~32 ms

Tab. 8-30: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[41], Parameter set 3: Speed controller: Tn

Function

In this parameter you can set the integral action time (T_n) of the speed controller when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “S-0-0101, Velocity controller integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	15.000 ms
Refresh time	~32 ms

Tab. 8-31: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[42], Parameter set 3: Pressure controller: Kp

Function

In this parameter you can set the proportional gain (K_p) of the pressure controller when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “P-0-1373, Kp, P-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	60.000 1/s
Refresh time	~32 ms

Tab. 8-32: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[43], Parameter set 3: Pressure controller: Tn

Function

In this parameter you can set the integral action time (T_n) of the pressure controller when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “P-0-1374, Tn, integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	120.000 ms
Refresh time	~32 ms

Tab. 8-33: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[44], Parameter set 3: Pressure controller: Kd

Function

In this parameter you can set the D-gain (K_d) of the pressure controller when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “P-0-1375, Kp, D-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	1
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	2.000
Refresh time	~32 ms

Tab. 8-34: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[45], Parameter set 3: Pressure command value filter for increasing values

Function

In this parameter you can set the filter time constant for PT1 filtering in pressure command value processing for increasing values when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “P-0-1384, Command value filter, filter time for increasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 3 P-0-1390 bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	25.000 ms
Refresh time	~32 ms

Tab. 8-35: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[46], Parameter set 3: Pressure command value filter for decreasing values

Function

In this parameter you can set the filter time constant for PT1 filtering in pressure command value processing for decreasing values when parameter set 3 is selected. When parameter set 3 is selected, the parameter in “P-0-1385, Command value filter, filter time for decreasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 1 P-0-1390 Bit 15/14 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	20.000 ms
Refresh time	~32 ms

Tab. 8-36: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[60], Parameter set 4: Speed controller: Kp

Function

In this parameter you can set the proportional gain (K_p) of the speed controller when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “S-0-0100, Velocity controller proportional gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	Nm/(rad/s)
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	4.000 Nm/(rad/s)
Refresh time	~32 ms

Tab. 8-37: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[61], Parameter set 4: Speed controller: Tn

Function

In this parameter you can set the integral action time (T_n) of the speed controller when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “S-0-0101, Velocity controller integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	15.000 ms
Refresh time	~32 ms

Tab. 8-38: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[62], Parameter set 4: Pressure controller: Kp

Function

In this parameter you can set the proportional gain (K_p) of the pressure controller when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “P-0-1373, Kp, P-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	60.000 1/s
Refresh time	~32 ms

Tab. 8-39: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[63], Parameter set 4: Pressure controller: Tn

Function

In this parameter you can set the integral action time (T_n) of the pressure controller when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “P-0-1374, Tn, integral action time” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

DBR AUTOMATION SL, Malaga Spain, Telf: +34 951709474 E-mail: comercial@dbrautomation.com

Default value	120.000 ms
Refresh time	~32 ms

Tab. 8-40: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[64], Parameter set 4: Pressure controller: Kd

Function

In this parameter you can set the D-gain (K_d) of the pressure controller when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “P-0-1375, Kp, D-gain” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	1
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	2.000
Refresh time	~32 ms

Tab. 8-41: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[65], Parameter set 4: Pressure command value filter for increasing values

Function

In this parameter you can set the filter time constant for PT1 filtering in pressure command value processing for increasing values when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “P-0-1384, Command value filter, filter time for increasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	25.000 ms
Refresh time	~32 ms

Tab. 8-42: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[66], Parameter set 4: Pressure command value filter for decreasing values

Function

In this parameter you can set the filter time constant for PT1 filtering in pressure command value processing for decreasing values when parameter set 4 is selected. When parameter set 4 is selected, the parameter in “P-0-1385, Command value filter, filter time for decreasing values” is copied.

Valid for the following configuration:

- Source selection for control parameter from parameter set P-0-1370, bit 12 = 1 and
- selection of parameter set 4 P-0-1390 bit 15/14 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	20.000 ms
Refresh time	~32 ms

Tab. 8-43: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[80], Operating point 1: Pressure command value

Function

In this parameter the pressure command value for operating point 1 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 1, P-0-1390 bit 4/3 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	70.000 bar
Refresh time	~32 ms

Tab. 8-44: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[81], Operating point 1: Speed command value

Function

In this parameter the speed command value for operating point 1 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 1, P-0-1390 bit 4/3 = 00

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	500.000 rpm
Refresh time	~32 ms

Tab. 8-45: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[82], Operating point 2: Pressure command value

Function

In this parameter the pressure command value for operating point 2 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 2, P-0-1390 bit 4/3 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	70.000 bar
Refresh time	~32 ms

Tab. 8-46: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[83], Operating point 2: Speed command value

Function

In this parameter the speed command value for operating point 2 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 2, P-0-1390 bit 4/3 = 01

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	500.000 rpm
Refresh time	~32 ms

Tab. 8-47: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[84], Operating point 3: Pressure command value

Function

In this parameter the pressure command value for operating point 3 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 3, P-0-1390 bit 4/3 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	70.000 bar
Refresh time	~32 ms

Tab. 8-48: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[85], Operating point 3: Speed command value

Function

In this parameter the speed command value for operating point 3 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 3, P-0-1390 bit 4/3 = 10

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	500.000 rpm
Refresh time	~32 ms

Tab. 8-49: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[86], Operating point 4: Pressure command value

Function

In this parameter the pressure command value for operating point 4 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 4, P-0-1390 bit 4/3 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	70.000 bar
Refresh time	~32 ms

Tab. 8-50: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[87], Operating point 4: Speed command value

Function

In this parameter the speed command value for operating point 4 is entered. With the selection of the operating point, operating points can be provided without cyclic interface.

Valid for the following configuration:

- Source selection for p/Q input from operating point set P-0-1370, bit 31 = 1 and
- selection of operating point 4, P-0-1390 bit 4/3 = 11

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	500.000 rpm
Refresh time	~32 ms

Tab. 8-51: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[200], Integral action time for switching I-term when overshooting

Function

In this parameter, integral action time T_n, which becomes effective when the integral action time is switched, is entered for the integrator of the controller. Switching of the integral action time serves to reduce overshooting in the control behavior in the event of a positive command value jump by means of the changed integral action time. For details regarding this function, see "Switching of integral action time" on page 39.

Valid for the following configuration: Activation of integral action time switching by means of P-0-1370, bit 1 = 1

Min./max. values	0/2147483.647
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	20.000 ms
Refresh time	~32 ms

Tab. 8-52: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[201], Switching threshold for switching I-term when overshooting

Function This parameter specifies at which pressure control deviation (S-0-0827) the integral action time T_n active for the pressure controller is switched.

See also "Switching of integral action time" on page 39

Valid for the following configuration: Activation of integral action time switching by means of P-0-1370, bit 1 = 1

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	5.000 bar
Refresh time	~32 ms

Tab. 8-53: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1311[202], Delay time for switching bb ⇒ Ab

Function This parameter determines the delay for switching from bb to AB for the Easy Control function. If the drive is enabled via the Easy Control function and, after switching to OM, remains in the bb state longer than this specified time, a warning is generated.

See also chapter 6.6 "Easy Control state control" on page 29

Min./max. values	0/2147483.647
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-54: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

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P-0-1311[204], Minimum speed in slave operation

Function In slave operation (closed-loop speed control) the speed command value from P-0-1282 or P-0-1377 (depending on the configuration of the source in P-0-1370 Bit 25) is used as actuating variable. P-0-1311[204] limits the controller output in the negative direction of flow.

See also chapter 6.12 "Master/slave operation" on page 44

Valid for the following configuration:

- Activation of dynamic master/slave operation P-0-1370 bit 10 = 0 and
- selection of slave operation P-0-1390, bit 0 = 0

Min./max. value	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.000 rpm
Refresh time	~32 ms

Tab. 8-55: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1311[208], Leakage compensation, determination speed

Function In this parameter the reference leakage is entered as speed for the leakage determination function.

See also chapter 6.9 "Leakage compensation" on page 32

☞ If P-0-1311[208] = 0 or P-0-1311[209] = 0, leakage compensation is disabled. No leakage offset is generated.

Min./max. value	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.000 rpm
Refresh time	~32 ms

Tab. 8-56: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

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P-0-1311[209], Leakage compensation, determination pressure

Function In this parameter the reference pressure is entered for the leakage determination function.

See also chapter 6.9 "Leakage compensation" on page 32

☞ If P-0-1311[208] = 0 or P-0-1311[209] = 0, leakage compensation is disabled. No leakage offset is generated.

Min./max. value	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.000 bar
Refresh time	~32 ms

Tab. 8-57: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1329, Acceleration limit of pump

Function In this parameter, the maximum permissible acceleration for the pump is entered.

☞ In the case of excessively high acceleration rates, the oil column may rupture and the pump may be damaged. Observe the maximum permissible limit values in the data sheet of the pump as well as the specialties of the hydraulic connection.

Min./max. values	0/P-0-1389[168]
Format	DEC
Unit	S-0-0160
Type	PLC Global Register
Editable	++
Decimal places	S-0-0161/S-0-00162
Buffered parameter	✓
Default value	8,000.000 rad/s²
Refresh time	~32 ms

Tab. 8-58: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1330, Deceleration limit of pump

Function In this parameter, the maximum permissible deceleration for the pump is entered.

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Min./max. values	0/P-0-1389[168]
Format	DEC
Unit	S-0-0160
Type	PLC Global Register
Editable	++
Decimal places	S-0-0161/S-0-00162
Buffered parameter	✓
Default value	12,000.000 rad/s²
Refresh time	~32 ms

Tab. 8-59: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1370, Configuration word

Function This parameter is used to configure the IMC system function.

Structure of the P-0-1370 and significance of the bits:

Bit	Designation/function	Comment
0	**Coordination of the motor's direction of rotation and flow** **0:** A positive speed (P-0-0112) results in a positive flow **1:** A negative speed (P-0-0112) results in a negative flow	Not editable in AF
1	**Activation of the switching I-term to reduce pressure overshoots** **0:** Deactivated **1:** Activated	
2	**Activation of Easy Control** **0:** Deactivated (drive enable via drive interfaces) **1:** Activated (drive enable via P-0-1390.5)	
3	**Configuration Easy Control enable** **0:** Edge-controlled **1:** Level-controlled	
9..4	**Reserved**	
10	**Activation of dynamic master/slave operation** **0:** Dynamic master/slave operation possible via P-0-1390, bit 0 **1:** Master operation as soon as drive in "AF"; pressure control incl. monitoring functions always active	
11	**Reserved**	

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Bit	Designation/function	Comment
12	**Source selection for controller parameter switching** **0:** Cyclic interface **1:** Controlled set mode (4 parameter sets)	
17..13	**Reserved**	
18	**Deactivation of error message from pump temperature model "F2211 01890023: Excessive heat accumulation"** **0:** Deactivated **1:** Activated	
19	**Reserved**	
20	**Source selection for speed command value in slave operation** **0:** P-0-1282 as n_{cmd} for slave **1:** P-0-1377 as n_{cmd} for slave	
21	**Deactivation of monitoring for inadmissible operating point** **0:** Monitoring activated **1:** Monitoring deactivated	
24..22	**Reserved**	
25	**Deactivation of power limitation function** **0:** Activate pressure relief function **1:** Function deactivated	
29...26	**Reserved**	
30	**Source selection communication / interface** **0:** Analog **1:** Field bus/Ethernet	
31	**Source selection p_{cmd}/Q_{cmd}** **0:** Cyclic interface for operating point input **1:** Input of operating points via sets	

Tab. 8-60: Structure of P-0-1370 and significance of the bits

Min./max. values	-/-
Format	BIN
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	-
Buffered parameter	✓

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Default value	0b0000.0000.0000.0000.0000.0100.0000.0011
Refresh time	16 ms

Tab. 8-61: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1373, Kp, P-gain

Function In this parameter the P-gain (K_p) for the pressure controller can be cyclically input.

Valid for the following configuration: P-0-1370, bit 12 = 0

Min./max. values	0/4294967.295
Format	DEC
Unit	1/s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	60.000 1/s
Refresh time	1 ms

Tab. 8-62: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1374, Tn, Integral action time

Function In this parameter the integral action time (T_n) for the pressure controller can be cyclically input.

Valid for the following configuration: P-0-1370, bit 12 = 0

Min./max. values	0/4294967295
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	120 ms
Refresh time	1 ms

Tab. 8-63: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1375, Kd, D-gain

Function In this parameter the D-gain (K_p) for the pressure controller can be cyclically input.

Valid for the following configuration: P-0-1370, bit 12 = 0

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Min./max. values	0/4294967.295
Format	DEC
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	2.000
Refresh time	1 ms

Tab. 8-64: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1377, Speed command value

Function In this parameter the speed command value (n_{cmd}) for the p/Q controller in master operation can be cyclically input.

Valid for the following configuration:

- Command value source from cyclic interface P-0-1370, bit 12 = 0
- Fixed master operation P-0-1370, bit 10 = 1
- Dynamic switching with master/slave operation, P-0-1370, bit 10 = 0, and cyclic selection of master operation with P-0-1390, bit 0 = 1

In this parameter the speed command value (n_{cmd}) in slave operation can be cyclically input.

Valid for the following configuration:

- Dynamic switching with master/slave operation, P-0-1370, bit 10 = 0, and cyclic selection of slave operation with P-0-1390, bit 0 = 0

Min./max. values	0/4294967.295
Format	DEC
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	1 ms

Tab. 8-65: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1378, Negative speed limit value

Function In this parameter, the maximum permissible negative speed for the pump is entered.

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Min./max. values	-/-
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	S-0-0045/S-0-0046
Buffered parameter	✓
Default value	-
Refresh time	16 ms

Tab. 8-66: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1381, Technology function identifier

Function 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	16 ms

Tab. 8-67: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1384, Command value filter, filter time for increasing values

Function In this parameter the filter time is entered for a PT1 element for pressure command value pre-processing for increasing values.

Valid for the following configuration: Source selection to cyclic interface for controller parameter P-0-1370, bit 12 = 0

Min./max. values	0/4294967295
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	0
Buffered parameter	✓

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Default value	25 ms
Refresh time	16 ms

Tab. 8-68: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1385, Command value filter, filter time for decreasing values

Function In this parameter the filter time is entered for a PT1 element for pressure command value pre-processing for decreasing values.

Valid for the following configuration: Source selection to cyclic interface for controller parameter P-0-1370, bit 12 = 0

Min./max. values	0/4294967295
Format	DEC
Unit	ms
Type	PLC Global Register
Editable	++
Decimal places	0
Buffered parameter	✓
Default value	20 ms
Refresh time	16 ms

Tab. 8-69: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1389[100], Pump type

Function This parameter serves to select the pump type (as far as supported). For selecting the type, an index is entered in the parameter, which results in a selection.

See also chapter 6.3 "Motor-pump system" on page 23

Min./max. values	0/200
Format	DEC
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	43,000
Refresh time	~32 ms

Tab. 8-70: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[101], Maximum pressure command value

Function This parameter serves to limit the maximum pressure command value.

See also chapter 6.10 "Command value limitation" on page 33

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Min./max. values	P-0-1389[102]/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	315.000 bar
Refresh time	~32 ms

Tab. 8-71: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[102], Minimum pressure command value

Function This parameter serves to limit the minimum pressure command value.

See also chapter 6.10 "Command value limitation" on page 33

Min./max. values	P-0-1389[177]/P-0-1389[101]
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	5.000 bar
Refresh time	~32 ms

Tab. 8-72: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[103], User-defined maximum pressure

Function This parameter is used to monitor pressure feedback value S-0-0804 optionally for value lower than stored in the pump data.

See also chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	P-0-1389[104] or P-0-1389[177]/ P-0-1389[176]
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	0.000 bar
Refresh time	~32 ms

Tab. 8-73: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[104], User-defined minimum pressure

Function This parameter is used to monitor pressure feedback value S-0-0804 optionally for a value higher than stored in the pump data.

See also chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	0/P-0-1389[176]
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.000 bar
Refresh time	~32 ms

Tab. 8-74: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[105], Debounce time for warning in invalid pressure range

Function This parameter is used to debounce the warning "E2211 0189001C: System pressure exceeds upper warning level"

See also chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	0/2147483.647
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	2.000 s
Refresh time	~32 ms

Tab. 8-75: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[106], Debounce time for error in critical pressure range

Function This parameter is used to debounce the warning "F2211 0189001F: System pressure exceeds upper critical alarm level"

See also chapter 6.13.2 "Pump pressure monitoring" on page 48

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Min./max. values	0/2147483.647
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.100 s
Refresh time	~32 ms

Tab. 8-76: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[107], Debounce time for error in invalid pressure range

Function This parameter is used to debounce the error "F2211 0189001D: System pressure exceeds upper alarm level"

See also chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	0/2147483.647
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	No indication
Refresh time	~32 ms

Tab. 8-77: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[111], Minimum flow command value

Function This parameter serves to input the minimum flow command value in master operation.

See also chapter 6.10 "Command value limitation" on page 33

Min./max. values	0/effective speed limitation of converter
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	40,000 rpm
Refresh time	~32 ms

Tab. 8-78: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[112], Maximum duration of soft start

Function This parameter serves to input the maximum duration of the soft start function. The soft start function is only available in master operation. When value 0 is entered, the soft start function is deactivated.

See also chapter 6.10 "Command value limitation" on page 33

Min./max. values	0/60
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.000 s
Refresh time	~32 ms

Tab. 8-79: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[113], Acceleration limit for soft start

Function This parameter serves to input the maximum acceleration of the drive at the beginning of the soft start. When value 0 is entered, the acceleration limit is deactivated.

See also chapter 6.10 "Command value limitation" on page 33

Min./max. values	0/2147483.647
Format	DEC
Unit	rad/s²
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	100.000 rad/s²
Refresh time	~32 ms

Tab. 8-80: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[114], Acceleration factor after soft start

Function This parameter serves to input the maximum acceleration of the motor at the end of the soft start for the transition to the flow command value. This is a

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percentage factor. The effective acceleration results from multiplication by "P-0-1329, Acceleration limit of pump".

See also chapter 6.10 "Command value limitation" on page 33

Min./max. values	>0/100
Format	DEC
Unit	%
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	50.000 %
Refresh time	~32 ms

Tab. 8-81: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[124], Cooling factor

Function This parameter represents the cooling factor for the thermal pump model. By entering discrete values in the range from 1 to 3 the measure for the heat dissipation of the pump (in a thermally stable state) is specified. The factors are classified as follows:

- **Factor 1** describes a pump, which cools down slowly (e.g. at high ambient temperature)
- **Factor 3** (default) describes a pump, which cools down faster (e.g. at room temperature).

See also chapter 6.13.3 "Temperature monitoring" on page 50.

Min./max. values	1/3
Format	DEC
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	3,000
Refresh time	~32 ms

Tab. 8-82: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[131], Debounce time of the actual speed value warning too short to optimize leakage

Function This parameter provides the debounce time for the warning "E2211 01890021: Low positive speed".

See also

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Min./max. values	0/2147483.647
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	1.000 s
Refresh time	~32 ms

Tab. 8-83: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[140], Monitoring of operating point: Speed threshold value

Function In this parameter, the speed threshold for the impermissible operating point is given.

See also chapter 6.13.4 "Inadmissible operating point" on page 52

Min./max. values	-2147483,648/0
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	No indication
Refresh time	~32 ms

Tab. 8-84: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[141], Monitoring of operating point: Torque threshold value

Function In this parameter, the torque threshold for the impermissible operating point is given.

See also chapter 6.13.4 "Inadmissible operating point" on page 52

Min./max. values	-2147483.648/2147483.647
Format	DEC
Unit	S-0-0086
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	No indication
Refresh time	~32 ms

Tab. 8-85: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[142], Monitoring of operating point: Debounce time

Function This parameter sets the debounce time for error "F2211 01890026: Invalid operation point detected".

See also chapter 6.13.4 "Inadmissible operating point" on page 52

Min./max. values	0/10
Format	DEC
Unit	s
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	0.100 s
Refresh time	~32 ms

Tab. 8-86: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[160], Displacement 1

Function This parameter displays the current displacement V_g if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, V_g is configured in P-0-1389[160].

☞ In AF, no changes can be made.

See also chapter 6.3 "Motor-pump system" on page 23

Min./max. values	0/2147483.647
Format	DEC
Unit	cm^3
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-87: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

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P-0-1389[163], Maximum input power

Function This parameter displays the maximum input power of the motor-pump group if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the maximum input power is configured in P-0-1389[163].

☞ In AF, no changes can be made.

See also

- chapter 6.3 "Motor-pump system" on page 23
- chapter 6.11.3 "Limitations" on page 42

Min./max. values	0/2147483.647
Format	DEC
Unit	kW
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-88: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[164], Pump moment of inertia

Function This parameter displays the pump moment of inertia if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the pump moment of inertia is configured in P-0-1389[164].

☞ In AF, no changes can be made.

See also chapter 6.3 "Motor-pump system" on page 23

Min./max. values	0/2147483.647
Format	DEC
Unit	gm^2
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-89: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

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P-0-1389[165], Maximum speed in continuous operation, bipolar

Function This parameter displays the maximum bipolar speed in continuous operation of the pump if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the maximum speed is configured in P-0-1389[165].

☞ In AF, no changes can be made.

See also chapter 6.3 "Motor-pump system" on page 23

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-90: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[166], Minimum speed in continuous operation, bipolar

Function This parameter displays the minimum bipolar speed in continuous operation of the pump if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the minimum speed is configured in P-0-1389[166].

☞ In AF, no changes can be made.

See also chapter 6.3 "Motor-pump system" on page 23

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0044
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-91: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

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P-0-1389[168], Maximum acceleration, bipolar

Function This parameter displays the maximum acceleration for the pump if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the maximum acceleration is configured in P-0-1389[168].

☞ In AF, no changes can be made.

See also

- chapter 6.3 "Motor-pump system" on page 23
- "Acceleration limitation" on page 43

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0160
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-92: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[175], Maximum critical pressure

Function This parameter displays the maximum critical pressure of the pump if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the maximum critical pressure is configured in P-0-1389[175].

☞ In AF, no changes can be made.

See also

- chapter 6.3 "Motor-pump system" on page 23
- chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	P-0-1389[176]/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-93: Parameter attributes

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See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[176], Maximum pressure in continuous operation

Function This parameter displays the maximum pressure of the pump in continuous operation if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the maximum pressure is configured in P-0-1389[176].

☞ In AF, no changes can be made.

See also

- chapter 6.3 "Motor-pump system" on page 23
- chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	P-0-1389[176]/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	-
Refresh time	~32 ms

Tab. 8-94: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1389[177], Minimum pressure in continuous operation

Function This parameter displays the minimum pressure of the pump in continuous operation if a valid pump has been selected in P-0-1389[100]. In the case of manual pump configuration, the minimum pressure is configured in P-0-1389[177].

☞ In AF, no changes can be made.

See also

- chapter 6.3 "Motor-pump system" on page 23
- chapter 6.13.2 "Pump pressure monitoring" on page 48

Min./max. values	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	PLC Global Register
Editable	++
Decimal places	3
Buffered parameter	✓

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Default value	-
Refresh time	~32 ms

Tab. 8-95: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-1390, Control word

Function

This parameter is used to control the IMC system function.

Structure of the P-0-1390 and significance of the bits:

Bit	Designation/function	Comment
0	**Switching of master/slave operation** **0:** Slave operation **1:** Master operation	Only takes effect if P-0-1370, bit 10 = 0
2..1	**Reserved**	
4/3	**Selection of operating point (p/Q)** **00:** Operating point 1 **01:** Operating point 2 **10:** Operating point 3 **11:** Operating point 4	Only takes effect if P-0-1370, bit 31 = 1
5	**Enabling (Easy Control)** **0:** Enable not set **1:** Enable set	
6	**Error acknowledgement (Easy Control)** **0:** Error acknowledgement not set **1:** Error acknowledgement set	
13..7	**Reserved**	
15/14	**Selection of parameter set** **00:** Set 1 **01:** Set 2 **10:** Set 3 **11:** Set 4	Only takes effect if P-0-1370, bit 12 = 1

Tab. 8-96: Structure of P-0-1390 and significance of the bits

Min./max. values	-/-
Format	BIN
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	-
Buffered parameter	✓

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Default value	-
Refresh time	1 ms

Tab. 8-97: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1410, Status word 1

Function This parameter displays current status information.

Structure of the P-0-1410 and significance of the bits:

Bit	Designation/function	Comment
0	**Status p/Q control active** **0:** Control active **1:** Closed-loop control inactive	
2/1	**Reserved**	
3	**Status of maximum speed limitation P-0-1289** **0:** Limitation not active **1:** Limitation active	
4	**Status of minimum speed limitation P-0-1290** **0:** Limitation not active **1:** Limitation active	
5	**Status of controller output limitation from power calculation** **0:** Limitation not active **1:** Limitation active	
6	**Status of controller output change limitation from acceleration limitation P-0-1329/P-0-1330** **0:** Limitation not active **1:** Limitation active	
7	**Status of negative speed limitation for protection against cavitation** **0:** Negative controller output allowed **1:** Negative controller output limited to positive values	
8	**Status of integral action time switching (T_n) for reducing pressure overshoots** **0:** Default integral action time (e.g. P-0-1374) **1:** Integral action time for the fast reduction of pressure overshoots P-0-1311[200]	
9	**Status of speed command value (P-0-1377) reached** **0:** Speed command value not reached **1:** Speed command value reached	
15..10	**Reserved**	

Tab. 8-98: Structure of P-0-1410 and significance of the bits

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Min./max. values	-/-
Format	BIN
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	-
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-99: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-1411, Status word 2

Function

This parameter displays current status information.

Structure of the P-0-1411 and significance of the bits:

Bit	Designation/function	Comment
0	**Reserved**	
1	**Status of pressure command value reached** **0:** Pressure differential outside tolerance band (S-0-0832) **1:** Pressure differential within tolerance band (S-0-0832)	
2	**Status of master/slave operation** **0:** Master operation active (p/Q control) **1:** Slave operation active (n control)	
15..3	**Reserved**	

Tab. 8-100: Structure of P-0-1411 and significance of the bits

Min./max. values	-/-
Format	BIN
Unit	-
Type	PLC Global Register
Editable	++
Decimal places	-
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-101: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

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P-0-1419, Patch function 1

Function This parameter has been reserved for internal purposes and must not be overwritten.

Min./max. values	-/-
Format	DEC
Unit	-
Type	PLC Global Register
Editable	--
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-102: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109

P-0-2806.0.12, Output pump pressure controller I-part

Function This parameter shows the integral term of the pressure controller.

Min./max. values	-2147483.648/2147483.647
Format	DEC
Unit	l/min
Type	Output register
Editable	--
Decimal places	3
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-103: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

P-0-4028, Device control word

Function In the case of devices with active application profile “analog” (P-0-4084 = 0xFF00), this parameter is used for controlling the drive. This functionality is required for Easy Control.

Min./max. values	-/-
Format	BIN
Unit	-
Type	Input register
Editable	++
Decimal places	-
Buffered parameter	–

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Default value	-
Refresh time	1 ms

Tab. 8-104: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0032, Primary operation mode

Function The primary operation mode determines the function of the drive. For technology function IMC it has to contain "0b0000.0000.0000.00100". For the various communication buses, operation modes are activated via the respective control word.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0099, C0500 Reset class 1 diagnostics

Function Command for resetting errors after they were rectified.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0100, Velocity controller proportional gain

Function The speed controller calculates a torque/force command value (P-0-0049) from the difference between velocity command value and velocity feedback value (S-0-0347).

Min./max. value	0/4294967.295
Format	DEC
Unit	Nm/(rad/s)
Type	Input register
Editable	++
Decimal places	3
Buffered parameter	✓
Default value	4.000 Nm/(rad/s)
Refresh time	1 ms

Tab. 8-105: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0101, Velocity loop integral action time

Function The speed controller calculates a torque/force command value (P-0-0049) from the difference between velocity command value and velocity feedback value (S-0-0347).

Min./max. value	0/6553.5
Format	DEC
Unit	ms
Type	Input register
Editable	++
Decimal places	1
Buffered parameter	✓

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Default value	15.0 ms
Refresh time	1 ms

Tab. 8-106: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0134, Master control word

Function The master control word is active for the selected application profile type (P-0-4084 = 0x0102) "FSP-Drive" and (P-0-4084 = 0x0002) "ServoDrive". The following control information is defined: Controller enable, drive halt, selection of set operation mode.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0135, Drive status word

Function The drive status word is active for the selected application profile type (P-0-4084 = 0x0102) "FSP-Drive" and (P-0-4084 = 0x0002) "ServoDrive". It contains essential status information such as: Readiness for operation of the control and the power section, drive errors, change bit of reset class 2 and 3, current operation mode.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0145, Signal control word

Function With the help of the signal control word signals can be transmitted from the control to the drive in real time. To this end, the signal control word has to be configured as cyclic datum in the command value telegram or a consumer connection.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0390, Diagnostic message number

Function This parameter shows the current diagnostic message number.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0390.0.136, Detailed diagnostics

Function Parameter S-0-0390.0.136 contains the reported detailed diagnostics in the form of a hexadecimal number and refers to the diagnostic message in parameter “S-0-0390, Diagnostic message number”.

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0800, Pressure command value

Function In this parameter the pressure command value (p_{cmd}) is specified for the p/Q controller.

Min./max. value	0/2147483.647
Format	DEC
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–

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Default value	-
Refresh time	1 ms

Tab. 8-107: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0804, Pressure feedback value

Function In this parameter the pressure command value (p_{act}) is for the p/Q controller is read.

Min./max. value	-2147483.648/2147483.647
Format	DEC
Unit	S-0-0806
Type	Input register
Editable	++
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-108: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0827, Pressure control deviation

Function Parameter "S-0-0827" indicates the difference between pressure command value (S-0-0800) and pressure feedback value (S-0-0804) in the pressure control loop.

Min./max. value	-2147483.648/2147483.647
Format	DEC
Unit	S-0-0806
Type	Output register
Editable	--
Decimal places	S-0-0807/S-0-0808
Buffered parameter	–
Default value	-
Refresh time	1 ms

Tab. 8-109: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0832, Pressure window

Function In this parameter the pressure window is entered, via which the achievement of a control quality is signaled. The window refers to the pressure command value (S-0-0800) in terms of amount.

See also chapter 6.11.2 "p/Q controller" on page 36

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Min./max. value	-2147483.648/2147483.647
Format	DEC
Unit	S-0-0806
Type	Input register
Editable	--
Decimal places	S-0-0807/S-0-0808
Buffered parameter	✓
Default value	5.000 bar
Refresh time	~32 ms

Tab. 8-110: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

S-0-0842, Flow feedback value

Function Parameter displaying the currently active flow feedback value.

Min./max. value	0/2147483.647
Format	DEC
Unit	S-0-0845
Type	Output register
Editable	--
Decimal places	S-0-0846/S-0-0847
Buffered parameter	✓
Default value	-
Refresh time	~16 ms

Tab. 8-111: Parameter attributes

See chapter 8.1.2 "Relevant parameters" on page 109.

8.2 Errors and warning messages

8.2.1 General

All diagnostic messages related to the technology function are displayed with the diagnostic code (S-0-0390), detailed diagnostics (S-0-0390.0.136) and the diagnostic text (S-0-0095).

The various diagnostic messages are subdivided into four categories, which are an integral part of the relevant diagnostic code. Errors and warnings issue diagnostic messages to the drive, upon which a possible reaction according to the table below is carried out on the part of the ctrlX DRIVE.

- **F8211**, fatal errors which do not allow a definable error reaction of the ctrlX DRIVE.
- **F2211**, non-fatal errors which allow a freely definable error reaction of the ctrlX DRIVE.
- **E8211**, fatal warnings which run a drive reaction of the ctrlX DRIVE.
- **E2211**, non-fatal warnings which do not run a drive reaction of the ctrlX DRIVE.

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For further information, refer to chapter 6.15 "Diagnostics/error handling" on page 53.

8.2.2 Diagnostic messages

F8211 (fatal errors)

S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
-	-	-

Tab. 8-112: F8211 (fatal errors)

F2211, non-fatal errors

S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
F2211 0189001D: System pressure exceeds upper alarm level	The actual pressure permanently exceeds the pressure allowed in continuous operation.	Check operating point or adjust to allowed pressure. If necessary, adjust monitoring value to the allowed pressure.
F2211 0189001F: System pressure exceeds upper critical alarm level	The actual pressure is in the critical pressure range, i.e. greater than maximum pressure.	Check operating point or adjust to allowed pressure. If necessary, adjust monitoring value to the allowed pressure.
F2211 01890023: Excessive heat accumulation	Temperature in pressure holding mode from the temperature model exceeds error threshold.	Check operating point of the pump, check dimensioning of the pump.
F2211 01890026: Invalid operation point detected	In admissible operating point has been detected.	Check pressure sensor signal and, if necessary, replace pressure sensor
F2211 01890027: Position loop closed, set P-0-0556.8	Firmware position control loop closed.	The position control loop has to be open with P-0-0556, bit 8 = 1
F2211 01890032: Init not completed, check config data	The drive cannot be switched to AF, because initializing has not been completed.	Check the configuration, check any warnings present.
F2211 01890033: Needed FW-Packages not available	The required FW functional packages are not available.	The FW functions “parameter interface for pressure and flow” as well as “control drive” have to be activated.
F2211 01890034: Parameter null pointer error	Input pointer of type IL_PARASET has not been initialized	Internal error: Please contact the support
F2211 01890038: Operation mode invalid, velocity control required	The drive is in the velocity control mode when the drive is enabled.	Select the velocity control mode
F2211 0189004A: Pump/sys data error	Input reference of type IL_PUMP_DATA is no valid reference	Internal error: Please contact the support
F2211 0189005C: Switching to OM failed	Easy Control: Impossible to switch drive to OM	Check command messages of firmware (C02xx) and eliminate causes of errors

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
F2211 0189005D: Internal command error	Easy Control: Internal error while executing a command	Internal error: Please contact the support
F2211 01891000: Internal error: event number not valid	Internal handling error.	COLD reset of MLD and restart. Obtain the latest released IMC version. Get in touch with Rexroth Service.

Tab. 8-113: E2211, non-fatal errors

E8211, fatal warnings

S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
-	-	-

Tab. 8-114: E8211, fatal warnings

E2211, non-fatal warnings

S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 01890001: Parameter set 1 out of range P-0-1311[0..6]	Controller parameter set [1] outside valid value range	Controller parameter set P-0-1311[0..6] has to contain values greater than/equal to 0.0.
E2211 01890002: Parameter set 2 out of range P-0-1311[20..26]	Controller parameter set [2] outside valid value range	Controller parameter set P-0-1311[20..26] has to contain values greater than/equal to 0.0.
E2211 01890003: Parameter set 3 out of range P-0-1311[40..46]	Controller parameter set [3] outside valid value range	Controller parameter set P-0-1311[40..46] has to contain values greater than/equal to 0.0.
E2211 01890004: Parameter set 4 out of range P-0-1311[60..66]	Controller parameter set [4] outside valid value range	Controller parameter set P-0-1311[60..66] has to contain values greater than/equal to 0.0.
E2211 01890005: Config data exceeds valid range P-0-1311[208]	Reference value for leakage speed less than 0	Parameter P-0-1311[208] has to be greater than/equal to 0.
E2211 01890006: Config data exceeds valid range P-0-1311[209]	Reference value for leakage pressure less than 0	Parameter P-0-1311[209] has to be greater than/equal to 0.
E2211 01890007: Config data exceeds valid range P-0-1311[80]	Pressure command value in set [1] outside valid value range	Parameter P-0-1311[80] has to be greater than 0.
E2211 01890008: Config data exceeds valid range P-0-1311[82]	Pressure command value in set [2] outside valid value range	Parameter P-0-1311[82] has to be greater than 0.
E2211 01890009: Config data exceeds valid range P-0-1311[84]	Pressure command value in set [3] outside valid value range	Parameter P-0-1311[84] has to be greater than 0.
E2211 0189000A: Config data exceeds valid range P-0-1311[86]	Pressure command value in set [4] outside valid value range	Parameter P-0-1311[86] has to be greater than 0.

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 0189000B: Config data exceeds valid range P-0-1389[102]	Minimum value of pressure command value limitation is invalid	Enter al value greater than P-0-1389[177] and less than P-0-1389[101] in P-0-1389[102].
E2211 0189000C: Config data exceeds valid range P-0-1389[111]	Minimum value of flow command value limitation is invalid	Enter a value greater than/equal to 0 and less than the active speed limitation of the converter in P-0-1389[111].
E2211 0189000D: Config data exceeds valid range P-0-1389[112]	The maximum soft start duration is invalid	Enter a time between 0 s and 60 s in P-0-1389[112]
E2211 0189000E: Pressure command value limited	The pressure command value is limited	Enter a value between the limit values in P-0-1389[101] and P-0-1389[102] for the pressure command value.
E2211 0189000F: Drive has to be in CM for Register Config	The PLC register has been configured outside CM (e.g. after PLC reset).	Switch to CM until the configuration of the PLC register is completed.
E2211 01890010: Register config is invalid for	The configuration of a PLC register is invalid	Internal error: Please contact the support
E2211 01890011: Too many registers for scaling update	Too many scaled PLC registers created	Internal error: Please contact the support
E2211 01890012: Invalid value for data type of	Value of the displayed parameter is invalid	Enter a value within the valid parameter range
E2211 01890013: Config data exceeds valid range P-0-1389[113]	The acceleration limit value for soft start is invalid.	Enter a value greater than/equal to 0 in P-0-1389[113].
E2211 01890014: A scaling type is invalid	At least one scaling setting is invalid.	Use scaling settings valid for the system
E2211 01890015: Flow rate command value limited	The flow command value is limited	Enter a value between the limit value in P-0-1389[111] and the maximum speed of the converter for the flow command value.
E2211 01890016: Config data exceeds valid range P-0-1389[177]	The permissible continuous minimum pressure is invalid.	Enter a value greater than 0 in P-0-1389[177]
E2211 01890017: Config data exceeds valid range P-0-1389[176]	The permissible continuous maximum pressure is invalid.	Enter al value greater than P-0-1389[177] and less than P-0-1389[175] in P-0-1389[176].
E2211 01890018: Config data exceeds valid range P-0-1389[104]	The user-defined lower limit of pressure monitoring is invalid.	Enter a value greater than 0 and less than P-0-1389[176] in P-0-1389[104] or deactivate the function by entering 0.
E2211 01890019: Config data exceeds valid range P-0-1389[103]	The user-defined upper limit of pressure monitoring is invalid.	Enter a value greater than P-0-1389[177]/P-0-1389[104] and less than P-0-1389[176] in P-0-1389[103] or deactivate the function by entering 0.
E2211 0189001A: Config data exceeds valid range P-0-1389[107]	Debounce time for the error of pressure monitoring is invalid.	Enter a value less than/equal to 10 s in P-0-1389[107].

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 0189001B: Config data exceeds valid range P-0-1389[106]	Debounce time for the error of pressure monitoring of critical ranges is invalid.	Enter a value less than/equal to 0.3 s in P-0-1389[106].
E2211 0189001C: System pressure exceeds upper warning level	The actual pressure briefly exceeds the pressure allowed in continuous operation.	Check operating point or adjust to allowed pressure. If necessary, adjust monitoring value to the allowed pressure.
E2211 0189001E: System pressure falls below lower warning level	The actual pressure briefly falls below the pressure allowed in continuous operation.	Check operating point or adjust to allowed pressure. If necessary, adjust monitoring value to the allowed pressure.
E2211 01890020: Config data exceeds valid range P-0-1389[124]	The cooling factor for the thermal model is invalid	Enter a value between 1 and 3 in P-0-1389[124]
E2211 01890021: Low positive speed	Actual speed value too low to compensate leakage	Possible defect of the pump, internal pump leakage very small, contact the support
E2211 01890022: Heat Accumulation exceeds warning level	Temperature in pressure holding mode from the temperature model exceeds warning threshold.	Check operating point of the pump, check dimensioning of the pump.
E2211 01890024: Config data exceeds valid range P-0-1389[140]	The speed threshold for operating point monitoring is invalid	Enter a value less than/equal to 0 in P-0-1389[140]
E2211 01890025: Config data exceeds valid range P-0-1389[142]	The debounce time for operating point monitoring is invalid.	Enter a value less than/equal to 10 s in P-0-1389[142]
E2211 01890028: Config data exceeds valid range P-0-1389[160]	The configuration of displacement 1 is invalid.	Enter a value greater than 0 in P-0-1389[160]
E2211 01890029: Config data exceeds valid range P-0-1389[161]	The configuration of displacement 2 is invalid.	Enter a value greater than 0 in P-0-1389[161]
E2211 0189002A: Config data exceeds valid range P-0-1389[163]	The configuration of the maximum mechanical drive power of the pump is invalid.	Enter a value greater than 0 in P-0-1389[163]
E2211 0189002B: Config data exceeds valid range P-0-1389[164]	The configuration of the mass moment of inertia of the pump is invalid.	Enter a value greater than 0 in P-0-1389[164]
E2211 0189002C: Config data exceeds valid range P-0-1389[165]	The configuration of the maximum speed range of the pump is invalid.	Enter a value greater than 0 in P-0-1389[165]
E2211 0189002D: Config data exceeds valid range P-0-1389[166]	The configuration of the minimum speed range of the pump is invalid.	Enter a value greater than 0 in P-0-1389[166]
E2211 0189002E: Config data exceeds valid range P-0-1389[168]	The configuration of the maximum bipolar acceleration of the pump is invalid.	Enter a value greater than 0 in P-0-1389[168]
E2211 0189002F: Config data exceeds valid range P-0-1389[175]	The configuration of the nominal pressure “output, intermittent” of the pump is invalid.	Enter a value greater than P-0-1389[176] in P-0-1389[175]
E2211 01890030: Config data exceeds valid range P-0-1389[176]	The configuration of the nominal pressure “output, continuous” of the pump is invalid.	Enter al value greater than P-0-1389[177] in P-0-1389[176].
E2211 01890031: Config data exceeds valid range P-0-1389[177]	The configuration of the minimum pressure on the high-pressure side of the pump is invalid.	Enter a value greater than 0 in P-0-1389[177]

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 01890035: Config data exceeds valid range	The filter time for the actual velocity value is negative	A positive filter time has to be specified
E2211 01890036: Config data exceeds valid range	The filter time for the actual pressure value is negative	A positive filter time has to be specified.
E2211 01890037: Config data exceeds valid range	The filter time for the actual torque value is negative	A positive filter time has to be specified
E2211 01890039: A scaling factor is invalid	Invalid scaling factor.	All scaling factors have to have the value 1
E2211 0189003A: Return value of mMD invalid	The return value of an internal check function is invalid.	Internal error: Please contact the support
E2211 0189003B: Config data exceeds valid range P-0-1311[81]	Flow command value in set [1] outside valid value range	Parameter P-0-1311[81] has to be greater than 0.
E2211 0189003C: Config data exceeds valid range P-0-1311[83]	Flow command value in set [2] outside valid value range	Parameter P-0-1311[83] has to be greater than 0.
E2211 0189003D: Config data exceeds valid range P-0-1311[85]	Flow command value in set [3] outside valid value range	Parameter P-0-1311[85] has to be greater than 0.
E2211 0189003E: Config data exceeds valid range P-0-1311[87]	Flow command value in set [4] outside valid value range	Parameter P-0-1311[87] has to be greater than 0.
E2211 0189003F: Parameter cannot be changed in AF P-0-1370.0	The coordination between direction of rotation of the motor and flow cannot be changed while the controller is enabled.	To change the configuration, switch the drive to Ab
E2211 01890040: Config data exceeds valid range P-0-1389[114]	The factor for the acceleration limit after soft start is invalid	Enter a value greater than 0 and less than/equal to 100 in P-0-1389[114]
E2211 01890041: Config data exceeds valid range P-0-1311[201]	The switching threshold for integral action time switching is invalid	Enter a value greater than/equal to 2.0 bar in P-0-1311[201].
E2211 01890042: Config data exceeds valid range P-0-1311[200]	The integral action time for integral action time switching is invalid	Enter a value greater than/equal to 0 and less than/equal to P-0-1374 in P-0-1311[200]
E2211 01890043: Config data exceeds valid range P-0-1373	The proportional factor is invalid.	Enter a value greater than/equal to 0 in P-0-1373
E2211 01890044: Config data exceeds valid range P-0-1374	The integration time is invalid.	Enter a value greater than/equal to P-0-1311[200] in P-0-1374 or the active parameter set
E2211 01890045: Config data exceeds valid range P-0-1375	The differentiation factor is invalid.	Enter a value greater than/equal to 0 in P-0-1375
E2211 01890046: Config data exceeds valid range P-0-1384	The filter time for increasing pressure command value is invalid	Enter a value greater than/equal to 0 in P-0-1384
E2211 01890047: Config data exceeds valid range P-0-1385	The filter time for decreasing pressure command value is invalid	Enter a value greater than/equal to 0 in P-0-1385
E2211 01890048: Config data exceeds valid range P-0-1329	The acceleration limit is invalid	Enter a value greater than 0 and less than/equal to P-0-1389[168] in P-0-1329

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 01890049: Config data exceeds valid range P-0-1330	The deceleration limit is invalid	Enter a value greater than 0 and less than/equal to P-0-1389[168] in P-0-1330
E2211 0189004B: Config data exceeds valid range P-0-1389[163]	The configuration of the maximum mechanical drive power of the pump is invalid.	Enter a value greater than/equal to 0 in P-0-1389[163]
E2211 0189004C: Config data exceeds valid range P-0-1389[165]	The configuration of the maximum speed range of the pump is invalid.	Enter a value greater than/equal to 0 in P-0-1389[165]
E2211 0189004D: Config data exceeds valid range P-0-1389[160]	The configuration of displacement 1 is invalid.	Enter a value greater than 0 in P-0-1389[160]
E2211 0189004E: Config data exceeds valid range P-0-1389[177]	The configuration of the minimum pressure on the high-pressure side of the pump is invalid.	Enter a value greater than/equal to 0 in P-0-1389[177]
E2211 0189004F: Config data exceeds valid range P-0-1389[168]	The configuration of the maximum bipolar acceleration of the pump is invalid.	Enter a value greater than/equal to 0 in P-0-1389[168]
E2211 01890050: Config data exceeds valid range S-0-0832	The configuration of the pressure tolerance window is invalid.	Enter a value greater than/equal to 0 in S-0-0832
E2211 01890051: Config data exceeds valid range P-0-1389[100]	The selection of the pump data set is invalid	Enter a valid value in P-0-1389[100].
E2211 01890052: Parameter cannot be read by Param-Handling	A parameter cannot be read by internal parameter handling	Internal error: Please contact the support
E2211 01890053: Parameter cannot be written by Param-Handling	A parameter cannot be written by internal parameter handling	Internal error: Please contact the support
E2211 01890054: Parameter cannot be changed in AF	A parameter of pump data was changed in AF	Exit AF state for changing the pump configuration
E2211 01890055: Internal pump data is invalid	Internally stored data for the selected pump are invalid	Select different pump in P-0-1389[100] or, if required, configure user-defined pump
E2211 01890056: Therm. pump model deactivated or not available	The thermal temperature model of the pump has been deactivated or pump data are not available.	Activate the thermal pump model with P-0-1370, bit 23 = 0. If no pump data are available, please contact the support.
E2211 01890057: Max power limited	The approached operating point exceeds the configured maximum pump power.	If you use a user-defined pump, check the configured maximum pump power (P-0-1389[163]). Check rating of the system and the machine cycle.
E2211 01890058: Acceleration/Deceleration limited	The current acceleration of the pump exceeds the configured limit value.	Check the configured acceleration and deceleration limit values (P-0-1329 and P-0-1330). Check the machine cycle for command value step changes.

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S-0-0095 (S-0-0390 + S-0-0390.0.136 + diagnostic text)	Cause	Remedy
E2211 01890059: Cavitation protection blocks negative speed	The system pressure is below the allowed continuous minimum pressure of the pump	Check the pump selection. If you use a user-defined pump, check the configured minimum pressure of the pump (P-0-1389[177]). Check setup of the machine cycle.
E2211 0189005A: Config data exceeds valid range	The filter time for the actual velocity value is negative	A positive filter time has to be specified
E2211 0189005B: Switching to CM failed	Easy Control: Impossible to switch drive to CM, because drive is in AF	Reset enable
E2211 0189005E: Time out by switching from bb to Ab	Easy Control: Drive has no power and does not switch from bb to Ab	Switch on power (e.g. by activating automatic soft start in P-0-0860) and, if necessary, adjust delay time in P-0-1311[202]
E2211 0189005F: Not possible to enable parked axis	Easy Control: Enable cannot be set in the drive state “parking axis”	Disable “parking axis” procedure command
E2211 01890060: Device control word cannot be written	Easy Control: Application profile “analog” is not set	Set application profile “analog” in master communication or ensure that P-0-4028 is not set cyclically
E2211 01890061: OpMode velocity control not configured	Easy Control: Velocity control has not been configured as primary or secondary operation mode	Configure velocity control as operation mode.
E2211 01890062: Config data exceeds valid range P-0-1389[177]	The permissible continuous minimum pressure is invalid.	Enter a value greater than 0 und less than P-0-1389[176] in P-0-1389[177]
E2211 01890063: Config data exceeds valid range P-0-1331	The lower integration term limit value is invalid	Enter a value in P-0-1331 that is less than/equal to 0 and greater than/ equal to P-0-1378
E2211 01890064: lower speed limit is greater than zero P-0-1378	The lower speed limit value is greater than the speed command value	Check the lower speed limit value P-0-1378 and configure a lower value. Check speed command value P-0-1377

Tab. 8-115: E2211, non-fatal warnings

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9 Appendix

9.1 Documentations

9.1.1 Drive systems, system components

Drive systems with single-axis drive controllers

Title	Type of documentation	Document number
SvP 7030 IMC Variable-Speed Pump Drives	Operating instructions	RE 62312-B
Drive systems ctrlX DRIVE	Project planning manual	R911386579
Drive systems ctrlX DRIVE	Operating instructions	R911386579
Integrated Safety Technology "Safe Torque Off"	Application manual	R911383774

Tab. 9-1: Documentation – Drive systems, system components

9.2 Firmware

Title Rexroth IndraDrive ...	Type of documentation	Material number
AXS-V-03 Functions	Application manual	R911410073
Diagnostic Messages of Runtime AXS-V-03RS	Reference Book	R911409763
Parameters of Runtime AXS-V-03RS	Reference Book	R911409808

Tab. 9-2: Documentation – firmware

9.3 Motor-pump unit

Title	Type of documentation	Material number
Sytronix Variable-speed pump drives	Product Catalog	R999000332
Rexroth Sytronix SvP 70xx Motor-Pump Unit MPA01	Operating instructions	R911339824
Rexroth Sytronix SvP 70xx Motor-Pump Unit MPA02	Operating instructions	R911387041

Tab. 9-3: Documentations – motor-pump unit

9.4 Abbreviations used

AF	Drive enable
AT	Cyclic actual values
AXS	Drive firmware
DRn	Constant pressure system with hydromechanical pressure control
EMC	ElectroMagnetic Compatibility

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FcP	Frequency-controlled pump
FW	Drive firmware (e.g. AXS-V-0308)
IMC	Injection Molding Control (p/Q control)
IW	IndraWorks
MDT	Cyclic command values
MLC	Motion Logic Control
MLD	Motion Logic Drive-based
NKS	Nachkommastellen (decimal places)
PFC	Position Force Control (x/F control)
SvP	Servo-variable pump
SWA	Software/parameter file (MLD program, CP-FWS-XD1-APP-SVP_IMC_AX03-NN-V-1002-NN)
Vg	Displacement per revolution

Tab. 9-4: Basic abbreviations

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10 Service and support

Contact for repairs

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97816 Lohr am Main
Phone +49 (0) 93 52 / 40 50 60
Germany

E-mail: service@boschrexroth.de
Internet: http://www.boschrexroth.com/service

Contacts for support

Bosch Rexroth AG
Zum Eisengießer 1
97816 Lohr am Main
Germany

E-mail: sytronix.support@boschrexroth.de

Required information

We can provide fast and efficient assistance, if you have the following information at hand:

- Detailed description of the fault and the circumstances
- Details on the nameplate of the affected products, especially type code and serial number
- Your contact details (phone and fax number, e-mail address)

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