rexroth
A Bosch Company

MLD Technology Function

Process Controller

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Purpose of Documentation	This documentation describes the MLD technology function "process controller". The "process controller" function allows an external variable to be controlled in addition to the operation modes and control types already available in the drive.
Record of Revisions	Edition 01, 2019-03 See tab. 1-1 "Record of revisions" on page 1
Copyright	
Liability	The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.
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1 About this documentation

Editions of this documentation

Edition	Release date	Notes
DOK-MLD***-TECFUNC*PC*-AP01-EN-P	2019-03-19	First edition

Tab. 1-1: Record of revisions

Means of representation in this documentation

To facilitate reading of this documentation, the table below contains the means of representation and notations of recurring terms.

What?	How?	For example...
Important facts to be highlighted in the body text	Boldface	With the safety function "Safe parking axis", the following monitoring functions are **deactivated**: ...
Parameter names, diagnostic message names, function designations	Quotation marks	The missing speed information can be replaced via the control bit "defined safety with parked axis" in "P-0-3210, Safety technology configuration".

Tab. 1-2: Conventions of notation

Helpful information and tips are highlighted in the text. A symbol tells you what kind of information is used in the text:

This box contains important information that should be taken into consideration.

This symbol highlights useful tips and tricks.

Signal words in accordance with ANSI Z535.6-2006 draw the reader's attention to hazards (see "Explanation of signal words and the safety alert symbol").

Your Feedback

Your experience is important for our improvement processes of products and documentations.

If you discover mistakes in this documentation or suggest changes, you can send your feedback to the following e-mail address:

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We need the following information to handle your feedback:

- The number indicated under "Internal File Reference".
- The page number.

2 Safety instructions for electric drives and controls

2.1 Definitions of terms

Application documentation Application documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Description, etc.

Component A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control system A control system comprises several interconnected control components placed on the market as a single functional unit.

Device A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Electrical equipment Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Electric drive system An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

Installation An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product Examples of a product: Device, component, part, system, software, firmware, among other things.

Project Planning Manual A Project Planning Manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified persons In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work

requires. To comply with these qualifications, it is necessary, among other things,

- to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them.
- to be trained or instructed to maintain and use adequate safety equipment.
- to attend a course of instruction in first aid.

User A user is a person installing, commissioning or using a product which has been placed on the market.

2.2 General information

2.2.1 Using the Safety instructions and passing them on to others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

2.2.2 Requirements for safe use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.

- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.
- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,
  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

- European countries: In accordance with European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

2.2.3 Hazards by improper use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!

- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

2.3 Instructions with regard to specific dangers

2.3.1 Protection against contact with electrical parts and housings

☞ This section concerns components of the electric drive and control system with voltages of **more than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch any electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).

- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a minimum cross section according to the table below. With an outer conductor cross section smaller than 10 mm^2 (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

Cross section outer conductor	Minimum cross section equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm^2 (16 AWG)	10 mm^2 (8 AWG)	2 × 1.5 mm^2 (16 AWG)
2.5 mm^2 (14 AWG)		2 × 2.5 mm^2 (14 AWG)
4 mm^2 (12 AWG)		2 × 4 mm^2 (12 AWG)
6 mm^2 (10 AWG)		2 × 6 mm^2 (10 AWG)
10 mm^2 (8 AWG)		-
16 mm^2 (6 AWG)	16 mm^2 (6 AWG)	-
25 mm^2 (4 AWG)		-
35 mm^2 (2 AWG)		-
50 mm^2 (1/0 AWG)	25 mm^2 (4 AWG)	-
70 mm^2 (2/0 AWG)	35 mm^2 (2 AWG)	-
...	...	...

Tab. 2-1: Minimum cross section of the equipment grounding connection

2.3.2 Protective extra-low voltage as protection against electric shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Rexroth, all connections and terminals with voltages up to 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

2.3.3 Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine’s range of motion and moving machine parts. Prevent personnel from accidentally entering the machine’s range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equip-

ment works. Do not operate the machine if the emergency stopping switch is not working.

- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.
- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  - mechanically securing the vertical axes,
  - adding an external braking/arrester/clamping mechanism or
  - ensuring sufficient counterbalancing of the vertical axes.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

2.3.4 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.

2.3.5 Protection against contact with hot parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

2.3.6 Protection during handling and mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- 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!

2.3.7 Battery safety

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

Risk of injury by improper handling!

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

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

2.3.8 Protection against pressurized systems

According to the information given in the Project Planning Manuals, motors and components cooled with liquids and compressed air can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids and cooling lubricants. Improper handling of the connected supply systems, supply lines or connections can cause injuries or property damage.

Risk of injury by improper handling of pressurized lines!

- Do not attempt to disconnect, open or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment (safety goggles, safety shoes, safety gloves, for example).
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

☞ Environmental protection and disposal! The agents (e.g., fluids) used to operate the product might not be environmentally friendly. Dispose of agents harmful to the environment separately from other waste. Observe the national regulations of your country.

2.4 Explanation of signal words and the Safety alert symbol

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

3 Important directions for use

3.1 Intended use

3.1.1 Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

⚠ WARNING **Personal injury and property damage caused by incorrect use of the products!**

The products have been designed for use in the industrial environment and may only be used in the intended way. If they are not used in the intended way, situations resulting in property damage and personal injury can occur.

☞ Rexroth as manufacturer is not liable for any damages resulting from unintended use. In such cases, the guarantee and the right to payment of damages resulting from unintended use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for an intended use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with their intended use.
- If the products take the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not install damaged or faulty products or put them into operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

3.1.2 Areas of use and application

Drive controllers made by Rexroth are designed to control electric motors and monitor their operation.

Control and monitoring of the Drive controllers may require additional sensors and actuators.

☞ The drive controllers may only be used with the accessories and parts specified in this documentation. If a component has not been specifically named, then it may neither be mounted nor connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant Functional Descriptions.

Drive controllers have to be programmed before commissioning to ensure that the motor executes the specific functions of an application.

Drive controllers of the Rexroth IndraDrive series have been developed for use in single- and multi-axis drive and control tasks.

To ensure application-specific use of Drive controllers, device types of different drive power and different interfaces are available.

Typical applications include, for example:

- Handling and mounting systems
- Packaging and food machines
- Printing and paper processing machines
- Machine tools

Drive controllers may only be operated under the assembly and installation conditions described in this documentation, in the specified position of normal use and under the ambient conditions as described (temperature, degree of protection, humidity, EMC, etc.).

3.2 Unintended use

Using the Drive controllers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "unintended use".

Drive controllers may not be used, if …

- they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extremely high maximum temperatures.
- Furthermore, Drive controllers may not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

Components of the Rexroth IndraDrive system are **products of Category C3** (with restricted distribution) in accordance with IEC 61800-3. This Category comprises EMC limit values for line-based and radiated noise emission. Compliance with this Category (limit values) requires the appropriate measures of interference suppression to be used in the drive system (e.g., mains filters, shielding measures).

These components are not provided for use in a public low-voltage mains supplying residential areas. If these components are used in such a mains, high-frequency interference is to be expected. This can require additional measures of interference suppression.

4 Required components

4.1 Drive controller

Each power section of the "Rexroth IndraDrive" product range is suited for using the technology functions (inverters: HMS01.1N-Wxxx, HMS02.1N-Wxxx, HMU05.1N-*; converters: HCS01.1E-Wxxxx, HCS02.1N-Wxxx, HCS03.1N-Wxxx).

For control sections, there is the following restriction: The selected technology function currently can only be used with single-axis control sections that are compatible with the drive firmware MPx18V08 and above [BASIC (**CSB02.x**) or ADVANCED (**CSH02.x**)].

The distributed servo drive **KSM** and the distributed drive controller **KMS** are also suited for using the technology functions.

4.2 Drive firmware

Since the technology functions have been implemented on the basis of the integrated PLC (IndraMotion MLD), the optional functional package "MA" is required in addition to the **MPB** or **MPC** drive firmware.

☞ In IndraWorks, functional packages can be enabled via the **Basic configuration / functional packages** submenu. The **Basic configuration / functional packages** submenu is contained in the menu bearing the device name (see example in the figure below). Functional packages can also be enabled by writing the parameter "P-0-2003, Selection of functional packages".

Please observe that functional packages may only be enabled if they have been licensed (see also Functional Description of firmware "Enabling functional packages")! If a non-licensed function is used, any guarantee on the part of Bosch Rexroth will expire!

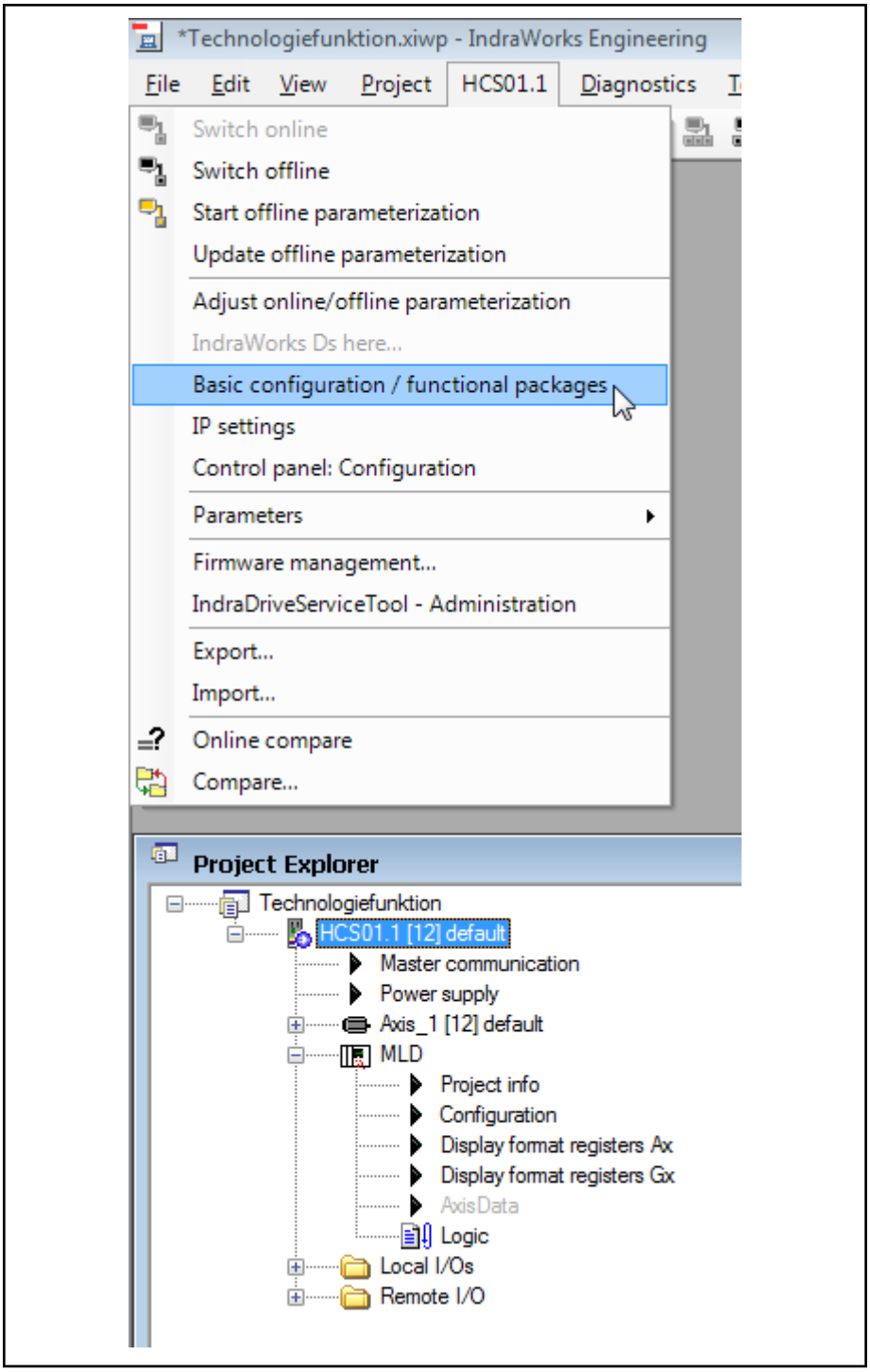

Fig. 4-1: Enabling functional packages

4.3 Commissioning software

The technology functions can be configured and operated via parameters. It is therefore possible to use the same software that is used to commission the drive controller: IndraWorks (e.g., IndraWorks MLD or IndraWorks Ds). The functions are consistently supported by individual operation and commissioning dialogs in IndraWorks.

5 Implementing the functions in the drive

5.1 Providing the technology functions

The technology functions are implemented in the drive by the drive-integrated PLC (IndraMotion MLD). The measured data are collected and adjusted in the drive.

Technology functions are made available as a compiled PLC project (*.par files) which provides the technology functions like a firmware function. Using the technology functions made available as a compiled PLC project does not require any programming knowledge.

5.2 Integration in the diagnostic system

The extended diagnostics of the technology function are automatically integrated in the standard diagnostic system of the drive. They can be used in a way identical to the standard diagnostics:

- Access via the master communication interface.
- The diagnostic message appears on the control panel display at the drive.
- The existing mechanisms are used, such as the operating hours counter and error memory of the drive.

☞ Additional information is output via an individual status word of the technology function (see P-0-1410).

5.3 Parameterization and operation

The function is preferably parameterized and operated via a commissioning dialog so that using the functions does not require any programming knowledge or additional software.

It is also possible to operate the entire function directly via the individual standard parameters (PLC registers). There are the following options to do this:

- With the IndraWorks commissioning software
- With a separate diagnostic PC via EtherNet
- Via the higher-level control unit

☞ The higher-level control unit can at any time take over control and, if required, start or terminate the technology function in the drive. Command values are still generated by command value input via the external control unit.

☞ All parameters/PLC registers allow data of a higher-level control unit to be exchanged with the drive.

6 Loading the technology function to the drive

Carry out the following steps once and one after the other to transmit the technology function (in the form of a parameter file) to the drive (here using the example of "vibration damping and avoiding"):

1. Switch the drive to the parameter mode (start command C0400).
2. Open the "Project info" dialog.
3. Use the "Load project…" button to select the technology function (parameter file to be loaded from hard disk or another storage medium) and transmit it to the drive.

In the IndraWorks installations 14V24 and above, as well as 15VRS and above, the parameter files of the technology functions are contained in the "MLD\TechFunc" subdirectory within the IndraWorks installation directory (e.g., "C:\Program Files\Rexroth \IndraWorks"). Alternatively, they can be requested from the Bosch Rexroth account manager.

The parameter values are transmitted to the drive.

4. Start the function using the "RUN" button.

   The transmitted technology function is running and available from now on (even after a restart).

5. Switch the drive to the operating mode (start command C0200).
6. Under the "MLD" branch in the Project Explorer it should now be possible to select the dialog for the technology function. If this is not the case, try terminating the connection between IndraWorks and the drive ("switching offline") and then reestablishing it ("switching online"). If thereafter it is still impossible to call the dialog, check the version of your IndraWorks installation (see "Commissioning software")

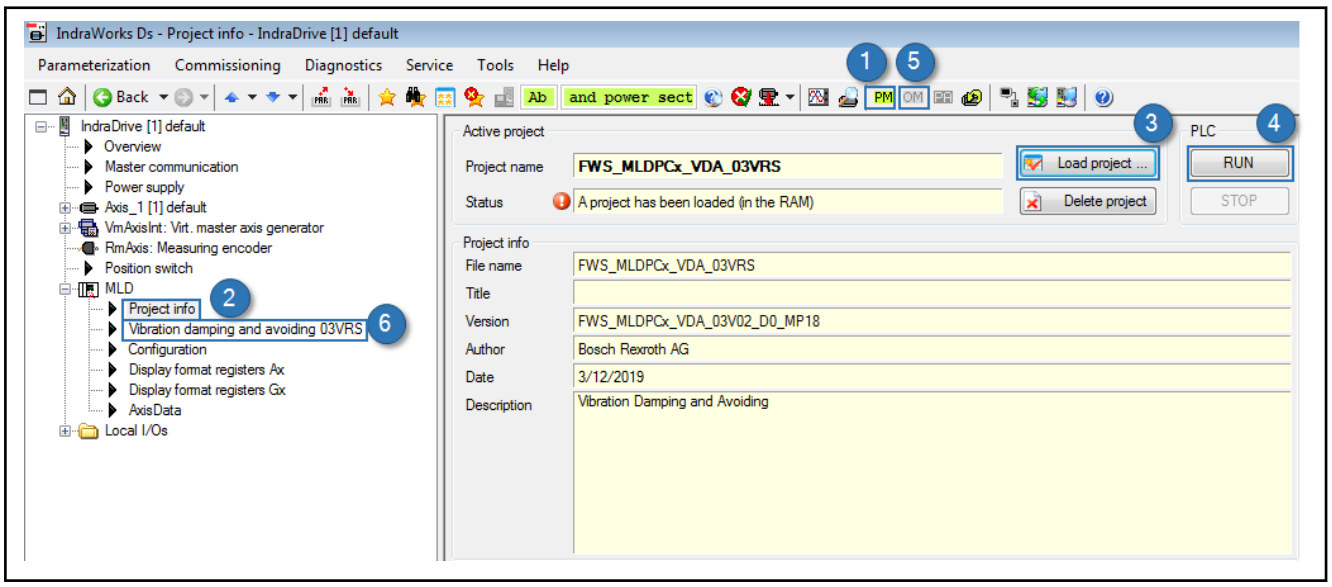

Fig. 6-1: Transmitting a technology function to the drive

7 Brief description of the function

The "process controller" function allows an external variable to be controlled in addition to the operation modes and control types already available in the drive. Thus, the drive can be used for direct, rapid process control. The possible options are force, pressure or distance control and many more, the feedback value being compensated by IndraMotion MLD directly in the drive. The command value can be preset by an external control unit, for example.

After control has been activated, the controller output is given and causes the process feedback value that was returned to reach the preset command value.

Requirements of use

To use the technology function, the firmware and hardware requirements for using MLD must have been fulfilled (see "Required components").

To use the "process controller" function, the PLC project "FWS_MLDPCx_PRE_01Vxx_D0_MPxx" must in addition have been loaded and activated in the drive (see "Loading the technology function to the drive").

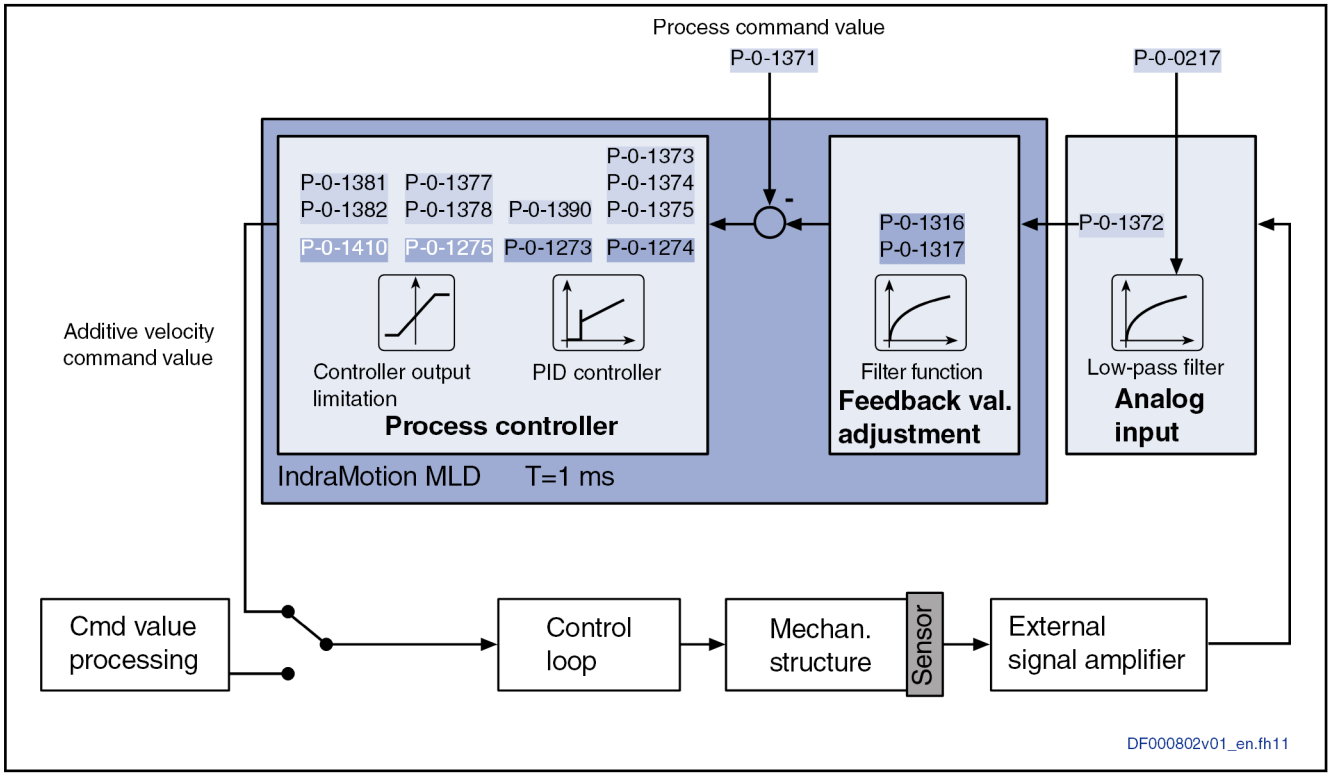

Fig. 7-1: Structural overview of the process controller

Features

The "process controller" function has the following properties:

- High quality of control by 1 ms controller clock
- Operated and parameterized via single parameters
- Process controller can be switched on and off at any time
- Cyclic command value input is possible
- Feedback values can be filtered by using a band-stop filter
- Controller output can be limited
- Switch cam depending on the velocity can be parameterized
- Torque feedforward is possible
- Position limitation is possible

- Command value feedforward is possible
- Controller switching, depending on the feedback value or velocity
- Ramp for changes in controller output
- Ramp for changes in command value
- PT1 command value filter

System requirements

The following requirements have to be met when process control is used:

Drive controller

Each power section of the "Rexroth IndraDrive" product range is suited for using the "process controller" (inverters: HMS01.1N-Wxxx, HMS02.1N-Wxxx; converters: HCS02.1N-Wxxx, HCS03.1N-Wxxx).

For control sections, there is the following restriction: The "process controller" currently can only be used with single-axis control sections [BASIC (CSB01.1) or ADVANCED (CSH01.xC)].

With IndraDrive Cs, the "process controller" can only be used for BASIC and ADVANCED devices.

☞ For BASIC double-axis control sections and IndraDrive Cs ECONOMY devices, the "process controller" is not available, since the required integrated PLC/MLD (optional firmware expansion package "MA") is not available for these devices.

☞ For BASIC devices (CSB01.1), the minimum cycle time of the process controller is 2 ms.

Drive firmware

The "process controller" function can be used for the firmware version MPB18VRS and above or MPC18VRS and above.

Since the "process controller" function has been implemented on the basis of the integrated PLC (IndraMotion MLD), the optional functional package "MA" is required in addition to the drive firmware.

Commissioning software

The process controller function can be configured and operated via parameters (see "Parameters involved"). It is therefore possible to use the same software that is used to commission the drive controller. With the software version IndraWorks MLD 12V04 and higher versions, the function is supported by individual operation and commissioning dialogs in IndraWorks. Dialogs are not available in older versions. With these versions, the function can only be operated via the parameter editor or the predefined parameter group.

Parameters involved

- P-0-1390, Control word
- P-0-1410, Status word
- P-0-1411, Switch cam status word
- P-0-1270, Effective control difference
- P-0-1271, Active command value
- P-0-1272, Torque feedforward, feedforward value
- P-0-1273, Effective process feedback value
- P-0-1274, Controller output
- P-0-1275, Controller output, limited
- P-0-1276, Controller cycle time

- P-0-1277, Disturbance observer DT1-term
- P-0-1278, Disturbance observer term, limited
- P-0-1279, Disturbance observer filter term
- P-0-1280, Disturbance observer upper limit, effective
- P-0-1290, Process controller diagnostics, ErrorID
- P-0-1291, Process controller diagnostics, ERROR_TABLE
- P-0-1292, Process controller diagnostics, Additional1
- P-0-1293, Process controller diagnostics, Additional2
- P-0-1316, Band-stop filter, center frequency
- P-0-1317, Band-stop filter, bandwidth
- P-0-1318, Switch cam, switch-on threshold
- P-0-1319, Switch cam, switch-off threshold
- P-0-1320, P-gain 2 of controller
- P-0-1321, I-term 2 of controller
- P-0-1322, Switch point of controller setting 2
- P-0-1323, Switch point of controller setting 1
- P-0-1325, Torque feedforward factor
- P-0-1326, PT1 command value filter, filter time constant
- P-0-1327, Maximum command value increase
- P-0-1328, Maximum command value decrease
- P-0-1329, Maximum controller output increase
- P-0-1330, Maximum controller output decrease
- P-0-1331, Lower limitation of disturbance observer
- P-0-1370, Config word
- P-0-1371, Process command value
- P-0-1372, Process feedback value, analog
- P-0-1373, Controller P-gain
- P-0-1374, Controller I-term
- P-0-1375, Disturbance observer factor
- P-0-1376, Upper limitation of disturbance observer
- P-0-1377, Controller output limitation, upper
- P-0-1378, Controller output limitation, lower
- P-0-1380, Tolerance window
- P-0-1381, Position limitation, upper
- P-0-1382, Position limitation, lower
- P-0-1384, Command value feedforward factor
- P-0-1385, Command value feedforward filter time constant

8 Functional description

Activating process control

Starting MLD (start behavior parameterized with P-0-1367 or manual start with P-0-1350; see also MLD Application Manual) initializes the function including the respective parameters. The actual process control is activated/ enabled via P-0-1390, bit 0.

To successfully activate process control, the drive has to be in drive enable (AF). Otherwise, bit 10 is set in the status word P-0-1410, if process control was activated via P-0-1390, bit 0, and control does not take place. In the case of successful activation, control over the drive is given to IndraMotion MLD and the drive is switched to the "velocity control" mode.

Structural overview of the process controller

The overview below outlines the basic functional principle and structure of the process controller (input values highlighted in light gray, display values highlighted in dark gray):

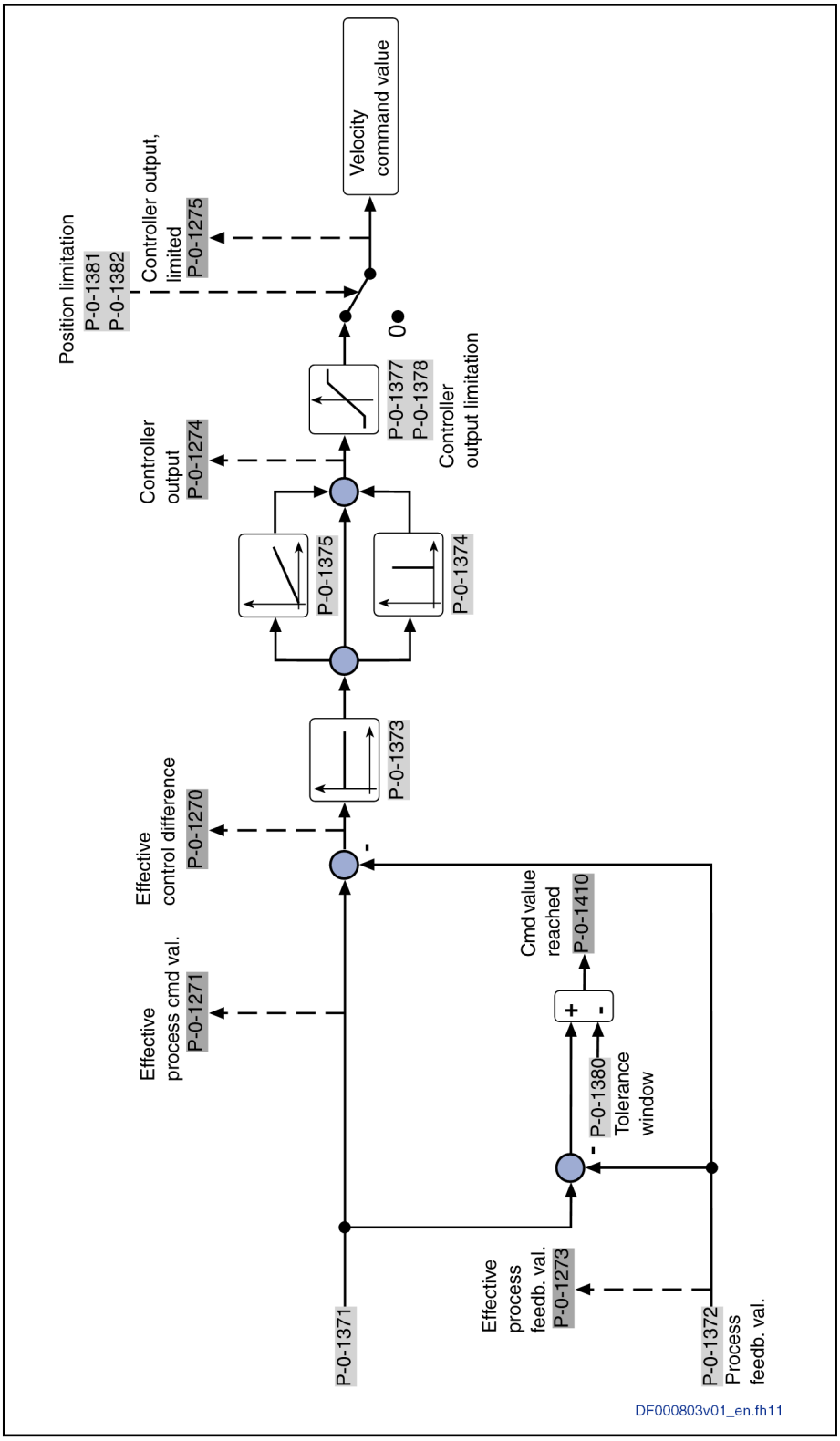

Fig. 8-1: Structural overview of the process controller

Functionality of process control

Immediately after the initialization phase, the process controller starts compensating the difference between command value and process feedback value via the controller output S-0-0037. This state is signaled back in the status word P-0-1410, bit 0.

As long as the process controller is active, i.e. bit 0 is set in P-0-1390, bit 0 remains set in the status word P-0-1410.

The command value is directly preset for the process controller via P-0-1371.

If necessary, the process feedback value supplied via P-0-1372 can be filtered with P-0-1316 and P-0-1317 with a band-stop filter.

Optional band-stop filter

The figure below shows the effect and parameter assignment of the band-stop filter:

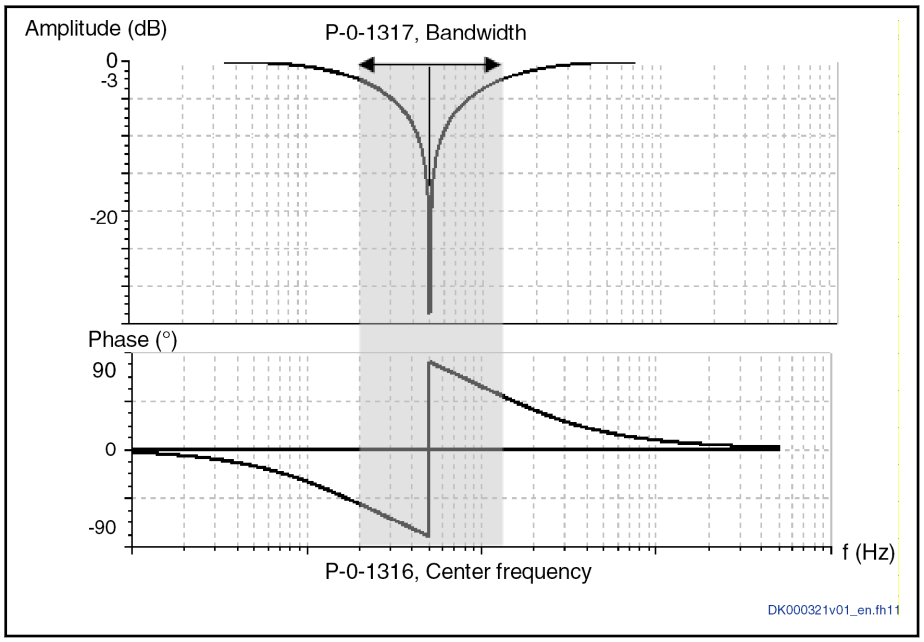

Fig. 8-2: Effect and parameter assignment of the band-stop filter

The feedback value that takes effect for the PI controller after filtering is displayed in "P-0-1273, Effective process feedback value".

The controller structure on which process control is based corresponds to the one of a PI controller.

This "typical" PI controller is parameterized with the following parameters

- P-0-1373, Controller P-gain
- P-0-1374, Controller I-term / PT1 disturbance filter, filter time constant

Besides this PI controller there is an alternative controller structure for process control.

It is a P-controller with disturbance observer.

This controller type takes effect if a value unequal zero has been entered in "P-0-1375, Disturbance observer factor" [if P-0-1375 = "0", the typical PI controller structure takes effect (see above)].

The P-controller with disturbance observer (P-0-1375) is parameterized with the following parameters:

- P-0-1373, Controller P-gain
- P-0-1374, Controller I-term / PT1 disturbance filter, filter time constant
- P-0-1375, Disturbance observer factor

> ☞ If necessary, the process command value (P-0-1371) can be changed at any time. The changes take immediate effect (possibly via a ramp or PT1 filter), the command value can therefore be permanently corrected.

When the effective process feedback value (P-0-1273) reaches the command value preset in P-0-1371, or when the difference between these feedback and command values is within the tolerance window (P-0-1380) that can be set, the drive signals this in the control word P-0-1410, bit 1.

The **control difference** (process command value - process feedback value) can be inverted with P-0-1370, bit 6. For this purpose, both the process command value and the process feedback value are inverted.

The effective and possibly inverted **process command value** is displayed in P-0-1271.

The effective and possibly inverted and filtered **process feedback value** is displayed in P-0-1273.

The effective (possibly inverted) **control difference** (P-0-1271 - P-0-1273) is displayed in P-0-1270. The inversion is required according to the process feedback value to achieve a correct control behavior. [Example of application for the inversion of the control difference: distance control (control difference decreases as the controller output increases)].

Controller switching

Depending on the effective process feedback value (P-0-1273) or the effective command velocity (P-0-0048), it is possible to switch the controller settings automatically:

When the absolute value of the effective process feedback value or the effective command velocity (to be selected in P-0-1370, bit 7) exceeds the value from "P-0-1322, Switch point of controller setting 2", the controller settings from P-0-1320 and P-0-1321 take effect. When the absolute value of the effective process feedback value or the effective command velocity falls below the value from "P-0-1323, Switch point of controller setting 1", the controller settings from P-0-1373 and P-0-1374 take effect again.

P-0-1410, bit 12, displays which controller setting is currently active and whether the controller settings are continuously adjusted. When both switch points (P-0-1322, P-0-1323) are "0" and switching has been set as hysteresis (P-0-1370, bit 8="0"), switching does not take place and the settings from P-0-1373 and P-0-1374 always take effect.

If required, the ramp for controller output limitation (P-0-1329, P-0-1330) can be used so that controller switching does not take effect abruptly. Otherwise, controller switching may cause jumps in the controller output.

Torque feedforward

With the factor for torque feedforward (P-0-1325), it is possible to implement feedforward in addition to the PID controller. Thereby, the value from "P-0-1325, Torque feedforward factor" is multiplied with the effective process command value. The process command value possibly was already inverted and/or filtered via a ramp. The torque value to be currently fed forward is displayed in "P-0-1272, Torque feedforward, feedforward value" and preset via "S-0-0081, Additive torque/force command value".

> ☞ Using torque feedforward (P-0-1325 unequal "0") can deactivate the controller output limitation!

Command value feedforward

The effective command value (P-0-1271) can be additionally fed forward in parallel with the actual PID controller. Thereby, a value calculated using the effective command value (P-0-1271) is added to the controller output calculated by the PID controller. The effective command value (P-0-1271) is multi-

plied with the factor for command value feedforward from P-0-1384 and subsequently filtered with the filter time constant from P-0-1385. The filtered value then is added to the controller output calculated in the PID controller.

Command value ramp

To limit the maximum change in the command value, the preset command value can be changed using a command value ramp, if the command value change preset in P-0-1371 is greater than set by the ramp. The maximum increase and decrease of the command value can be set independently of each other via P-0-1327 and P-0-1328. What has to be set is the maximum command value change per process controller cycle, e.g. a maximum of 10 N/ms. The possibly limited and filtered command value is displayed in P-0-1271.

Bit 7 in P-0-1410 shows whether the possibly limited and filtered active command value (P-0-1271) complies with the original command value from P-0-1371. If bit 7="0", the command value change is limited by the ramp and/or the filter: P-0-1271 <> P-0-1371.

This is a mere limitation, not general filtering or interpolation! The command value is not changed if the command value change does not exceed the specified limits!

With P-0-1327 or P-0-1328="0", the respective ramp limitation is deactivated.

Command value filter

Another option for changing the command value is the (PT1) command value filter. Its filter time constant can be entered in P-0-1326. In this case, the command value, preset in P-0-1371 and possibly limited by the command value ramp with P-0-1327 and P-0-1328, is filtered. The effective process command value is displayed in P-0-1271.

Bit 7 in P-0-1410 shows whether the possibly limited and filtered active command value (P-0-1271) complies with the original command value from P-0-1371. If bit 7="0", the command value change is limited by the ramp and/or the filter: P-0-1271 <> P-0-1371.

If a filter time constant of 0 ms is entered in P-0-1326, the command value is not filtered.

Controller output ramp

To limit the maximum change in the controller output, the preset controller output can be changed using a controller output ramp, if the controller output change to be output (calculated from PID controller, controller output feedforward and command value feedforward) is greater than set by the ramp. The maximum increase and decrease of the controller output can be set independently of each other via P-0-1329 and P-0-1330. What has to be set is the maximum controller output change per process controller cycle, e.g. a maximum of 10 N/ms.

This is a mere limitation, not general filtering or interpolation! The controller output is not changed if the controller output change does not exceed the specified limits!

Controller output limitation

With the parameters P-0-1377 and P-0-1378, an upper and a lower limit can be set for the controller output (→velocity), i.e. the process controller output. The status word P-0-1410, bit 2 and bit 3, shows whether the limitation is active or not.

This is a mere limitation, not general filtering or interpolation! The controller output is not changed if the controller output change does not exceed the specified limits! In order not to limit the controller output, enter accordingly high values in P-0-1377 or P-0-1378.

Limiting the disturbance observer

With the parameters P-0-1376 and P-0-1331, it is possible to set an upper and a lower limit for the disturbance observer term of the controller output.

The general controller output limitation via P-0-1377 and P-0-1378 always takes effect (independent of P-0-1331, P-0-1376).

In order not to limit the disturbance observer term, enter the value "0" in P-0-1331 or P-0-1376.

This is a mere limitation, not general filtering or interpolation!

This controller output term is not changed if the disturbance observer term does not exceed the specified limits!

With P-0-1375 = "0" (PI controller), only the I-term is limited by P-0-1331 and P-0-1376.

Limiting the position

Furthermore, it is possible to limit the absolute position of the drive. This is done via "P-0-1381, Position limitation, upper" and "P-0-1382, Position limitation, lower". The value in "S-0-0386, Active position feedback value" is monitored to find out whether it exceeds the preset position limits (P-0-1381/ P-0-1382). When the process controller detects that the value has exceeded the limit (S-0-0386 <= P-0-1382 or P-0-1381 <= S-0-0386), the controller output is set to "0". The exceeded limit is displayed in the status word P-0-1410 in bit 5 or bit 6. As long as the controller calculates and outputs a controller output (P-0-1274, Controller output) that does not cause the axis to move between the two limits again, the effective controller output is set to "0". Only if the controller output causes a motion that moves the axis out of the limits is the controller output really transmitted to the drive. The actually effective and possibly limited controller output is displayed in "P-0-1275, Controller output, limited". The position limitation can be activated via P-0-1370, bit 2.

Since the drive cannot stop abruptly, it might still move a little beyond the limitation. How far it moves depends on the initial velocity immediately before the limit, as well as on the delay that takes effect for velocity control.

Using a switch cam

Besides the actual control function, the process controller makes available a switch cam depending on the velocity. Depending on the absolute value of the current command velocity (absolute value of P-0-0040), the bit 0 is set in P-0-1411, Switch cam status word. If the velocity exceeds the velocity value set in P-0-1318, the bit is set. If the absolute value of the feedback velocity falls below the value in P-0-1319, the bit is reset to 0. If both velocity thresholds (P-0-1318, P-0-1319) are "0", the generation of the switch cam depending on the velocity is deactivated and the bit 0 in P-0-1411, Switch cam status word is always "0". The switch-on threshold has to be greater than the switch-off threshold so that the function of a hysteresis is given. If the value in "P-0-1318, Switch cam, switch-on threshold" is smaller than the value in "P-0-1319, Switch cam, switch-off threshold", this is displayed in the status word P-0-1410 in bit 11.

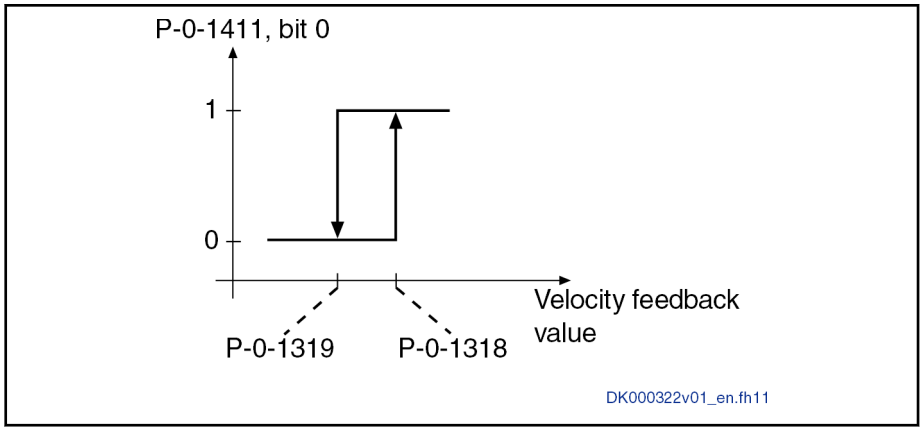

Fig. 8-3: Hysteresis function of the parameterizable switch cam

The velocity feedback value can be filtered by the average value filter for display in the drive firmware (see functional description).

The switch cam status word (P-0-1411) is updated/generated every 10 ms. It is also generated if the process controller is not active, but only when the drive is in the "OM" state.

Switching off the process controller

The process controller is switched off with P-0-1390, bit 0 = 0, and the drive is stopped. Control is returned to the master communication, and the drive is switched back to the preset operation mode.

Removing drive enable also switches off the process controller, and control is returned to the master communication.

9 Commissioning and utilization

9.1 General information

NOTICE

Destruction of device-internal, non-volatile memory ("flash") by frequent accesses via non-cyclic interfaces!

In order not to exceed the maximum possible writing cycles of the device-internal, non-volatile memory, the storage mode should have been set to "volatile" (S-0-0269="1").

Note: Parameters written via the **cyclic channel of the field bus interface** are not saved, independent of the setting in S-0-0269.

The function of the process controller is based on the MLD function in the drive. To use the process controller, the functional package "IndraMotion MLD Advanced" ("MA") therefore has to be enabled (see "Enabling functional packages").

Using the process controller as a library

If other functionalities besides the process controller are required in MLD, the process controller cannot be used as a self-contained, loadable parameter file. In this case, the process controller has to be included in the MLD program as a library (FWS_MLDPCx_PRE_01Vxx_DE_MPxx.compiled-library).

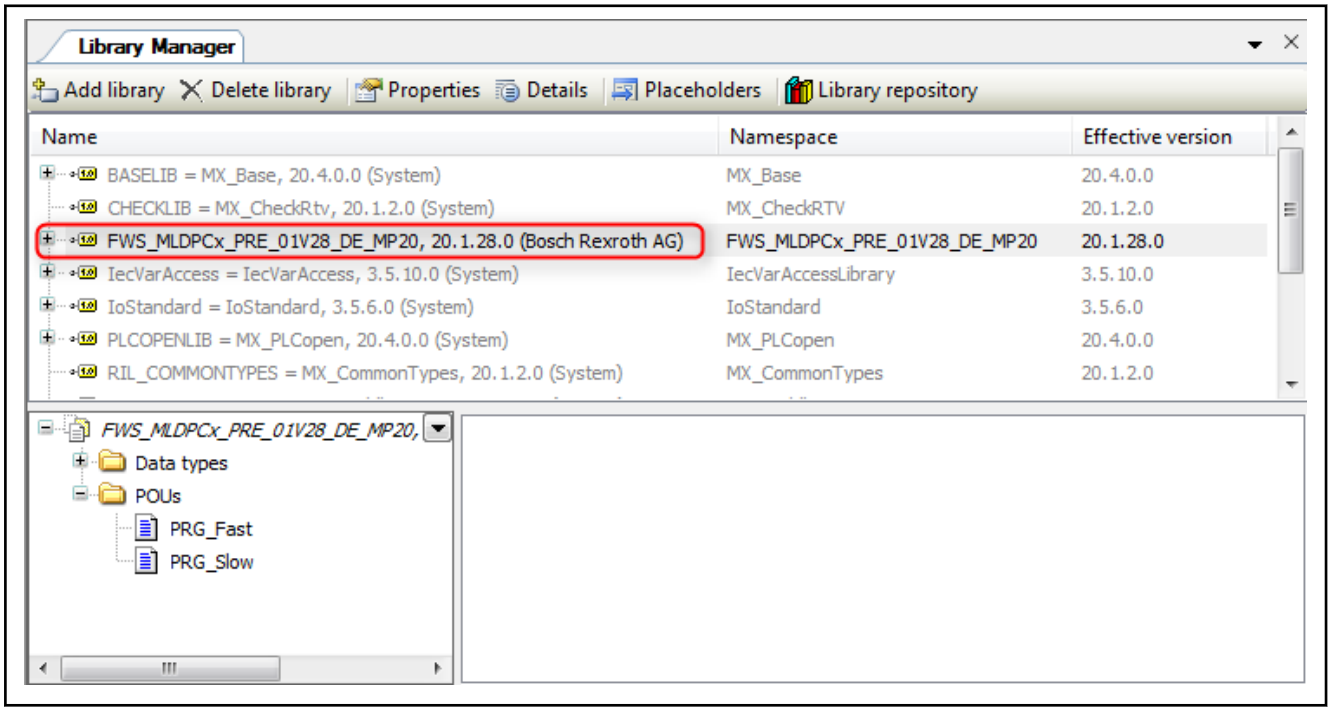

Fig. 9-1: Process controller - including a library

The respective programs from the process controller library then have to be called in the corresponding tasks:

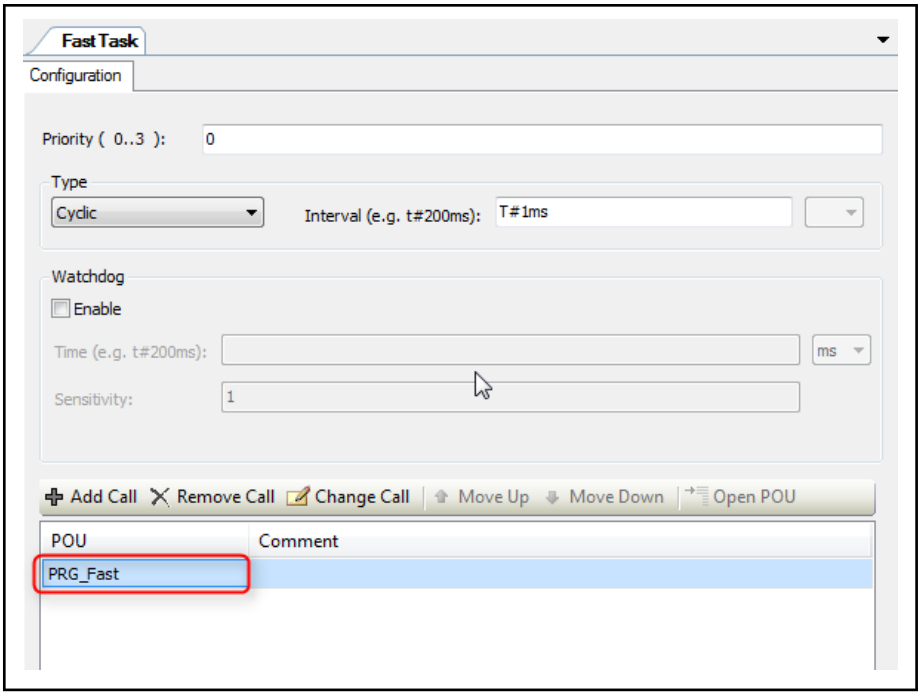

Fig. 9-2: Process controller - program called in fast task

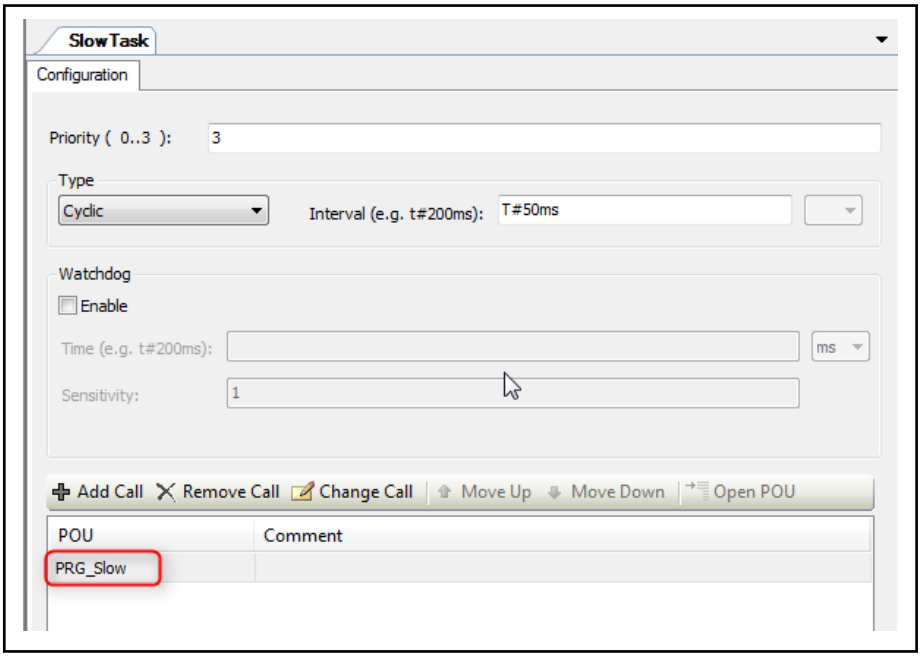

Fig. 9-3: Process controller - program called in slow task

To use the IndraWorks dialogs for operating and diagnosing the process controller when employing the library, the IndraWorks project name has to begin with the following characters: FWS_MLDPCx_PRE_01.

If other functionalities besides the process controller function have to be implemented in MLD, it is recommended to use the exemplary project "FWS_MLDPCx_PRE_01Vxx_MPxx.xiwp" as a template or basis. This ensures that the IndraWorks dialogs can be operated and the correct task con-

figuration is available, and that the correct programs are included at the right places.

Using the process controller as a self-contained function

If the process controller function is exclusively used and required, no additional programming effort is necessary and the functionality can always be accessed via the dialogs in IndraWorks. In this case, the ready-made and self-contained function has to be loaded to the drive in the form of a parameter file "FWS_MLDPCx_PRE_01Vxx_MPxx.par". Among other things, this can be done via the "Project info" dialog in IndraWorks.

See also "Loading the technology function to the drive"

9.2 Operating the process controller by an external control / master communication

Signals for cyclic operation

To control the process controller in the drive in a useful way, certain data/ parameters have to be exchanged between the drive and the external control unit (see fig. 9-4 "Communication channels to control and diagnose the process controller" on page 36). The data are automatically exchanged within the drive between drive control (firmware) and process controller (MLD). The data between the external control unit and the drive via the master communication have to be configured accordingly.

The following parameters **have to** be transmitted/written by the control unit to the drive:

- Drive control word (e.g., P-0-4077 with Profibus master communication)
- Process controller control word (P-0-1390)
- Process command value (P-0-1371)

The following parameters **should** be transmitted by the drive to the control unit (and be evaluated):

- Drive status word (e.g., P-0-4078 with Profibus master communication)
- Process controller status word (P-0-1410)
- Effective process feedback value (P-0-1273)
- Diagnostic message (S-0-0390)

Depending on the application, it might be useful to transmit more parameters!

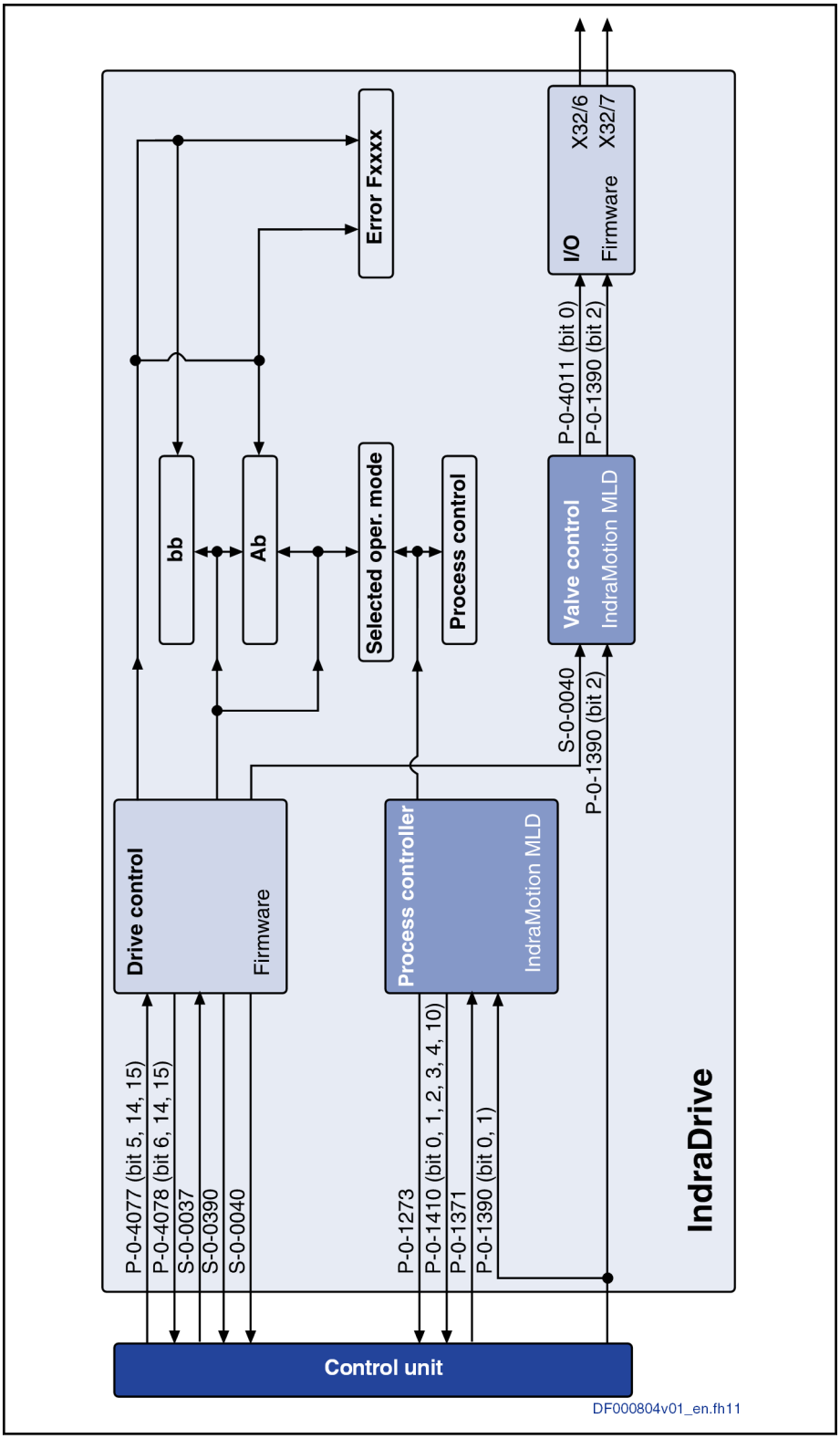

Fig. 9-4: Communication channels to control and diagnose the process controller

Control signals to operate the process controller

To operate the process controller, the drive has to be brought to the "Drive enable" state (by external control unit, digital input,…). As soon as the drive has reached this state, the process controller can be activated/started via P-0-1390, bit 0. If the process controller has been deactivated (P-0-1390, bit

0="0"), the axis is operated in the selected operation mode and can be used like a normal servo axis (e.g., in velocity control, drive-internal interpolation, …). The process controller then does not preset any axis motion.

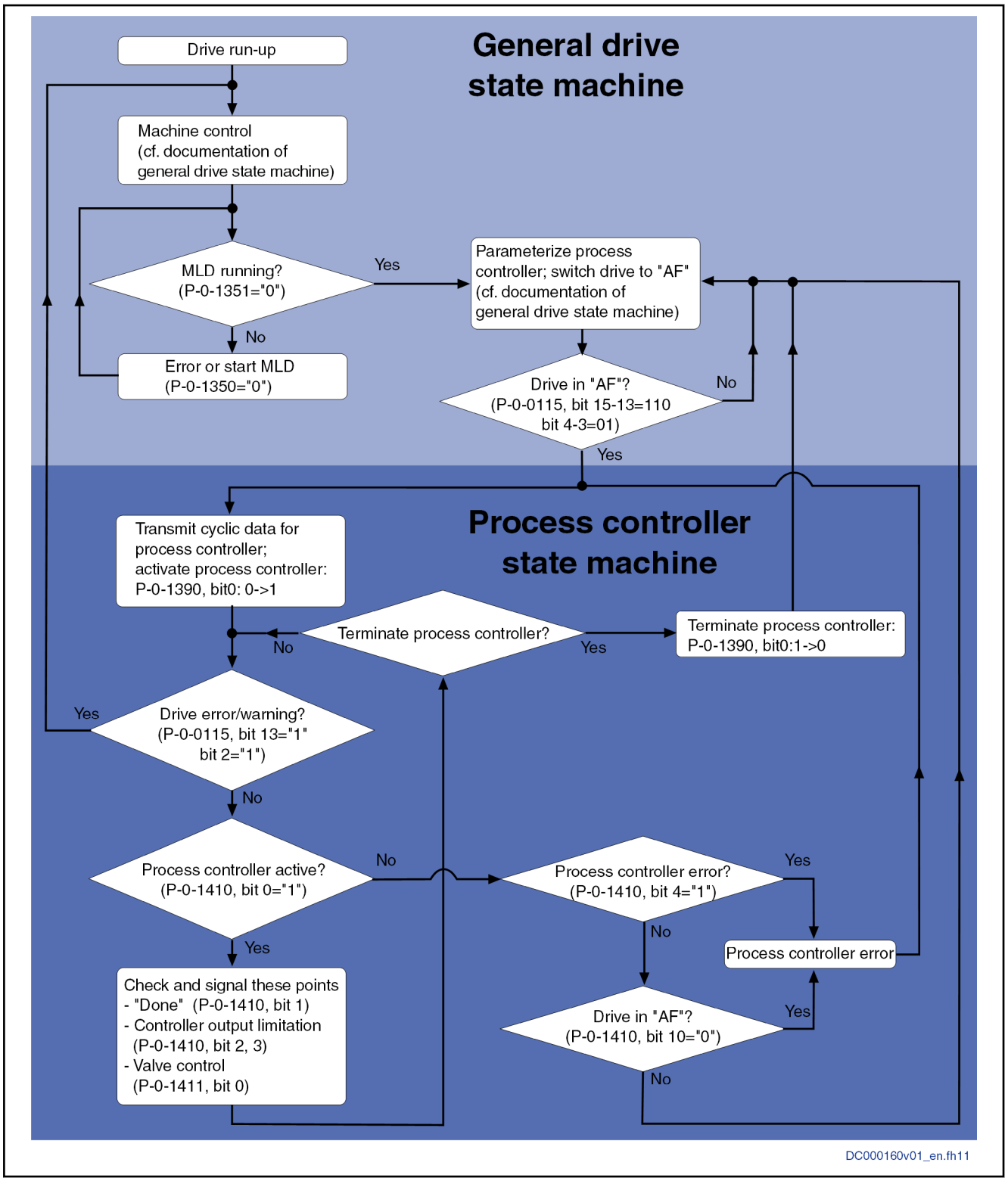

Fig. 9-5: Sequence and state diagram for operating the process controller

9.3 Operating and setting the process controller via dialogs in IndraWorks

Requirement for operating the process controller

To operate the process controller, the drive has to be brought to the "Drive enable" state (by external control unit, digital input, "easy startup" mode,…).

For operating and parameterizing the process controller with IndraWorks, access the dialog via the project tree under MLD. Double-clicking "Process controller" opens the main dialog of the process controller function:

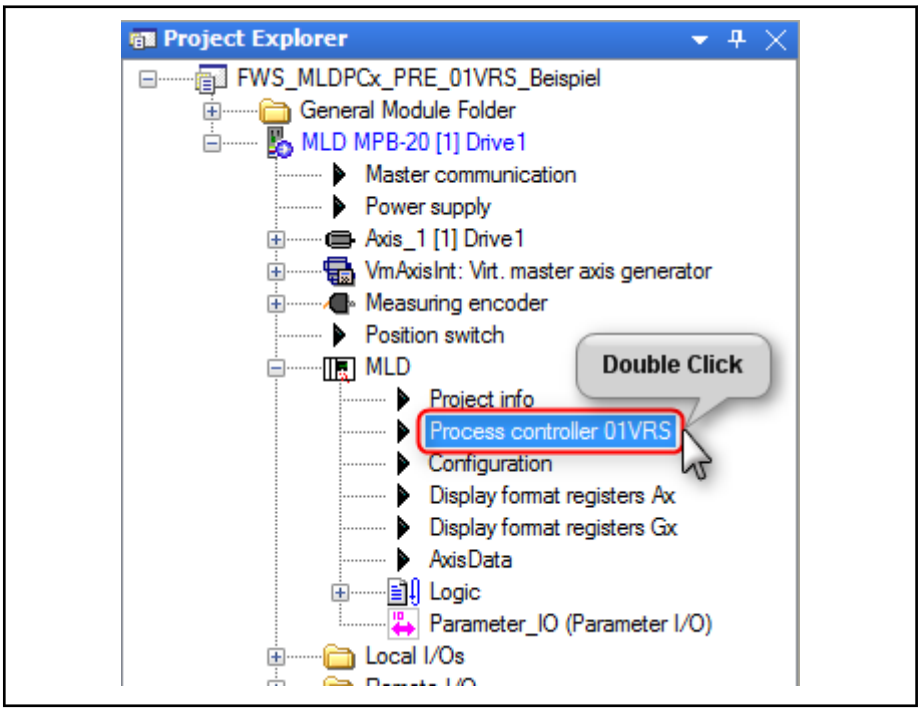

Fig. 9-6: Opening the process controller dialog

Main/operation dialog

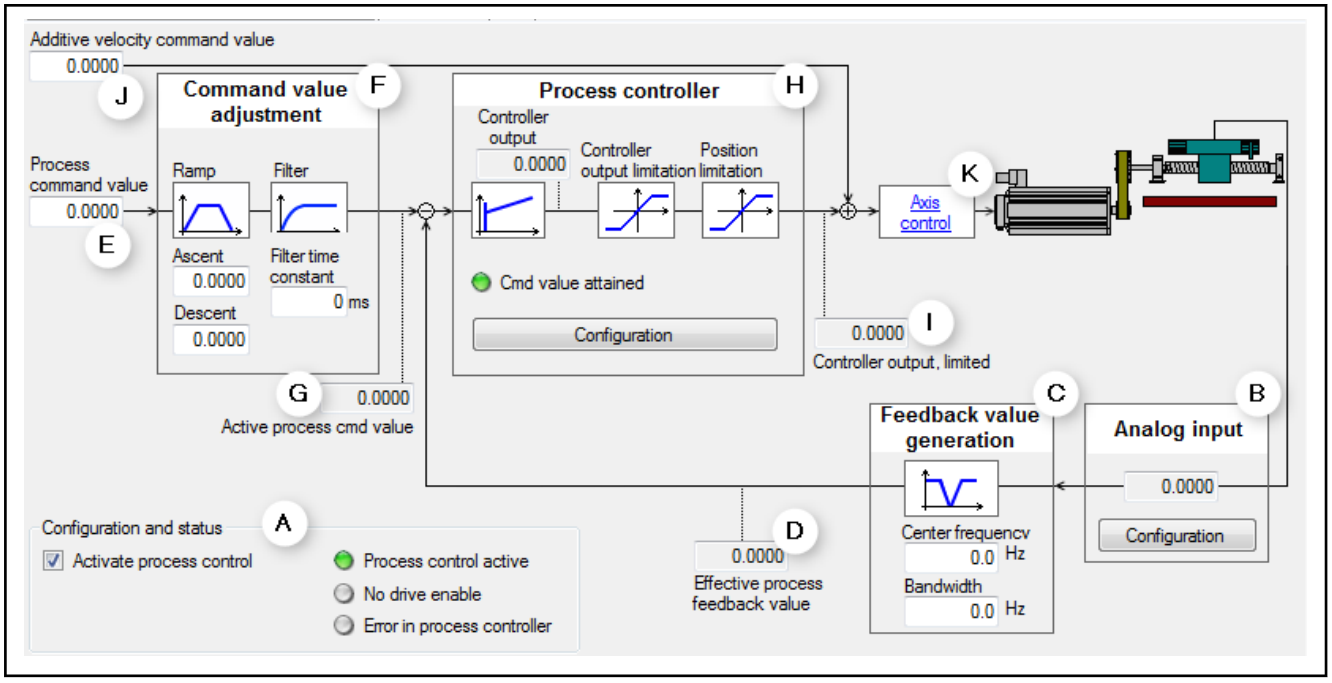

Fig. 9-7: Main dialog in IndraWorks for operating the process controller

Configuration and status Ⓐ

"Configuration and status" Ⓐ provides the displays and input options required for operating the process controller. As soon as the drive is in the "Drive enable" state (NO red dot next to "No drive enable"), the process controller can be activated/started via the "Activate process control" check box. Thereupon, the dot next to "Process control active" turns green. This indicates that the process controller is working and moving the axis in such a way that feedback value reaches the command value. When the process controller has been deactivated, i.e. the "Activate process control" check box has NOT been selected, the axis is operated in the selected operation mode and can be used like a normal servo axis (e.g., in velocity control, drive-internal interpolation, …). In this case, the dot next to "Process control active" is no longer green. The process controller then does not preset any axis motion. If an error occurs within the process controller, the dot next to "Error in process controller" turns red (Fxxxx drive errors are NOT displayed here!).

Analog input Ⓑ

The feedback value written to P-0-1372 by the analog input of the drive or a control unit is displayed under Analog input Ⓑ. Clicking the "Configuration" button opens the dialog for setting the analog input for the connected sensor (see also „configuration dialog of analog input“).

Feedback value generation Ⓒ Ⓓ

Under "Feedback value generation" Ⓒ, the process feedback value previously read in can be additionally adjusted. A band-stop filter available as a feedback value filter can be set and activated at this point.

The possibly adjusted/filtered feedback value is displayed in the field as the "Effective process feedback value" ⓓ. The value is directly used to generate the control difference for the controller.

Command value and command value adjustment Ⓔ Ⓕ Ⓖ

The "Process command value" Ⓔ can be preset directly in the dialog, or the process command value preset via the master communication is displayed at this point.

Under "Command value adjustment" Ⓕ, it is possible to limit the increase and decrease per process controller clock (e.g., 1ms) of the process command value preset in this way. Here, it is also possible to activate and set a subsequently effective PT1 command value filter in order to additionally filter the (possibly limited) process command value.

This adjusted process command value is displayed as the "Active process cmd value" Ⓖ which then is directly used to generate the control difference for the controller.

Process controller Ⓗ

In the "Process controller" Ⓗ area, the dot next to "Cmd value attained" signals whether the process feedback value complies with the preset active process command value. If the dot is green, the control difference is within the tolerance range, the feedback value so to speak has reached the command value.

The controller output that was given by the PID controller due to the calculated control difference, is displayed in the "Controller output" field.

In the "Controller output limitation" and "Position limitation" diagrams, a red dot at the corresponding point in the respective diagram signals that one of these limitations has been reached.

Clicking the "Configuration" button opens the configuration dialog for setting the process controller and the limitations (see „Process controller configuration dialog“).

Controller output, limited Ⓘ

The "Controller output, limited" Ⓘ field displays the velocity actually preset by the process controller for the drive. The velocity is required to compensate the control difference.

Additive velocity command value Ⓙ

Under "Additive velocity command value" Ⓙ, an additional velocity command value can be preset for the drive, in addition to the controller output of the process controller.

Axis control Ⓚ

The "Axis control" Ⓚ link leads to the dialogs required for setting the basic drive control of IndraDrive (speed controller, feedforwards, etc.).

Process controller configuration dialog

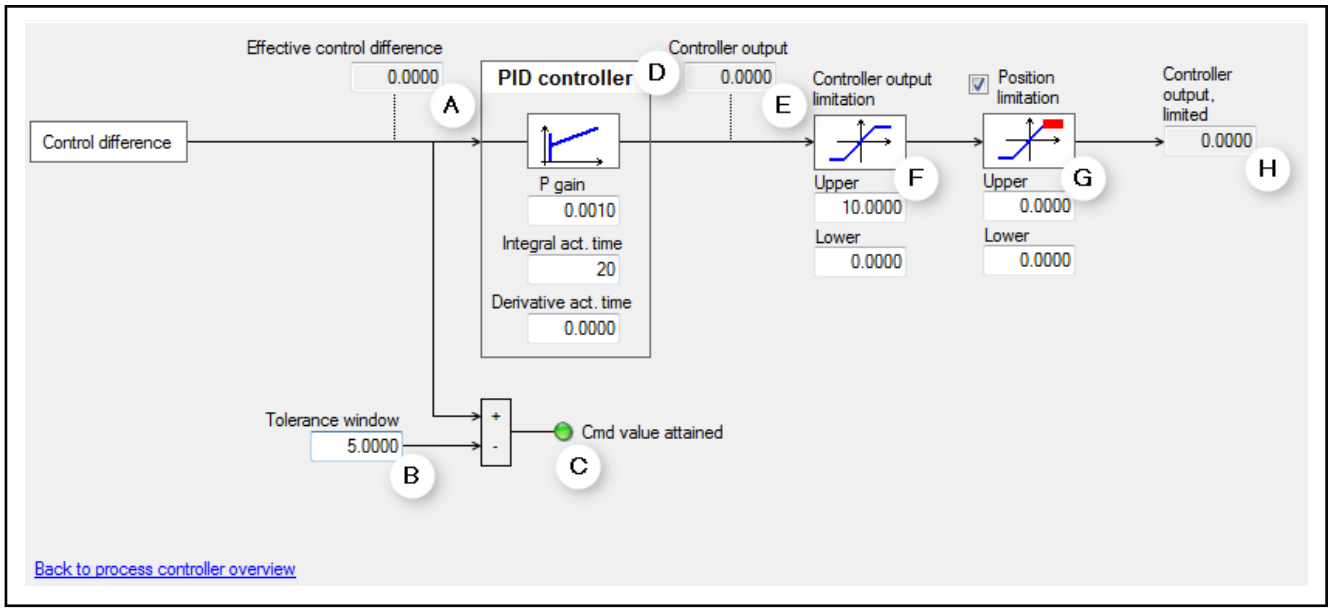

Fig. 9-8: IndraWorks configuration dialog for setting the properties of the process controller

Effective control difference Ⓐ

The field under "Effective control difference" Ⓐ displays the difference between the effective command value and feedback value. This value is the input value for the PID controller.

Tolerance window Ⓑ and Command value attained Ⓒ

If the absolute value is smaller than the entered "Tolerance window" Ⓑ, this is signaled by a green dot next to "Cmd value attained" Ⓒ.

PID controller Ⓓ

The actual PID process controller can be set under "PID controller" Ⓓ.

Controller output Ⓔ

The "Controller output" Ⓔ field displays the controller output calculated by the PID controller due to the effective control difference and required to adjust the feedback value to the command value.

Controller output limitation Ⓕ

It might be necessary to limit the controller output given by the PID controller; for example, if the velocity is not allowed to exceed a certain value. For this purpose, the upper and lower controller output limitation can be set independently of each other under "Controller output limitation" Ⓕ.

Position limitation Ⓖ

If position limitation is additionally required for the process controller, e.g. for force control, this can be activated with "Position limitation" Ⓖ. Here, the upper and lower position limit have to be entered separately.

Controller output, limited Ⓗ

The "Controller output, limited" Ⓗ field displays the controller output (velocity) actually preset, after all possible limitations, by the process controller for the drive to compensate the control difference.

Configuring the analog input for the process feedback value

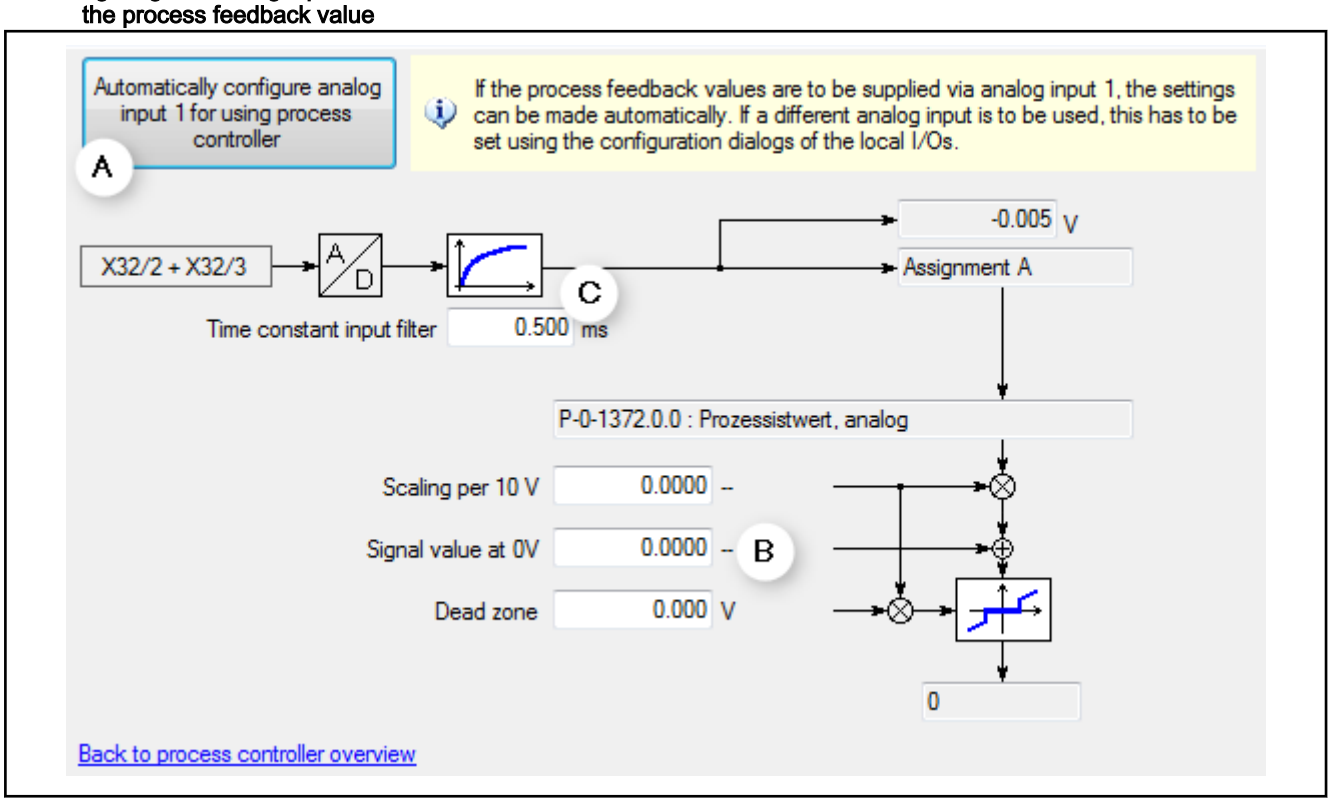

Fig. 9-9: Configuration dialog for reading in the external sensor via analog input 1 of the drive

If the process feedback value of an external sensor (e.g., force transducer, pressure sensor…) is to be read in via the analog input 1 of the drive and written to "P-0-1372, Process feedback value", all required presettings can be automatically made via the Ⓐ button. The only thing left to do is to set the signal scaling via the Ⓑ fields and to set the filter effect of the analog input filter with Ⓒ.

10 Diagnostic and status messages

Possible process controller diagnostics

The states of the process controller are displayed in "P-0-1410, Status word".

In addition, error information of the process controller is output in the following parameters:

- P-0-1290, Process controller diagnostics, ErrorID
- P-0-1291, Process controller diagnostics, ERROR_TABLE
- P-0-1292, Process controller diagnostics, Additional1
- P-0-1293, Process controller diagnostics, Additional2

ErrorID P-0-1290	ERROR_TABLE P-0-1291	Additional 1 P-0-1292	Additional 2 P-0-1293	Significance
RESOURCE_ERROR 0x0003	F_RELATED_TABLE 0x0170	0x000F	0x0003	Required optional functional firmware package "MA" not enabled
INPUT_RANGE_ERROR 0x0006	F_RELATED_TABLE 0x0170	0x0C01	0x0003	Controller output limitation: "upper limit" is smaller than "lower limit"

Tab. 10-1: Possible process controller diagnostics

11 Descriptions of the parameters

11.1 P-0-1390, Control word

The parameter P-0-1390 is used as the (cyclic) control word of process control.

Bit	Description/function	Comment
0	**Activating/enabling process control** 0: Not active 1: Active/enabled	
1	Freeze controller output	
2	Controlling a digital output	If process control has been deactivated via bit 0 (see above), this bit can be freely written and, if necessary, assigned to a digital output
3	Reserved	
4	Reserved	
5	Reserved	
6	0→1: Loading default values	The parameters of the process controller are set to their default values
7	Reserved	
8	Injection process active 0: Normal operation 1: Injection process active	Information to process controller that injection process is active
9..13	Reserved	
14/15	Parameter set switching: 00: Activate set 1 01: Activate set 2 10: Activate set 3 11: Activate set 4	These bits allow the controller parameterization to be switched, if this has been configured in P-0-1370, bit 13/12 (P-0-1370, bit 13/12 = 0/1)

Tab. 11-1: Parameter structure

Min./max. value	-/-
Format	BIN
Unit	-
Type	Input register
Decimal places	None
Buffered parameter	No
Default value	-

Tab. 11-2: Parameter attributes

11.2 P-0-1410, Status word

The parameter P-0-1410 is used as the status word of process control.

Bit	Description/function	Comment
0	Process control active	Process control was activated (P-0-1390, bit 0) and initialization has been completed
1	**Control difference within tolerance window?** 0: Control difference > tolerance window 1: Control difference <= tolerance window	Displays whether control difference (P-0-1371 - P-0-1273) within tolerance window (P-0-1380)
2	Upper controller output limitation active	Controller output is limited by P-0-1377
3	Lower controller output limitation active	Controller output is limited by P-0-1378
4	Error	An error has occurred in process control
5	Upper position limit exceeded	Upper position limit P-0-1381 exceeded
6	Lower position limit exceeded	Lower position limit P-0-1382 exceeded
7	**Limitation of command value change NOT active** 0: Command value change is limited/filtered (P-0-1371 <> P-0-1271) 1: Command value complies with possibly limited/filtered active command value (P-0-1371 = P-0-1271)	Displays whether P-0-1371 = P-0-1271 If bit 7 = 0, the command value change is limited by the ramp and/or the filter
8	**Injection process** 0: Allowed observer filter term P-0-1280 is not additionally limited 1: Injection process active and allowed observer filter term P-0-1280 is additionally limited	This bit shows whether the allowed observer filter term P-0-1280 is limited during the injection process (P-0-1390, bit 8 = 1)
9	I-term switching active: 0: Standard filter time constant for I-term from P-0-1374 or the parameter sets in P-0-1311 takes effect 1: Filter time constant from P-0-1311, list element 200, takes effect	
10	No AF	The drive is not in drive enable when process control is activated
11	**Switch cam velocity** 1: Switch-on threshold (P-0-1318) smaller than switch-off threshold (P-0-1319)	
12	**Active controller setting** 0: Controller setting 1 takes effect (P-0-1373, P-0-1374) 1: Controller setting 2 takes effect (P-0-1320, P-0-1321)	Displays which controller settings are currently active, depending on the effective process feedback value (P-0-1273), or on the effective velocity command value (P-0-0048) and on the switch points (P-0-1322, P-0-1323) that have been set.
13	Reserved	
14/15	**Active parameter set:** 00: Set 1 active 01: Set 2 active 10: Set 3 active 11: Set 4 active	If external parameter set switching has been configured (P-0-1370, bit13/12 = 0/1), the active parameter set selected in P-0-1390, bit 14/15, is displayed here

Tab. 11-3: Parameter structure

Min./max. value	-/-
Format	BIN
Unit	-
Type	Output register
Decimal places	None
Buffered parameter	No
Default value	-

Tab. 11-4: Parameter attributes

11.3 P-0-1411, Switch cam status word

The parameter P-0-1411 is used as the status word of the generated switch cams. If the generation of a switch cam or bit has been activated via the corresponding configuration, the respective bit in P-0-1411 is written depending on the configuration.

Bit	Description/function	Comment
0	**Switch cam, control difference** 0: Switch-on difference not attained or value below switch-off difference 1: Switch-on difference exceeded or value not below switch-off difference	The bit is set depending on P-0-1318 and P-0-1319, taking the control difference P-0-1270 into account The generation of the bit can be inverted via P-0-1370, bit 7
1	**Switch cam, fan control** 0: S-0-0383 has not yet reached switch-on temperature from P-0-1300, list element 202, or has fallen below the switch-on temperature 1: S-0-0383 has reached switch-on temperature from P-0-1311, list element 202, or has exceeded the switch-on temperature	The bit is set depending on the motor temperature (S-0-0383) and the fan switch-on threshold from P-0-1311, list element 202. This bit allows an external fan to be controlled. If P-0-1311, list element 202 = 0, the bit is not set and thus its value is permanently 0
2-15	Reserved	

Tab. 11-5: Parameter structure

Min./max. value	0/-
Format	BIN
Unit	-
Type	Output register
Decimal places	None
Buffered parameter	No
Default value	-

Tab. 11-6: Parameter attributes

11.4 P-0-1270, Effective control difference

P-0-1270 displays the control difference that actually takes effect for the PID controller. For this purpose, the effective process feedback value (P-0-1273) (possibly inverted and filtered) is subtracted from the effective process com-

mand value (P-0-1271) (possibly inverted and filtered). The value is used, among other things, to generate P-0-1410, bit 1.

Min./max. value	-/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-7: Parameter attributes

11.5 P-0-1271, Effective command value

P-0-1271 displays the command value that actually takes effect for the generation of the control difference. The value might be filtered (P-0-1326). If the control difference has been inverted (P-0-1370, bit 6), the value is displayed in inverted form.

Min./max. value	-/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-8: Parameter attributes

11.6 P-0-1272, Torque feedforward, feedforward value

With active torque feedforward (P-0-1325 <> 0), P-0-1272 displays the value preset by torque feedforward. The value is calculated from the effective process command value (P-0-1271) and is preset in addition to the controller output of the process controller via the additive torque/force command value. With active controller output / position limitation, the value of torque feedforward is "0".

Min./max. value	-/-
Format	DEC_MV
Unit	Like S-0-0081
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-9: Parameter attributes

11.7 P-0-1273, Effective process feedback value

For diagnostic purposes, P-0-1273 displays the feedback value for the process controller that actually takes effect. It is the value after feedback value adjustment, i.e. after all filter functions (e.g. band-stop filter). If the control difference has been inverted (P-0-1370, bit 6), the value is displayed in inverted form.

Min./max. value	-/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-10: Parameter attributes

11.8 P-0-1274, Controller output

P-0-1274 displays the controller output calculated in the PID controller. The position and controller output limitation is not taken into account for the displayed value. A possible limitation by the controller output ramp, as well as the controller output feedforward are used for calculating the value (only if the functions are really used!).

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-11: Parameter attributes

11.9 P-0-1275, Controller output, limited

P-0-1275 displays the controller output which is limited by P-0-1377 and P-0-1378 (controller output limitation) and thereby takes effect for the drive. This value is preset for the drive via P-0-0690. If a position limitation exists, the value is "0".

Min./max. value	P-0-1377/P-0-1378
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-12: Parameter attributes

11.10 P-0-1276, Controller cycle time

P-0-1276 indicates the actual and current cycle time in which the process controller is calculated in the drive. The cycle time depends on the control section used and on the device design, and besides can depend on the current device load.

Min./max. value	1/-
Format	DEC_OV
Unit	µs
Type	Output register
Decimal places	0
Buffered parameter	No
Default value	-

Tab. 11-13: Parameter attributes

11.11 P-0-1277, Disturbance observer, observer term

P-0-1277 displays the DT1-term of the disturbance observer.

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-14: Parameter attributes

11.12 P-0-1278, Disturbance observer term, limited

P-0-1278 displays the limited term of the disturbance observer. The value thus complies with the sum from P-0-1277 and P-0-1279 limited with P-0-1331 and P-0-1376.

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-15: Parameter attributes

11.13 P-0-1279, Disturbance observer filter term

P-0-1279 displays the controller output (P-0-0690) filtered (low-pass filter P-0-1374) for the disturbance observer.

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-16: Parameter attributes

11.14 P-0-1280, Disturbance observer upper limit, effective

P-0-1280 displays the effective upper limit for the disturbance observer term. Usually, this is the value from P-0-1376. If the injection phase has been activated via P-0-1390, the limitation can also be set for another value (cf. injection function).

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Output register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-17: Parameter attributes

11.15 P-0-1290, Process controller diagnostics, ErrorID

In the case of an error, P-0-1290 displays additional information on the cause of the error.

See also "descriptions of diagnostic messages"

Min./max. value	-/-
Format	HEX
Unit	-
Type	Output register
Decimal places	-
Buffered parameter	No
Default value	-

Tab. 11-18: Parameter attributes

11.16 P-0-1291, Process controller diagnostics, ERROR_TABLE

In the case of an error, P-0-1291 displays additional information on the cause of the error.

See also "descriptions of diagnostic messages"

Min./max. value	-/-
Format	HEX
Unit	-
Type	Output register
Decimal places	-
Buffered parameter	No
Default value	-

Tab. 11-19: Parameter attributes

11.17 P-0-1292, Process controller diagnostics, Additional 1

In the case of an error, P-0-1292 displays additional information on the cause of the error.

See also "descriptions of diagnostic messages"

Min./max. value	-/-
Format	HEX
Unit	-
Type	Output register
Decimal places	-
Buffered parameter	No
Default value	-

Tab. 11-20: Parameter attributes

11.18 P-0-1293, Process controller diagnostics, Additional 2

In the case of an error, P-0-1293 displays additional information on the cause of the error.

See also "descriptions of diagnostic messages"

Min./max. value	-/-
Format	HEX
Unit	-
Type	Output register
Decimal places	-
Buffered parameter	No
Default value	-

Tab. 11-21: Parameter attributes

11.19 P-0-1316, Band-stop filter, center frequency

In P-0-1316, set the center frequency of the band-stop filter (rejection filter). Entering the minimum input value (zero) switches the filter off.

Min./max. value	0.0/-
Format	DEC_OV
Unit	Hz
Type	Input register
Decimal places	1
Buffered parameter	Yes
Default value	0.0

Tab. 11-22: Parameter attributes

11.20 P-0-1317, Band-stop filter, bandwidth

In P-0-1317, enter the value for the bandwidth of the band-stop filter (rejection filter). Entering the minimum input value (zero) switches the filter off.

Min./max. value	0.0/-
Format	DEC_OV
Unit	Hz
Type	Input register
Decimal places	1
Buffered parameter	Yes
Default value	0.0

Tab. 11-23: Parameter attributes

11.21 P-0-1318, Switch cam, switch-on threshold

If the **absolute value** of the control difference (|P-0-1270|) exceeds the value entered in P-0-1318, the bit 0 is set in "P-0-1411, Switch cam status word". If P-0-1318 and P-0-1319 are simultaneously "0", the switch cam depending on the control difference is deactivated, i.e. the bit 0 in P-0-1411 is always "0".

If the value in "P-0-1318, Switch cam control difference, switch-on threshold" is smaller than the value in "P-0-1319, Switch cam control difference, switch-off threshold", this is displayed in the status word P-0-1410 in bit 11.

Min./max. value	0.000/-
Format	DEC_MV
Unit	bar
Type	Input register
Decimal places	3
Buffered parameter	Yes
Default value	0.000

Tab. 11-24: Parameter attributes

11.22 P-0-1319, Switch cam, switch-off threshold

If the **absolute value** of the control difference (|P-0-1270|) falls below the value entered in P-0-1319, the bit 0 in "P-0-1411, Switch cam status word" is set to "0". If P-0-1318 and P-0-1319 are simultaneously "0", the switch cam depending on the control difference is deactivated, i.e. the bit 0 in P-0-1411 is always "0".

If the value in "P-0-1318, Switch cam control difference, switch-on threshold" is smaller than the value in "P-0-1319, Switch cam control difference, switch-off threshold", this is displayed in the status word P-0-1410 in bit 11.

Min./max. value	0.000/-
Format	DEC_MV
Unit	bar
Type	Input register
Decimal places	3
Buffered parameter	Yes
Default value	0.000

Tab. 11-25: Parameter attributes

11.23 P-0-1320, P-gain 2 of controller

The parameter P-0-1320 is used to preset the optional P-term of the PID controller for switching the controller setting. P-0-1320 has no function if the switching of the controller setting has not been set with P-0-1322/P-0-1323.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0010

Tab. 11-26: Parameter attributes

11.24 P-0-1321, I-term 2 of controller

The parameter P-0-1321 is used to preset the optional I-term (integral-action time) of the PID controller for switching the controller setting. P-0-1321 has no function if the switching of the controller setting has not been set with P-0-1322/P-0-1323.

Min./max. value	0.000/-
Format	DEC_OV
Unit	ms
Type	Input register
Decimal places	3
Buffered parameter	Yes
Default value	20.000

Tab. 11-27: Parameter attributes

11.25 P-0-1322, Switch point of controller setting 2

If the absolute value of the effective process feedback value (P-0-1273) or the effective command velocity (P-0-0048) (can be set via P-0-1370, bit 7) is greater than the value entered in P-0-1322, other values (P-0-1320/P-0-1321) become valid for P- and I-terms of the PID controller. If P-0-1323="0" and P-0-1322="0", the controller setting is not switched.

The active controller setting is displayed in P-0-1410, bit 12.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	N or Nm; bar; mm; … or like P-0-0048
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-28: Parameter attributes

11.26 P-0-1323, Switch point of controller setting 1

If the absolute value of the effective control difference (P-0-1270) or the effective command velocity (P-0-0048) (can be set via P-0-1370, bit 7) is smaller than the value entered in P-0-1323, the original values (P-0-1373/P-0-1374) become valid again for P- and I-terms of the PID controller. If P-0-1323="0" and P-0-1322="0", the controller setting is not switched.

The active controller setting is displayed in P-0-1410, bit 12.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	N or Nm; bar; mm; … or like P-0-0048
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-29: Parameter attributes

11.27 P-0-1325, Torque feedforward factor

With P-0-1325, set the torque feedforward. For this purpose, the effective process command value (P-0-1271) is multiplied with the value from P-0-1325 and then preset for the drive as the additive torque/force command value via S-0-0081.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-30: Parameter attributes

11.28 P-0-1326, PT1 command value filter, filter time constant [ms]

In P-0-1326, enter the filter time constant of the command value filter. In this case, the possibly inverted (P-0-1370, bit 6) command value is filtered. The filtered command value is displayed in P-0-1271. P-0-1326="0,0" deactivates the command value filter. P-0-1271 then corresponds to the unfiltered, possibly inverted command value P-0-1371.

Min./max. value	0.0/-
Format	DEC_OV
Unit	ms
Type	Input register
Decimal places	1
Buffered parameter	Yes
Default value	0.0

Tab. 11-31: Parameter attributes

11.29 P-0-1327, Maximum command value increase

With P-0-1327, a maximum possible increase of the command value can be set. If the preset command value increases by more than the value set in this parameter within one process controller clock (corresponds to minimum MLD cycle time; for example, 1 ms with MPH firmware), the increase of the command value is limited to the maximum allowed value set here. The command value with a possibly limited increase is displayed in P-0-1271.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-32: Parameter attributes

11.30 P-0-1328, Maximum command value decrease

With P-0-1328, a maximum possible decrease of the command value can be set. If the preset command value decreases by more than the value set in this parameter within one process controller clock (corresponds to minimum MLD cycle time; for example, 1 ms with MPH firmware), the decrease of the command value is limited to the maximum allowed value set here. The command value with a possibly limited decrease is displayed in P-0-1271.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-33: Parameter attributes

11.31 P-0-1329, Maximum controller output increase

With P-0-1329, a maximum possible increase of the controller output is set. If the calculated controller output increases by more than the value set in this parameter within one process controller clock (corresponds to minimum MLD cycle time; for example, 1 ms with MPH firmware), the increase of the controller output is limited to the maximum allowed value set here. The controller output with a possibly limited increase is displayed in P-0-1274.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	Like S-0-0036
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-34: Parameter attributes

11.32 P-0-1330, Maximum controller output decrease

With P-0-1330, a maximum possible decrease of the controller output is set. If the calculated controller output decreases by more than the value set in this parameter within one process controller clock (corresponds to minimum MLD cycle time; for example, 1 ms with MPH firmware), the decrease of the controller output is limited to the maximum allowed value set here. The controller output with a possibly limited decrease is displayed in P-0-1274.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	Like S-0-0036
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-35: Parameter attributes

11.33 P-0-1331, Lower limitation of disturbance observer

Via P-0-1331, it is possible to set a lower limit for the controller output term of the disturbance observer. The term of the disturbance observer actually preset for the controller output and possibly limited is displayed in P-0-1278. The upper limitation of the disturbance observer term is entered in P-0-1376.

This lower limitation always takes effect with the value from P-0-1331 (even if P-0-1331 = "0"). If no lower limit is to be set, enter an accordingly high negative value in P-0-1331 (P-0-1331 < P-0-1378). The entered value has to be signed!

In the case of external parameter set switching (P-0-1370, bit 13/12 = "0/1"), P-0-1331 displays the valid value of P-0-1311 from the parameter set selected via P-0-1390.

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-36: Parameter attributes

11.34 P-0-1370, Configuration

The parameter P-0-1370 is used to configure process control.

Bit	Description/function	Comment
1/0	**Controller output** 00: Velocity command value (P-0-0690)	Set with regard to which variable in the drive the process controller takes effect.
2	**Position limit value monitoring** 0: Not active 1: Active	This bit allows position limit value monitoring to be activated. The limits are set in P-0-1381 and P-0-1382.
4/3	**Source of process feedback value** 00: Analog input / external sensor (P-0-1372)	Set wherefrom the process feedback value comes.
5	**Switch-off behavior** 0: Controller output = 0	Set how the drive is to behave when the process controller is switched off.
6	**Control difference** 0: Not inverted 1: Inverted	This bit allows the control difference to be inverted, if necessary
7	**Signal source for controller switching** 0: Effective process feedback value P-0-1273 1: Effective velocity command value P-0-0048	With this bit, select the signal to which the switch points for controller switching (P-0-1322, P-0-1323) relate
8	**Starting velocity upon start of process controller** 0: 0 1: Effective velocity command value P-0-0048 upon activation	With this bit, set at which velocity the drive is to move (S-0-0036) before the actual process control starts
9…31	Not used	

Tab. 11-37: Parameter structure

Min./max. value	0/-
Format	BIN
Unit	-
Type	Input register
Decimal places	None
Buffered parameter	Yes
Default value	-

Tab. 11-38: Parameter attributes

11.35 P-0-1371, Process command value

The command value for the process controller is preset via P-0-1371. Like this, the command value can be preset by a control unit via the master communication or an analog input.

Min./max. value	-/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	-

Tab. 11-39: Parameter attributes

11.36 P-0-1372, Process feedback value, analog

The feedback value for the process controller is read in via P-0-1372. Ideally, this parameter is assigned to an analog input of the drive controller.

Min./max. value	-/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Input register
Decimal places	4
Buffered parameter	No
Default value	-

Tab. 11-40: Parameter attributes

11.37 P-0-1373, Controller P-gain

The parameter P-0-1373 is used to preset the P-term of the process controller.

☞ In the case of external parameter set switching (P-0-1370, bit 13/12 = "0/1"), P-0-1373 displays the valid value of P-0-1311 from the parameter set selected via P-0-1390.

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0010

Tab. 11-41: Parameter attributes

11.38 P-0-1374, Controller I-term/PT1 disturbance filter, filter time constant

The parameter P-0-1374 is used to preset the I-term (integral-action time) of the process controller. If this integral action time is smaller than or equal to the controller cycle time, the I-term internally used to calculate the controller output is set to zero and thus is without effect. The I-term (P-0-1374) only takes effect for the typical PI controller (P-0-1375, Disturbance observer factor = "0").

If the value in "P-0-1375, Disturbance observer factor" is unequal "0", the time entered in P-0-1374 takes effect as the filter time constant of the PT1 filter in the disturbance observer.

☞ In the case of external parameter set switching (P-0-1370, bit 13/12 = "0/1"), P-0-1374 displays the valid value of P-0-1311 from the parameter set selected via P-0-1390.

Min./max. value	0.000/-
Format	DEC_OV
Unit	ms
Type	Input register
Decimal places	0
Buffered parameter	Yes
Default value	20

Tab. 11-42: Parameter attributes

11.39 P-0-1375, Disturbance observer factor

The parameter P-0-1375 is used to set the basic controller structure of the process controller.

If P-0-1375 = "0", it is a PI controller.

If P-0-1375 <> "0", it is a P-controller with disturbance observer.

The value in P-0-1375 can be used to set the influence of the disturbance observer on process control.

☞ In the case of external parameter set switching (P-0-1370, bit 13/12 = "0/1"), P-0-1375 displays the valid value of P-0-1311 from the parameter set selected via P-0-1390.

Min./max. value	0.000/-
Format	DEC_OV
Unit	rpm/ (bar/s)
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-43: Parameter attributes

11.40 P-0-1376, Upper limitation of disturbance observer

P-0-1376 can be used to set an upper limit for the controller output term of the disturbance observer. The term of the disturbance observer actually preset for the controller output and possibly limited is displayed in P-0-1278.

The lower limitation of the disturbance observer term is entered in P-0-1331. If the value in P-0-1376 = "0", the value from P-0-1377 takes effect as the upper limitation.

With the injection function activated (P-0-1390, bit 8 = 1), the value specified by the injection function always takes effect as the upper limitation of the ID-term. This value can deviate from the value entered in P-0-1376, if the relation of pressure feedback value to pressure command value exceeds the value from P-0-1311, list element 210. As long as P-0-1376 <> "0" and the relation of pressure feedback value to pressure command value is smaller than the value entered in P-0-1311, list element 210, an upper limit is set for the ID-term of the controller output to the value entered in P-0-1376.

If P-0-1376 = 0, P-0-1377 takes effect even with the injection function activated (as long as the relation of pressure feedback value to pressure command value is smaller than the value entered in P-0-1311, list lement 210). See also description of P-0-1377.

Min./max. value	-/-
Format	DEC_MV
Unit	Like P-0-0690
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-44: Parameter attributes

11.41 P-0-1377, Controller output limitation, upper

Via this parameter, it is possible to set an upper limit for the process controller output. The status word P-0-1410, bit 2, displays whether or not the limitation is active.

As long as P-0-1376 = "0", the value from P-0-1377 is also used for the lower limitation of the disturbance observer term (see also description of P-0-1376).

The value entered in P-0-1377 is also used for the injection function (P-0-1390, bit 8 = "1"): As long as P-0-1376 = "0" and the relation of pressure

feedback value to pressure command value is smaller than the value entered in P-0-1311, list element 210, an upper limit is set for the ID-term of the controller output to the value entered in P-0-1377.

With the slave mode/Q command value control activated, the value from P-0-1377 is preset for the drive as "S-0-0036, Velocity command value".

In order not to limit the controller output, enter accordingly high values in P-0-1377 (e.g., P-0-1377 > S-0-0091).

The entered value has to be signed!

If P-0-1328 <> "0", P-0-1377 is written by analog input 4 -> P-0-1377 = P-0-0229 * P-0-1328

For the slave mode to work correctly, the velocity control mode has to be active in the drive.

The slave mode is active if P-0-1370, bit 10 = "0" and P-0-1390, bit 0 = "0"

If the value in P-0-1377 is smaller than the value entered in P-0-1311, list element 204, the value from P-0-1311, list element 204, is preset in S-0-0036.

Min./max. value	-/-
Format	DEC
Unit	Like S-0-0091
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	10.0000

Tab. 11-45: Parameter attributes

11.42 P-0-1378, Controller output limitation, lower

Via this parameter, it is possible to set a lower limit for the process controller output. The status word P-0-1410, bit 3, displays whether or not the limitation is active.

In order not to limit the controller output, enter accordingly high values in P-0-1378 (e.g., P-0-1378 < S-0-0091).

The entered value has to be signed!

Min./max. value	-/-
Format	DEC
Unit	Like S-0-0091
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	-10.0000

Tab. 11-46: Parameter attributes

11.43 P-0-1380, Tolerance window

The tolerance window defines a range around the preset command value (P-0-1371). When the feedback value (P-0-1372) is within this range, the process controller signals back "Done" in the status word (P-0-1410, bit 1), i.e. the effective control difference (P-0-1270) is smaller than the tolerance window.

Min./max. value	0.0000/-
Format	DEC_MV
Unit	N or Nm; bar; mm; …
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	5.0000

Tab. 11-47: Parameter attributes

11.44 P-0-1381, Position limitation, upper

The parameter P-0-1381 is used to preset the upper (→ more positive) position limit value which the axis is not allowed to pass. When the position feedback value S-0-0051 reaches/exceeds the position limit that was set, the drive decelerates until standstill has been reached (command velocity = 0), as long as the process controller outputs controller output values (P-0-1385) which would not cause the drive to leave the limit. The entered value has to be signed! The position limitation is activated via P-0-1370, bit 2.

Min./max. value	-/-
Format	DEC_MV
Unit	Like position data
Type	Input register
Decimal places	Like position data
Buffered parameter	Yes
Default value	0

Tab. 11-48: Parameter attributes

11.45 P-0-1382, Position limitation, lower

The parameter P-0-1382 is used to preset the lower (→ more negative) position limit value which the axis is not allowed to pass. When the position feedback value S-0-0051 reaches or falls below the position limit that was set, the drive decelerates until standstill has been reached (command velocity = 0), as long as the process controller outputs controller output values (P-0-1385) which would not cause the drive to leave the limit. The entered value has to be signed! The position limitation is activated via P-0-1370, bit 2.

Min./max. value	-/-
Format	DEC_MV
Unit	Like position data
Type	Input register
Decimal places	Like position data
Buffered parameter	Yes
Default value	0

Tab. 11-49: Parameter attributes

11.46 P-0-1384, Command value feedforward factor

For command value feedforward, the effective process command value (P-0-1271) is multiplied with the value entered in P-0-1384 and subsequently is filtered (see P-0-1385).

Min./max. value	0.0000/-
Format	DEC_OV
Unit	-
Type	Input register
Decimal places	4
Buffered parameter	Yes
Default value	0.0000

Tab. 11-50: Parameter attributes

11.47 P-0-1385, Command value feedforward filter time constant

The effective process command value previously multiplied with P-0-1384 can be additionally filtered. In P-0-1385, the time constant in [ms] is set for this filter. The value thus filtered is then added to the controller output calculated in parallel in the PID controller. With P-0-1385="0", the filter is deactivated and the process command value is not filtered. In this case, feedforward of the effective process command value (P-0-1271), multiplied with P-0-1384, takes place directly, i.e. the effective process command value is added to the controller output of the PID controller.

Min./max. value	0/-
Format	DEC_OV
Unit	ms
Type	Input register
Decimal places	0
Buffered parameter	Yes
Default value	0

Tab. 11-51: Parameter attributes

12 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

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Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

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Fax:	**+49 9352 18 4941**
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Internet:	http://www.boschrexroth.com

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Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

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