

MLD Technology Function

Kinetic Buffering

Application Manual
R911397139

Edition 01



MLD

Title	MLD Technology Function Kinetic Buffering
Type of Documentation	Application Manual
Document Typecode	DOK-MLD***-TECFUNC*KB*-AP01-EN-P
Internal File Reference	RS-ee2bcb049530cafa0a347e86310d3d5a-1-en-US-4
Purpose of Documentation	This documentation describes the MLD technology function "Kinetic Buffering". The "Kinetic Buffering" function allows energy to be buffered.
Record of Revisions	Edition 01, 2019-03 See tab. 1-1 "Record of revisions" on page 1
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Editorial Department	DC-AE/ESW4 (wernhind), DC-AE/EPI5 (svenanso), DC-AE/EPI4 (barbboee)

Table of Contents

	Page
1 About this documentation.....	1
2 Safety instructions for electric drives and controls.....	3
2.1 Definitions of terms.....	3
2.2 General information.....	4
2.2.1 Using the Safety instructions and passing them on to others.....	4
2.2.2 Requirements for safe use.....	4
2.2.3 Hazards by improper use.....	6
2.3 Instructions with regard to specific dangers.....	6
2.3.1 Protection against contact with electrical parts and housings.....	6
2.3.2 Protective extra-low voltage as protection against electric shock	8
2.3.3 Protection against dangerous movements.....	8
2.3.4 Protection against electromagnetic and magnetic fields during operation and mounting.....	9
2.3.5 Protection against contact with hot parts.....	10
2.3.6 Protection during handling and mounting.....	10
2.3.7 Battery safety.....	10
2.3.8 Protection against pressurized systems.....	11
2.4 Explanation of signal words and the Safety alert symbol.....	12
3 Important directions for use.....	13
3.1 Intended use.....	13
3.1.1 Introduction.....	13
3.1.2 Areas of use and application.....	13
3.2 Unintended use.....	14
4 Required components.....	15
4.1 Drive controller.....	15
4.2 Drive firmware.....	15
4.3 Commissioning software.....	16
5 Implementing the functions in the drive.....	17
5.1 Providing the technology functions	17
5.2 Integration in the diagnostic system.....	17
5.3 Parameterization and operation.....	17
6 Loading the technology function to the drive.....	19
7 Brief description of the function.....	21
8 Functional description.....	25
8.1 Controller structure.....	25
8.2 Functionality.....	28

Table of Contents

	Page
9 Notes on commissioning and operation.....	35
9.1 Configuring and operating via parameters.....	35
9.2 Configuring and operating via IndraWorks.....	35
9.3 Setting the error reaction for the Kinetic Buffer drive.....	38
9.4 Setting the error reaction for the motion axis/axes.....	39
9.5 Higher-level control unit: sequence control.....	39
10 Diagnostic and status messages.....	41
11 Descriptions of the parameters.....	43
11.1 P-0-1270, Voltage controller output.....	43
11.2 P-0-1271, Power feedforward controller output.....	43
11.3 P-0-1272, Speed controller output.....	43
11.4 P-0-1280, Current mechanical energy.....	44
11.5 P-0-1300, Sum of DC bus powers of axes.....	44
11.6 P-0-1301, Sum of DC bus powers	45
11.7 P-0-1319, Power feedforward factor	46
11.8 P-0-1320, Lower power threshold	46
11.9 P-0-1321, Upper power threshold	46
11.10 P-0-1329, E-Stop delay.....	47
11.11 P-0-1331, Error ID.....	47
11.12 P-0-1370, Config word.....	48
11.13 P-0-1371, Buffer command speed	50
11.14 P-0-1372, Upper speed threshold	50
11.15 P-0-1373, Lower speed threshold	51
11.16 P-0-1374, DC bus capacitance	51
11.17 P-0-1375, Total inertia	51
11.18 P-0-1376, Speed controller P-gain	52
11.19 P-0-1377, Speed controller integral action time	53
11.20 P-0-1379, Speed controller torque limit value	53
11.21 P-0-1380, Nominal command voltage	54
11.22 P-0-1381, Maximum voltage dip	54
11.23 P-0-1382, Maximum voltage increase	55
11.24 P-0-1383, Voltage controller P-gain	55
11.25 P-0-1384, Voltage controller integral action time	56
11.26 P-0-1387, Diagnostic text.....	56
11.27 P-0-1390, Control word.....	56
11.28 P-0-1391, Delayed E-Stop input.....	57
11.29 P-0-1410, Status word	58
12 Service and support.....	61
Index.....	63

1 About this documentation

Editions of this documentation

Edition	Release date	Notes
DOK-MLD***-TECFUNC*KB*-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.

Qualified personnel for handling functionally safe products

Individuals configuring, commissioning and operating functionally safe products must have the knowledge specified under "[Qualified persons](#)". Additionally, these individuals must be familiar with technical safety concepts as well as prevailing standards and regulations in the field of functional safety.

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 mm² (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 equipment 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!

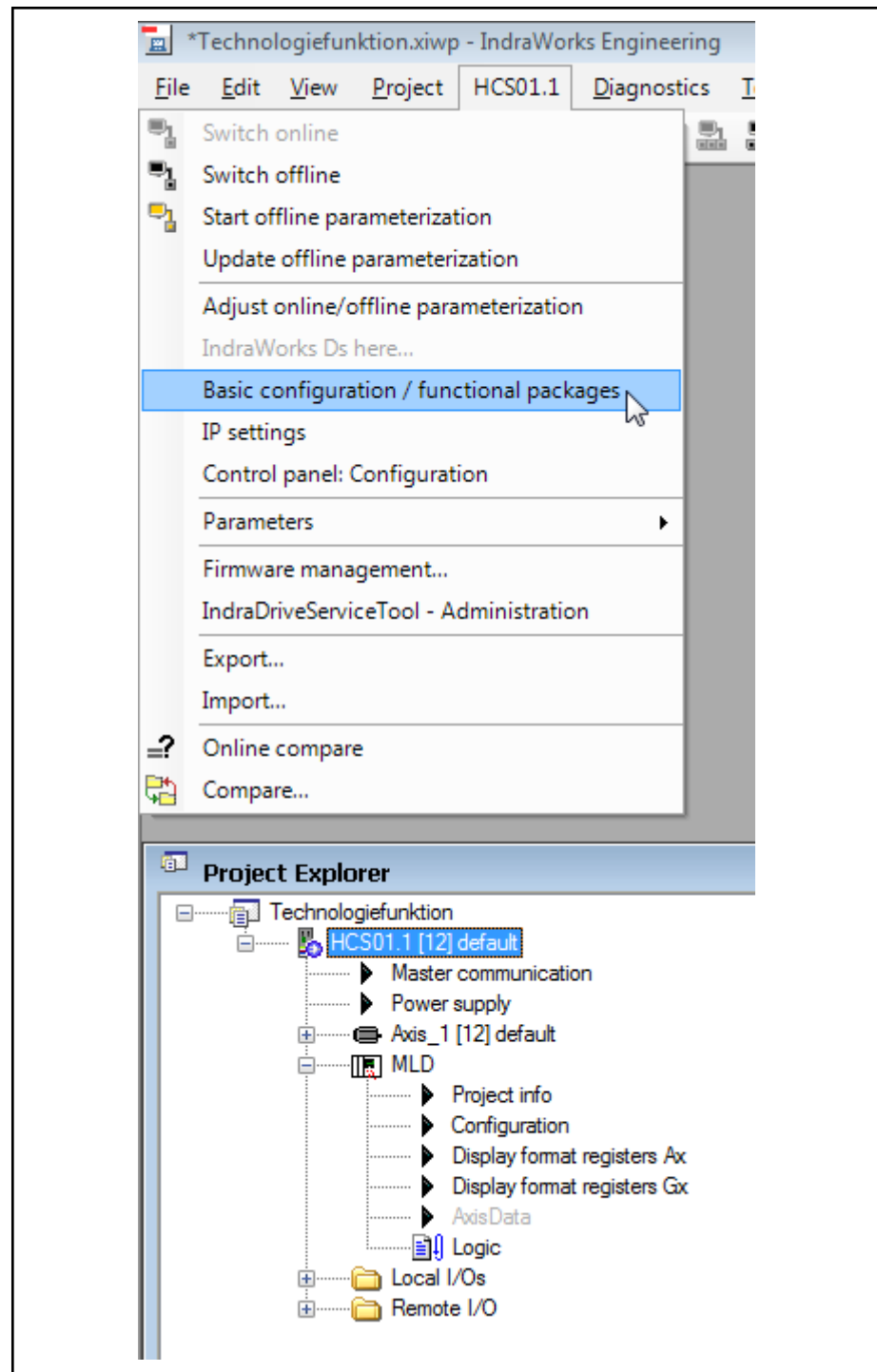


Fig. 4-1: Enabling functional packages

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](#)")

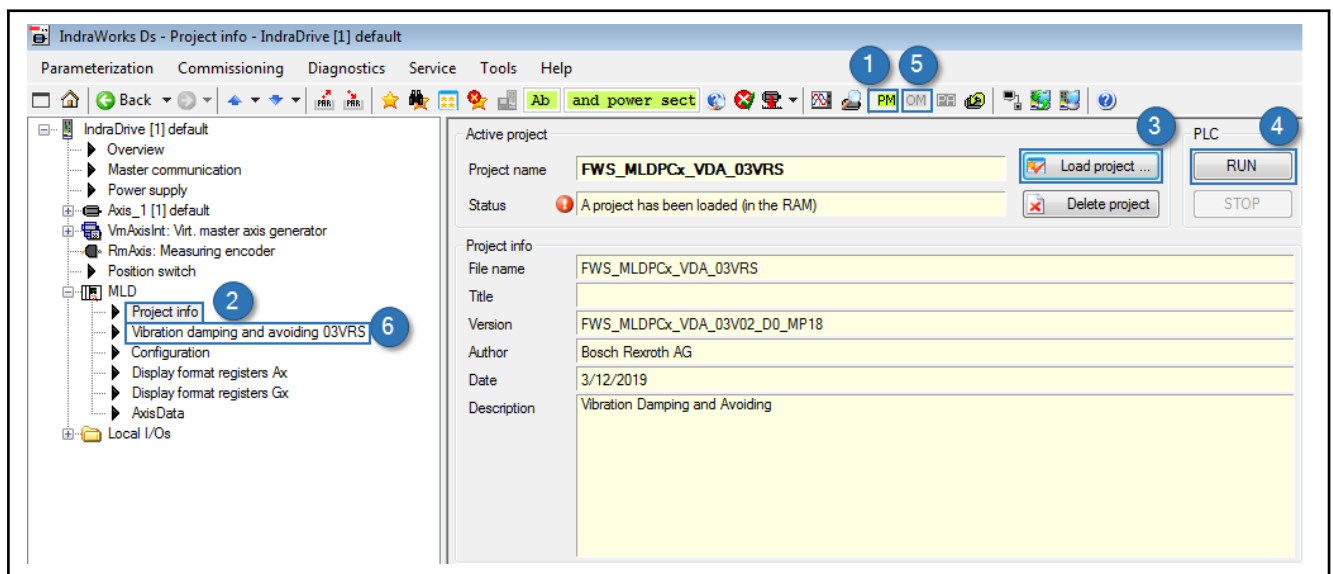


Fig. 6-1: Transmitting a technology function to the drive

7 Brief description of the function

Purpose of the function The MLD technology function "Kinetic Buffering" is used to control a flywheel energy-storage system employed as a kinetic energy buffer.

The MLD technology function "Kinetic Buffering" is made available as the "FWS_MLDEAx_KIB_xxVxx_D0_MPxx" project file. To use an MLD technology function, it has to be loaded to the drive (see "[Loading the technology function to the drive](#)").

The flywheel energy-storage system is embedded in a system consisting of a controlled/uncontrolled supply and one or multiple machine axes. Supply, power sections of the machine axes and power section of the flywheel energy-storage system are coupled via the DC bus.

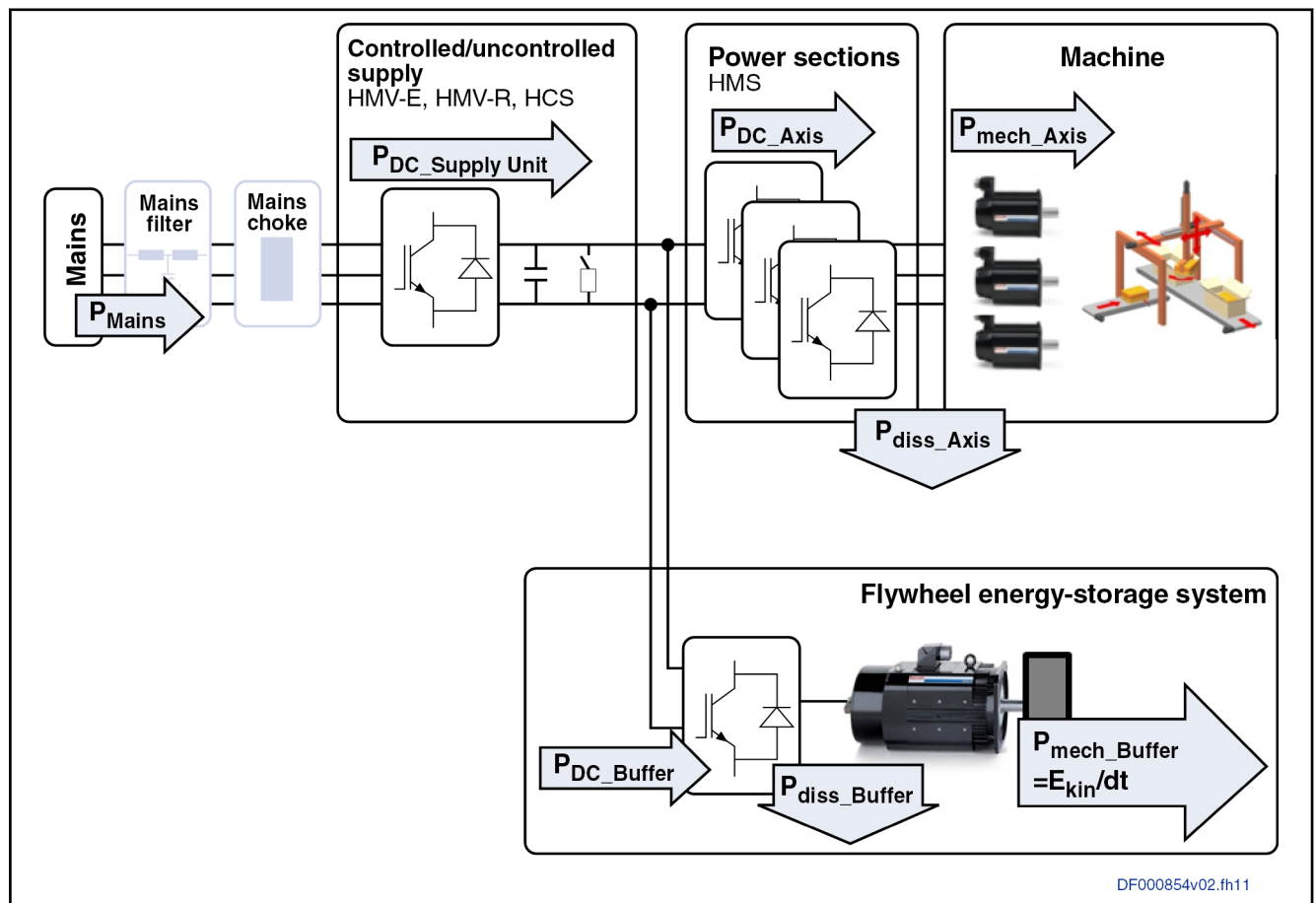


Fig. 7-1: System structure

The kinetic energy buffer stores energy in a rotating mass (motor and, if required, additional inertia).

The kinetic energy is **reduced** or **increased** as required.

The average buffer motor speed is constant. The losses of the flywheel energy-storage system and of the machine axes plus the possibly required process energy are covered by the mains.

Brief description of the function

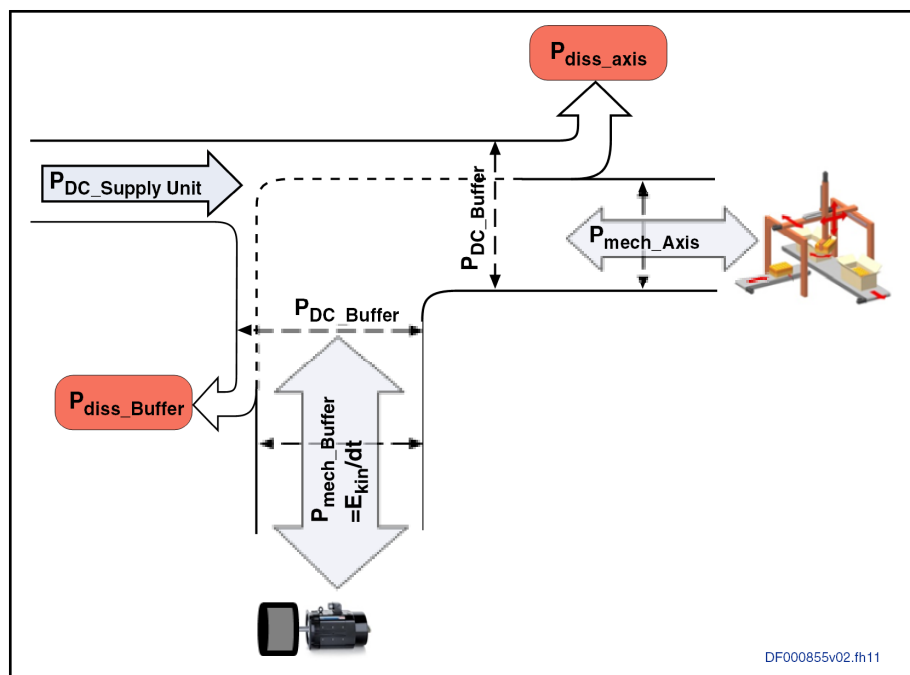


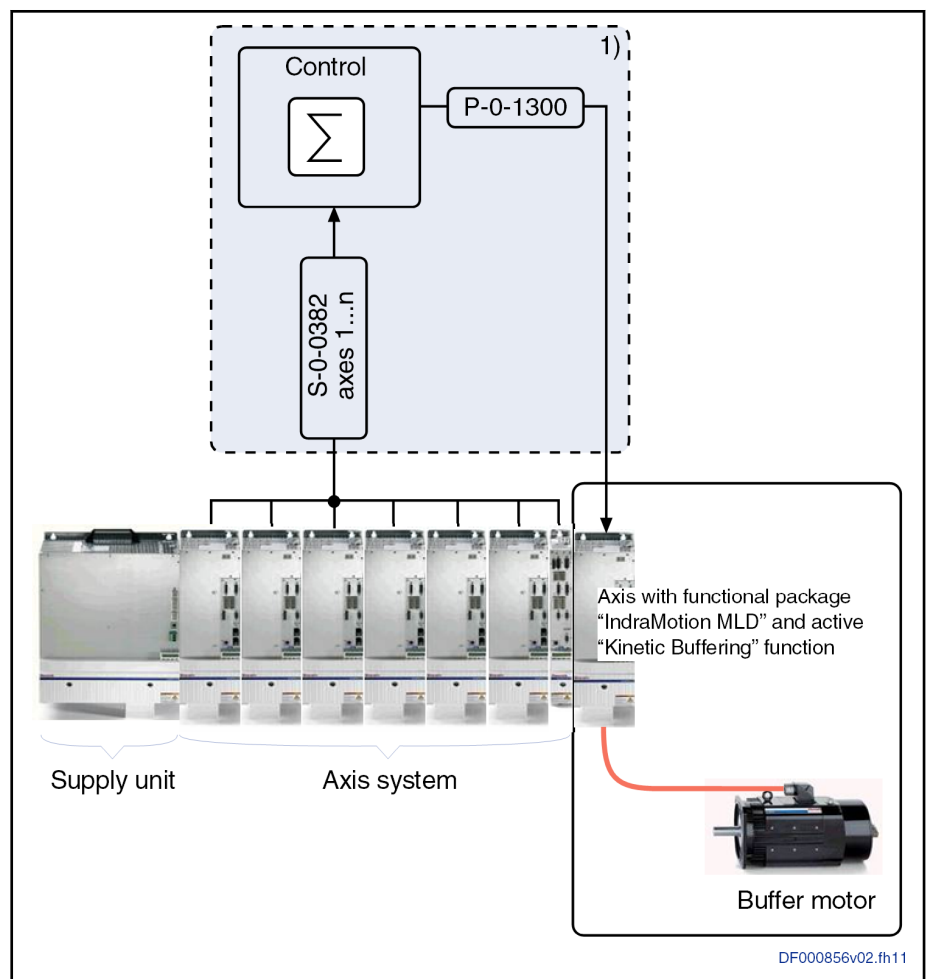
Fig. 7-2: Mains power regulation

Areas of application

These are the fields of application of the function:

- Reducing the mains peak power by dynamically buffering the machine peak power.
- Mains failure buffering to maintain the DC bus supply in the case of mains failure.
- Stabilizing the DC bus voltage in the case of mains variations.
- Absorption of regenerative power of the machine in the case of uncontrolled supply units, and output of regenerative power to the machine.

Requirements of use



- 1) The sum of the DC bus powers of the axes (P-0-1300) has to be generated in a higher-level control unit (a CCD master is also possible) by summing the parameter S-0-0382 of the individual machine axes.

Fig. 7-3: System requirements

- Supply unit: uncontrolled supply (HMF-E, HCS) or controlled supply (HMF-R)
- Axis system with DC bus coupling
- Additional buffer axis with the following components:
 - Power section
 - Buffer motor (synchronous or asynchronous, with encoder)
 - MLD technology function "Kinetic Buffering"

Restrictions of the function Only buffer motors with encoder are supported.

Parameters involved See "[Parameters](#)"

8 Functional description

The technology function "Kinetic Buffering" runs on the drive-integrated "IndraMotion MLD" control.

8.1 Controller structure

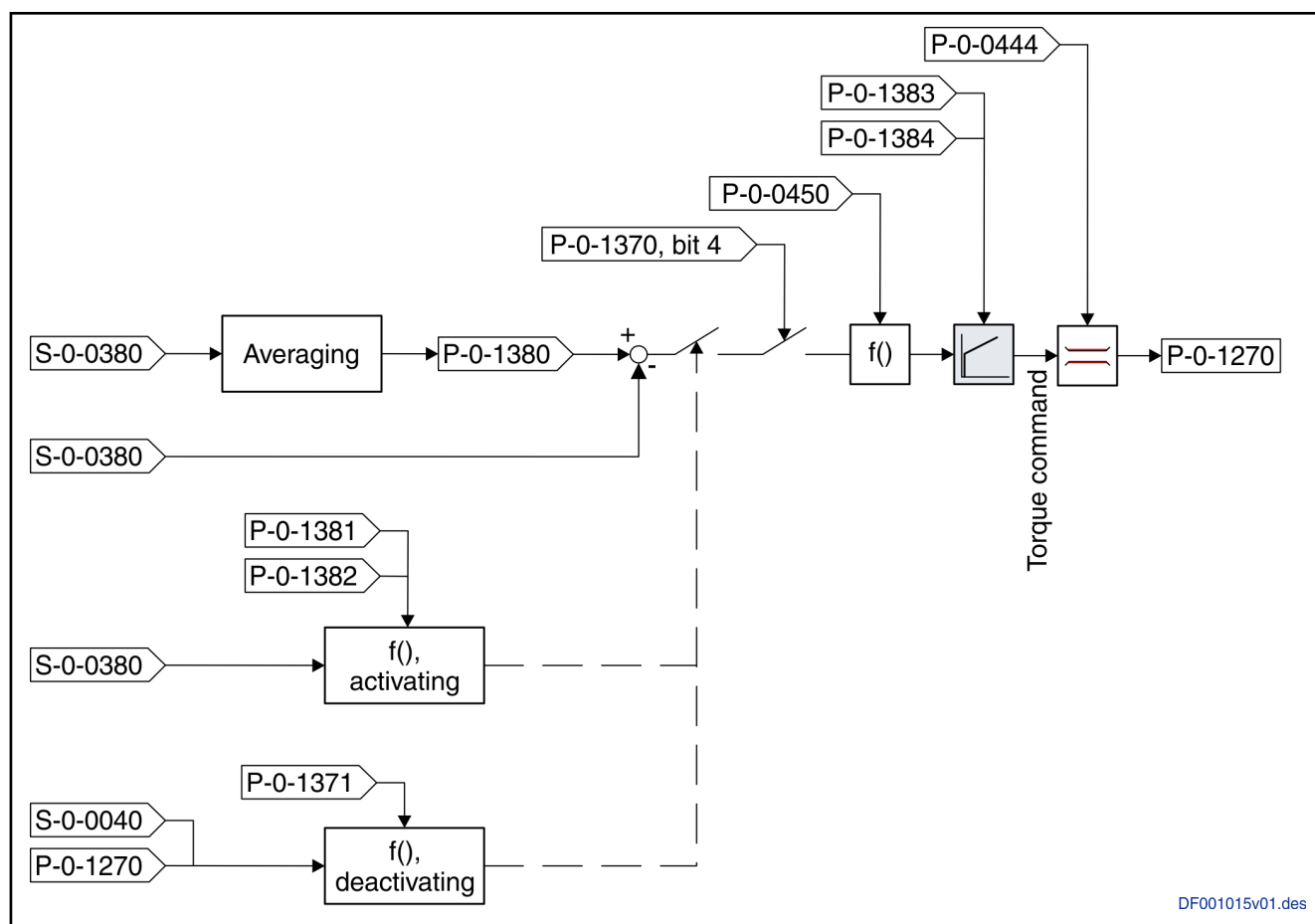
"Kinetic Buffering" basically involves four controllers:

1. Voltage controller
2. Power controller
3. Velocity controller
4. Torque controller

Voltage controller

- Determining and correcting a nominal DC bus command voltage (see P-0-1380)
- Mains failure detection
- Controlling the voltage with regard to the nominal DC bus command voltage in the case of mains failure
- Output of an additive torque command value
- Torque limitation

Functional description

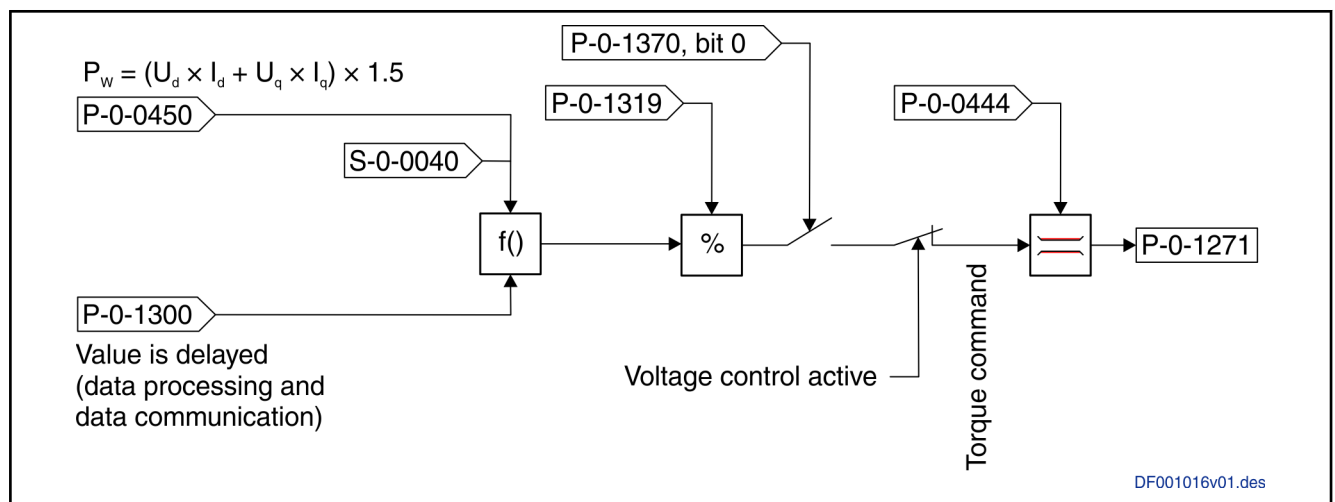


P-0-0444	Actual value peak torque limit
P-0-0450	Current torque/force constant
P-0-1270	Voltage controller output
P-0-1370, bit 4	DC voltage control activated/deactivated
P-0-1371	Buffer command speed
P-0-1380	Nominal command voltage
P-0-1381	Maximum voltage dip
P-0-1382	Maximum voltage increase
P-0-1383	Voltage controller P-gain
P-0-1384	Voltage controller integral action time
S-0-0040	Velocity feedback value of encoder 1
S-0-0380	DC bus voltage

Fig. 8-1: Voltage controller

Power controller

- Converting the sum of the DC bus powers of all axes to torque
- Torque scaling with power feedforward factor
- Output of an additive torque command value
- Torque limitation

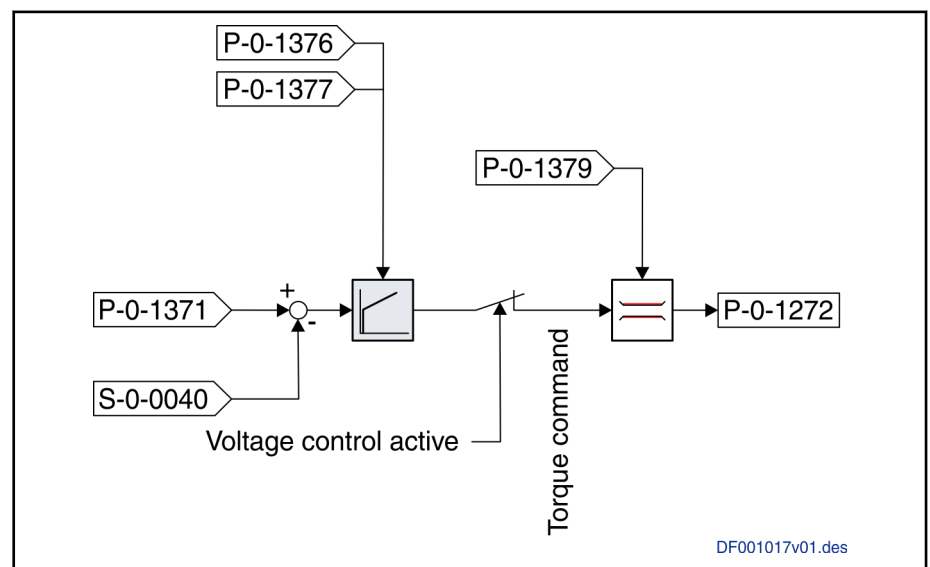


- P-0-0444** Actual value peak torque limit
P-0-0450 Current torque/force constant
P-0-1271 Power feedforward controller output
P-0-1300 Sum of DC bus powers of axes
P-0-1319 Power feedforward factor
P-0-1370, bit 0 Power feedforward activated/deactivated
S-0-0040 Velocity feedback value of encoder 1

Fig. 8-2: Power controller

Velocity controller

- Control with regard to the buffer command speed
- Output of an additive torque command value
- Torque limitation



- P-0-1272** Speed controller output
P-0-1371 Buffer command speed
P-0-1376 Speed controller P-gain
P-0-1377 Speed controller integral action time
P-0-1379 Speed controller torque limit value
S-0-0040 Velocity feedback value of encoder 1

Fig. 8-3: Velocity controller

Functional description

Torque controller Adding the additive torque command values of voltage controller, power controller and velocity controller and writing the total torque to S-0-0081 (additive torque/force command value).

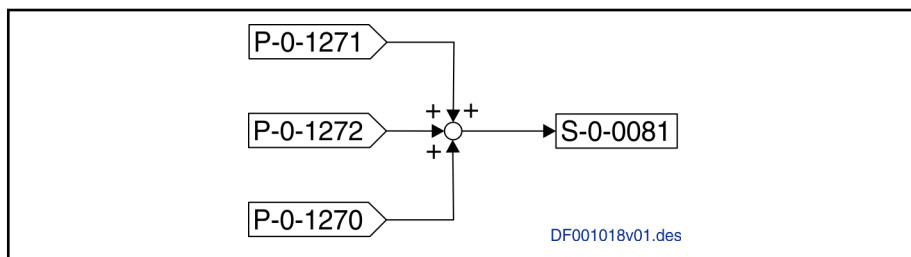


Fig. 8-4: Torque controller

Normally, only the power controller and the speed controller are active (if activated in P-0-1370). The voltage controller only becomes active in the case of overvoltage or undervoltage in the DC bus (if activated in P-0-1370). If the voltage controller is active, the power controller and speed controller are deactivated.

8.2 Functionality

The technology function provides the following functionality:

- Mains failure detection and DC bus voltage stabilization in the case of mains failure
- Mains power regulation: mains power smoothing / mains peak power reduction

Mains failure detection and DC bus voltage stabilization in the case of mains failure

The DC bus voltage stabilization is activated in P-0-1370, bit 4.

In the case of mains failure, the DC bus voltage is stabilized by the buffer motor outputting energy to the DC bus or absorbing energy from the DC bus. It is thereby possible to bring the machine axes to a safe position or complete a machine cycle that was started. The control voltage has to be maintained by an independent power supply. As long as the buffer motor power is greater than the machine power, the DC bus voltage does not drop.

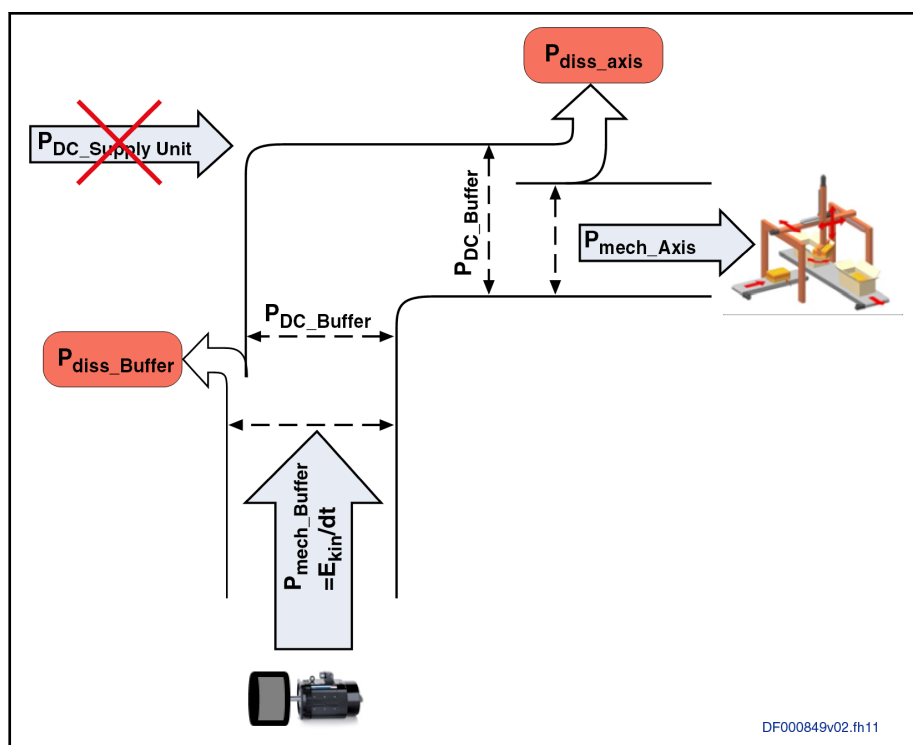


Fig. 8-5: Mains failure: reducing the kinetic energy by power output to the DC bus

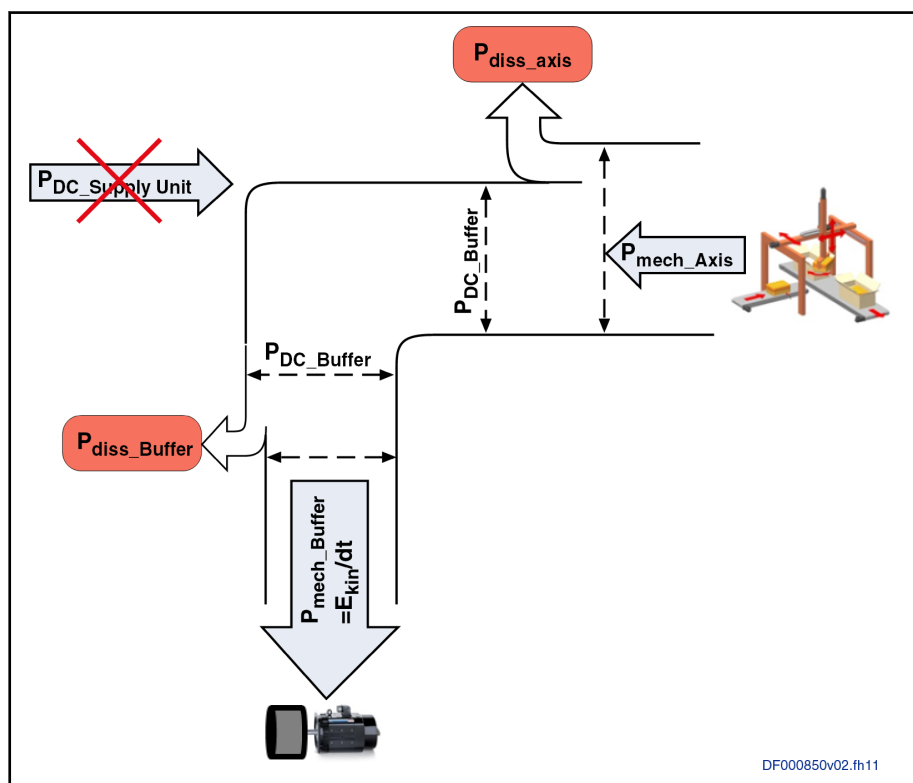


Fig. 8-6: Mains failure: increasing the kinetic energy by power absorption from the DC bus



If only the mains failure buffering function is required, it is not necessary to use a specific buffer motor if certain conditions have been complied with. An available machine axis can be used instead. The machine axis always has to be in motion and at any time needs to have enough energy available for possible mains failures. Conceivable solutions are, for example, drives in presses that drive the flywheel or drives in printing machines that run in continuous operation. If the buffer axis is part of the motion, voltage stabilization is the only option. This special case is activated in P-0-1370, bit 15.

Mains power regulation: mains power smoothing / mains peak power reduction

The mains failure is detected via the maximum voltage dip (P-0-1381), and/or via the module bus status word P-0-0461, bit 1 (falling edge) for HMU05 or P-0-0461, bit 3 (rising edge) for HCS01/02/03/04, HMV01/02, and/or via the control word P-0-1390, bit 0 (rising edge). Mains failure detection requires that the DC bus voltage stabilization be activated (P-0-1370, bit 4).

The mains power regulation (mains peak power reduction / power feedforward) is activated in P-0-1370, bit 0.

Mains power regulation serves the purpose of mains power smoothing. The Kinetic Buffer can reduce mains peaks.

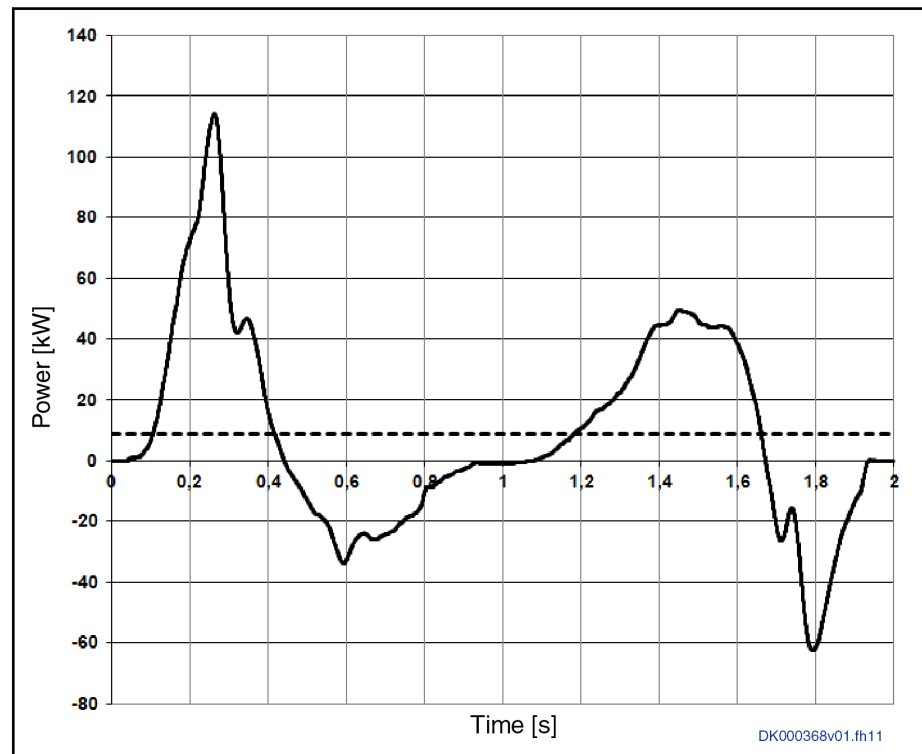
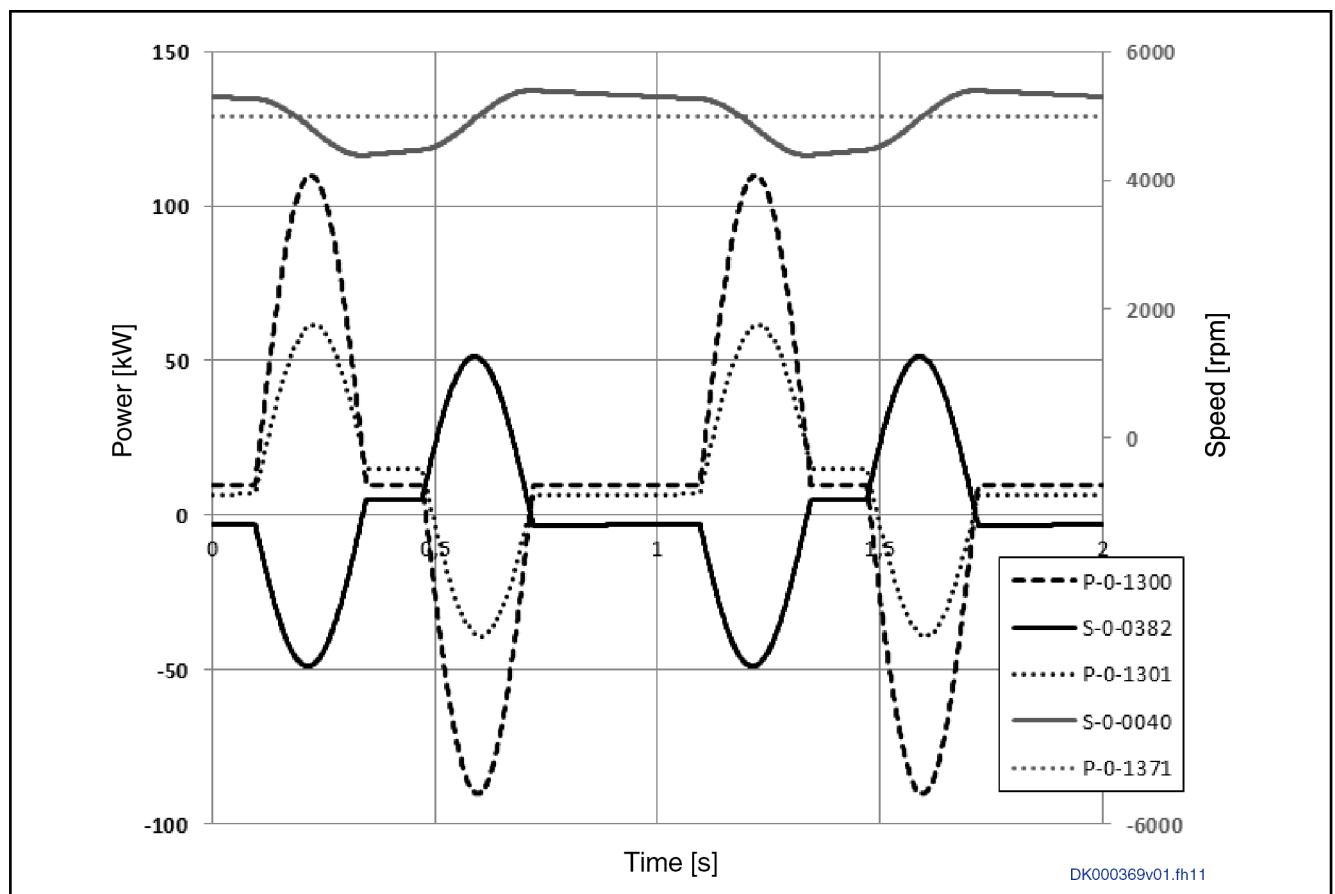


Fig. 8-7: Example of a performance profile with high positive and negative power peaks

High power peaks imply high mains-side current peaks and thus high losses ($P \sim R \times I^2$) in the supply unit and the mains components (filter, choke, fuse, transformer). Since the supply unit and the mains components are sized according to the required peak power, it might be possible to use supply units of lower performance and mains connection components of lower performance. Reducing mains peaks can be essential in areas of weak grids.

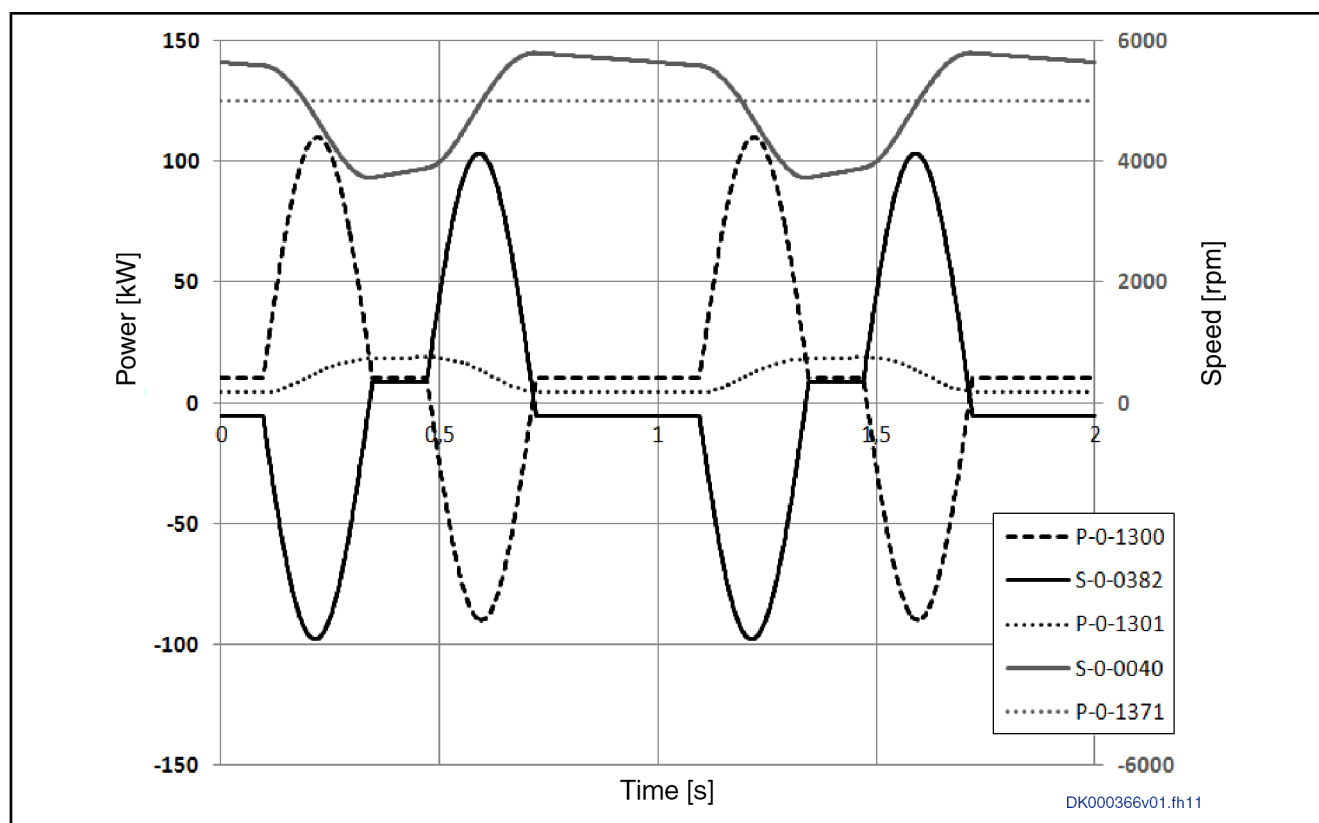
Via the power feedforward factor, a percentage can be set that defines the extent to which the buffer axis is to buffer the sum of the DC bus powers of the axes (P-0-1300).



P-0-1300	Sum of DC bus powers of axes
P-0-1301	Sum of DC bus powers
P-0-1371	Buffer command speed
S-0-0040	Velocity feedback value of encoder 1
S-0-0382	DC bus power

Fig. 8-8: Power feedforward factor 50%

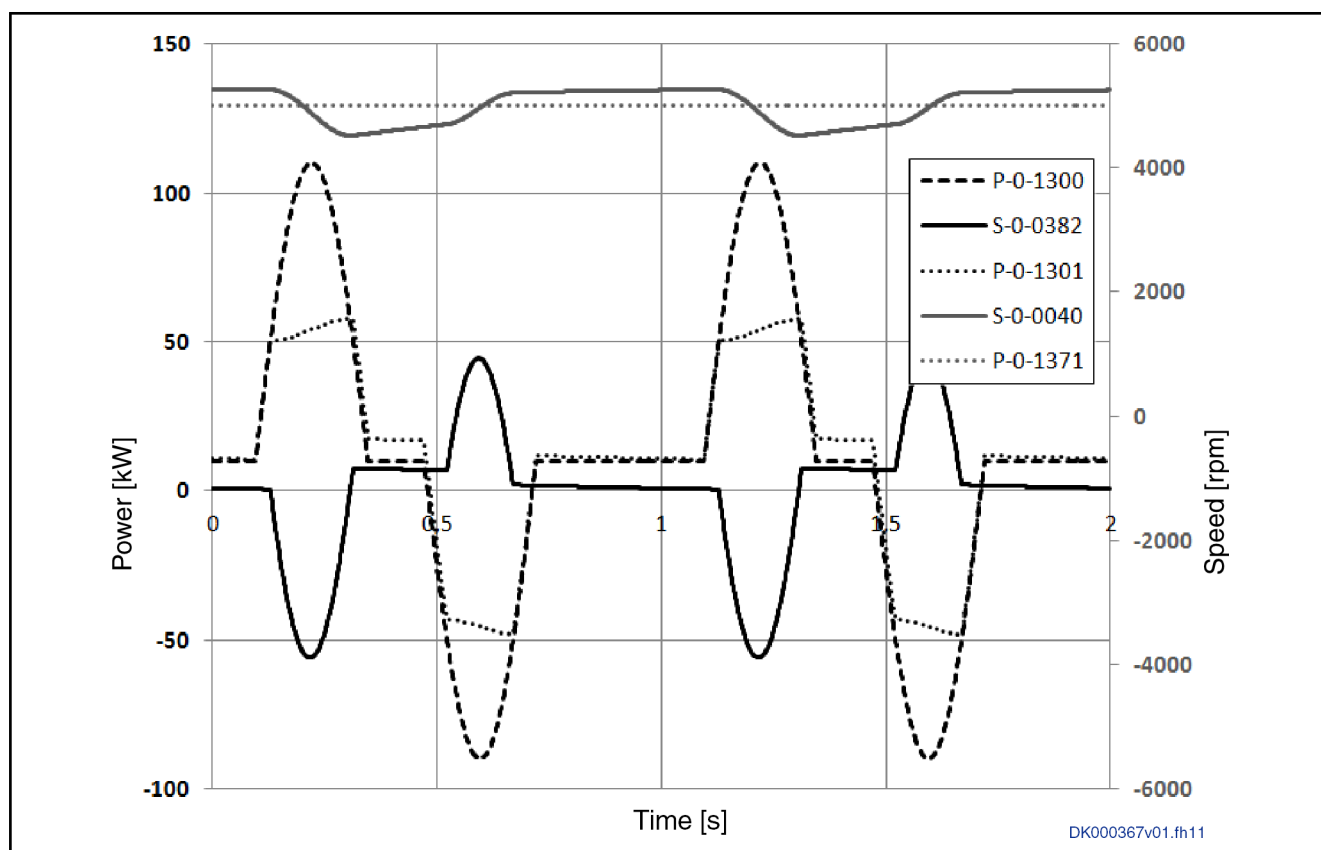
Functional description



P-0-1300	Sum of DC bus powers of axes
P-0-1301	Sum of DC bus powers
P-0-1371	Buffer command speed
S-0-0040	Velocity feedback value of encoder 1
S-0-0382	DC bus power

Fig. 8-9: Power feedforward factor 100%

"P-0-1320, Lower power threshold" in conjunction with "P-0-1321, Upper power threshold" are used to define a power masking window in which the mains power regulation is not active. Outside of this power masking window, the sum of the DC bus powers of the axes (P-0-1300) is regulated, less the power masking window.



P-0-1300	Sum of DC bus powers of axes
P-0-1301	Sum of DC bus powers
P-0-1371	Buffer command speed
S-0-0040	Velocity feedback value of encoder 1
S-0-0382	DC bus power

Fig. 8-10: Upper power threshold = 50 kW and lower power threshold = -50 kW



Inputting "0" for the lower power threshold switches off the threshold.

Inputting "0" for the upper power threshold switches off the threshold.

9 Notes on commissioning and operation

The MLD technology function "Kinetic Buffering" is made available as the "FWS_MLDEAx_KIB_xxVxx_D0_MPxx" project file. To use an MLD technology function, it has to be loaded to the drive (see "Loading the technology function to the drive").

9.1 Configuring and operating via parameters

Parameterize the following registers:

- Enter buffer command speed in P-0-1371
- Enter rotor inertia in P-0-0510 and load inertia in P-0-4010. The total inertia (sum of rotor inertia and load inertia) is displayed in P-0-1375
- Set speed controller torque limit value to 50 % of nominal motor torque in P-0-1379
- Enter upper speed threshold in P-0-1372 and lower speed threshold in P-0-1373. Please observe "S-0-0091, Bipolar velocity limit value".
- Configure desired function in P-0-1370
- For optional "DC bus voltage stabilization" function (P-0-1370, bit 4):
 - Enter DC bus capacitance in P-0-1374
 - Enter maximum voltage dip in P-0-1381 and maximum voltage increase in P-0-1382
- For optional "mains peak power reduction" function (P-0-1370, bit 0):
 - Enter power feedforward factor in P-0-1319
 - Enter lower power threshold in P-0-1320 and upper power threshold in P-0-1321
- Setting operation mode of buffer axis: Set primary operation mode to "torque control" in S-0-0032

9.2 Configuring and operating via IndraWorks

When the technology function Kinetic Buffering has been loaded to the axis via IndraWorks, the user interface can be opened using the "Kinetic Buffering" button in the branch below MLD.

Notes on commissioning and operation

Technology function Kinetic Buffering

Status

☐ Error (see status text)

Function ready

☐ Speed in tolerance window

Motor velocity Rev/s Total inertia kgm² Current mechanical energy kW

Configuration

Buffer command speed Rev/s Motor inertia kgm² Load inertia kgm²

☒ Power feedforward

Power feedforward factor %

Total DC bus power Without Buffer Watt

DC bus power Buffer Watt

Controller output power feedforward %

Controller output power feedforward Watt

Total DC bus voltage

☒ DC voltage control

Total capacity mF

DC bus voltage Nominal V

dc Bus voltage V

DC Voltage Control

Controller output DC voltage control %

Active

Mains failure

Limit active

Torque control

Parameter group

DB001070_v01.png

Fig. 9-1: User interface for the technology function "Kinetic Buffering"

If the check box for power feedforward has been ticked, the configuration dialog for power feedforward can be opened by clicking the **Power feedforward** button.

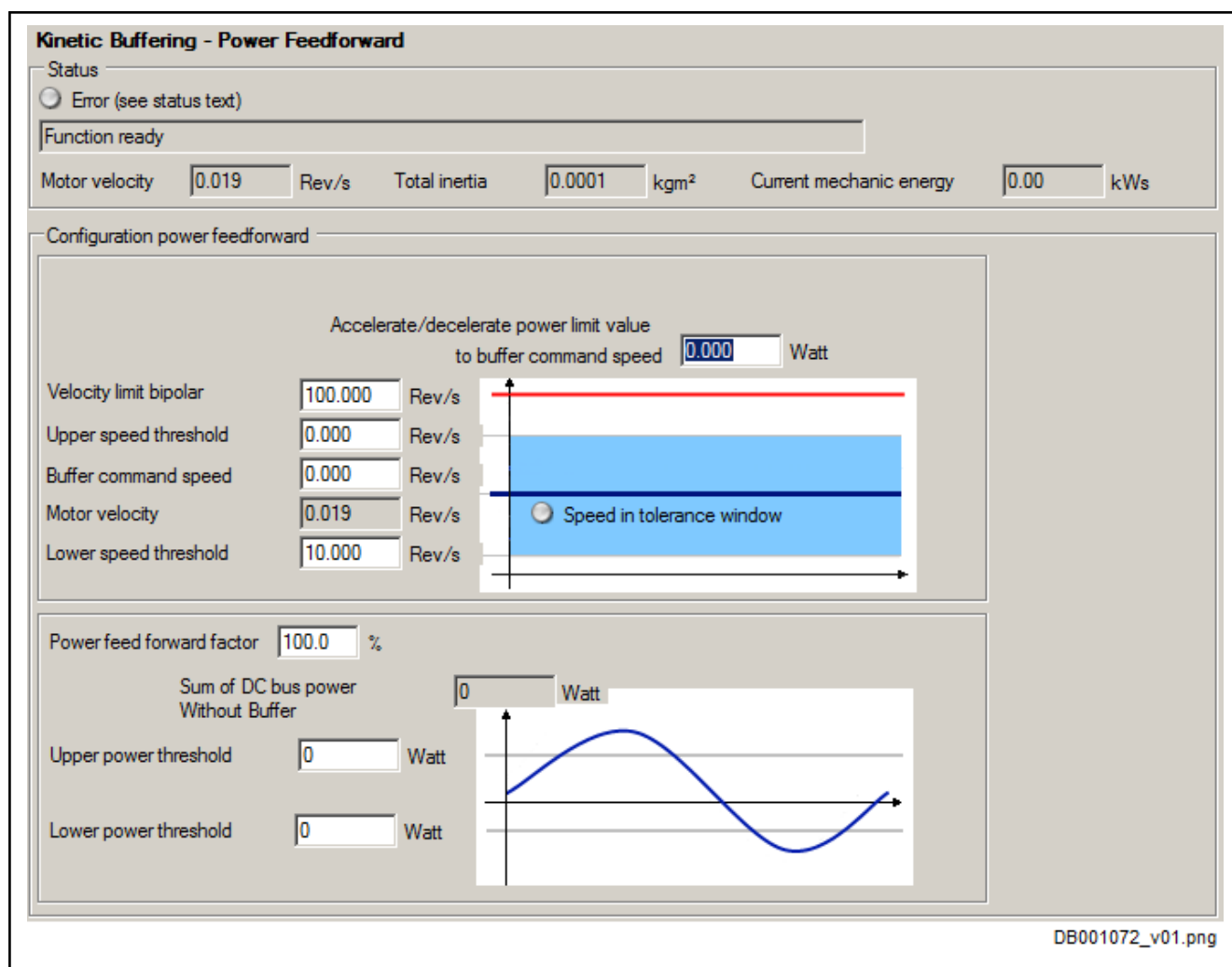


Fig. 9-2: Configuring power feedforward

If the check box for DC voltage control has been ticked, the configuration dialog for DC voltage control can be opened by clicking the **DC voltage control** button.

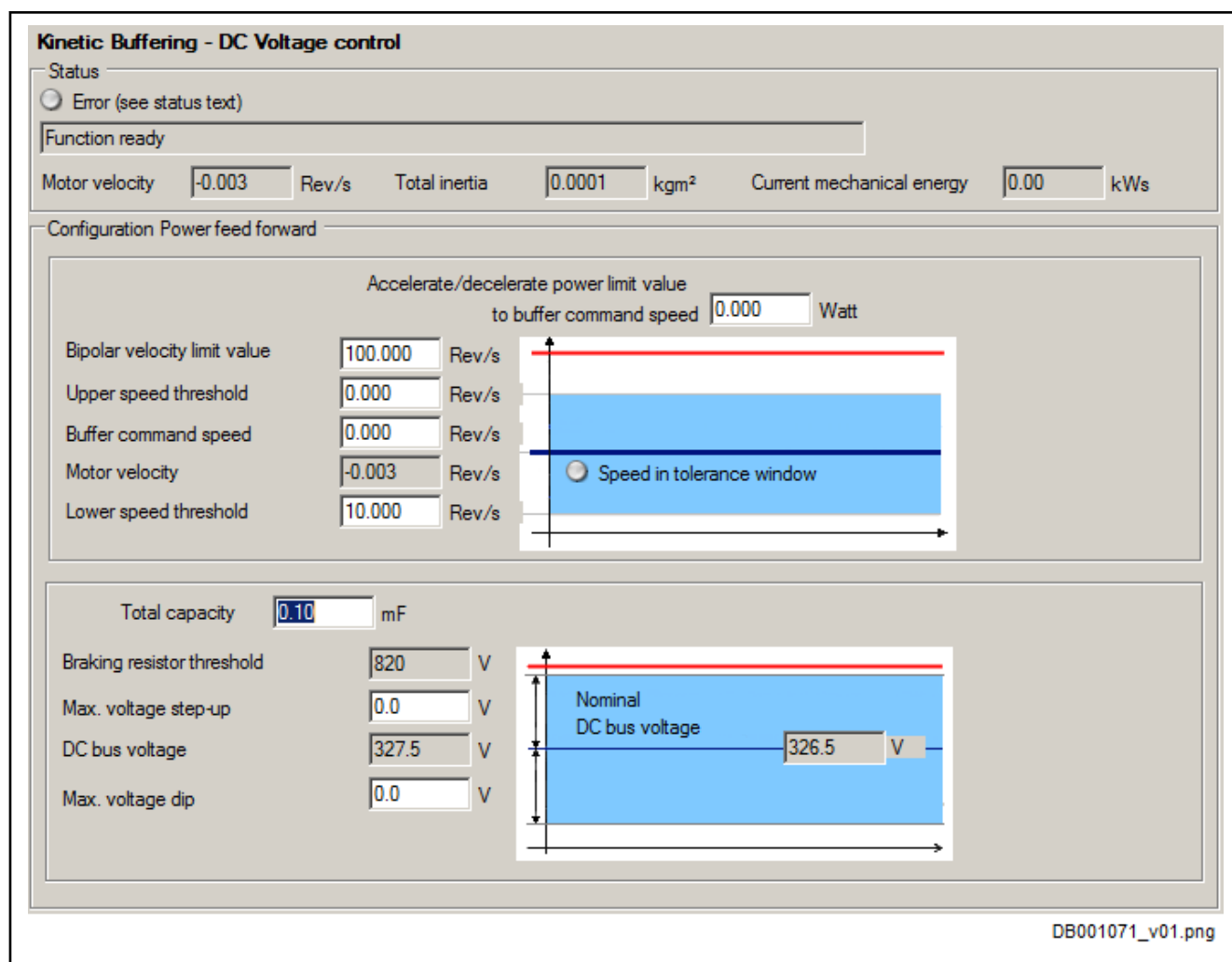


Fig. 9-3: Configuring DC voltage control

9.3 Setting the error reaction for the Kinetic Buffer drive



The settings described here are to be understood as examples and have to be adjusted to the application requirements.

Error reaction drive (P-0-0117)

Drive reaction to errors and by switching off drive enable: 30s external NC reaction, then best possible deceleration

Best possible deceleration:

F2/F3/F4 errors: Velocity command value reset (emergency stop) with ramp and filter

F6/F7 errors: Velocity command value reset (emergency stop) with ramp and filter

Emergency halt deceleration (S-0-0429): e.g. 500 rad/s²

Error reaction power section (P-0-0118.0.0):

- Package reaction:
 - Reaction to errors in the module group (to be activated optionally)

- Package reaction triggered in the case of error (to be activated optionally)
- DC bus undervoltage: undervoltage as a non-fatal warning (E2026), no drive error reaction
- Power off in the case of error: only for power supply errors

9.4 Setting the error reaction for the motion axis/axes



The settings described here are to be understood as examples and have to be adjusted to the application requirements.

Error reaction power section (P-0-0118.0.0):

- Package reaction:
 - Reaction to errors in the module group (to be activated optionally)
 - Package reaction triggered in the case of error (to be activated optionally)
- DC bus undervoltage: undervoltage as a non-fatal warning (E2026), no drive error reaction
- Power off in the case of error: only for power supply errors

9.5 Higher-level control unit: sequence control

In the view of the buffer axis the higher-level control unit is the master. The following sequence control has to be implemented in the higher-level control unit:

- Switching buffer axis from Ab to AF
- Activating buffer command speed (P-0-1390, bit 1), if bit 8 = 1 was set in P-0-1370; otherwise, the run-up to buffer speed occurs automatically when switching from Ab to AF takes place
- Waiting until buffer motor has reached its command speed; for this purpose checking bit 12 in P-0-1410
- As soon as P-0-1410, bit 12 = 1, the motion of the machine axes can be started.
- The higher-level control unit sums up the DC bus powers of all machine axes (S-0-0382) connected to a common DC bus together with the buffer motor. The total power is cyclically written to P-0-1300.

10 Diagnostic and status messages

The status of MLD is output as a hexadecimal encoded number (e.g., "0xE2011001") via P-0-1331.

Error ID	Diagnostic/status message
0x00000000	Function ready
0xE2011001	Buffer command speed P-0-1371 greater than velocity limit value
0xE2011002	Velocity tolerance window upper threshold P-0-1372 < lower threshold P-0-1373
0xE2011003	Velocity tolerance window upper/lower threshold P-0-1372/P-0-1373 > velocity limit value
0xE2011004	Motor inertia P-0-0510 not parameterized
0xE2011005	Load inertia P-0-4010 not parameterized
0xE2011006	Total capacitance P-0-1374 not parameterized
0xE2011007	E-Stop delay outside of input range (0... 30 s)
0xE2011008	Waiting time for "nominal command voltage correction" outside of input range (0...30s)
0xE2011009	Required optional functional package "MA" not activated

11 Descriptions of the parameters

11.1 P-0-1270, Voltage controller output

The parameter displays the torque command value generated by the DC voltage controller.



The display value is only updated every 50 ms

Attributes

Data length	4 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Default	-
Type	Output register
Decimal places	S-0-0093 / S-0-0094
Buffered if control voltage fails	No

Tab. 11-1: Parameter attributes - P-0-1270, Voltage controller output

11.2 P-0-1271, Power feedforward controller output

The parameter displays the torque command value generated by power feedforward.



The display value is only updated every 50 ms

Attributes

Data length	4 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	S-0-0086
Default	-
Type	Output register
Decimal places	S-0-0093 / S-0-0094
Buffered if control voltage fails	No

Tab. 11-2: Parameter attributes - P-0-1271, Power feedforward controller output

11.3 P-0-1272, Speed controller output

The parameter displays the torque command value generated by the MLD speed controller.



The display value is only updated every 50 ms

Attributes	Data length	4 bytes
	Min./max. value	-/-
	Format	DEC_MV
	Unit	S-0-0086
	Default	-
	Type	Output register
	Decimal places	S-0-0093 / S-0-0094
	Buffered if control voltage fails	No

Tab. 11-3: Parameter attributes - P-0-1272, Speed controller output

11.4 P-0-1280, Current mechanical energy

The parameter displays the mechanical (kinetic) energy E_{kin} currently stored in the buffer motor.

$$E_{\text{kin}} = \frac{1}{2} \times J \times \frac{\left(n \times \frac{\pi}{30} \right)^2}{1000} \text{ [kJ]}$$

E_{kin} Mechanical (kinetic) energy
 J [kgm²] Inertia (motor and load inertia)
 n [rpm] Motor speed

Fig. 11-1: Calculating the mechanical energy



The value will only be displayed correctly if "P-0-0510, Rotor inertia" and "P-0-4010, Load inertia" have been parameterized exactly.

Attributes	Data length	4 bytes
	Min./max. value	-/-
	Format	DEC_MV
	Unit	kJ
	Default	-
	Type	Output register
	Decimal places	2
	Buffered if control voltage fails	No

Tab. 11-4: Parameter attributes - P-0-1280, Current mechanical energy

11.5 P-0-1300, Sum of DC bus powers of axes

The parameter cyclically transmits the sum of the DC bus powers of all machine axes $P_{\text{DC_axes}}$ that have been connected to a common DC bus together with the buffer motor.



The sum P_{DC_axes} has to be generated in a higher-level control unit (a CCD master is also possible) by summing the parameter S-0-0382 of the individual machine axes.

$$P-0-1300 = \sum_{k=1}^n S-0-0382_k \text{ [watt]}$$

n Number of axes

k Axis index

S-0-0382 [watt] DC bus power

P-0-1300 [watt] Sum of DC bus powers of axes

Fig. 11-2: Calculating the sum of the DC bus powers of all machine axes

See also [""Mains power regulation: mains power smoothing / mains peak power reduction"" on page 30](#)

Attributes

Data length	4 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	watt
Default	-
Type	Input register
Decimal places	0
Buffered if control voltage fails	No

Tab. 11-5: Parameter attributes - P-0-1300, Sum of DC bus powers of axes

11.6 P-0-1301, Sum of DC bus powers

This parameter displays the sum of the "P-0-1300, Sum of DC bus powers of axes" and the DC bus power of the buffer motor (S-0-0382). This value conforms to the power output by the supply system to the DC bus.

$P-0-1301 = P-0-1300 + S-0-0382_{\text{buffer motor}}$
P-0-1301, Sum of DC bus powers
P-0-1300, Sum of DC bus powers of axes
S-0-0382, DC bus power of buffer motor

Tab. 11-6: Calculating the sum of the DC bus powers

See also [""Mains power regulation: mains power smoothing / mains peak power reduction"" on page 30](#)

Attributes

Data length	4 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	watt
Default	-
Type	Output register

Decimal places	0
Buffered if control voltage fails	Yes

Tab. 11-7: Parameter attributes - P-0-1301, Sum of DC bus powers

11.7 P-0-1319, Power feedforward factor

This parameter is used to set a percentage that defines the extent to which the buffer motor is to buffer the sum of the DC bus powers of the axes (P-0-1300).

See also [""Mains power regulation: mains power smoothing / mains peak power reduction" on page 30"](#)

Attributes

Data length	4 bytes
Min./max. value	0/1000.0
Format	DEC_0V
Unit	%
Default	-
Type	Input register
Decimal places	1
Buffered if control voltage fails	Yes

Tab. 11-8: Parameter attributes - P-0-1319, Power feedforward factor

11.8 P-0-1320, Lower power threshold

If the mains power regulation is used, a power masking window in which the mains power regulation is not active can be defined using "P-0-1320, Lower power threshold" in conjunction with "P-0-1321, Upper power threshold". Outside of this power masking window, the sum of the DC bus powers of the axes (P-0-1300) is regulated, less the power masking window. Inputting "0" for the power threshold switches off the threshold.

See also [""Mains power regulation: mains power smoothing / mains peak power reduction" on page 30"](#)

Attributes

Data length	4 bytes
Min./max. value	-2147483647/0
Format	DEC_MV
Unit	watt
Default	-
Type	Input register
Decimal places	0
Buffered if control voltage fails	Yes

Tab. 11-9: Parameter attributes - P-0-1320, Lower power threshold

11.9 P-0-1321, Upper power threshold

If the mains power regulation is used, a power masking window in which the mains power regulation is not active can be defined using "P-0-1321, Upper

power threshold" in conjunction with "P-0-1320, Lower power threshold". Outside of this power masking window, the sum of the DC bus powers of the axes (P-0-1300) is regulated, less the power masking window. Inputting "0" for the power threshold switches off the threshold.

See also [""Mains power regulation: mains power smoothing / mains peak power reduction" on page 30"](#)

Attributes	Data length	4 bytes
	Min./max. value	0/2147483647
	Format	DEC_MV
	Unit	watt
	Default	-
	Type	Input register
	Decimal places	0
	Buffered if control voltage fails	Yes

Tab. 11-10: Parameter attributes - P-0-1321, Upper power threshold

11.10 P-0-1329, E-Stop delay

Setting parameter for the delay when using the delayed E-Stop input (P-0-1391).

Use



- The delay only takes effect if the delayed E-Stop input (P-0-1391) is used.
- The E-Stop delay only takes effect when the "E-Stop function" is activated via the delayed E-Stop input (P-0-1391), but not when the "E-Stop function" is deactivated.

Attributes	Data length	4 bytes
	Min./max. value	0/30
	Format	DEC_OV
	Unit	s
	Default	-
	Type	Input register
	Decimal places	0
	Buffered if control voltage fails	Yes

Tab. 11-11: Parameter attributes - P-0-1329, E-Stop delay

11.11 P-0-1331, Error ID

P-0-1331 is used to output the status of MLD as a hexadecimal encoded number, e.g. "0xE2011001".

See also ["Diagnostic and status messages"](#)

Descriptions of the parameters

Attributes	Data length	4 bytes
	Min./max. value	0x00000000/0xFFFFFFFF
	Format	HEX
	Unit	-
	Default	-
	Type	Output register
	Decimal places	0
	Buffered if control voltage fails	Yes

Tab. 11-12: Parameter attributes - P-0-1331, Error ID

11.12 P-0-1370, Config word

P-0-1370 is used to configure the "Kinetic Buffering" function.

Structure

Bit	Description/function	Comment
0	Mains peak power reduction (power feedforward) 0: Not activated 1: Activated	
3-1	Not used	
4	DC bus voltage stabilization (DC voltage control) 0: Not activated 1: Activated	
5	Mains failure detection via maximum voltage dip P-0-1381 0: Active 1: Deactivated	
6	Mains failure detection via module bus status word: P-0-0461, bit 1 (falling edge) or P-0-0461, bit 3 (rising edge) 0: Active 1: Deactivated	
7	Mains failure detection via control word P-0-1390, bit 0 (rising edge) 0: Active 1: Deactivated	e.g., external input
8	Activating buffer command speed 0: With drive enable 1: Control word P-0-1390, bit 1 (rising edge)	
9	Not used	
10	External inertia existing 0: no 1: yes	

Bit	Description/function	Comment
11	Determining controller parameters 0: Automatic 1: Manual input	
14-12	Not used	
15	Buffer axis is motion axis 0: No 1: Yes	If the buffer axis contributes to the process cycle of the machine (motion axis), voltage stabilization is the only option
31-16	Not used	

Tab. 11-13: Relevant bits - P-0-1370, Config word

Use Observe the following aspects for parameterization:

- **Bit 0, mains peak power reduction (power feedforward):**
Bit for activating the "mains peak power reduction" function.
- **Bit 4, DC bus voltage stabilization (DC voltage control):**
Bit for activating the "DC bus voltage stabilization (control)" function if the DC bus voltage dips and/or increases, e.g. in the case of mains failure.
- **Bit 7-5, mains failure detection via:**
The settings define how the function diagnoses mains failure. These bits only take effect if bit 4 has been set, too. If one of the activated conditions has been fulfilled, the mains failure is displayed by bit 6 in the status word P-0-1410.



As soon as MLD diagnoses the mains failure, DC bus voltage control is activated and the DC bus voltage (S-0-0380) is controlled with regard to the nominal voltage command value (P-0-1380).

- **Bit 8, activating buffer command speed:**
The setting defines whether the buffer motor, with drive enable having been set, is immediately controlled with regard to the parameterized buffer command speed (P-0-1371) or only upon a rising edge of bit 1 of P-0-1390
- **Bit 10, external inertia existing:**
The setting defines whether an additional load inertia has been attached to the buffer motor.
- **Bit 11, determining controller parameters:**
By default (bit 11="0"), the controller parameters of MLD for the speed and voltage controllers are determined from the parameterized values for the total inertia [sum of motor inertia (P-0-0510) and load inertia (P-0-4010)] and the DC bus capacitance (P-0-1374). Setting the controller parameters manually (bit 11="1") only makes sense if the voltage controller tends to oscillation, for example.
- **Bit 15, buffer axis is motion axis:**
The setting defines whether the buffer axis is a motion axis, i.e. an axis that contributes to the process cycle of the machine.

Attributes	Data length	4 bytes
	Min./max. value	-/-
	Format	BIN
	Unit	-
	Default	0
	Type	Input register
	Decimal places	0
	Buffered if control voltage fails	Yes

Tab. 11-14: Parameter attributes - config word P-0-1370

11.13 P-0-1371, Buffer command speed

In this parameter, input the buffer command speed with regard to which the buffer motor is controlled on average.

Attributes	Data length	4 bytes
	Min./max. value	0 / 2147483647
	Format	DEC_OV
	Unit	S-0-0044
	Default	-
	Type	Input register
	Decimal places	S-0-0045/S-0-0046
	Buffered if control voltage fails	Yes

Tab. 11-15: Parameter attributes - P-0-1371, Buffer command speed

11.14 P-0-1372, Upper speed threshold

Input parameter for the upper speed threshold.

If the actual speed (S-0-0040) is between the upper speed threshold (P-0-1372) and the lower speed threshold (P-0-1373), bit 11="1" (speed in tolerance window) is set in P-0-1410.

Use If the value for P-0-1372 equals "0", the value from "S-0-0091, Bipolar velocity limit value" is internally used as the upper speed threshold.

Attributes	Data length	4 bytes
	Min./max. value	0 / 2147483647
	Format	DEC_OV
	Unit	S-0-0044
	Default	-
	Type	Input register
	Decimal places	S-0-0045/S-0-0046
	Buffered if control voltage fails	Yes

Tab. 11-16: Parameter attributes - P-0-1372, Upper speed threshold

11.15 P-0-1373, Lower speed threshold

Input parameter for the lower speed threshold.

If the actual speed (S-0-0040) is between the upper speed threshold (P-0-1372) and the lower speed threshold (P-0-1373), bit 11="1" (speed in tolerance window) is set in P-0-1410.

Use If the value for P-0-1373 equals "0", the value 50 rpm is internally used as the lower speed threshold.

Attributes

Data length	4 bytes
Min./max. value	0 / 2147483647
Format	DEC_OV
Unit	S-0-0044
Default	-
Type	Input register
Decimal places	S-0-0045/S-0-0046
Buffered if control voltage fails	Yes

Tab. 11-17: Parameter attributes - P-0-1373, Lower speed threshold

11.16 P-0-1374, DC bus capacitance

Input parameter for the sum of all capacitances connected to the DC bus.

Use

- The DC bus capacitance is required to automatically determine the controller parameters for the voltage controller, the voltage controller P-gain (P-0-1383) and the voltage controller integral action time (P-0-1384).
- You can find the DC bus capacitance of a device in the corresponding Project Planning Manual in the "Technical data" section.

Attributes

Data length	4 bytes
Min./max. value	0 / 2147483647
Format	DEC_OV
Unit	mF
Default	-
Type	Input register
Decimal places	2
Buffered if control voltage fails	Yes

Tab. 11-18: Parameter attributes - P-0-1374, DC bus capacitance

11.17 P-0-1375, Total inertia

Output parameter for the sum of rotor inertia (P-0-0510) and load inertia (P-0-4010).

Descriptions of the parameters

$$P-0-1375 = P-0-0510 + P-0-1410 \text{ [kgm}^2\text{]}$$

P-0-1375, Total inertia

P-0-0510, Rotor inertia

P-0-4010, Load inertia

Tab. 11-19: Calculating the total inertia

- Use**
- The total inertia is required to automatically determine the controller parameters for the speed controller of the buffer motor [speed controller P-gain (P-0-1376) and speed controller integral action time (P-0-1377)].
 - For the rotor inertia (P-0-0510), please see the data sheet of the motor.
 - If the load inertia (P-0-4010) is unknown, it can also be determined by the "Automatic setting of axis control" function.
(See also Functional Description of firmware "Automatic setting of axis control").

Attributes

Data length	4 bytes
Min./max. value	0 / 214748.3647
Format	DEC_OV
Unit	kgm ²
Default	-
Type	Output register
Decimal places	4
Buffered if control voltage fails	Yes

Tab. 11-20: Parameter attributes - P-0-1375, Total inertia

11.18 P-0-1376, Speed controller P-gain

Output or input parameter for the speed controller P-gain of the MLD-internal speed controller.



The MLD-internal speed controller cannot be compared to the standard speed controller of the firmware, because the MLD-internal speed controller's task is to merely control the average speed with regard to the buffer command speed (P-0-1371).

- Use**
- By default, the speed controller P-gain is automatically determined from the total inertia (P-0-1375).
 - The speed controller P-gain can also be set manually (P-0-1370, bit 11="1"). However, this only makes sense if, for example, the load inertia could not be determined or the speed drops too much in the first machine cycle when using the "mains peak power reduction" function.

Attributes

Data length	4 bytes
Min./max. value	0 / 2147.483647
Format	DEC_OV
Unit	Nm/(rad/s)
Default	-

Type	Output/input register
Decimal places	6
Buffered if control voltage fails	Yes

Tab. 11-21: Parameter attributes - P-0-1376, Speed controller P-gain

11.19 P-0-1377, Speed controller integral action time

Output or input parameter for the speed controller integral action time of the MLD-internal speed controller.



The MLD-internal speed controller cannot be compared to the standard speed controller of the firmware, because the MLD-internal speed controller's task is to merely control the average speed with regard to the buffer command speed (P-0-1371).

- Use**
- By default, the speed controller integral action time is automatically determined by the technology function.
 - The speed controller integral action time can also be set manually (P-0-1370, bit 11="1"). However, this only makes sense if, for example, the speed drops too much in the first machine cycle when using the "mains peak power reduction" function.

Attributes

Data length	4 bytes
Min./max. value	0 / 2147483647
Format	DEC_OV
Unit	ms
Default	-
Type	Output/input register
Decimal places	0
Buffered if control voltage fails	Yes

Tab. 11-22: Parameter attributes - P-0-1377, Speed controller integral action time

11.20 P-0-1379, Speed controller torque limit value

Input parameter for the speed controller torque limit value of the MLD-internal speed controller.



The MLD-internal speed controller cannot be compared to the standard speed controller of the firmware, because the MLD-internal speed controller's task is to merely control the average speed with regard to the buffer command speed (P-0-1371).

- Use**
- Only the output of the MLD-internal speed controller is limited to this limit value.
 - This limit value is used to set the dynamics with which the drive is run up to the buffer command speed (P-0-1371).
 - Use 50% of the nominal motor torque as the start value.

Attributes	Data length	4 bytes
	Min./max. value	0 / 2147483647
	Format	DEC_OV
	Unit	S-0-0086
	Default	-
	Type	Input register
	Decimal places	S-0-0093 / S-0-0094
	Buffered if control voltage fails	Yes

Tab. 11-23: Parameter attributes - P-0-1379, Speed controller torque limit value

11.21 P-0-1380, Nominal command voltage

Display value for the nominal DC bus command voltage.

- Use**
- This value is determined from the filtered actual DC bus voltage value (S-0-0380), starting in the "Ab" drive state.
 - If the "DC bus voltage stabilization" function (P-0-1410, bit 4="1") has been activated, the DC bus voltage is controlled with regard to this value.



The display value is only updated every 50 ms

Attributes	Data length	4 bytes
	Min./max. value	-214748364.8 / 214748364.7
	Format	DEC_MV
	Unit	V
	Default	-
	Type	Output register
	Decimal places	1
	Buffered if control voltage fails	Yes

Tab. 11-24: Parameter attributes - P-0-1380, Nominal command voltage

11.22 P-0-1381, Maximum voltage dip

Input value for the maximum voltage dip (voltage delta) if the "DC bus voltage stabilization" function (P-0-1370, bit 4="1") has been activated.

- Use**
- If the DC bus voltage (S-0-0380) drops by this voltage delta below the nominal DC bus voltage (P-0-1380), the "DC bus voltage stabilization" function is activated.
 - If a value smaller than 20 V is input, 20 V is internally used as the effective value.

Attributes	Data length	4 bytes
	Min./max. value	0 / 214748364.7
	Format	DEC_OV

Unit	V
Default	-
Type	Input register
Decimal places	1
Buffered if control voltage fails	Yes

Tab. 11-25: Parameter attributes - P-0-1381, Maximum voltage dip

11.23 P-0-1382, Maximum voltage increase

Input value for the maximum voltage increase (voltage delta) if the "DC bus voltage stabilization" function (P-0-1370, bit 4="1") has been activated.

- Use**
- If the DC bus voltage (S-0-0380) increases by this voltage delta above the nominal DC bus voltage (P-0-1380), the "DC bus voltage stabilization" function is activated.
 - If a value smaller than 20 V is input, 20 V is internally used as the effective value.

Attributes

Data length	4 bytes
Min./max. value	0 / 214748364.7
Format	DEC_OV
Unit	V
Default	-
Type	Input register
Decimal places	1
Buffered if control voltage fails	Yes

Tab. 11-26: Parameter attributes - P-0-1382, Maximum voltage increase

11.24 P-0-1383, Voltage controller P-gain

Output or input parameter for the voltage controller P-gain of the voltage controller.

- Use**
- By default, the voltage controller P-gain is automatically determined from the DC bus capacitance (P-0-1374).
 - The voltage controller P-gain can also be set manually (P-0-1370, bit 11="1"). However, this only makes sense if, for example, the DC bus capacitance (P-0-1374) could not be determined, or the voltage controller tends to oscillation or is not dynamic enough.

Attributes

Data length	4 bytes
Min./max. value	0 / 214748.3647
Format	DEC_OV
Unit	A/V
Default	-
Type	Output/input register

Decimal places	4
Buffered if control voltage fails	Yes

Tab. 11-27: Parameter attributes - P-0-1383, Voltage controller P-gain

11.25 P-0-1384, Voltage controller integral action time

Output or input parameter for the integral action time of the voltage controller.

- Use**
- By default, the voltage controller integral action time is automatically determined by the technology function.
 - The voltage controller integral action time can also be set manually (P-0-1370, bit 11="1"). However, this only makes sense if the voltage controller tends to oscillation or is not dynamic enough.

Attributes

Data length	4 bytes
Min./max. value	0 / 214748.3647
Format	DEC_OV
Unit	ms
Default	-
Type	Output/input register
Decimal places	0
Buffered if control voltage fails	Yes

Tab. 11-28: Parameter attributes - P-0-1384, Voltage controller integral action time

11.26 P-0-1387, Diagnostic text

P-0-1387 outputs the status of MLD as a diagnostic text, e.g. "Function ready".

See also ["Diagnostic and status messages"](#)

Min./max. value	-/-
Format	ASCII
Unit	-
Type	Output register
Decimal places	-
Buffered if control voltage fails	Yes

Tab. 11-29: Parameter attributes - P-0-1387, Diagnostic text

11.27 P-0-1390, Control word

The parameter P-0-1390 is used for extended control of the function. Whether the individual bits take effect depends on the settings in the config word (P-0-1370).

Structure

Bit	Description/function	Comment
0	Mains failure 0: no 1: yes	only takes effect if P-0-1370, bit 6, 5=10
1	Activating buffer command speed Positive edge: accelerating to command speed Negative edge: decelerating to command speed ="0"	only takes effect if P-0-1370, bit 8="1"

Tab. 11-30: Parameter structure - P-0-1390, Control word

Use • **Bit 0, mains failure:**

If bit 0="1" is set, the DC bus voltage control is activated and the DC bus voltage (S-0-0380) is controlled with regard to the nominal voltage command value (P-0-1380).



Using this bit only makes sense if mains failure is detected via external mains voltage monitoring, such as an external independent power supply.

• **Bit 1, activating buffer command speed:**

If the buffer command speed is not to be activated automatically with drive enable, but via this bit (i.e. P-0-1370, bit 8="1"), this is what happens when drive enable has been set:

- Positive edge: the buffer axis is accelerated to the buffer command speed (P-0-1371)
- Negative edge: the buffer axis is decelerated to "0" speed

Attributes

Data length	2 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	-
Default	-
Type	Input word
Decimal places	0
Buffered if control voltage fails	No

Tab. 11-31: Parameter attributes - P-0-1390, Control word

11.28 P-0-1391, Delayed E-Stop input

A delayed E-Stop input can be implemented using the parameter P-0-1391.

Structure

Bit	Description/function	Comment
0	State of E-Stop input: 0: Activated (0 V) 1: Not activated (+24 V)	only takes effect if P-0-1370, bit 8="1"

Tab. 11-32: Parameter structure - P-0-1391, Delayed E-Stop input

Descriptions of the parameters

Use If a delayed E-Stop is to be implemented via P-0-1391, do **not** assign the digital input used to the bit 0 of P-0-0223 but to the bit 0 of P-0-1391 when activating the "E-Stop function". The bit 0 of P-0-0223 in this case is set by MLD.

- When the E-Stop is **activated** (digital hardware input = 0 V), MLD resets the bit 0 of P-0-0223 **with a delay** according to the delay set via P-0-1329 (E-Stop delay).
- When the E-Stop is **deactivated** (digital hardware input = 24 V), MLD sets the bit 0 of P-0-0223 **without delay**. Thus, the delay only takes effect when the E-Stop is activated.

Attributes

Data length	2 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	-
Default	-
Type	Input word
Decimal places	0
Buffered if control voltage fails	No

Tab. 11-33: Parameter attributes - delayed E-Stop P-0-1391

11.29 P-0-1410, Status word

The current status of the MLD functionality is read via P-0-1410.

Structure

Bit	Description/function	Comment
0	Mains peak power reduction (power feedforward) 0: Not active 1: Active	
1	Torque limitation - mains peak power reduction 0: Not active 1: Active: $ P-0-1271 > P-0-0444$	
3-2	Not used	
4	DC bus voltage stabilization (DC voltage control) 0: Not active 1: Active	
5	Torque limitation - DC bus voltage control 0: Not active 1: Active: $ P-0-1270 > P-0-0444$	
6	Mains failure detected 0: no 1: yes	

Bit	Description/function	Comment
7	DC bus voltage in tolerance window 0: no 1: yes	
8	Parameterization error 0: no 1: yes	
10-9	Not used	
11	Speed in tolerance window 0: no 1: Yes: $P-0-1373 < S-0-0040 < P-0-1372$	
12	Buffer command speed attained (90%) 0: no 1: yes: $S-0-0040 > 0.9 \times P-0-1371$	
13	Buffer standstill 0: no 1: yes • $S-0-0040 < 50 \text{ rpm}$ - or - • $S-0-0040 < S-0-0124$	
15-14	Not used	

Tab. 11-34: Relevant bits - P-0-1410, Status word

Use Observe the following aspects for use:

- **Bit 0, mains peak power reduction (power feedforward):**

If the "mains peak power reduction" function (P-0-1370, bit 0="1") has been activated, this bit is set if the following conditions occur simultaneously:

- The axis is in "AF".
- The sum of the DC bus powers of all machine axes (P-0-1300) is greater or smaller than the parameterized lower / upper power threshold (P-0-1320 / P-0-1321).
- Bit 11 (speed in tolerance window) has been set.

- **Bit 1, torque limitation - mains peak power reduction:**

If the "mains peak power reduction" function (P-0-1370, bit 0="1") has been activated, this bit is set if the absolute value of the power feedforward controller output (P-0-1271) is greater than the actual value of peak torque limitation (P-0-0444).

- **Bit 4, DC bus voltage stabilization (DC voltage control):**

If the "DC bus voltage stabilization" function (P-0-1370, bit 4="1") has been activated, this bit is set if the following conditions occur simultaneously:

- The axis is in "AF".

Descriptions of the parameters

- The DC bus voltage (S-0-0380) has increased or dropped by the maximum voltage increase (P-0-1383) or the maximum voltage dip (P-0-1381) with regard to the nominal command voltage (P-0-1380), or mains failure is detected.
- **Bit 5, torque limitation - DC bus voltage control:**
If the "DC bus voltage stabilization" function (P-0-1370, bit 4="1") has been activated, this bit is set if the absolute value of the voltage controller output (P-0-1270) is greater than the actual value of peak torque limitation (P-0-0444).
- **Bit 6, mains failure detected:**
This bit is set if mains failure has been detected. How mains failure is detected depends on the configuration of the mains failure detection (P-0-1370, bits 5 and 6).
- **Bit 7, DC bus voltage in tolerance window**
If the "DC bus voltage stabilization" function (P-0-1370, bit 4="1") has been activated, this bit is set if the axis is in "AF" and the DC bus voltage (S-0-0380) does not deviate from the nominal command voltage (P-0-1380) by more than the maximum voltage increase (P-0-1383) or by less than the maximum voltage dip (P-0-1381).
- **Bit 8, parameterization error**
This bit is set if a parameter required for the function has been incorrectly parameterized. Extended diagnostics is enabled via the diagnostic text in P-0-1387 and the error ID P-0-1331.
- **Bit 11, speed in tolerance window:**
This bit is set if the actual speed (S-0-0040) is within the speed window defined via the upper and lower velocity thresholds (P-0-1372 and P-0-1373).
- **Bit 12, buffer command speed attained (90%):**
This bit is set if the actual speed (S-0-0040) for the first time has attained 90% of the buffer command speed (P-0-1371) after "AF" was switched on. The bit is only reset again in "Ab".
- **Bit 13, buffer standstill:**
This bit is set if the actual speed (S-0-0040) is smaller than 50 rpm or smaller than the standstill window (S-0-0124).

Attributes

Data length	2 bytes
Min./max. value	-/-
Format	DEC_MV
Unit	-
Default	-
Type	Output register
Decimal places	0
Buffered if control voltage fails	No

Tab. 11-35: Parameter attributes - P-0-1410, Status word

12 Service and support

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- 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)

Index

A

Absorption of regenerative power
see Fields of application..... 22

D

DC bus voltage stabilization in the case of
mains failure..... 28
Drive system..... 3

E

Electric drive system..... 3

F

Fields of application..... 22

H

Helpdesk..... 61
Hotline..... 61

I

Intended use..... 13
Applications..... 13

K

Kinetic Buffering
Configuring and operating via IndraWorks..... 35
Configuring and operating via parameters..... 35
P-0-1270..... 43
P-0-1271..... 43
P-0-1272..... 43
P-0-1280..... 44
P-0-1300..... 44
P-0-1301..... 45
P-0-1319..... 46
P-0-1320..... 46
P-0-1321..... 46
P-0-1329..... 47
P-0-1331..... 47
P-0-1370..... 48
P-0-1371..... 50
P-0-1372..... 50
P-0-1373..... 51
P-0-1374..... 51
P-0-1375..... 51
P-0-1376..... 52
P-0-1377..... 53
P-0-1379..... 53
P-0-1380..... 54
P-0-1381..... 54
P-0-1382..... 55
P-0-1383..... 55
P-0-1384..... 56
P-0-1387..... 56
P-0-1390..... 56

P-0-1391..... 57
P-0-1410..... 58

M

Mains failure buffering
see Fields of application..... 22
Mains failure detection..... 28
Mains power regulation..... 30
Means of representation
Conventions of notation..... 1
Notations..... 1

P

PELV..... 8
Power controller..... 26
Protective extra-low voltage..... 8
Purpose of the function..... 21

R

Reducing the mains peak power
see Fields of application..... 22
Requirements of use..... 23
Restrictions of the function..... 23

S

Safety instructions for electric drives and
controls..... 3
Service hotline..... 61
Stabilizing the DC bus voltage in the case of
mains variations
see Fields of application..... 22
State-of-the-art..... 13
Support..... 61
System requirements..... 23
System structure..... 21

T

Torque controller..... 28

U

Unintended use..... 14
Consequences, exclusion of liability..... 13
Use
Intended use..... 13
Unintended use..... 14

V

Velocity controller..... 27
Voltage controller..... 25

Notes

Notes

Bosch Rexroth AG

Electric Drives and Controls

P.O. Box 13 57

97803 Lohr, Germany

Bgm.-Dr.-Nebel-Str. 2

97816 Lohr, Germany

Phone +49 9352 18 0

Fax +49 9352 18 8400

www.boschrexroth.com/electrics



R911397139