

MLD Technology Function

Vibration Damping and Avoiding

Application Manual
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Purpose of Documentation	This documentation describes the MLD technology function "vibration damping and avoiding" The "vibration damping and avoiding" function is a method which intervenes in the production process in order to increase the productivity of a machine and the product quality. Likewise, a longer life cycle of the machine and its mechanics is achieved by reducing mechanical stress. The function has to be adjusted (configured/parameterized) to the installation in which it is to be used.
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1 About this documentation

Editions of this documentation

Edition	Release date	Notes
DOK-MLD***-TECFUNC*VDA-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 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!

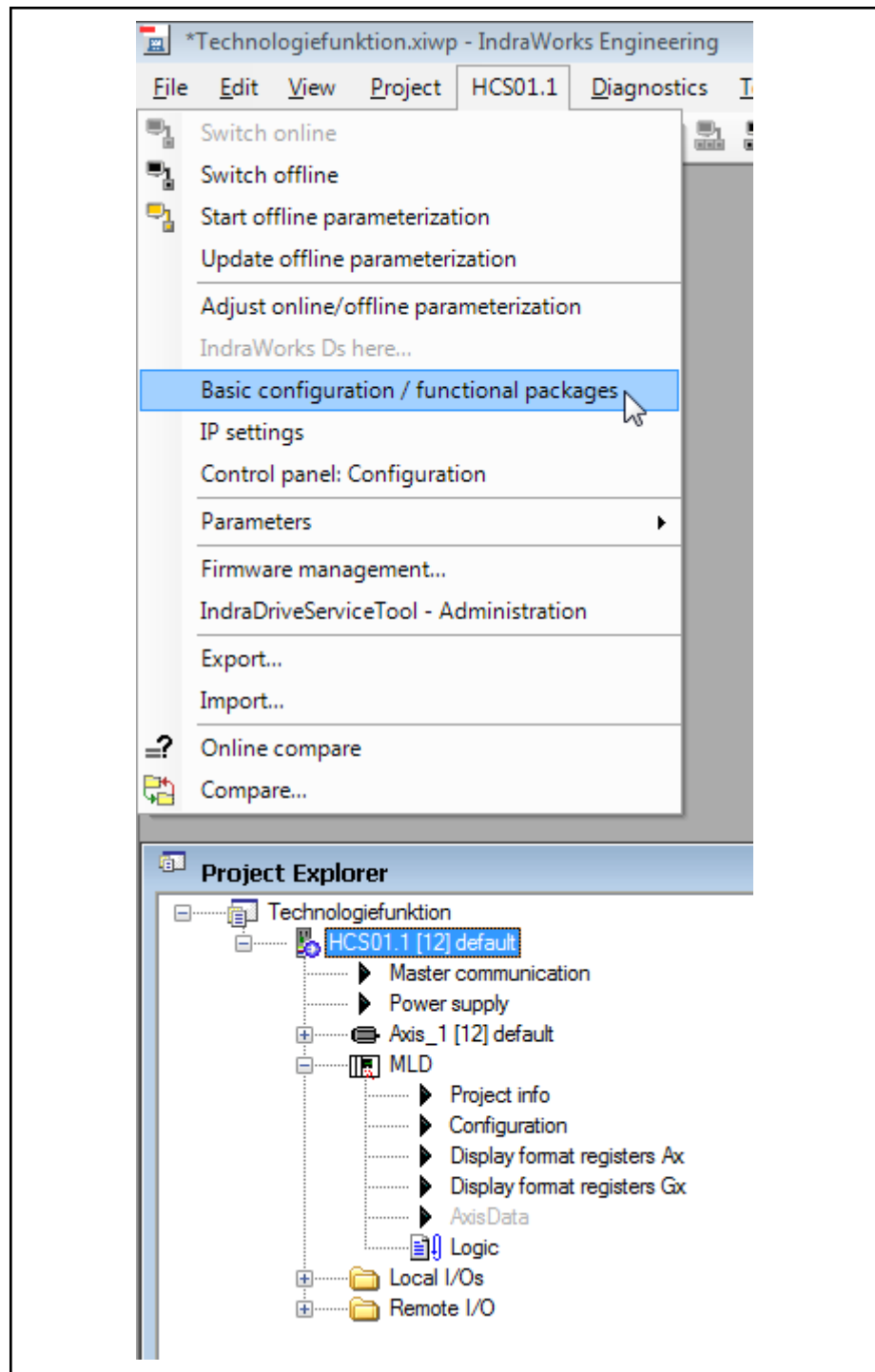


Fig. 4-1: Enabling functional packages

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](#)")

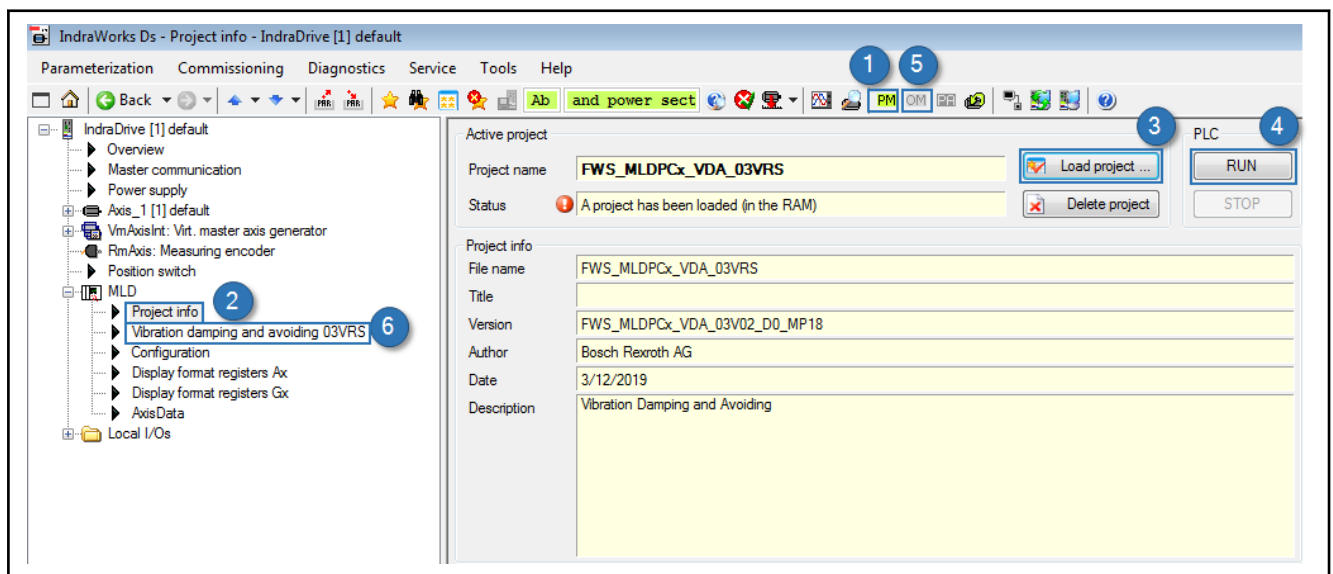


Fig. 6-1: Transmitting a technology function to the drive

7 Brief description of the functions

The "vibration damping and avoiding" function is a method which intervenes in the production process in order to increase the productivity of a machine and the product quality. Likewise, a longer life cycle of the machine and its mechanics is achieved by reducing mechanical stress.

This can be accomplished by filtering the command value profile and by actively damping the vibration of the mechanics.

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 "vibration damping and avoiding" function, the PLC project "FWS_MLDPCx_VDA_03Vxx_D0_MPxx" must in addition have been loaded and activated in the drive (see "[Loading the technology function to the drive](#)").



The dialog is displayed in IndraWorks 14V20 and above.

Fields of application

The "vibration damping and avoiding" function can be used wherever low-frequency vibrations, which have a negative influence on the production cycle, are excited in a machine or its Tool Center Point due to the mechanical structure or the ambient conditions. According to the design and the work flow of the machine, different configurations of vibration avoiding and/or vibration damping can be used. A standard mode is available for simple applications. It allows most of the tasks to be quickly implemented. If the application requires a higher degree of intervention, use the expert mode of the technology function. It considerably extends the scope of functions. Both modes are supported by IndraWorks dialogs. The user may switch between the modes, the parameterizations made will be saved and reloaded when the mode is switched back. **Exception:** The latter does not apply to subfunctions available both in the standard mode and in the expert mode, such as the P-gain in vibration damping.



The scope of functions of the standard mode is a subset of the expert mode. Parameterizations only available and made in the expert mode are no longer active when switching to the standard mode.

- **Vibration Avoiding - VA:**
 - Filtering of the command value profile preset by a higher-level control unit.
 - Filter parameterization on the basis of the mechanical vibration and damping behavior.
 - Filter type and command value source can be configured.
 - Using a command value filter does not make the system (drive + mechanics + control) instable.
- **Vibration Damping - VD:**
 - Active damping of mechanics or system vibrations < 50 Hz by intervening in the controller structure of the drive.
 - Damping is possible without and with additional sensors (acceleration sensor or optional position encoder).
 - PI(D-T1) controller structure with feedback and command value generation that can be configured in different ways.

Brief description of the functions

- Different target parameters can be set as controller output (additive position/velocity/torque command value).
- It is possible to suppress a fundamental vibration of the machine that does not have any influence on the quality of the production process.
- The system vibration can be captured by external sensors or in sensorless form by drive-internal signals.

Limitations of the function

The "vibration damping and avoiding" function has the following limitations:

- Sensorless control with vibration damping is only possible if the parasitic vibration has an impact on the mechanical drive system. The quality of control depends on the degree of the impact.
- With active vibration **damping**, the system (drive + mechanics + control) may become **instable** due to incorrect parameterization and/or system properties.
- In conjunction with modulo scaling, the band-stop filter cannot be parameterized as a command value filter for vibration avoiding.
- With non-linear kinematics, the desired effect of vibration **avoiding** can only be achieved to a limited extent (for each individual case check whether it is suitable).

Parameters involved

The lists below contain the parameters used in conjunction with the "vibration damping and avoiding" function.

General:

- [P-0-1370](#), Config word
- [P-0-1410](#), Status word
- [P-0-1290](#), Error diagnostics Error ID
- [P-0-1291](#), Error diagnostics ErrorIdent: Table
- [P-0-1292](#), Error diagnostics ErrorIdent: Additional 1
- [P-0-1293](#), Error diagnostics ErrorIdent: Additional 2
- [P-0-1387](#), Error text display

Vibration damping:

- [P-0-1298](#), VD - acceleration feedback value, external
- [P-0-1316](#), VD - low-pass filter analog input, cutoff frequency
- [P-0-1317](#), VD - analog input, offset
- [P-0-1318](#), VD - analog input, dead zone (bipolar)
- [P-0-1319](#), VD - sensor sensitivity (incl. amplifier)
- [P-0-1320](#), VD - sensor distance to pivot
- [P-0-1321](#), VD - torque/force feedback value, scaling factor
- [P-0-1371](#), VD - PI(D-T1) controller, proportional gain
- [P-0-1372](#), VD - PI(D-T1) controller, integral-action time
- [P-0-1373](#), VD - PI(D-T1) controller, derivative action time
- [P-0-1374](#), VD - PI(D-T1) controller, smoothing time constant, D-term
- [P-0-1375](#), VD - PI(D-T1) controller, limitation
- [P-0-1376](#), VD - 2nd order high-pass filter, cutoff frequency
- [P-0-1377](#), VD - 2nd order low-pass filter, cutoff frequency
- [P-0-1378](#), VD - acceleration feedback value, low-pass filter, cutoff frequency

- [P-0-1379](#), VD - band-stop filter, center frequency
- [P-0-1380](#), VD - band-stop filter, bandwidth
- [P-0-1381](#), VD - acceleration feedback value, band-stop filter, center frequency
- [P-0-1382](#), VD - acceleration feedback value, band-stop filter, bandwidth
- [P-0-1383](#), VD - acceleration command value delay
- [P-0-1384](#), VD - closing the control loop

Important display parameters for commissioning:

- [P-0-1272](#), VD - adjusted acceleration feedback value
- [P-0-1273](#), VD - control difference
- [P-0-1277](#), VD - control difference after filter cascade
- [P-0-1278](#), VD - controller output after limitation
- [P-0-1279](#), VD - acceleration command value

Vibration avoiding:

- [P-0-1300](#), VA - NC position command value
- [P-0-1301](#), VA - NC velocity command value
- [P-0-1322](#), VA - anti-vibration filter 2, frequency
- [P-0-1323](#), VA - anti-vibration filter 2, damping
- [P-0-1324](#), VA - band-stop filter, center frequency
- [P-0-1325](#), VA - band-stop filter, bandwidth
- [P-0-1326](#), VA - anti-vibration filter 1, frequency
- [P-0-1327](#), VA - anti-vibration filter 1, damping
- [P-0-1385](#), VA - average value filter, frequency

Diagnostics involved

- E2011 Changing the config word not allowed in AF
- E2012 Limitation of controller output is active (see [P-0-1375](#))

8 Brief description of the dialogs

The figure below shows the technology function dialog, when the dialog is opened for the first time. The upper status bar displays information and error messages related to the function.

The diagram beneath gives an overview of the structural operating principle, the points of intervention, as well as any currently effective controller output of vibration damping and avoiding.

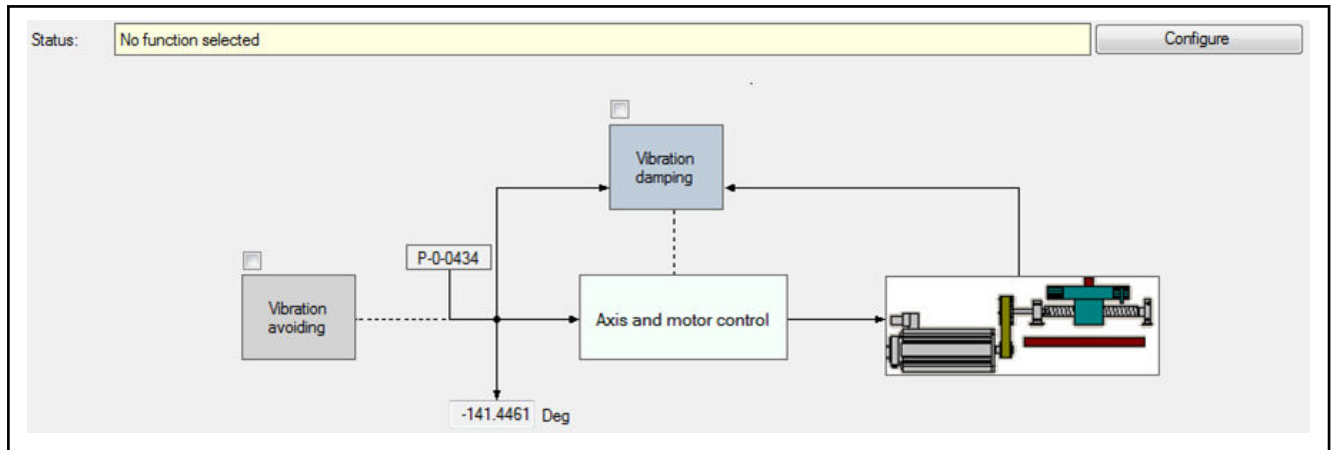


Fig. 8-1: "Vibration damping and avoiding" dialog with deactivated functions (start image)

Using the check boxes, the diagram allows vibration damping or vibration avoiding to be activated or deactivated.

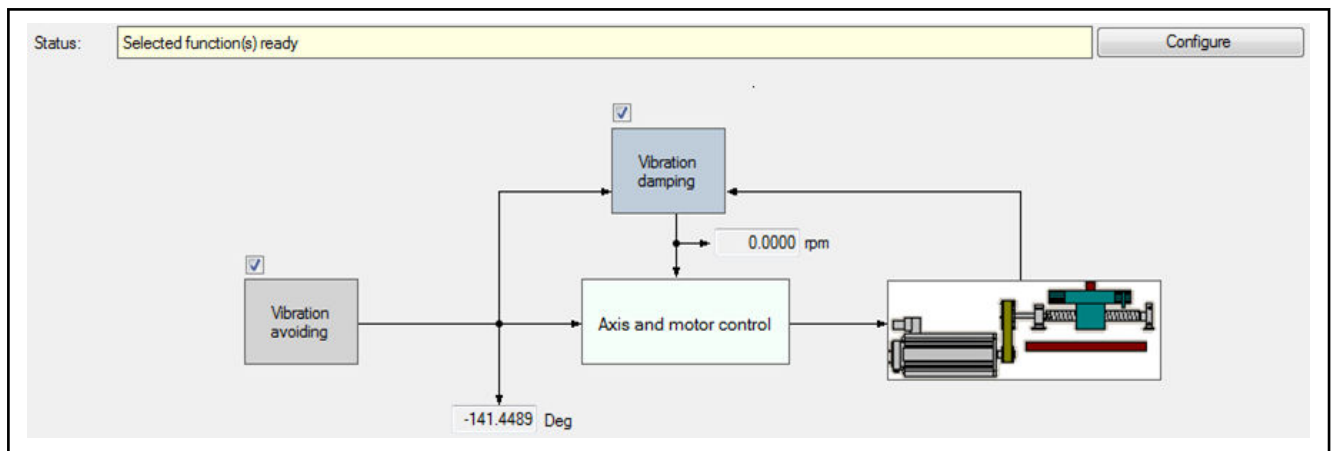


Fig. 8-2: "Vibration damping and avoiding" dialog with activated functions (start image)

Use the "Configure" button - to the right of the status bar - to open the dialog for configuring and parameterizing the functions.

The dialog for configuring and parameterizing the functions has a design similar to the start image, but a greater scope of functions.

The sections for configuring vibration damping (1) and vibration avoiding (2) have different colors, just like in the start image.

To simplify the parameterization and handling of the technology function for the user, the technology function provides two levels: There is a standard mode and an expert mode. Additional functions are available in the expert mode. The figure below shows the dialog in the standard mode. Use the check box (3) to switch between the standard mode and the expert mode.

Brief description of the dialogs

In the dialog section for configuring vibration damping, the sections for configuring command value paths (5) and actual value paths (6) can be shown and hidden.

Use the "Close configuration" (4) button to go to the start image.

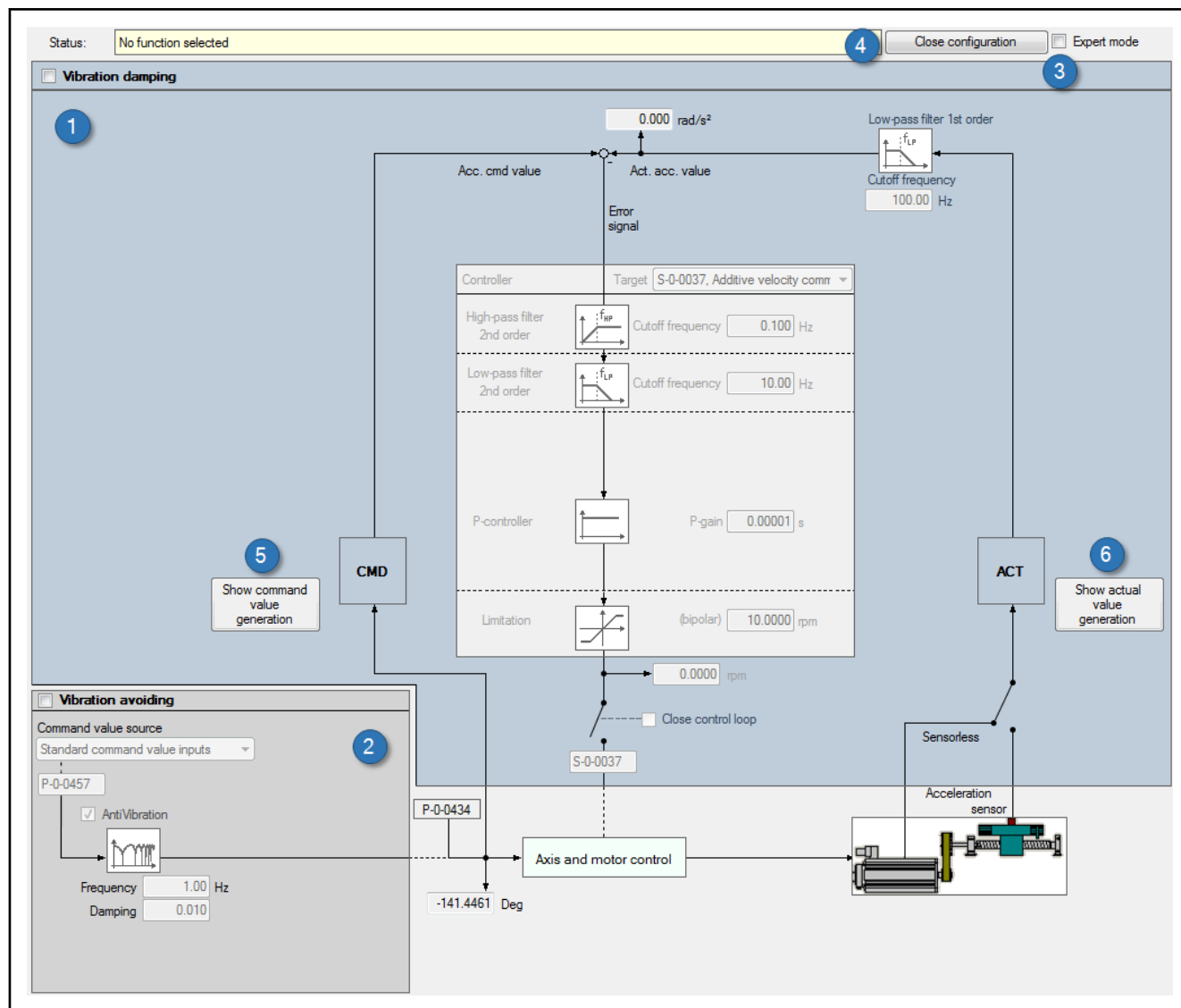


Fig. 8-3: "Vibration damping and avoiding" dialog with deactivated functions (configuration)

9 Vibration damping

9.1 Functional description

The figure below illustrates the functional principle of "vibration damping and avoiding". The two functions "vibration avoiding" and "vibration damping" can be activated individually or together.

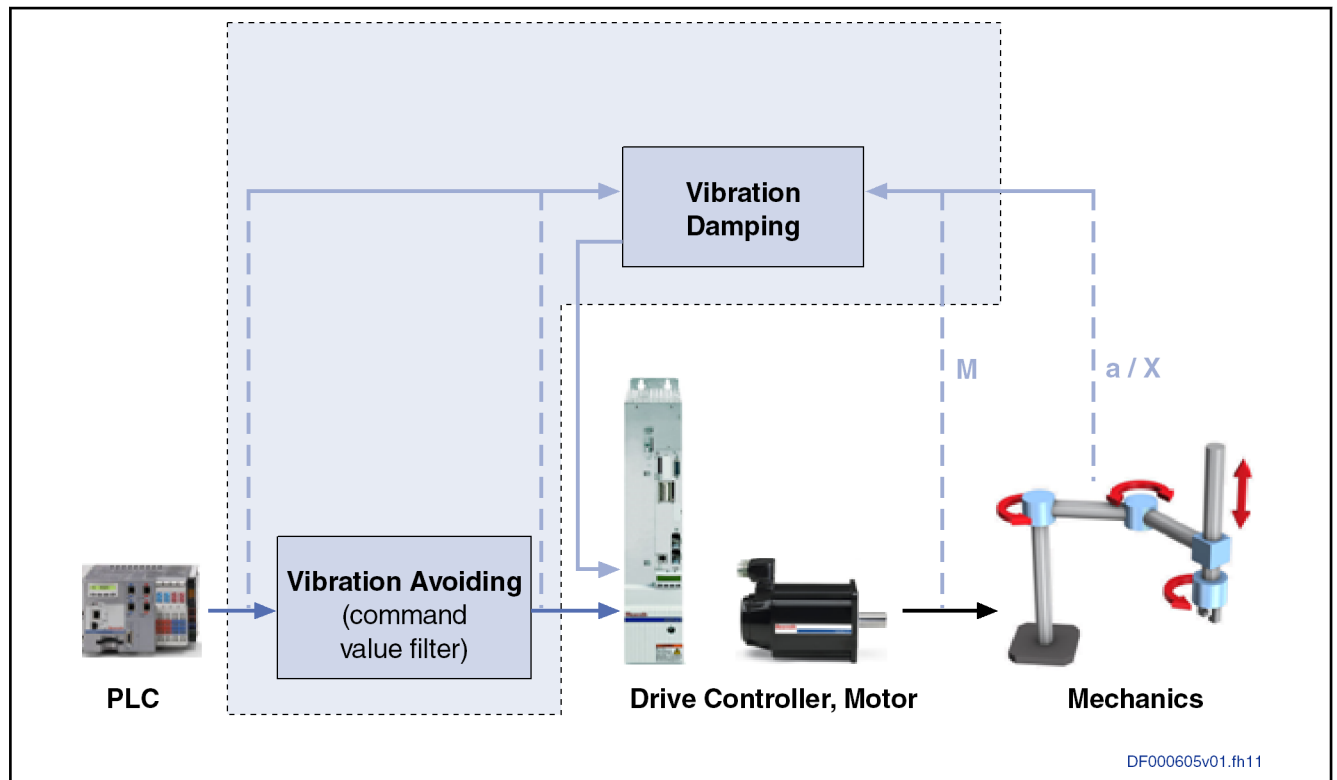


Fig. 9-1: Functional principle of "vibration damping and avoiding"

Vibration damping

The vibration damping function can be used for applications in which low-frequency vibrations (< 50 Hz) of the mechanics occur. In these applications, it is possible to compensate for influences such as external disturbances which cannot be damped by a prefilter or a low-pass filter in the control loop. Low-frequency vibrations often can also be caused when the connection of the mechanics is flexible or when the mass inertias during positioning are mismatched. When trying to eliminate this behavior by adjusting the controller parameters for position control and velocity control, the typical cascade structure of drive control can easily become instable and the unwanted vibration can only be minimized by reducing the dynamic response of the controller.

The additional control loop of active vibration damping improves the control behavior, especially for systems characterized by the flexible connection of the load. For control, a command acceleration, determined from a preset motion profile, for example, is compared to a measured (actual) acceleration. If the application-related requirements have been complied with, external analog signals of an optional sensor can be used as actual values and so can internal parameters, such as the torque/force feedback value of drive control, velocity or acceleration feedback values of the encoders. Furthermore, an acceleration signal already adjusted can be transmitted by a control unit.

Optional sensors are:

- Acceleration sensor
- Second position measuring systems (on the load side)

Requirements of actual torque/force value feedback (sensorless):

- Rigid connection between the vibrating mechanics and the motor
- The quality of control depends on how strong the effect of the vibration is on the motor side, i.e. how weak the damping of the vibration by the mechanical connection is.

When using an optional sensor, the sensor should be installed as near as possible to the point in the mechanics that is to be damped (usually the Tool Center Point). Just like the feedback, the command value generation for active vibration damping can be configured in different ways and thereby adjusted to the application-related conditions. Numerous digital filters allow the signals to be sufficiently adjusted and the machine's fundamental vibrations to be eliminated.

Command value generation:

Different signal sources can be configured as command values for the "vibration damping" function. The command vibration contained in the command value input can be determined from the following parameters:

Standard mode	Expert mode
• Command vibration = "0" • "P-0-0434, Position command value of controller" (in position control only)	• Command vibration = "0" • "P-0-0434, Position command value of controller" (in position control only) • "P-0-0454, Velocity feedforward actual value" (in position control only) • "P-0-0455, Acceleration feedforward actual value" • "P-0-0048, Effective velocity command value" (in velocity control only)

Furthermore, it is possible to delay the command value by a certain time in milliseconds before it is used as an active command value in control. This might be necessary, for example, if latencies occur in the signal transmission of external sensors.

Actual value generation:

Depending on the application-related requirements, control section type and available optional modules, different signal sources can be configured for the actual value:

- Acceleration sensor
 - Analog input 1
 - Analog input 2
 - Analog input 3
 - Analog input 1 (optional module "DA")
 - Analog input 2 (optional module "DA")
- Optional encoders
 - Acceleration feedback value encoder 2 (S-0-0195)

- Velocity feedback value of encoder 2 (S-0-0156)
- Sensorless
 - Torque/force feedback value (S-0-0084)
- Preset by control unit
 - External acceleration feedback value (via [P-0-1298](#))

When an acceleration sensor is used, the following settings have to be made:

- Connection of the sensor at analog input 1-3 (define multi-purpose inputs as voltage inputs!) or at analog input 1/2 of the DA module
- Configuration for sensor connection and sensor sensitivity

When an optional position measuring system is used, it has to be configured as an optional encoder at the drive controller.

The other optional and required settings for using a sensor are described in the chapter "[Configuring and operating vibration damping with IndraWorks](#)".

Furthermore, a filter is provided to adjust the actual value signal with an additional sensor (acceleration or position). The machine's fundamental vibrations can be filtered out with this filter. With a flexible structure of the machine housing, low-frequency vibration can occur. Although it is to be captured by the sensor that is employed, the vibration is not to be used to compensate the parasitic vibrations.

Control:

To compensate the unwanted parasitic vibrations, a PI(D-T1) controller structure with controller output limitation and prefilters can be configured. The chapter "[Notes on commissioning and operation](#)" contains simple instructions on how to parameterize which parts of this structure.

Configurable target parameters for the controller output of control:

- P-0-0059, Additive position command value, controller
- S-0-0037, Additive velocity command value
- S-0-0081, Additive torque/force command value

The resulting controller output can be preset as an additive command value at the different points of the typical cascade structure of drive control. This is more or less successful at these points (according to the application, determine the most effective point at which the command value takes effect, if necessary by "trial and error"). After the summation point of command value and actual value, a sufficient number of filters can be parameterized for the calculated control difference to improve the signal quality and consequently the quality of control according to the circumstances.

Parameterizable filters:

- P-0-1376, VD - 2nd order high-pass filter, cutoff frequency
- P-0-1377, VD - 2nd order low-pass filter, cutoff frequency
- P-0-1379, VD - band-stop filter, center frequency
- P-0-1380, VD - band-stop filter, bandwidth

9.2 Notes on commissioning and operation

9.2.1 General information

Initial situation The successful commissioning of the "vibration damping and avoiding" function requires the following initial situation:

Overview of required steps for commissioning vibration damping

- The functional package "MA" has been enabled so that the drive-integrated PLC can be used.
- The PLC project "FWS_MLDPCx_VDA_03Vxx_D0_MPxx" has been loaded and activated for the firmware version at hand (see ["Loading the technology function to the drive"](#)).

Configuring the function

1. Activating vibration damping
2. Configuring and adjusting the actual value signal
3. Configuring and adjusting the command value signal
4. Parameterizing the controller and the required filters
 - Controller settings
 - Target parameters for the calculated controller output
5. Closing the control loop
6. Optimizing the controller and filter settings

Operating/using the function

As soon as the function has been activated via the config word, it is always active as long as no configuration error occurs. When a configuration error is present, the controller output is set to "0". Compensating the vibration is only possible when the drive is with torque (AF, AH).



Below, the individual steps will be described in detail and the chapter ["Configuring and operating vibration damping with IndraWorks"](#) will explain these steps.

9.2.2 Configuring and operating vibration damping with IndraWorks

Commissioning step 1: Activating vibration damping

To parameterize vibration damping via the IndraWorks dialog, activate it by ticking the check box:



Fig. 9-2: Activating vibration damping

Commissioning step 2: Configuring and adjusting the actual value signal

Click "Show actual value generation" on the right in the dialog to select the signal source used for actual value generation. In the standard mode, the most frequently used sources torque/force feedback value and an analog input for acceleration sensors are available. Depending on the selected source, other transmission elements are displayed in the actual value path. These elements allow the processing of the signal to be additionally adjusted.

Independent of the actual value source, the expert mode contains a band-stop filter. With a preset center frequency and a bandwidth in Hz it can filter out a small frequency range of the feedback signal. Possible applications are, for example, a periodically occurring disturbance or a fundamental vibration of the machine visible in the torque/force feedback value or in the sensor signal, but irrelevant to the compensation of the parasitic vibration.



For instructions on how to parameterize the band-stop filter, see the chapter ["Configuring and operating vibration avoiding via parameters"](#), commissioning step 4.

The parameter [P-0-1272](#) displays the acceleration feedback value as it is used in the summation point for calculating the control difference, after it has been completely adjusted.

Standard mode	Expert mode

Tab. 9-1: Selection options for the actual value signal

Acceleration sensor (analog input)

1. Install the sensor system, mount and orient the acceleration sensor at a position in the vibrating mechanics in accordance with the manufacturer's specifications. Afterwards, the voltage output of the sensor system has to be connected to one of the possible interfaces for the analog input.

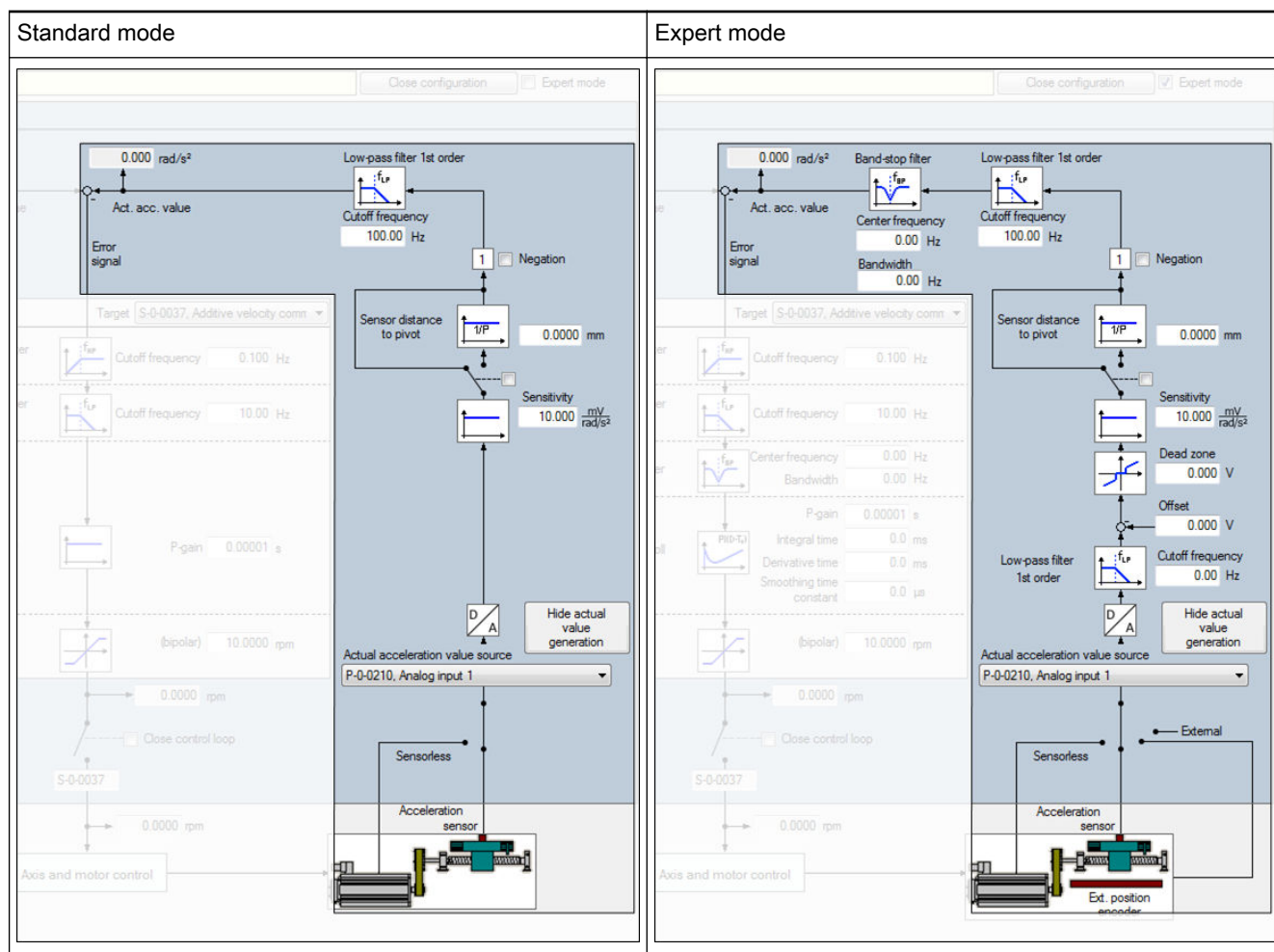


- The type of control section and the optional modules used determine which analog input interface is available.
- Comply with the allowed voltage range for the selected analog input.

See also Functional Description of firmware "Analog inputs"

2. If an "analog input" is selected, additional configuration elements are displayed depending on the mode:

Vibration damping



Tab. 9-2: Actual value generation via an analog input

- Under "Sensitivity" enter the sensor sensitivity in mV/g or mV/(rad/s²), i.e. the conversion factor for the voltage value at the analog input in accordance with the sensor system.

Example:

- Sensitivity of sensor (according to data sheet), e.g.: 100 mV/g (note: 1 m/s² = 0.1019 g)
- Measuring amplifier / coupler: Gain = 20

Thus, the value "2000" has to be entered in the "Sensitivity" field (20 × 100 mV/g = 2000 mV/g).

- Acceleration sensors can either capture an angular acceleration (e.g., Ferraris sensor in mV/(rad/s²)) or a linear acceleration. However, it might be possible that due to application-related conditions, a sensor measuring a linear acceleration has been mounted to the mechanics, but the axis carries out rotary motions.

Thus, observe the relation between the measuring principle of the acceleration sensor and the occurring acceleration direction, or the acceleration direction you are interested in. Therefore, click the check box above the "Sensitivity" field in the case of differing linear/rotary direction. In the "Sensor distance to pivot" field, enter the distance in mm.

5. Check whether the mounting direction of the sensor complies with the coordinate system of the drive. If they are opposed, the sensor signal can be negated via the "Negation" check box.

The orientation of the two systems can be identified by a simple measurement.

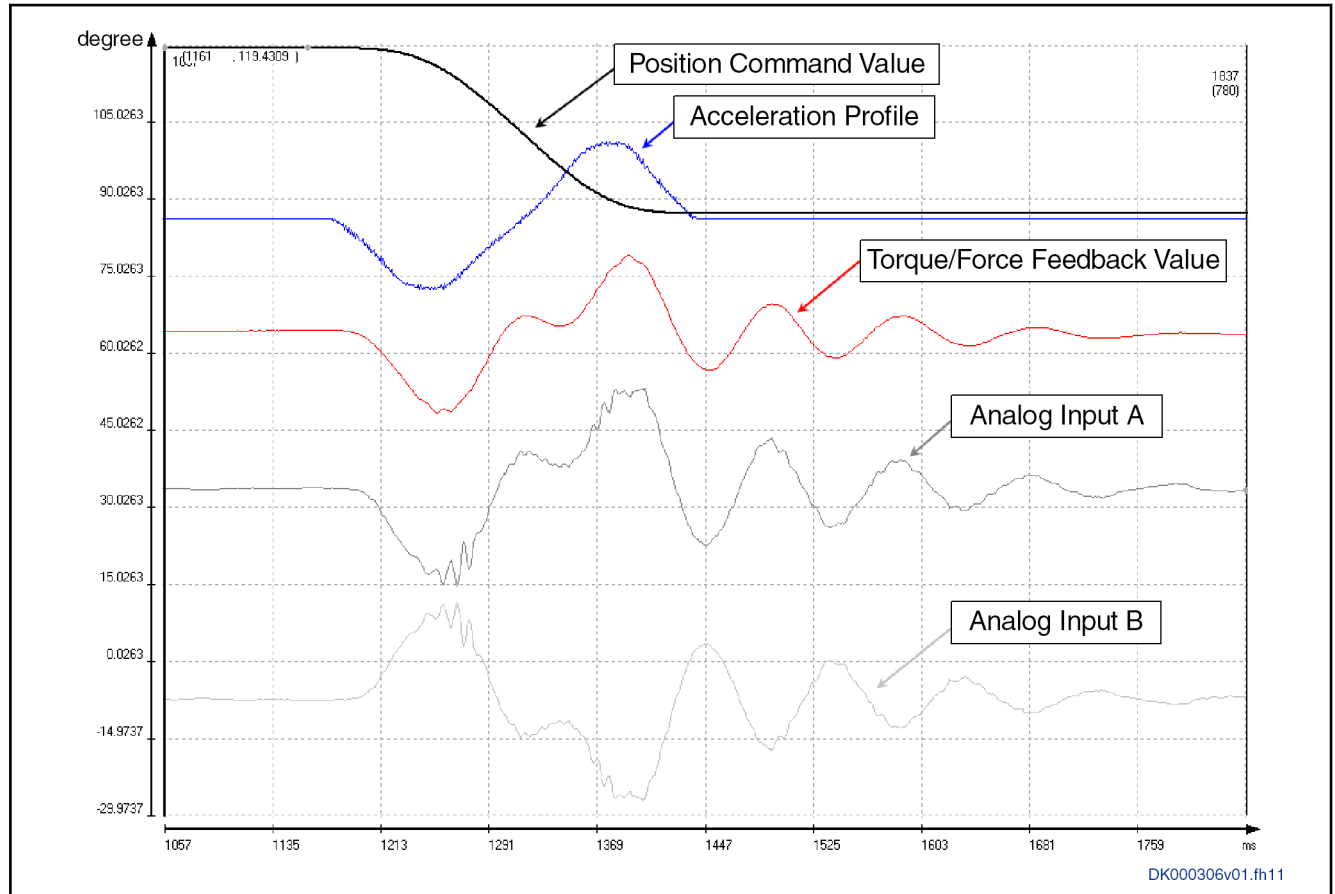


Fig. 9-3: Measurement identifying the orientation of the sensor as compared to the coordinate system of the drive

In the case of "analog input A", the mounting direction of the sensor complies with the orientation of the coordinate system of the axis: The measured acceleration curve matches the preset position command value and the torque /force feedback value. In the case of "analog input B", the two curves are opposed. This is due to the difference in orientation of the measuring system as compared to the coordinate system of the axis. In this case, tick the "Negation" check box.

6. [Expert mode]

In the "Cutoff frequency" field enter the cutoff frequency in Hz for a digital 1st order low-pass filter. The filter is inactive if the value "0" has been input. Ideally, all frequencies above the interference frequency are filtered.

It is recommended to specify the cutoff frequency as described in the following example:

The vibration to be compensated has a frequency of $f = 1/T = 10.8$ Hz. All higher frequencies can be regarded as interference frequencies and are to be filtered out without considerably influencing the 10.8 Hz in amplitude and phase.

The cutoff frequency is calculated as follows: $f_{\text{cutoff}} = 3 * f = 32.4 \text{ Hz}$



If several frequencies are to be compensated, the highest frequency value to be compensated is used in the formula.



The cutoff frequency is internally converted to a time constant and directly used for parameterizing the low-pass filter of the analog input and thus the sensor signal (for the analog input 1, for example, it is the parameter P-0-0217).

7. [Expert mode]

A voltage offset of the sensor signal can be compensated in the "Offset" field. The value entered here in V is subtracted from the sensor signal at the analog input.

8. [Expert mode]

In the "Dead zone" field, specify a bipolar voltage range around 0 V. The function will interpret the voltage range as the voltage value 0 V. This allows useful signals to be better separated from the natural sensor noise.

Torque/force feedback value

1. If "Torque/force feedback value" is selected, an impact of the mechanics vibration on the motor shaft has to be noticeable, as shown in the figure below.

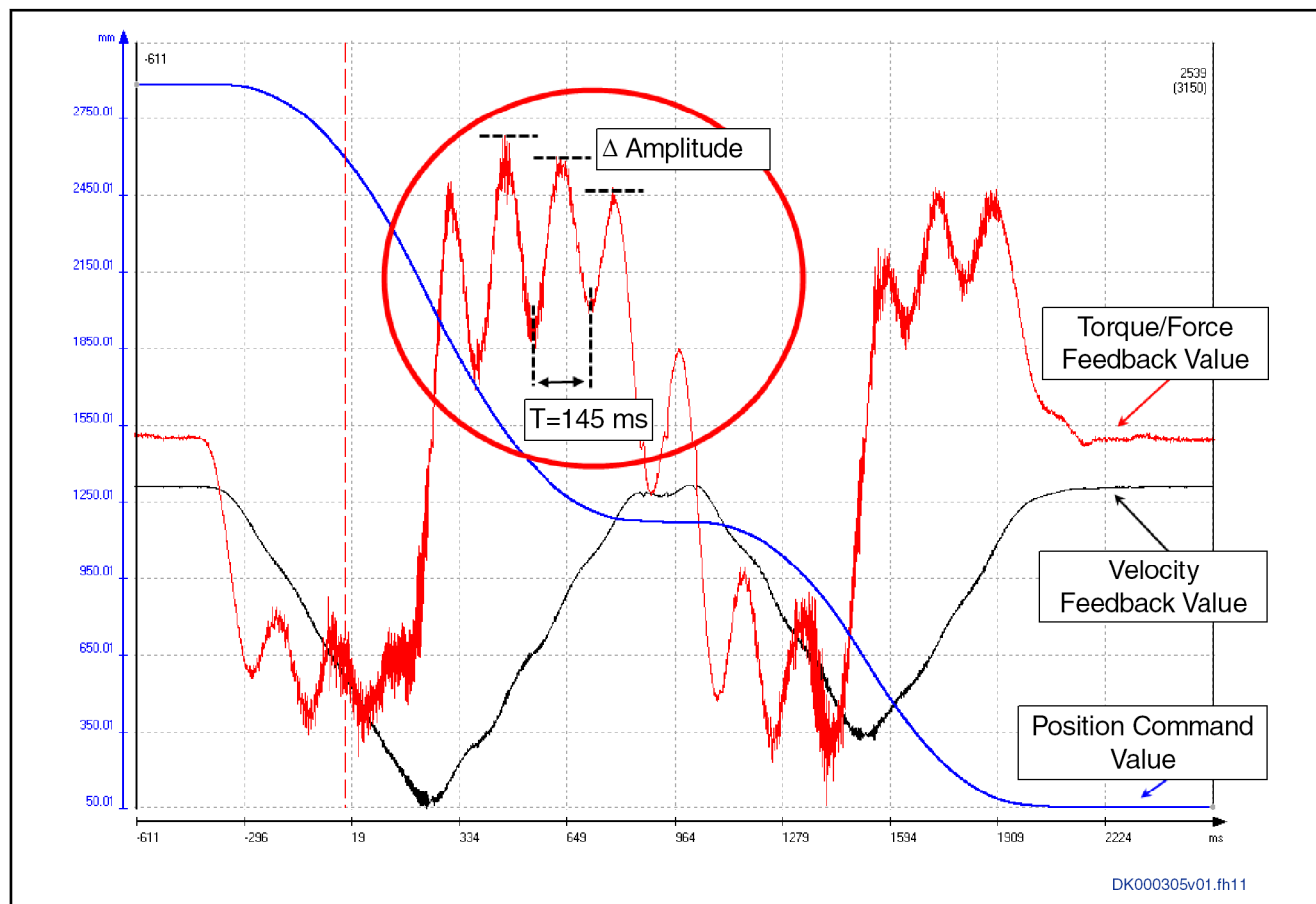


Fig. 9-4: Impact of the mechanics vibration on the motor shaft

A 7 Hz vibration can be clearly seen in the torque/force feedback value. The velocity feedback value also reflects this vibration.

As the dialog shows, a scaling factor is required when this option is activated. This factor is used to convert the torque (or force) to an acceleration. Enter the system inertia as the scaling factor:

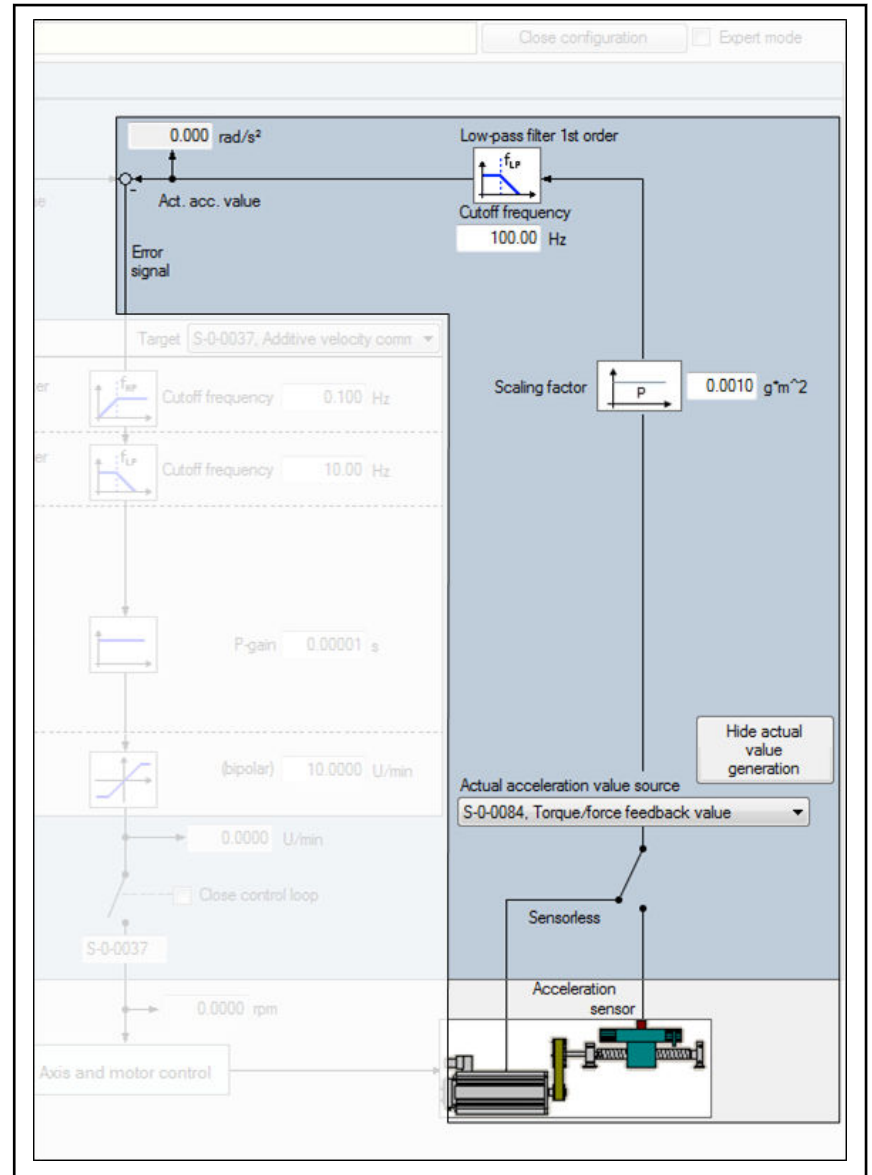


Fig. 9-5: Scaling factor for sensorless vibration damping

2.
 - Linear acceleration:
In this case, the moved total mass in kg related to the motor has to be entered as the scaling factor.
 - Rotary acceleration:
In this case, the total inertia in gm² related to the motor has to be entered as the scaling factor.



The total mass / total inertia consists of motor **and** load.

Vibration damping

If the value is unknown, it can be determined by an experiment. For this purpose, the axis is accelerated and decelerated with reduced torque (or reduced force) and the torque/force curve, as well as the change of velocity, are evaluated. Here, it is necessary to examine a section of the recording with a constant acceleration curve.

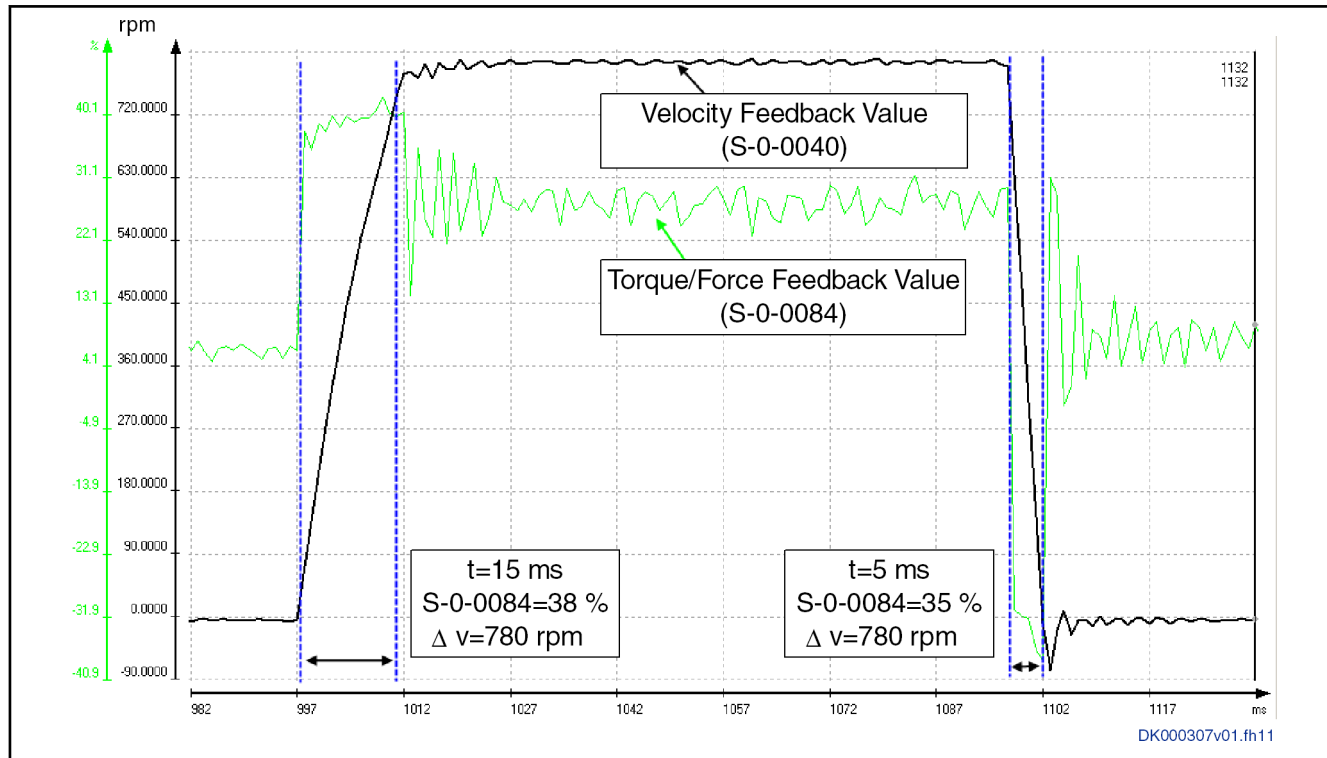


Fig. 9-6: Measurement identifying the scaling factor

Other parameters required for the calculation:

- S-0-0111, Motor current at standstill
- P-0-0051, Torque/force constant

The difference in the behavior for acceleration and deceleration is due to the friction in the system. The friction can be deducted when calculating the two curves.

$$\begin{aligned}
 J_A &= \frac{T_A}{\alpha_A} = \frac{0.01 \cdot S-0-0084 \cdot S-0-0111 \cdot P-0-0051}{\Delta S-0-0040 \cdot \frac{2\pi}{60 \cdot \Delta t}} \\
 &= \frac{0.01 \cdot 38 \cdot 1.5 A_{ms} \cdot 0.29 \frac{Nm}{A_{ms}}}{81.68 \frac{rad}{s} \cdot \frac{1}{0.015 s}} \\
 &= 0.00003 \frac{Nm s^2}{rad} = 0.00003 kgm^2 = 0.03 gm^2
 \end{aligned}$$

$$\begin{aligned}
 J_D &= \frac{T_D}{a_D} = \frac{0.01 \cdot S-0-0084 \cdot S-0-0111 \cdot P-0-0051}{\Delta S-0-0040 \cdot \frac{2\pi}{60 \cdot \Delta t}} \\
 &= \frac{0.01 \cdot 35 \cdot 1.5 A_{ms} \cdot 0.29 \frac{Nm}{A_{ms}}}{81.68 \frac{rad}{s} \cdot \frac{1}{0.005 s}} \\
 &\approx 0.00001 \frac{Nm s^2}{rad} = 0.00001 kg m^2 = 0.01 gm^2
 \end{aligned}$$

$$J = \frac{J_A + J_D}{2} = 0.02 gm^2$$

Thus, the total inertia of the system is

With variable inertia/mass, this value can be corrected to improve control or allow the parasitic vibration to be compensated. This is the case with kinematics such as robot arms. The control unit knows the angles of the different axes and can calculate a current inertia of the arm and cyclically transmit it to the function, i.e. to the "P-0-1321, VD - torque/force feedback value, scaling factor".

Velocity or acceleration feedback value [expert mode]

Besides the torque/force, the velocity feedback value and the acceleration feedback value are available as an additional "sensorless" signal detection. The velocity feedback value is differentiated once internally, whereas the acceleration feedback value made available on the firmware side was already filtered by a low-pass filter for 4 ms.

Vibration damping

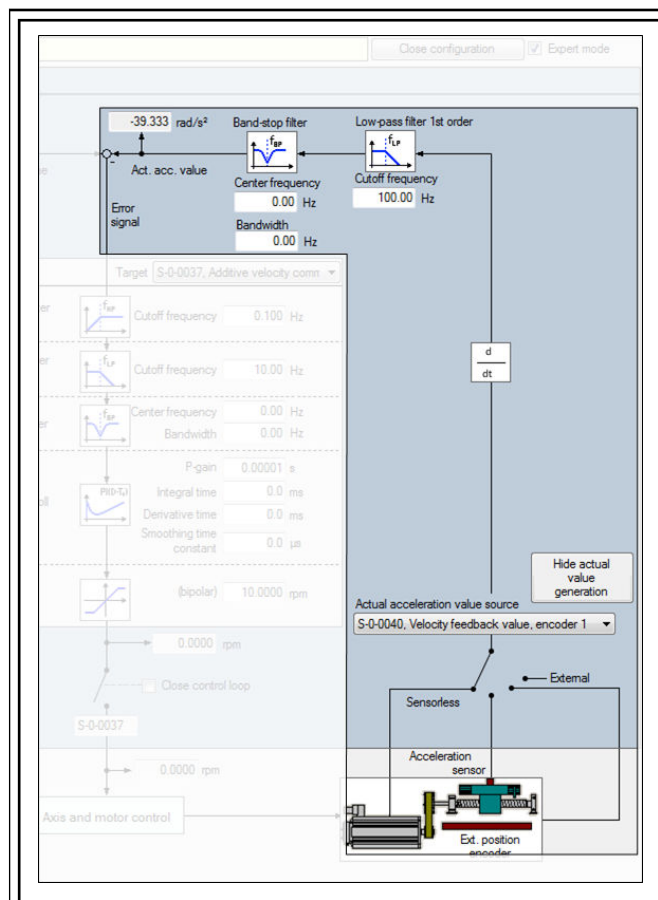


Fig. 9-7: Actual value generation via the velocity feedback value, encoder 1

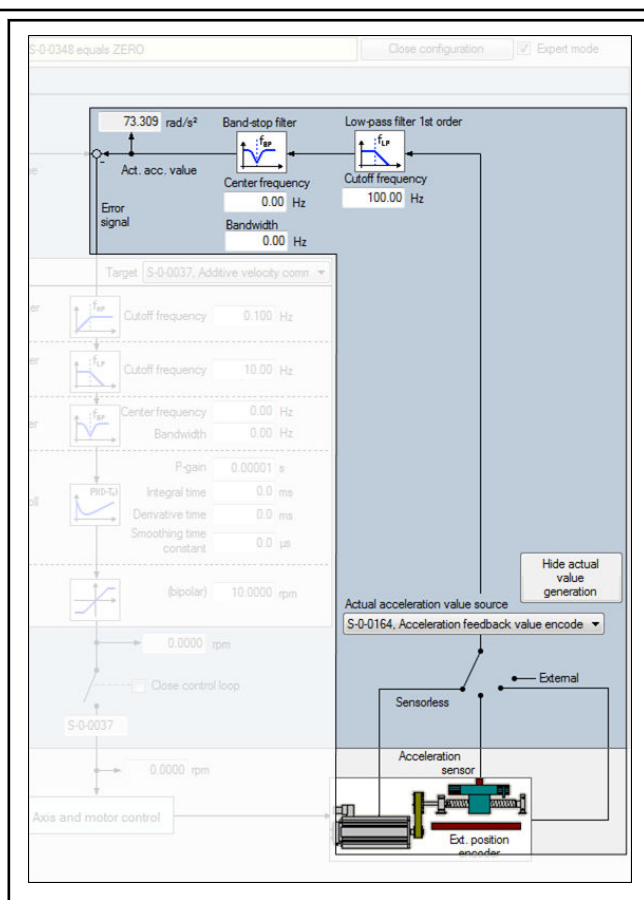


Fig. 9-8: Actual value generation via the acceleration feedback value, encoder 1

Optional position encoder [expert mode]

If an optional position encoder is used in the machine, it is possible to choose between the two options either to have the actual value signal generated from the velocity feedback value 2 or to directly use the acceleration feedback value 2 as the actual value. The same information applies as for the internal values (encoder 1).

External acceleration feedback value [expert mode]

In certain cases, it might be useful to use acceleration values that are determined in a higher-level control unit or that are already available. These values can then be made available via the parameter [P-0-1298](#).

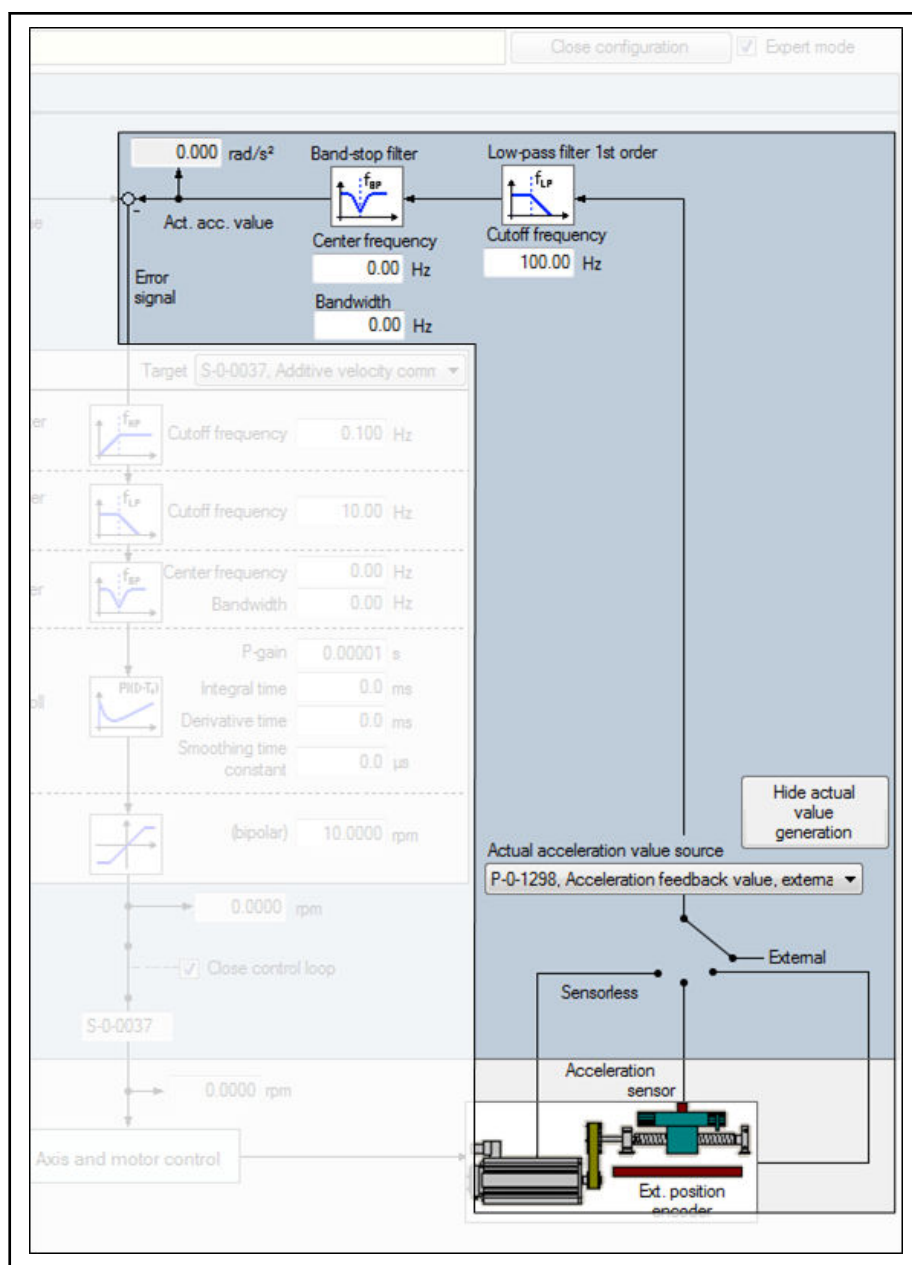


Fig. 9-9: Actual value generation with external signal

Commissioning step 3: Configuring and adjusting the command value signal

Use parameter "P-0-1370, Config word", bits 4 to 6, to select the signal source used for command value generation. In the standard mode, the most frequently used sources "command value = 0" and "P-0-0434, Position command value of controller" are available.

Independent of the command value source, the expert mode contains a delay element. If the acceleration command curve is to be delayed, this delay element with the parameterized "P-0-1383, VD - acceleration command value delay" provides the option to delay the command value, before it is used in the summation point for calculating the control difference.

The parameter P-0-1279 displays the acceleration command value as it is used in the summation point for calculating the control difference.

The parameter P-0-1273 displays the control difference directly after the summation point.

Command value = 0

Select this setting if the acceleration is to be set to ZERO, i.e. completely compensated. This setting can be helpful for dynamic axes with the corresponding filter settings.

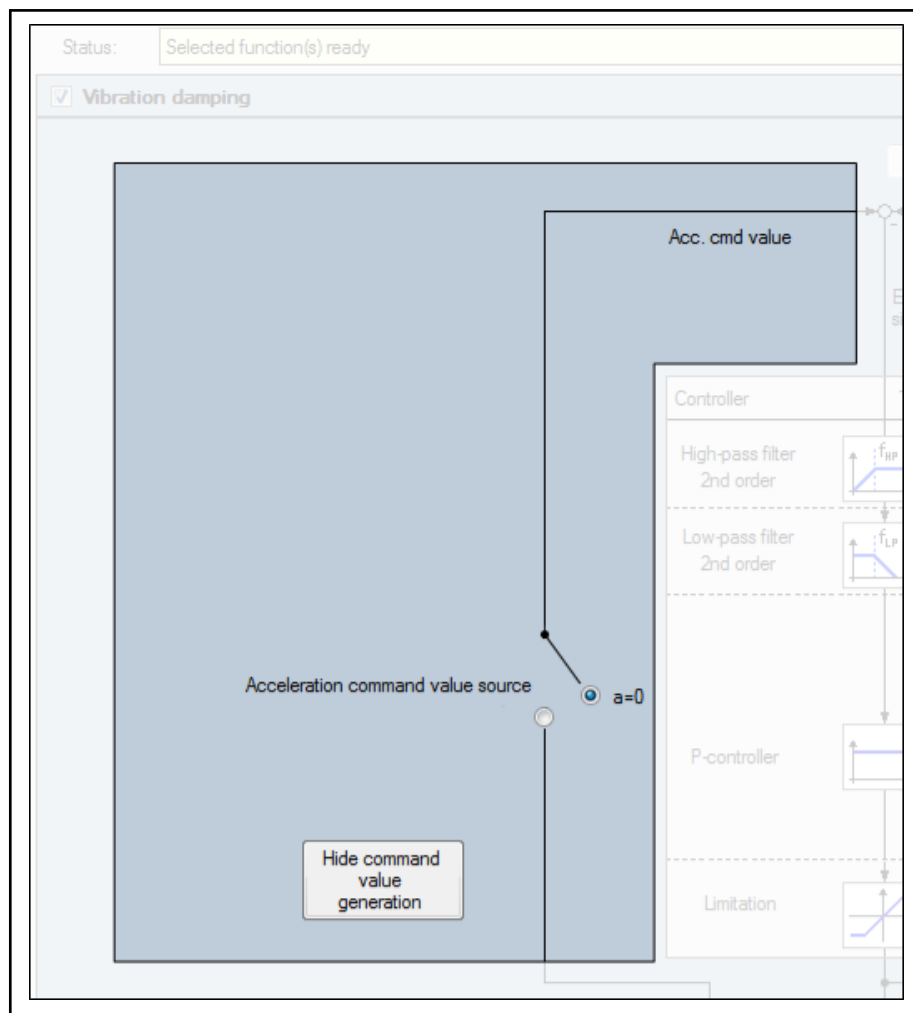


Fig. 9-10: Generating the command value with command value = 0

Filtered position command value

The position command value possibly pre-filtered in the "vibration avoiding" block makes available, after twofold differentiation, the acceleration command value of the position controller.

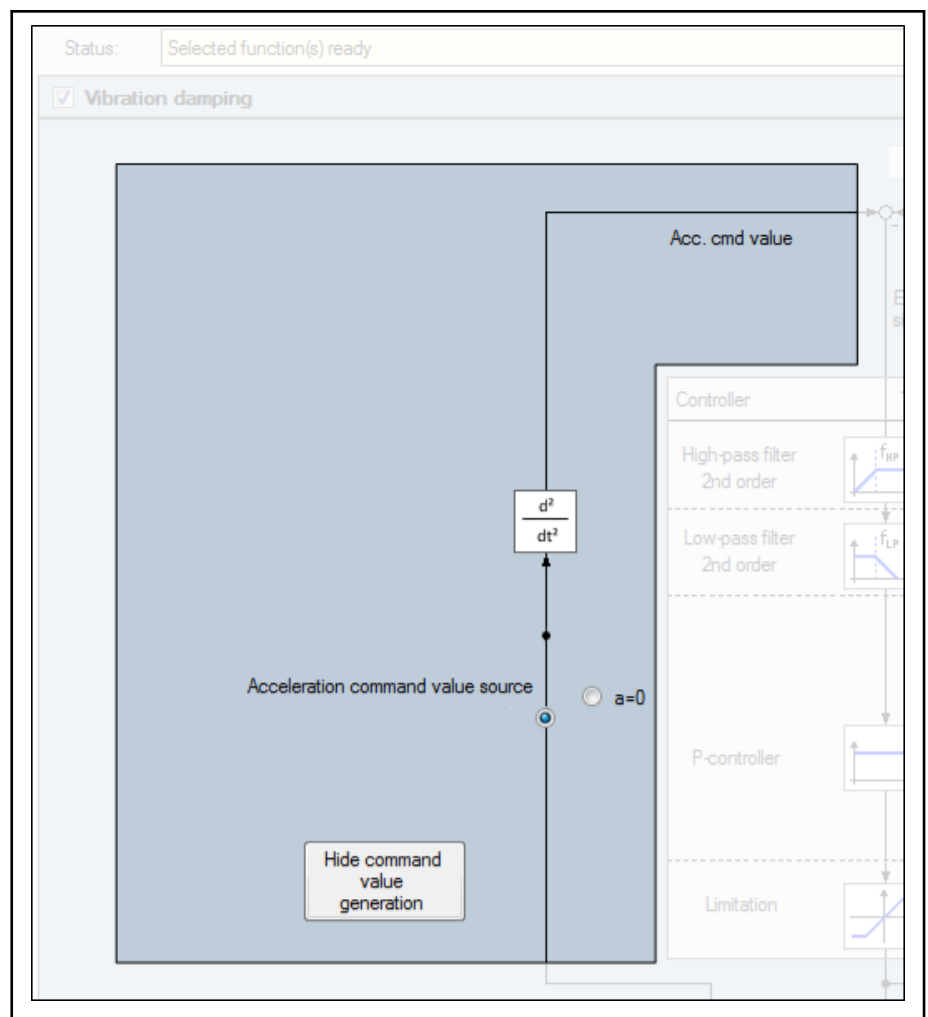


Fig. 9-11: Generating the command value from the position command value

Velocity feedforward actual value [expert mode]

This setting can be used in the "position control, lagless" mode. In this case, the parameter P-0-0454 is the command value source.



The correct function has to be ensured by parameterizing "P-0-0040, Velocity feedforward evaluation" greater than 0 in the drive.

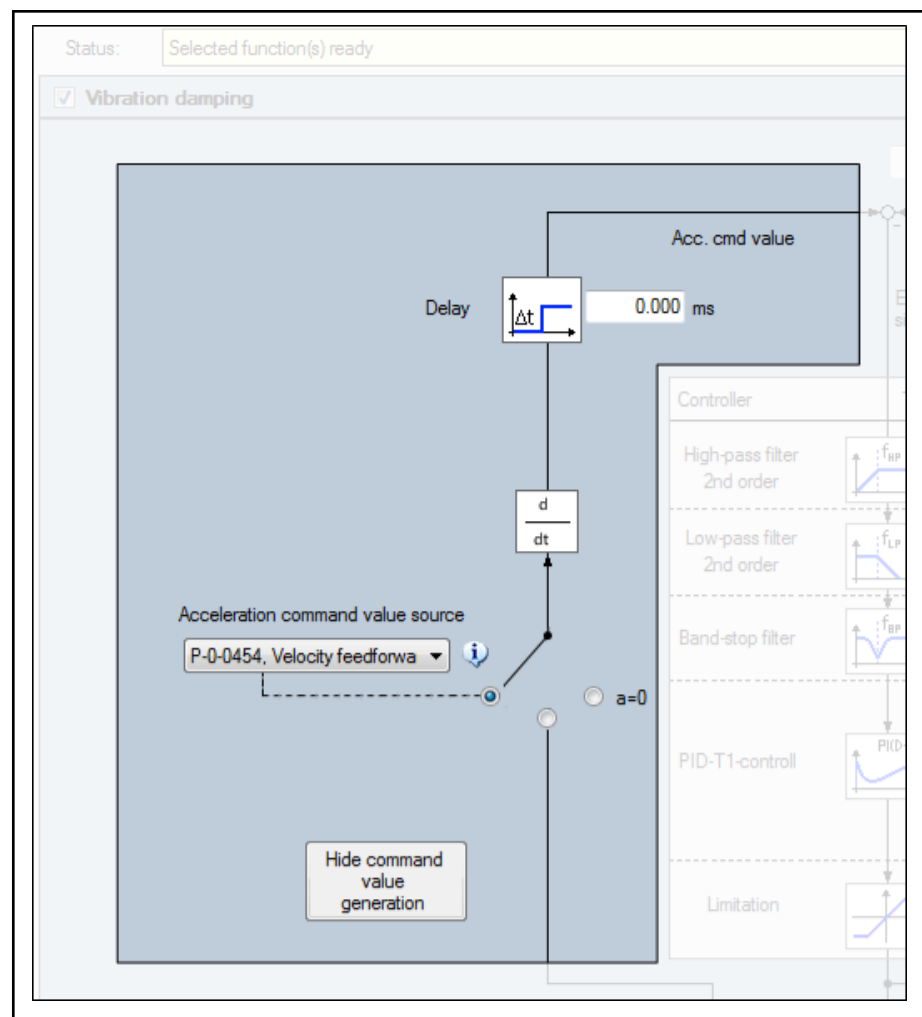


Fig. 9-12: Generating the command value from the velocity feedforward actual value

Acceleration feedforward actual value [expert mode]

In the drop-down list, the parameter P-0-0455 is contained twice as the command value source; once for the "position control, lagless" mode and once for velocity control:

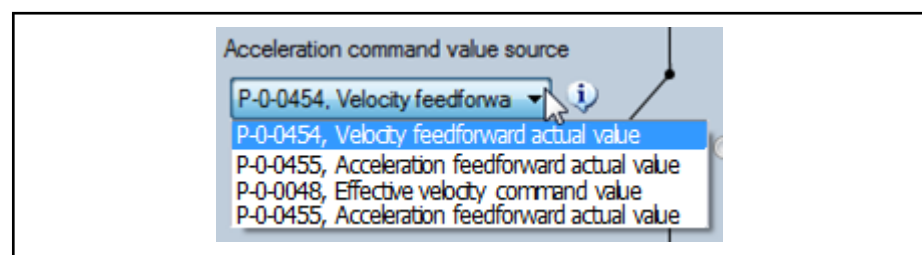


Fig. 9-13: Command value source drop-down list

The following requirements apply:

- Position control: The correct function has to be ensured by parameterizing "S-0-0348, Acceleration feedforward gain" greater than "0" in the drive.
- Velocity control: The correct function has to be ensured by parameterizing "P-0-1126, Velocity control loop: Acceleration feedforward" greater than "0" in the drive.

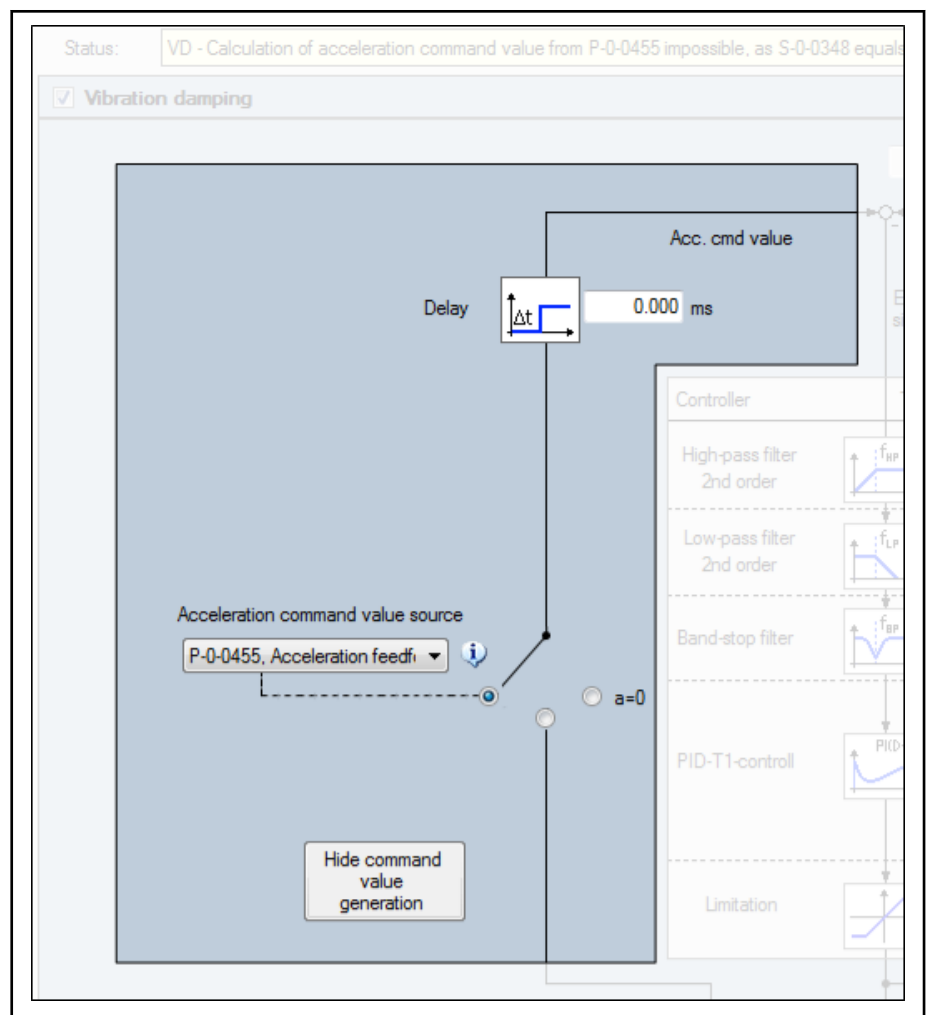


Fig. 9-14: Generating the command value from the acceleration feedforward actual value

Velocity command value [expert mode]

This setting can be used in the velocity control mode. In this case, the parameter P-0-0048 is the command value source.

Vibration damping

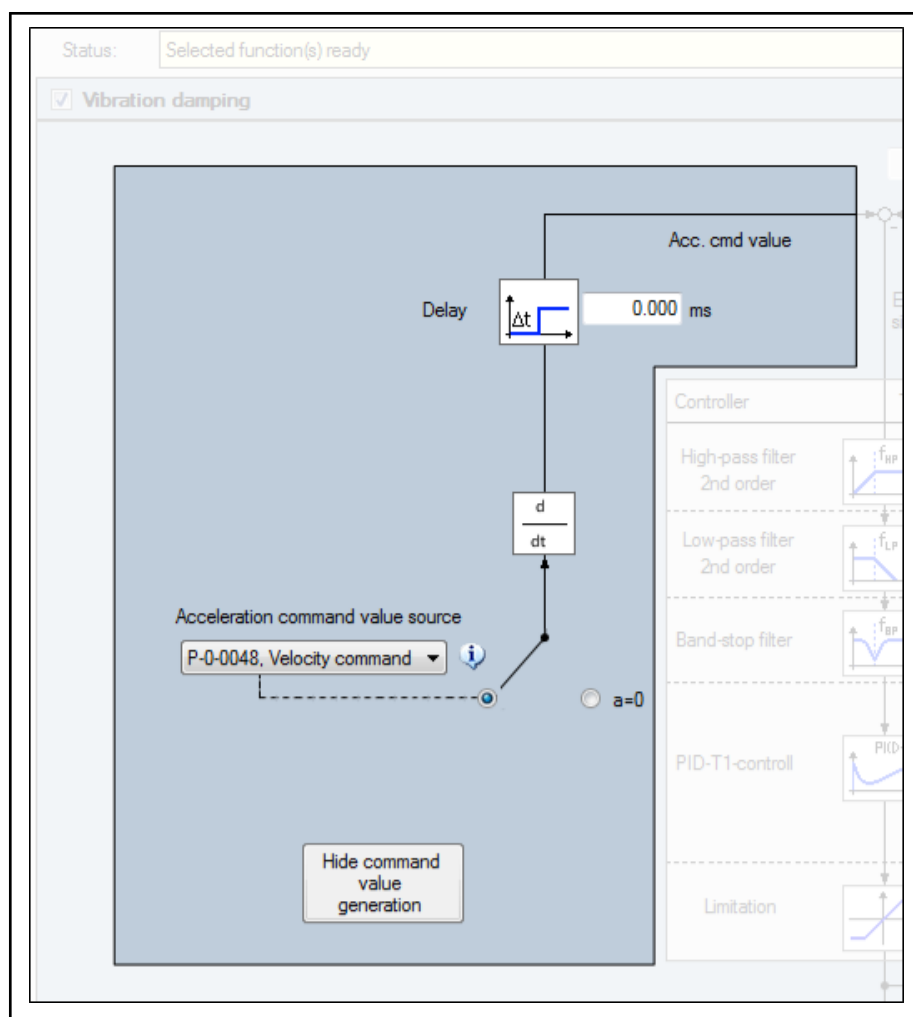
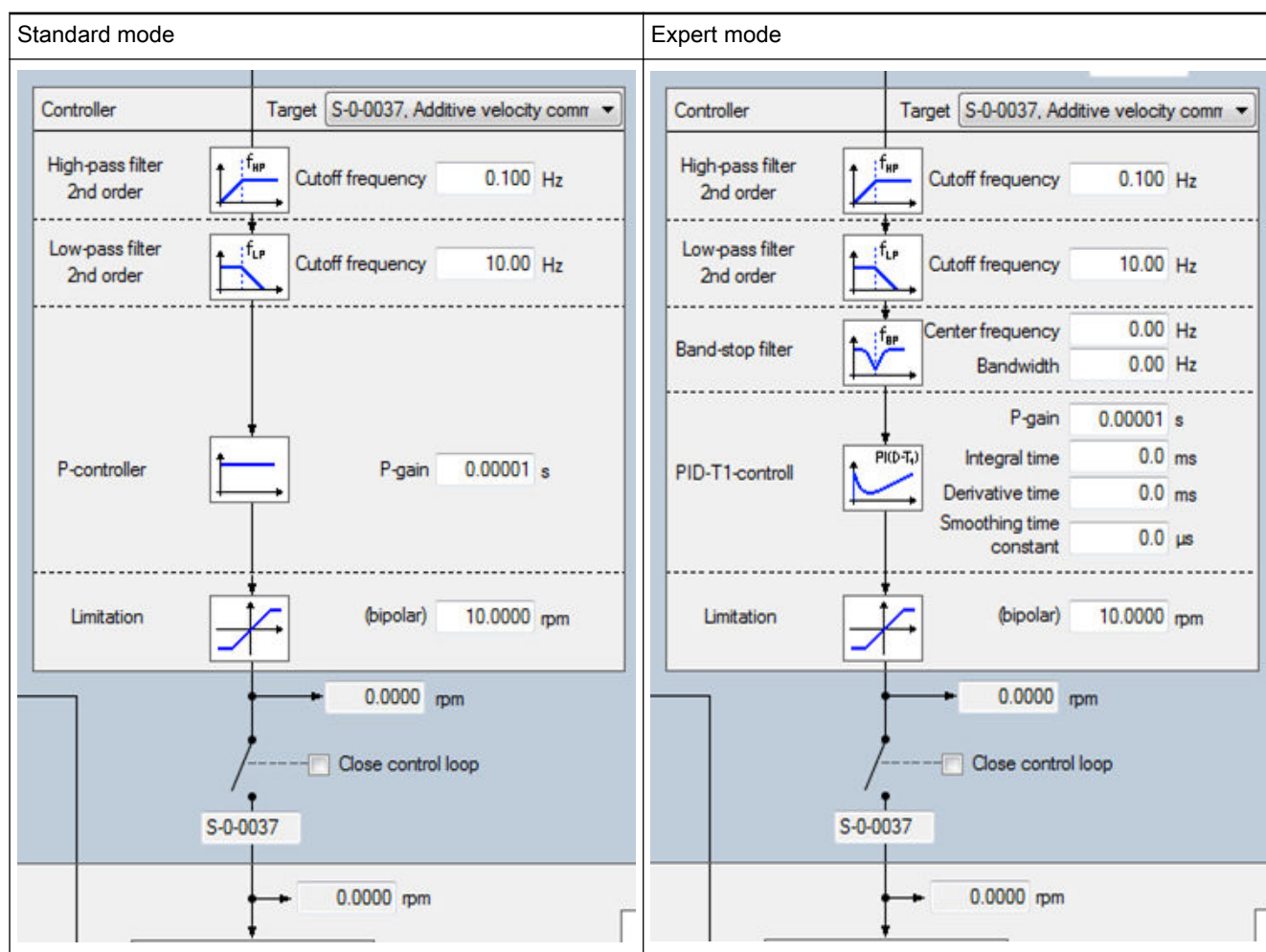


Fig. 9-15: Generating the command value with the effective velocity command value

Commissioning step 4: Parameterizing the controller and the required filters



Tab. 9-3: Damping controller setting parameters

1. Filtering

The control difference is displayed in the parameter [P-0-1273](#) and can be sufficiently filtered. For this purpose, a 2nd order low-pass filter and a 2nd order high-pass filter are available, as well as an additional band-stop filter in the expert mode. It is recommended to parameterize the low-pass filter. The high-pass filter can be used to eliminate an offset in the control difference or an error in the actual acceleration feedback value calculation. If the values "0" are set for the cutoff frequencies, the filters are inactive.



The cutoff frequencies in Hz are directly preset for these filters. In doing so, the following calculation formula should be complied with in order not to obtain any significant phase shift or amplitude change in the signal.

Low-pass filter: $f_{\text{cutoff}} \geq 3 \cdot f_{\text{dist}}$

High-pass filter: $f_{\text{cutoff}} \leq 1/3 \cdot f_{\text{dist}}$

The completely filtered control difference is displayed in the parameter [P-0-1277](#).

2. Damping controller

In the standard mode, the actual controller consists of a proportional gain (P-controller) only that is perfectly sufficient for most of the tasks.

The expert mode makes available a PI(D-T1) controller structure with the following parameters:

- [P-0-1371](#), VD - PI(D-T1) controller, proportional gain
- [P-0-1372](#), VD - PI(D-T1) controller, integral-action time
- [P-0-1373](#), VD - PI(D-T1) controller, derivative action time
- [P-0-1374](#), VD - PI(D-T1) controller, smoothing time constant, D-term
- [P-0-1375](#), VD - PI(D-T1) controller, limitation

The calculated and limited controller output is displayed in the parameter [P-0-1278](#).

Via the "Target" drop-down list, the point at which the controller output takes effect in the drive control loop is determined for damping control:

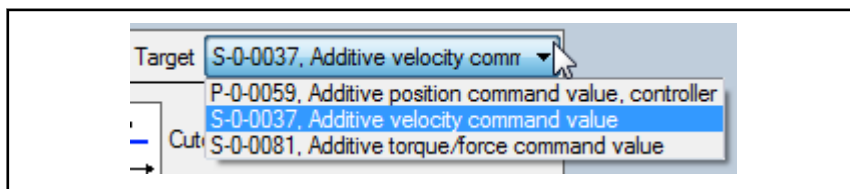


Fig. 9-16: Target parameters drop-down list

When parameterizing the controller and the target parameter for the controller output, observe the following guidelines:

Target parameter	Controller structure
Additive position command value	P-controller
Additive velocity command value	P-controller (recommended setting)
Additive torque/force command value	PI-controller, a D-T1 path might possibly allow further improvement

Tab. 9-4: Relation between controller structure and target parameter

Commissioning step 5: Closing the control loop

Below or at the output of the damping controller, the dialog contains the switch for closing the control loop. Only if the switch is active, the calculated controller output takes effect for the drive and thus for the entire machine.



Parameterizing the controller

It is recommended to configure vibration damping with a mere P-controller and the additive velocity command value as the target parameter, since this allows the best results to be achieved in a large part of the known applications → **standard mode**.

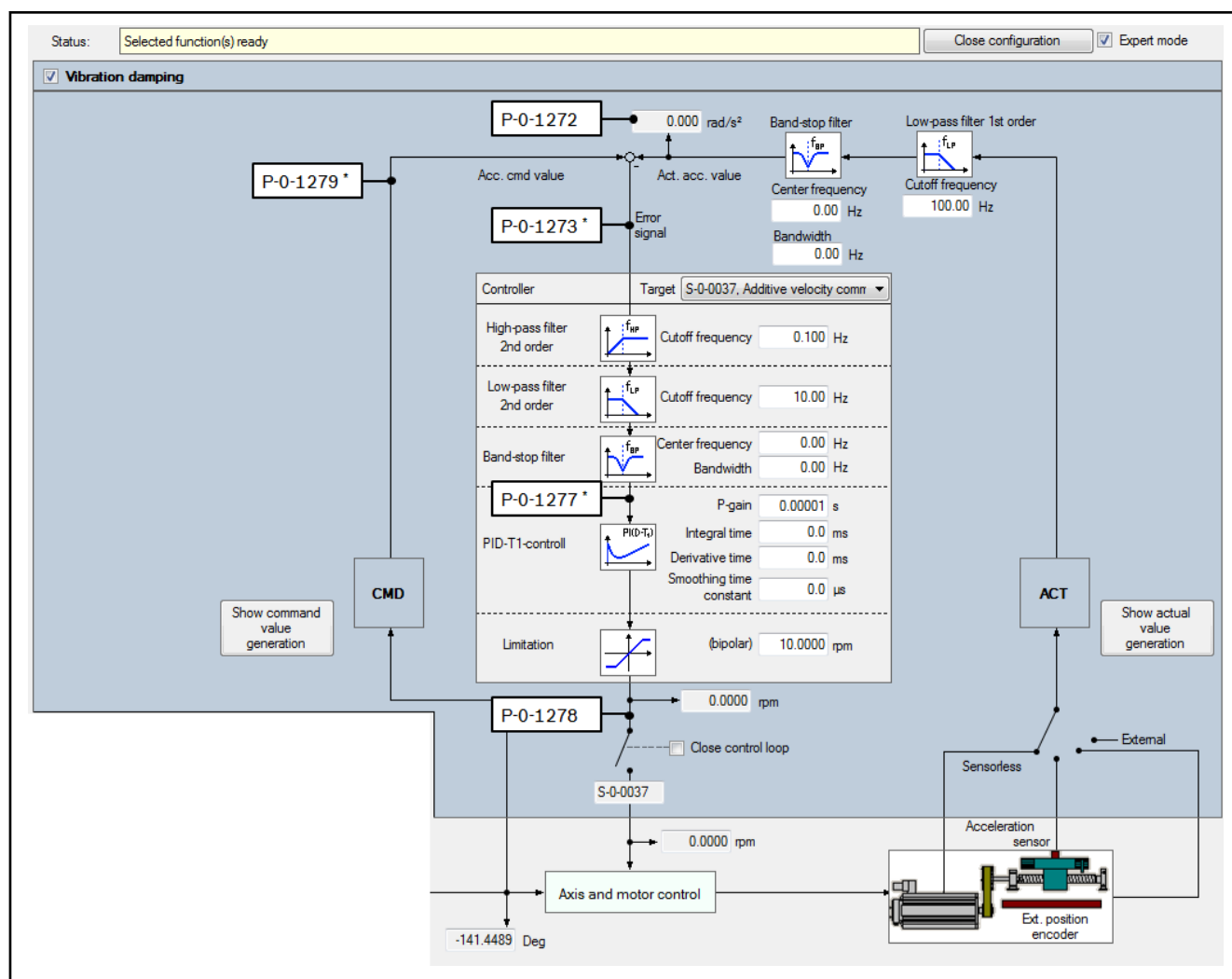
The "velocity command value" (S-0-0037) is selected as the target parameter for the controller output, and the limitation of the controller output is set to a low value (a safe value for this application). It is now possible to parameterize the P-gain without risking an enormous axis motion. Starting with a small value for the P-gain and then increasing the P-gain, it is possible, using the drive-internal oscilloscope function, to quickly get a picture of the range in which the value for the respective application is to be found. This is done by recording the calculated controller output (S-0-0037, Additive velocity command value, in this case). Increasing the P-gain requires adjusting the controller limitation, too.

Commissioning step 6: Optimizing the controller and filter settings

This step is optional and shows that, in practical application, determining the optimum filter and controller settings may require multiple attempts.

The figure below again shows the controller structure with all possible display parameters available for easy and troublefree commissioning.

Vibration damping



- P-0-1272** Adjusted acceleration feedback value
- P-0-1273 *** Control difference (only available for Advanced control sections)
- P-0-1277 *** Control difference after filter cascade (only available for Advanced control sections)
- P-0-1278** Controller output after limitation
- P-0-1279 *** Acceleration command value (only available for Advanced control sections)

Fig. 9-17: Controller structure with display parameters

9.2.3 Configuring and operating vibration damping via parameters

Use the parameter "P-0-1370, Config word", bit 31, to switch between the standard mode and the expert mode.

Commissioning step 1: Activating vibration damping

Activate vibration damping in "P-0-1370, Config word", bit 0.

Commissioning step 2: Configuring and adjusting the actual value signal

According to the configuration of the actual value, the signal source may or has to be adjusted in different ways. The actual value source is set in the parameter "P-0-1370, Config word", bits 8 to 11. In the standard mode, the most frequently used sources torque/force feedback value and an analog input for acceleration sensors are available.

Independent of the actual value source, a band-stop filter can be parameterized in the expert mode. With a preset "P-0-1381, VD - acceleration feedback value, band-stop filter, center frequency" and "P-0-1382, VD - acceleration feedback value, band-stop filter, bandwidth" in Hz the band-stop filter can filter out a small frequency range of the feedback signal. Possible applications are, for example, a periodically occurring disturbance or a fundamental vibration of the machine visible in the torque/force feedback value or in the sensor signal, but irrelevant to the compensation of the parasitic vibration.



For instructions on how to parameterize the band-stop filter, see the chapter "[Configuring and operating vibration avoiding with IndraWorks](#)", commissioning step 4 under "Calculating the filter parameters".

The parameter P-0-1272 displays the acceleration feedback value as it is used in the summation point for calculating the control difference, after it has been completely adjusted.

Acceleration sensor (analog input)

1. Install the sensor system, mount and orient the acceleration sensor at a position in the vibrating mechanics in accordance with the manufacturer's specifications. Afterwards, the voltage output of the sensor system has to be connected to one of the possible interfaces for the analog input.



- The type of control section and the optional modules used determine which analog input interface is available.
- Comply with the allowed voltage range for the selected analog input.

See also Functional Description of firmware "Analog inputs"

2. Via the parameter "P-0-1370, Config word", bits 8 to 11, set the analog input to which the sensor signal is connected. (0000: AI1, 0001: AI2, 0010: AI3, 0011: AI1 (DA), 1010: AI2 (DA))
3. In the parameter "P-0-1319, VD - sensor sensitivity (incl. amplifier)", enter the sensor sensitivity in mV/g or mV/(rad/s²), i.e. the conversion factor for the voltage value at the analog input in accordance with the sensor system.



By way of example, the chapter "[Configuring and operating vibration damping with IndraWorks](#)" shows how to determine the conversion factor.

4. Acceleration sensors can either capture an angular acceleration (e.g., Ferraris sensor in mV/(rad/s²)) or a linear acceleration. However, it might be possible that due to application-related conditions, a sensor measuring a linear acceleration has been mounted to the mechanics, but the axis carries out rotary motions.

Thus, observe the relation between the measuring principle of the acceleration sensor and the occurring acceleration direction, or the acceleration direction you are interested in. Therefore, set bit 6 in "P-0-1370, Config word" in the case of differing linear/rotary direction. In the parameter "P-0-1320, VD - sensor distance to pivot", enter the distance in mm.

5. In the final step, check whether the mounting direction of the sensor matches the coordinate system of the drive. If they are opposed, the sensor signal can be negated via "P-0-1370, Config word", bit 3.



For instructions on how to determine the appropriate configuration by way of measurement, see the chapter ["Configuring and operating vibration damping with IndraWorks"](#).

6. [Expert mode]

In the parameter "P-0-1316, VD - low-pass filter analog input, cutoff frequency", set the cutoff frequency in Hz for a digital 1st order low-pass filter. The filter is inactive if the value "0" has been input. Ideally, all frequencies above the interference frequency are filtered.



By way of example, the chapter ["Configuring and operating vibration damping with IndraWorks"](#) shows how to determine the cutoff frequency.

7. [Expert mode]

A voltage offset of the sensor signal can be compensated via "P-0-1317, VD - analog input, offset". The value entered here in V is subtracted from the sensor signal at the analog input.

8. [Expert mode]

In "P-0-1318, VD - analog input, dead zone (bipolar)", specify a bipolar voltage range around 0 V. The function will interpret the voltage range as the voltage value 0 V. This allows useful signals to be better separated from the natural sensor noise.

Torque/force feedback value

1. With "P-0-1370, Config word", bits 8 to 11 = 1000, the signal "S-0-0084, Torque/force feedback value" is selected as the source.
2. Afterwards, the "P-0-1321, VD - torque/force feedback value, scaling factor" has to be determined.



For instructions on how to determine the scaling factor, see the chapter ["Configuring and operating vibration damping with IndraWorks"](#).

Velocity or acceleration feedback value [expert mode]

1. Besides the torque/force, the velocity feedback value and the acceleration feedback value are available as an additional "sensorless" signal detection. The velocity feedback value is differentiated once internally, whereas the acceleration feedback value made available on the firmware side was already filtered by a low-pass filter for 4 ms.

Via the parameter "P-0-1370, Config word", bits 8 to 11, configure one of the two following options:

- Bits 8 to 11 = 0100: d(S-0-0040, Velocity feedback value encoder 1)/dt
- Bits 8 to 11 = 0110: S-0-0164, Acceleration feedback value encoder 1

Optional position encoder [expert mode]

If an optional position encoder is used in the machine, it is possible to choose between the two options either to have the actual value signal generated from the velocity feedback value 2 or to directly use the acceleration

Commissioning step 3: Configuring and adjusting the command value signal

feedback value 2 as the actual value. The same information applies as for the internal values (encoder 1).

Via the parameter "[P-0-1370](#), Config word", bits 8 to 11, configure one of the two following options:

- Bits 8 to 11 = 0101: $d(S-0-0156, \text{Velocity feedback value encoder 2})/dt$
- Bits 8 to 11 = 0111: S-0-0195, Acceleration feedback value encoder 2

External acceleration feedback value [expert mode]

In certain cases, it might be useful to use acceleration values that are determined in a higher-level control unit or that are already available. These values can then be made available via the parameter [P-0-1298](#) by parameterizing "[P-0-1370](#), Config word", bits 8 to 11 = 1001.

Click "Show command value generation" on the left in the dialog to select the signal source used for command value generation. In the standard mode, the most frequently used sources "command value = 0" and "P-0-0434, Position command value of controller" are available.

Independent of the command value source, the expert mode contains a delay element. If the acceleration command curve is to be delayed, this delay element with the parameterized "[P-0-1383](#), VD - acceleration command value delay" provides the option to delay the command value, before it is used in the summation point for calculating the control difference.

The parameter [P-0-1279](#) displays the acceleration command value as it is used in the summation point for calculating the control difference.

The parameter [P-0-1273](#) displays the control difference directly after the summation point.

Command value = 0

Select "[P-0-1370](#), Config word, bits 4 to 6 = 000: 0", if the acceleration is to be set to ZERO, i.e. completely compensated. This setting can be helpful for dynamic axes with the corresponding filter settings.

Filtered position command value

The position command value possibly pre-filtered in the "vibration avoiding" block makes available, after twofold differentiation, the acceleration command value of the position controller with "[P-0-1370](#), Config word", bits 4 to 6 = 001: "P-0-0434, Position command value of controller".

Velocity feedforward actual value [expert mode]

"[P-0-1370](#), Config word", bits 4 to 6 = 010: $d(P-0-0454, \text{Velocity feedforward actual value})/dt$ can be used in the "position control, lagless" mode. In this case, the parameter P-0-0454 is the command value source.



The correct function has to be ensured by parameterizing "P-0-0040, Velocity feedforward evaluation" greater than "0" in the drive.

Acceleration feedforward actual value [expert mode]

The parameter P-0-0455 can be configured twice as the command value source; once for the "position control, lagless" mode and once for velocity control:

- "[P-0-1370](#), Config word", bits 4 to 6 = 011: P-0-0455, Acceleration feedforward actual value (position control mode, via S-0-0348)
- "[P-0-1370](#), Config word", bits 4 to 6 = 101: P-0-0455, Acceleration feedforward actual value (velocity control mode, via P-0-1126)

The following requirements apply:

- Position control: The correct function has to be ensured by parameterizing "S-0-0348, Acceleration feedforward gain" greater than "0" in the drive.
- Velocity control: The correct function has to be ensured by parameterizing "P-0-1126, Velocity control loop: Acceleration feedforward" greater than "0" in the drive.

Velocity command value [expert mode]

"P-0-1370, Config word", bits 4 to 6 = 100: d(P-0-0048, Effective velocity command value)/dt can be used in the "velocity control" mode. In this case, the parameter P-0-0048 is the command value source.

Commissioning step 4: Parameterizing the controller and the required filters

1. Filtering

The control difference is displayed in the parameter P-0-1273 and can be sufficiently filtered. For this purpose, a low-pass filter and a high-pass filter are available, as well as an additional band-stop filter in the expert mode (P-0-1379, VD - band-stop filter, center frequency; P-0-1380, VD - band-stop filter, bandwidth). It is recommended to parameterize the "P-0-1377, VD - 2nd order low-pass filter, cutoff frequency". The "P-0-1376, VD - 2nd order high-pass filter, cutoff frequency" can be used to eliminate an offset in the control difference or an error in the actual acceleration feedback value calculation. If the values "0" are set for the cutoff frequencies, the filters are inactive.



By way of example, the chapter "Configuring and operating vibration damping with IndraWorks" shows how to determine the time constants for the low-pass and the high-pass filters.

The completely filtered control difference is displayed in the parameter P-0-1277.

2. Damping controller

In the standard mode, the actual controller consists of a proportional gain (P-controller) only that is perfectly sufficient for most of the tasks.

The expert mode makes available a PI(D-T1) controller structure with the following parameters:

- P-0-1371, VD - PI(D-T1) controller, proportional gain
- P-0-1372, VD - PI(D-T1) controller, integral-action time
- P-0-1373, VD - PI(D-T1) controller, derivative action time
- P-0-1374, VD - PI(D-T1) controller, smoothing time constant, D-term
- P-0-1375, VD - PI(D-T1) controller, limitation

The calculated and limited controller output is displayed in the parameter P-0-1278.

In "P-0-1370, Config word", bits 1 and 2, the point at which the controller output takes effect in the drive control loop is determined for damping control:

- Bits 1, 2 = 00: P-0-0059, Additive position command value, controller
- Bits 1, 2 = 01: S-0-0037, Additive velocity command value
- Bits 1, 2 = 10: S-0-0081, Additive torque/force command value

When parameterizing the controller and the target parameter for the controller output, observe the following guidelines:

Target parameter	Controller structure
Additive position command value	P-controller
Additive velocity command value	P-controller (recommended setting)
Additive torque/force command value	PI-controller, a D-T1 path might possibly allow further improvement

Tab. 9-5: Relation between controller structure and target parameter

-
-  For a possible procedure used to parameterize and optimize the controller setting, see the chapter ["Configuring and operating vibration damping with IndraWorks"](#).

The control loop is closed with "P-0-1384, VD - closing the control loop", bit 0. Only when this bit has been set, the calculated controller output takes effect for the drive and thus for the entire machine.
-
-  For a possible procedure used to parameterize and optimize the controller setting, see the chapter ["Configuring and operating vibration damping with IndraWorks"](#).

See chapter ["Configuring and operating vibration damping with IndraWorks"](#). This is a summary of the display parameters for commissioning:

 - [P-0-1272](#), VD - adjusted acceleration feedback value
 - [P-0-1273](#), VD - control difference (**only available for Advanced control sections**)
 - [P-0-1277](#), VD - control difference after filter cascade (**only available for Advanced control sections**)
 - [P-0-1278](#), VD - controller output after limitation
 - [P-0-1279](#), VD - acceleration command value (**only available for Advanced control sections**)

10 Vibration avoiding

10.1 Functional description

The figure below illustrates the functional principle of "vibration damping and avoiding". The two functions "vibration avoiding" and "vibration damping" can be activated individually or together.

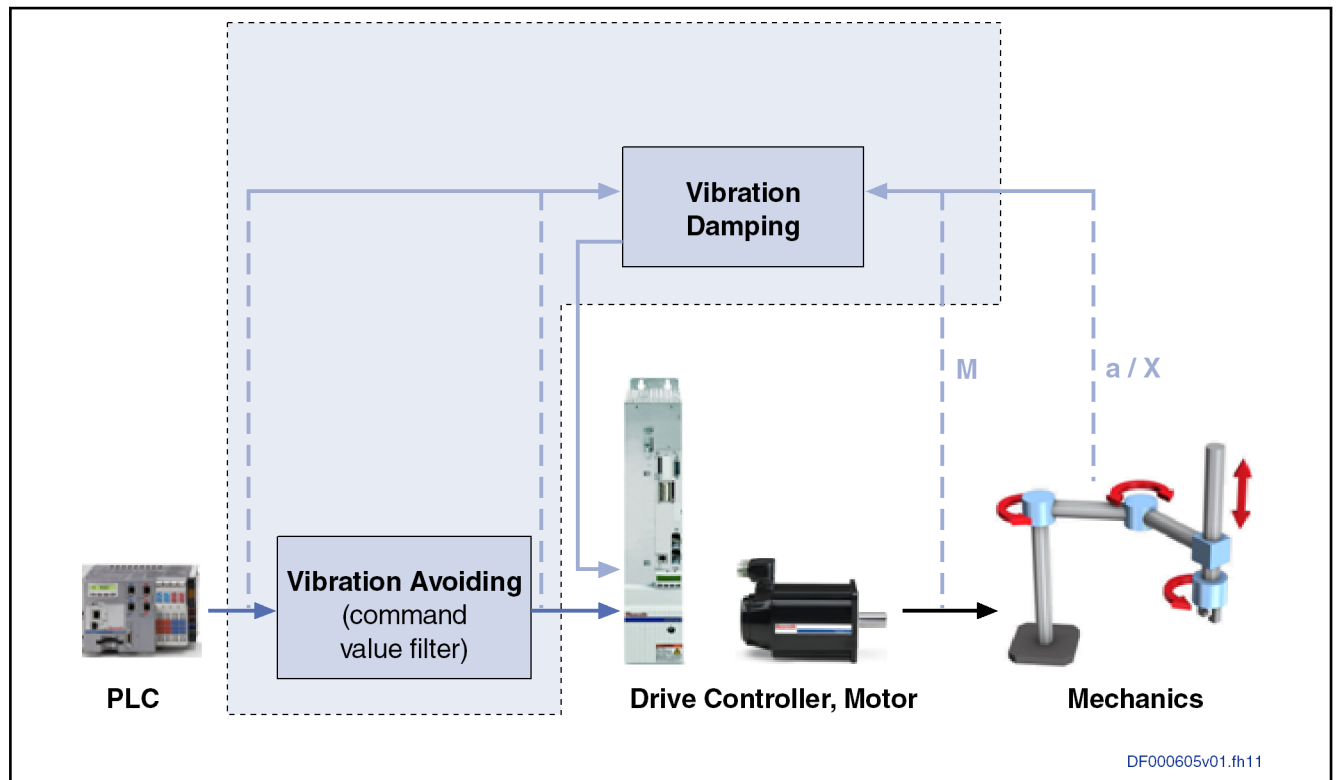


Fig. 10-1: Functional principle of "vibration damping and avoiding"

Vibration avoiding

The operating principles of vibration avoiding and vibration damping have to be distinguished. If structural vibrations, that are not due to external disturbance forces, occur in the normal travel mode of axes, they are caused by the excitation by the travel profile that generally contains a broad range of frequencies. In such cases, the commanded position profile or velocity profile can be pre-filtered so that one or multiple certain mechanical frequencies are no longer excited by the filtered profile.

The standard command value inputs can be used in the position-controlled operation modes "position control with cyclic command value input", "drive-internal interpolation", "drive-controlled positioning" and "positioning block mode". For this purpose, the parameter "P-0-0457, Position command value generator" is used internally.

When position command values are preset, the higher-level control unit can alternatively write them to the parameter "P-0-1300, VA - NC position command value". When velocity command values are preset, the higher-level control unit has to write them to the parameter "P-0-1301, VA - NC velocity command value". If one of the latter options is used, the respective parameter (P-0-1300/P-0-1301) still has to be included in the cyclic protocol and the actual parameter for the cyclic command value input (S-0-0047 for the position command value and S-0-0036 for the velocity command value) has to be removed from it.

Vibration avoiding can be deactivated or individual filters can be deactivated temporarily, if the axis is not with torque. If vibration avoiding is completely deactivated, the transmitted command value becomes active unfiltered in the drive (in accordance with the previous parameterization of vibration avoiding), with a delay of 2 position controller clocks (when using the standard command value inputs) or one NC cycle (when using the parameters [P-0-1300/P-0-1301](#)).

Commissioning the pre-filters requires knowledge of the parasitic system vibrations. Therefore, the torque/force feedback value (S-0-0084) has to be recorded in an appropriate way, if necessary, or the vibration of the mechanics has to be captured with an external sensor, if the impact of the vibration on the torque curve in the drive does not show.

The mechanics can also be excited to vibrate by an external force (e.g., hammer blow). In this case, the filter parameters result from the analysis of the decaying vibration.



For an exemplary analysis of the vibration and determination of the characteristic values, see the chapter ["Configuring and operating vibration avoiding with IndraWorks"](#).



Path accuracy and command value filtering cannot be implemented simultaneously. According to the application, decide whether or not it is possible to make a compromise between these two objectives and which consequences this has on the application/mechanics used. Each one of coupled axes should definitely have the same command value filtering to avoid unwanted behavior or damage to the mechanics due to deformation.

Anti-vibration filter:

The technology function contains two anti-vibration filters connected in series. They filter out the signal components at the specified characteristic frequency and all odd-numbered multiples (3rd, 5th, 7th, etc.) of the command value profile. There is no low-pass filter behavior for the remaining frequency range like it occurs with the usual average value filters. On this account, these filters have a higher contour precision than an average value filter.



Only the 1st filter is available for BASIC control sections and in the standard mode.

Average value filter [expert mode]:

The average value filter filters out the signal components at the characteristic frequency and all multiples (2nd, 3rd, 4th, etc.) of the command value profile. There is a low-pass filter behavior for the remaining frequency range.

Band-stop filter [expert mode]:

The frequency behavior of this filter is similar to the behavior of the anti-vibration filter. With the entered bandwidth, the rejection filter, however, only filters out the center frequency and not the multiples of the command profile. Here, there is no low-pass filter behavior for the remaining frequency range either.



This filter is only available for ADVANCED control sections in the expert mode.

Filter comparison:

The figure below illustrates the effects of the respective filters on an input signal in the frequency range. Each of the three filters was parameterized for a frequency of 10 Hz. The damping of the anti-vibration filter is 0.005, the bandwidth of the band-stop filter is 15 Hz. Observe the double logarithmic display:

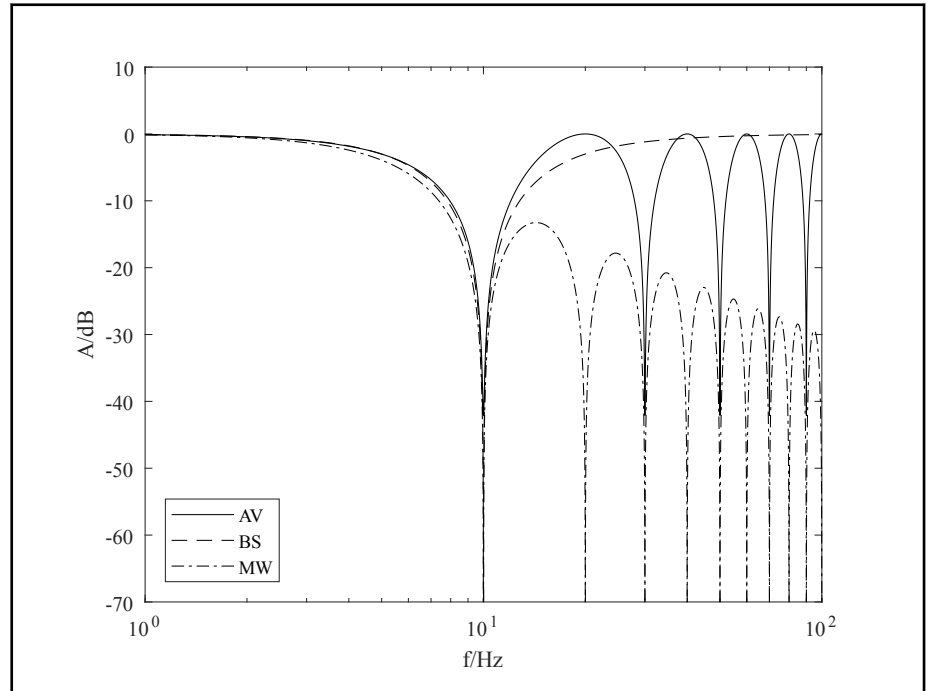


Fig. 10-2: Vibration avoiding, filter comparison (AV: anti-vibration filter, BS: band-stop filter, MW: average value filter)

10.2 Notes on commissioning and operation

10.2.1 General information

Initial situation The successful commissioning of the "vibration damping and avoiding" function requires the following initial situation:

- The functional package "MA" has been enabled so that the drive-integrated PLC can be used.
- The PLC project "FWS_MLDPCx_VDA_03Vxx_D0_MPxx" has been loaded and activated for the firmware version at hand (see "[Loading the technology function to the drive](#)").

Overview of required individual steps for commissioning vibration avoiding

Configuring the function

1. Activating vibration avoiding
2. Selecting the command value source
3. Preparatory measures
4. Selecting and parameterizing the filters

Operating/using the function

As soon as the function and the individual filters have been activated via the config word, they are always active as long as no configuration error occurs. The filter parameters may be modified and adjusted at any time.



Below, the individual steps will be described in detail and the chapter "Configuring and operating vibration avoiding with IndraWorks" will explain these steps.

10.2.2 Configuring and operating vibration avoiding with IndraWorks

Commissioning step 1: Activating vibration avoiding

To parameterize vibration avoiding via the IndraWorks dialog, activate it by ticking the check box:

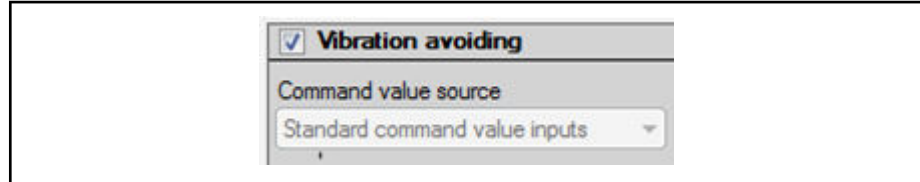


Fig. 10-3: Activating vibration avoiding

Commissioning step 2: Selecting the command value source

In the standard mode, only the standard command value inputs are available. This setting is sufficient for the majority of applications. In the expert mode, it is furthermore possible to access command values written to register parameters by a higher-level control unit:

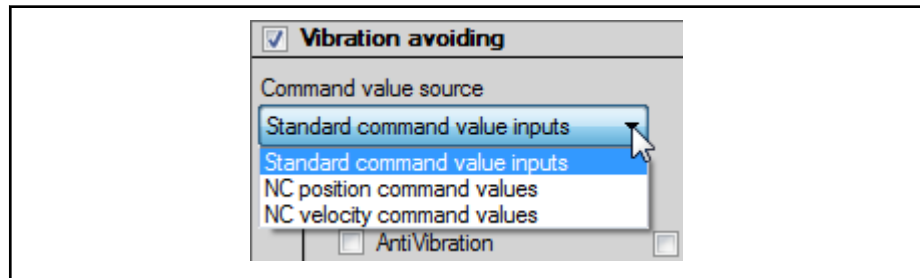


Fig. 10-4: Selecting the command value sources in the expert mode

Commissioning step 3: Preparatory measures

1. If the standard command value inputs are to be used for position values, the value "2" first has to be assigned to the parameter "P-0-0456, Position command value delay" (steps 1 to 4). Besides, bit 9 has to be set in the parameter "P-0-0556, Config word of axis controller" and thus the additive position command value P-0-0059 has to be used for feedforward (steps 5 and 6).

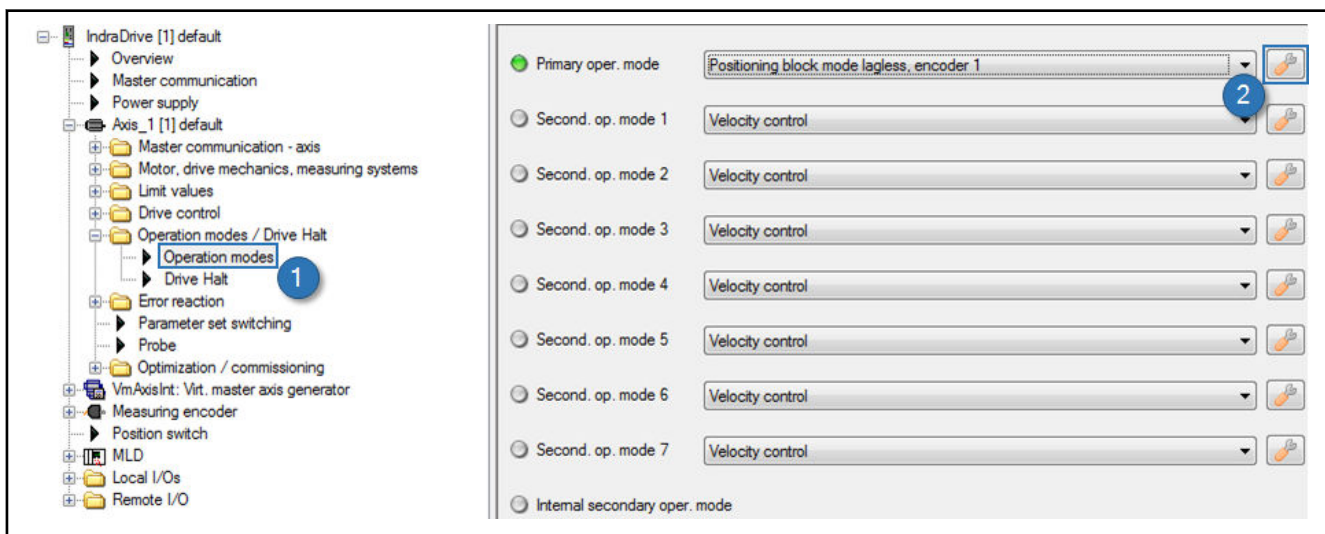


Fig. 10-5: Operation modes dialog

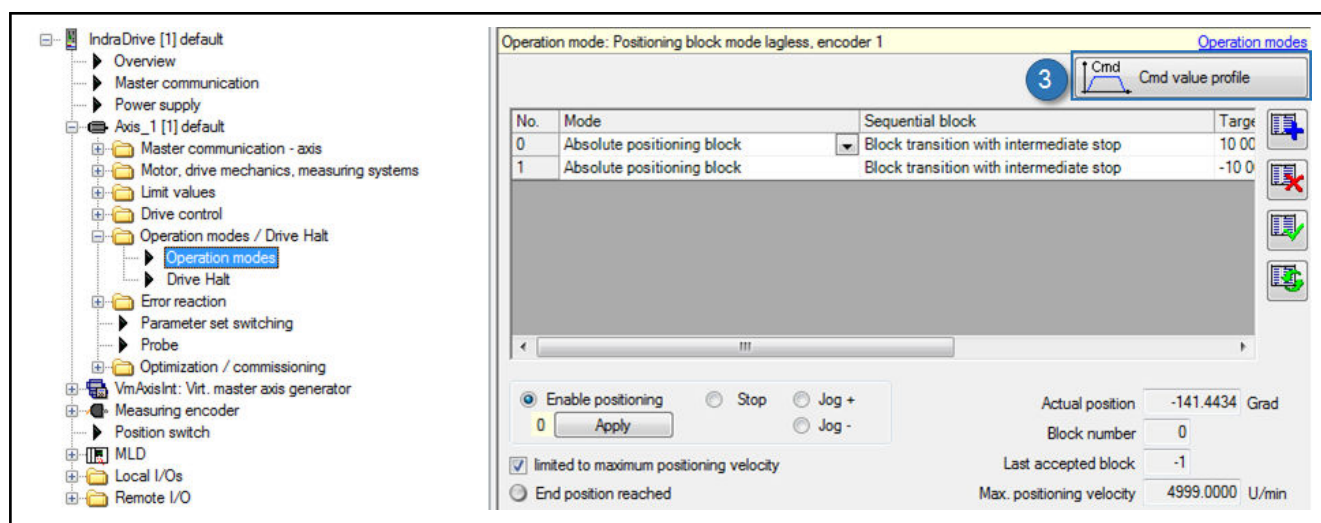


Fig. 10-6: Positioning block dialog

Here, the position command value delay (P-0-0456) can be set to the value "2" (step 4):

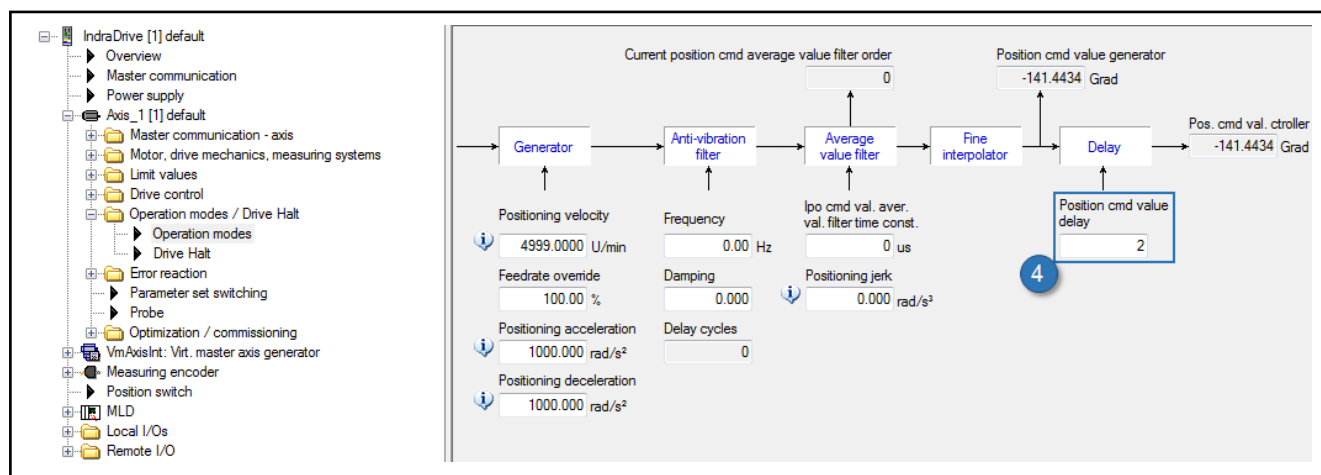


Fig. 10-7: Command value profile dialog

In the "Axis control settings" dialog, the bit 9 can be set in P-0-0556 using a switch and thus the additive position command value P-0-0059 can be used for feedforward:

Vibration avoiding

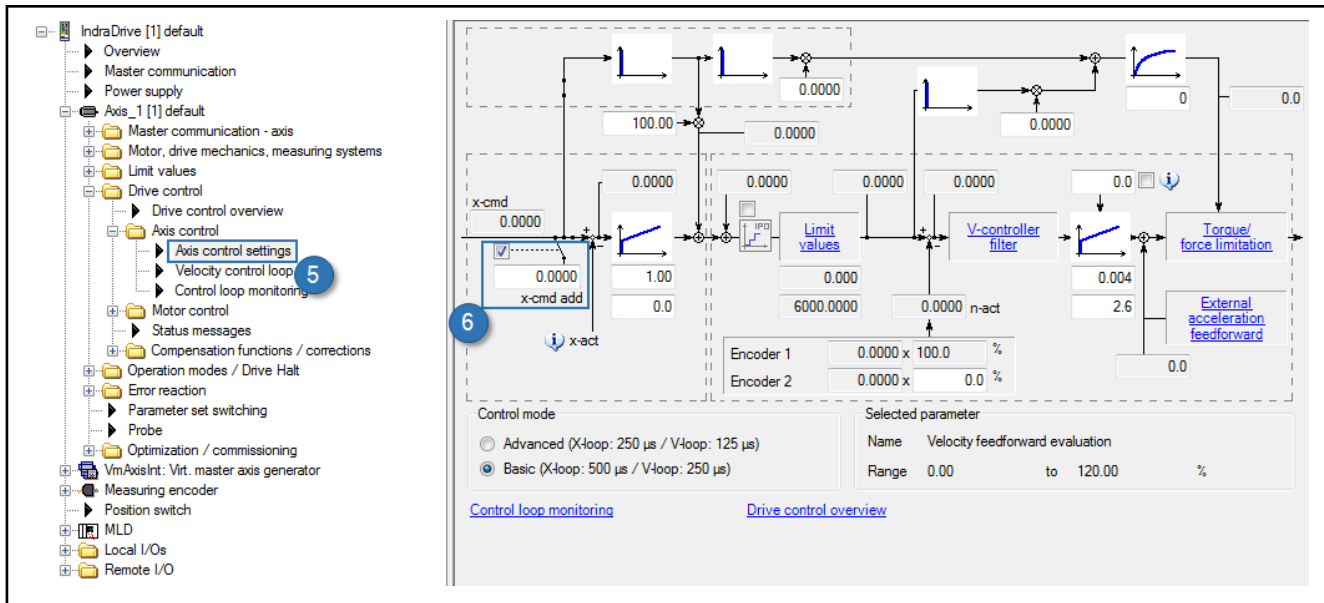


Fig. 10-8: "Axis control settings" dialog

2. In the case of alternative command value input via the parameters **P-0-1300** (when presetting **position command values**) or **P-0-1301** (when presetting **velocity command values**), they have to be parameterized as target parameters for command value input in the cyclic protocol and the standard target parameter S-0-0047 (or S-0-0036) has to be removed:

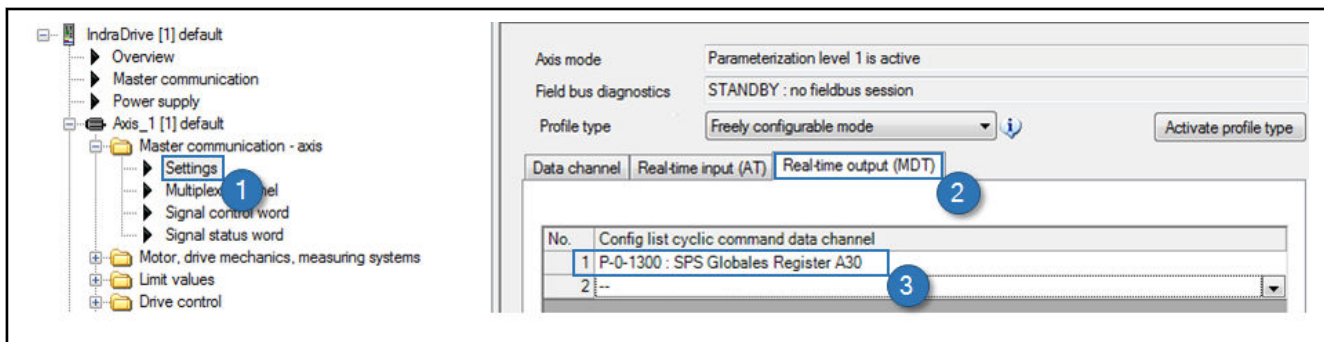


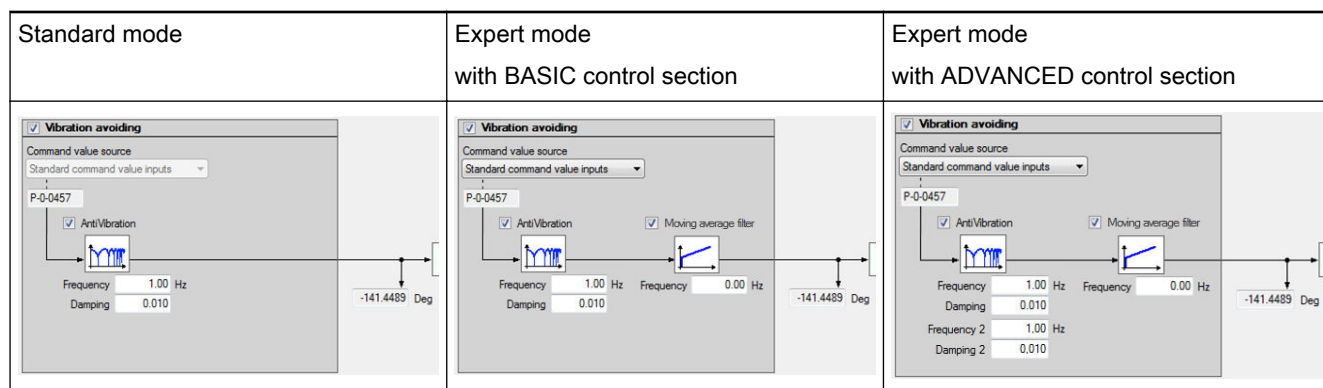
Fig. 10-9: Configuring the cyclic data transmission

The screenshot shows how to call the dialog for configuring the cyclic data transmission and how to extend the cyclic telegram in the "PROFINET" example by the parameter "P-0-1300, VA - NC position command value".

Commissioning step 4: Selecting and parameterizing the filters

In the expert mode, it is possible to choose between three different filters. The filters can be used individually or together, and in addition to the drive-integrated position command value filters (average value filter P-0-0041/ P-0-0042, also anti-vibration filter P-0-0642/P-0-0643 with MPx20 and above). The notch filter cannot be accessed via a dialog, but it can be optionally switched on and parameterized via parameter. The filters have to be selected for each application due to their effectivity. When an ADVANCED control section is used in the expert mode, two anti-vibration filters connected in series are available.

Basically, it is recommended to use the anti-vibration filter. In the standard mode, only one anti-vibration filter is available and effective.



Tab. 10-1: Dialog for vibration avoiding with different configurations

The filters are inactive if a frequency of 0 Hz has been set.

Anti-vibration filter

The anti-vibration filter is activated via a check box in the dialog. Thereupon, the edit fields for frequency and damping are displayed (if both anti-vibration filters connected in series are available, they are both activated).

The filter can be parameterized by a measurement at the load (with an acceleration sensor or an optional position encoder) or by measuring the torque/force feedback value of the drive.

The example below illustrates this with an acceleration measurement at the mechanics:

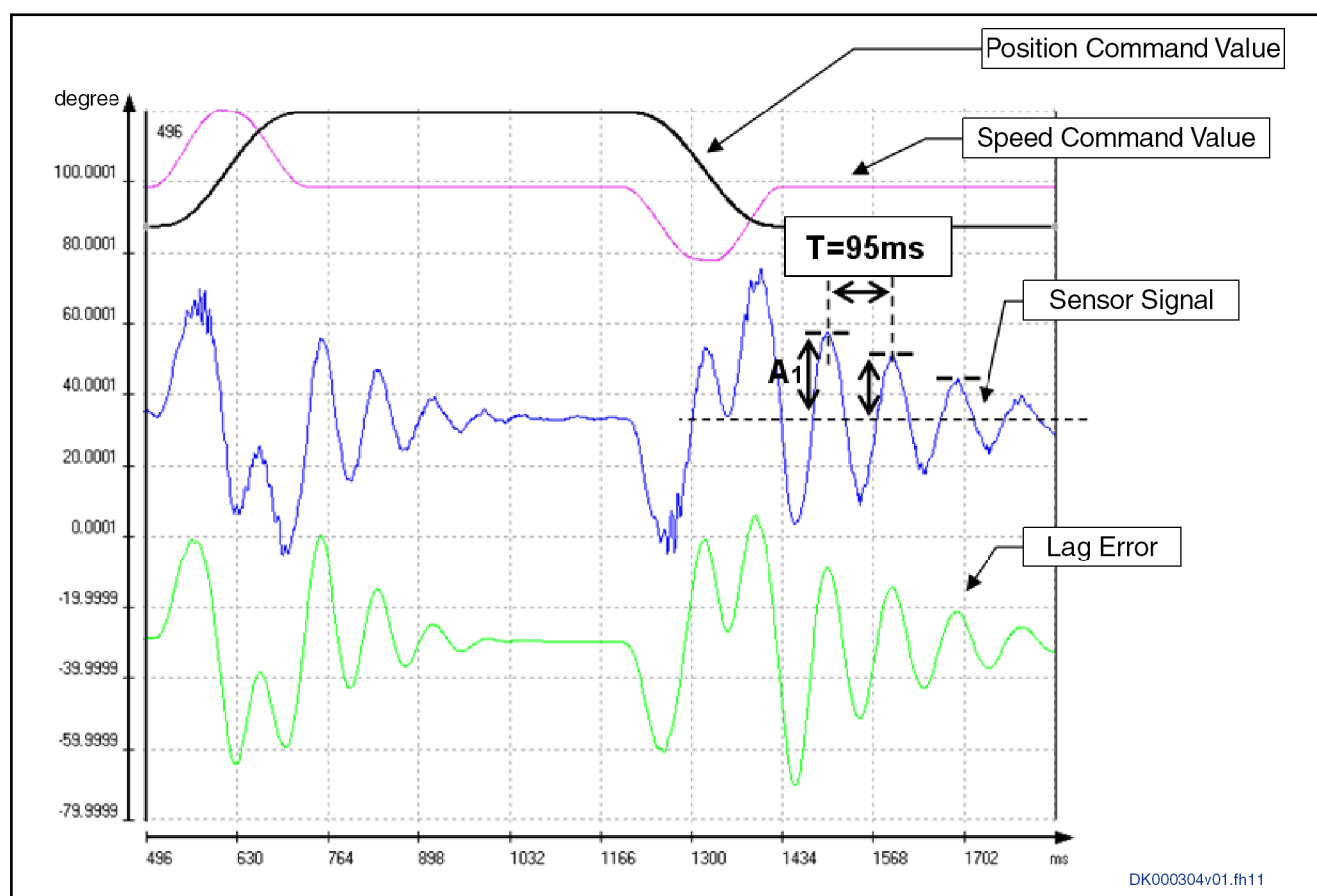


Fig. 10-10: Calculating the filter parameters

The frequency of the vibration can be read out on the basis of the vibration period and has to be entered in Hz in the corresponding edit field. The damping of the system can be calculated using the amplitude values of successive vibrations. The corresponding formula is:

$$D = \frac{\ln \left(\frac{A_i}{A_{i+1}} \right)}{\sqrt{4\Pi^2 + \ln \left(\frac{A_i}{A_{i+1}} \right)}}$$

By "trial and error", a feasible method can be used in this case, too, by entering a start value of 0.1 and subsequently testing the effect on the system by adjusting the value between 0.7 and 0.005.

The vibration in the above figure has a frequency of approximately 10.5 Hz. This frequency also has an effect on the velocity feedback value and position feedback value/lag error. The resulting settings for the anti-vibration filter are as follows:

- Frequency = $1/T = 1/0.095 \text{ s} = 10.5 \text{ Hz}$
- Damping = 0.1

The damping results from the amplitude change of the vibration in the case of a step response. It is possible to start with a value of 0.1. With active command value filtering, the damping value can be subsequently optimized.

NOTICE

Possible property damage caused by jump in command value input, when frequency or damping are adjusted with the filter having been activated and while the axis is in motion.

If possible, only adjust the frequency or damping if the axis is not under torque or in standstill.

Average value filter [expert mode]

The average value filter is activated via a check box in the dialog. Thereupon, the edit field for the frequency is displayed.

The frequency is determined as described for the anti-vibration filter.

Band-stop filter [expert mode]

The band-stop filter cannot be entered via the dialog, it has to be entered via individual parameters. See ["Configuring and operating vibration avoiding via parameters"](#).

10.2.3 Configuring and operating vibration avoiding via parameters

Commissioning step 1: Activating vibration avoiding

Use "P-0-1370, Config word", bit 31, to switch between the standard mode and the expert mode.

Activate vibration avoiding in "P-0-1370, Config word", bit 16.

Commissioning step 2: Selecting the command value source

Via "P-0-1370, Config word", bits 17 and 18, set the parameter from which the cyclic command values are read. The following options can be selected:

Standard mode	Expert mode
00: Standard command value inputs (via P-0-0457)	00: Standard command value inputs (via P-0-0457) 01: NC position command values (to P-0-1300) 10: NC velocity command values (to P-0-1301)

Commissioning step 3: Preparatory measures

1. If the standard command value inputs are to be used for position values, the value "2" first has to be assigned to the parameter "P-0-0456, Position command value delay" and bit 9 has to be set in the parameter "P-0-0556, Config word of axis controller". Thus, the additive position command value P-0-0059 has to be used for feedforward.
2. In the case of alternative command value input via the parameters P-0-1300 (when presetting **position command values**) or P-0-1301 (when presetting **velocity command values**), they have to be parameterized as target parameters for command value input in the cyclic protocol and the standard target parameter S-0-0047 (or S-0-0036) has to be removed.

Commissioning step 4: Selecting and parameterizing the filters

In the expert mode, it is possible to choose between three different filters. The filters can be used individually or together, and in addition to the drive-integrated position command value filters (average value filter P-0-0041/P-0-0042, also anti-vibration filter P-0-0642/P-0-0643 with MPx20 and above). The filters have to be selected for each application due to their effectivity. When an ADVANCED control section is used in the expert mode, two anti-vibration filters connected in series are available.

Basically, it is recommended to use the anti-vibration filter. In the standard mode, only one anti-vibration filter is available and effective.

The filters are inactive if a frequency of 0 Hz has been set.

Anti-vibration filter

Activate the anti-vibration filter via parameter "P-0-1370, Config word", bit 20 (if both anti-vibration filters connected in series are available, they are both activated).

Use the filter parameters "P-0-1326, VA - anti-vibration filter 1, frequency" and "P-0-1327, VA - anti-vibration filter 1, damping" for configuration or (if available) "P-0-1322, VA - anti-vibration filter 2, frequency" and "P-0-1323, VA - anti-vibration filter 2, damping". The frequencies have to be consistently set in Hz.

The filter can be parameterized by a measurement at the load (with an acceleration sensor or an optional position encoder) or by measuring the torque/force feedback value of the drive.



The chapter "[Configuring and operating vibration avoiding with IndraWorks](#)" shows an exemplary calculation of the filter parameters.

NOTICE

Possible property damage caused by jump in command value input, when frequency or damping are adjusted with the filter having been activated and while the axis is in motion.

If possible, only adjust the frequency or damping if the axis is not under torque or in standstill.

Average value filter [expert mode]

Activate the average value filter via parameter "P-0-1370, Config word", bit 21. Set the parameter "P-0-1385, VA - average value filter, frequency" in Hz for the filter.

The frequency is determined as described for the anti-vibration filter.

Band-stop filter [expert mode]

Activate the band-stop filter (also called notch filter or rejection filter) via the parameter "P-0-1370, Config word", bit 19. For this filter, the two parameters "P-0-1324, VA - band-stop filter, center frequency" and "P-0-1325, VA - band-stop filter, bandwidth" have to be determined and set, each of them in Hz.

The center frequency of the filter can be determined in the same way as the characteristic frequency of the anti-vibration filter. As a rule of thumb, set the bandwidth to the 1.5-fold value of the determined center frequency. Then these values can be optimized by "trial and error".

These are the results with the values from the example:

- "P-0-1324, VA - band-stop filter, center frequency" = $1/T = 1/0.095 \text{ s} = 10.5 \text{ Hz}$
- "P-0-1325, VA - band-stop filter, bandwidth" = $1.5 * \text{center frequency} = 15.8 \text{ Hz}$

11 Diagnostic and status messages

Overview of drive warnings

- E2011 Changing the config word not allowed in AF
- E2012 Limitation of controller output is active (see [P-0-1375](#))

Error output overview

The information for Additional 1 and Additional 2 is output via the parameters [P-0-1292](#) and [P-0-1293](#):

ErrorID	ErrorIdent			Explanation
	ErrorTable	Additional1	Additional2	
16#0000	16#1000	16#0000	16#0000	Selected function(s) ready No function selected Waiting for PM/OM switching
16#0001	16#1000	16#0001	16#0008	VD - impossible to calculate command acceleration from P-0-0454 with P-0-0059 as VD target parameter (see P-0-1370)
16#0001	16#1000	16#0001	16#0009	VD - impossible to calculate command acceleration from P-0-0455 with P-0-0059 as VD target parameter (see P-0-1370)
16#0001	16#1000	16#0001	16#000A	VD - impossible to use P-0-0059 as VD target parameter with P-0-1301 as VA source parameter
16#0001	16#1000	16#0001	16#000B	VD - impossible to calculate command acceleration from P-0-0454 (in position control) with P-0-1301 as VA source parameter
16#0001	16#1000	16#0001	16#000C	VD - impossible to calculate command acceleration from P-0-0455 (in position control) with P-0-1301 as VA source parameter
16#0001	16#1000	16#0001	16#000D	VD - impossible to calculate command acceleration from P-0-0048 (in velocity control) with P-0-0059 as VD target parameter
16#0001	16#1000	16#0001	16#000E	VD - impossible to calculate command acceleration from P-0-0048 (in velocity control) with P-0-1300 as VA source parameter
16#0001	16#1000	16#0001	16#000F	VD - impossible to calculate command acceleration from P-0-0455 (in velocity control) with P-0-0059 as VD target parameter
16#0001	16#1000	16#0001	16#0010	VD - impossible to calculate command acceleration from P-0-0455 (in velocity control) with P-0-1300 as VA source parameter
16#0001	16#1000	16#000E	16#0001	VD - setting for acceleration command value not possible in standard mode
16#0001	16#1000	16#000E	16#0002	VD - setting for performance level not possible in standard mode
16#0001	16#1000	16#000E	16#0003	VD - setting for acceleration feedback value not possible in standard mode
16#0001	16#1000	16#000E	16#0004	VA - setting for command value source not possible in standard mode

Diagnostic and status messages

ErrorID	ErrorIdent			Explanation
	ErrorTable	Additional1	Additional2	
16#0001	16#1000	16#000E	16#0005	VA - impossible to use notch filter in standard mode
16#0001	16#1000	16#000E	16#0006	VA - impossible to use average value filter in standard mode
16#0001	16#1000	16#000E	16#0007	VA - impossible to use notch filter with Basic firmware (MPB)
16#0001	16#1000	16#1001	16#0001	Changing the config word P-0-1370 not allowed in "AF"
16#0001	16#1000	16#1001	16#0003	VD - Advanced performance (P-0-1370 , bit 7) not possible with Basic firmware (MPB)
16#0003	16#0170	16#000F	16#0003	The required functional package MA has not been activated
16#0004	16#1000	16#1001	16#0002	Target parameter for of active vibration damping cyclically configured
16#0004	16#1000	16#1001	16#0005	VD - analog input 1 not available VD - analog input 2 not available VD - analog input 3 not available VD - analog input 1 (DA) not available VD - analog input 2 (DA) not available
16#0006	16#1000	16#0002	16#0001	VD - P-0-1376 outside of input range
16#0006	16#1000	16#0003	16#0001	VD - P-0-1377 outside of input range
16#0006	16#1000	16#0004	16#0001	VD - P-0-1378 outside of input range
16#0006	16#1000	16#0005	16#0001	VD - P-0-1379 outside of input range
16#0006	16#1000	16#0005	16#0002	VD - P-0-1380 outside of input range
16#0006	16#1000	16#0006	16#0001	VD - P-0-1381 outside of input range
16#0006	16#1000	16#0006	16#0002	VD - P-0-1382 outside of input range
16#0006	16#1000	16#0007	16#0001	VD - P-0-1383 outside of input range
16#0006	16#1000	16#0008	16#0001	VD - P-0-1371 outside of input range
16#0006	16#1000	16#0008	16#0002	VD - P-0-1372 outside of input range
16#0006	16#1000	16#0008	16#0003	VD - P-0-1373 outside of input range
16#0006	16#1000	16#0008	16#0004	VD - P-0-1374 outside of input range
16#0006	16#1000	16#0008	16#0005	VD - P-0-1375 outside of input range
16#0006	16#1000	16#0009	16#0001	VA - P-0-1385 outside of input range
16#0006	16#1000	16#0009	16#0002	VA - average value filter, internal memory too small
16#0006	16#1000	16#0010	16#0001	VA - P-0-1324 outside of input range
16#0006	16#1000	16#0010	16#0002	VA - P-0-1325 outside of input range
16#0006	16#1000	16#0011	16#0001	VA - P-0-1326 outside of input range VA - P-0-1322 outside of input range
16#0006	16#1000	16#0011	16#0002	VA - P-0-1327 outside of input range VA - P-0-1323 outside of input range

ErrorID	ErrorIdent			Explanation
	ErrorTable	Additional1	Additional2	
16#0006	16#1000	16#0011	16#0003	VA - anti-vibration 1, internal memory too small VA - anti-vibration 2, internal memory too small
16#0006	16#1000	16#0017	16#0001	VA - vibration avoiding using band-stop filter not possible with modulo axes
16#0007	16#1000	16#0001	16#0001	VD - impossible to calculate command acceleration from P-0-0454, since P-0-0040 equals ZERO
16#0007	16#1000	16#0001	16#0002	VD - impossible to calculate command acceleration from P-0-0455, since S-0-0348 equals ZERO
16#0007	16#1000	16#0001	16#0004	VD - impossible to calculate command acceleration from P-0-0455, since P-0-1126 equals ZERO
16#0007	16#1000	16#0001	16#0005	VD - impossible to calculate feedback acceleration, since P-0-1319 equals ZERO
16#0001	16#1000	16#0001	16#0006	VD - impossible to calculate feedback acceleration from S-0-0084, since P-0-1321 equals ZERO
16#0007	16#1000	16#0001	16#0007	VD - impossible to calculate feedback acceleration, since P-0-1320 equals ZERO
16#7FFE	16#1000	16#0014	16#0002	VA - bit 9 has to be set in P-0-0556 to use P-0-0457 as command value
16#7FFE	16#1000	16#0014	16#0003	VA - P-0-0456 has to be set to "2" to use P-0-0457 as command value

ErrorID 16#0000 NONE_ERROR
 ErrorID 16#0001 INPUT_INVALID_ERROR
 ErrorID 16#0003 RESOURCE_ERROR
 ErrorID 16#0004 ACCESS_ERROR
 ErrorID 16#0006 INPUT_RANGE_ERROR
 ErrorID 16#0007 CALCULATION_ERROR
 ErrorID 16#7FFE OTHER_ERROR
 ErrorTable 16#0000 NO_TABLE_USED
 ErrorTable 16#0170 F_RELATED_TABLE
 ErrorTable 16#1000 USER1_TABLE

Tab. 11-1: Overview of error messages

12 Descriptions of the parameters

12.1 Updating/sampling times

The updating times of the parameters (input parameters and display parameters) depend on the task cycle time in the MLD program and on the selected performance level of vibration damping ([chapter 12.2 "P-0-1370, Config word" on page 69](#)), or on the control loop performance in the axis controller (P-0-0556, Config word of axis controller).

The tables below contain an overview of the possible cycle times.

T_{Fast}	2 ms
-------------------------	------

Tab. 12-1: Sampling time of fast task

T_{Slow}	200 ms
-------------------------	--------

Tab. 12-2: Sampling time of slow task

Control loop performance	Basic	Advanced
T_{A_position}	500 µs	250 µs

Tab. 12-3: Position control loop sampling time

VD performance level	Standard	Advanced
T_{VD}	T _{Fast}	T _{A_position}

Tab. 12-4: Vibration damping sampling time



Only in the slow task are input parameters read in.

12.2 P-0-1370, Config word

[P-0-1370](#) is used to configure vibration damping and avoiding.



Changes in drive enable or the drive under torque are ignored and signaled by an error status (see "[Diagnostic and status messages](#)").

Bit	Description / function	Comment
0	VD activation 0: Inactive 1: Active	Activating vibration damping
1-2	VD target parameter 00: P-0-0059, Additive position command value, controller 01: S-0-0037, Additive velocity command value 10: S-0-0081, Additive torque/force command value	Specifies the parameter for which vibration damping takes effect
3	VD negation of acceleration sensor signal 0: Inactive 1: Active	Negation of the acceleration sensor signal

Descriptions of the parameters

Bit	Description / function	Comment
4-6	VD acceleration command value [Standard mode] 000: 0 001: $d^2(P-0-0434, \text{Position command value of controller})/dt^2$ [Expert mode] 010: $d(P-0-0454, \text{Velocity feedforward actual value})/dt$ 011: P-0-0455, Acceleration feedforward actual value (position control mode, via S-0-0348) 100: $d(P-0-0048, \text{Effective velocity command value})/dt$ 101: P-0-0455, Acceleration feedforward actual value (velocity control mode, via P-0-1126)	Specifies the acceleration command value that is to be used (see Drive control overview) 001: in position control only 010: in position control only 011: in position control only 100: in velocity control only 101: in velocity control only
7	VD performance level [Expert mode] 0: Standard (T_{Fast}) 1: Advanced ($T_{A_position}$)	Performance of the control loop of active vibration damping (sampling time)
8-11	VD acceleration feedback value [Standard mode] 0000: Sensor at analog input 1 1000: S-0-0084, Torque/force feedback value [Expert mode] 0001: Sensor at analog input 2 0010: Sensor at analog input 3 0011: Sensor at analog input 1 (DA) 1010: Sensor at analog input 2 (DA) 0100: $d(S-0-0040, \text{Velocity feedback value encoder 1})/dt$ 0101: $d(S-0-0156, \text{Velocity feedback value encoder 2})/dt$ 0110: S-0-0164, Acceleration feedback value encoder 1 0111: S-0-0195, Acceleration feedback value encoder 2 1001: P-0-1298 , VD - acceleration feedback value, external	Specifies the acceleration feedback value that is to be used For S-0-0040, observe the velocity mix factor P-0-1119. The acceleration feedback values are filtered with 4 ms.
12	VD sensor mounting / type 0: Linear / linear or rotary / rotary 1: Rotary / linear	
13-15	No function	

Bit	Description / function	Comment
16	VA activation 0: Inactive 1: Active	Activating vibration avoiding
17-18	VA command value source [Standard mode] 00: Standard command value inputs [Expert mode] 01: The cyclic command values of the NC are transmitted to the parameter P-0-1300 , VA - NC position command value 10: The cyclic command values of the NC are transmitted to the parameter P-0-1301 , VA - NC velocity command value	00: - For operation modes "position control with cyclic command value input", "drive-internal interpolation", "drive-controlled positioning" and "positioning block mode" - Effective target parameter: P-0-0059 - Calculation in the position controller clock - Required additional parameterization: - P-0-0556, Config word of axis controller; bit 9 = 1 - P-0-0456, Position command value delay: 2 01: - For "position control with cyclic command value input" mode - Effective target parameter: S-0-0047 10: - For "velocity control" mode - Effective target parameter: S-0-0036
19	VA filter selection: Band-stop filter [Expert mode] 0: Inactive 1: Active	
20	VA filter selection: Anti-vibration filter 0: Inactive 1: Active	
21	VA filter selection: Average value filter [Expert mode] 0: Inactive 1: Active	
22-30	No function	
31	Expert mode switch 0: Standard mode 1: Expert mode	

Tab. 12-5: Bit assignment

Min./max. value	-/-
Format	BIN

Descriptions of the parameters

Unit	-
Editable	++
Decimal places	-
Buffered parameter	√
Standard value	-
Updating time	T _{Slow}

Tab. 12-6: Parameter attributes

12.3 P-0-1410, Status word

The current status of the MLD functionality can be read out via [P-0-1410](#).

- The bits 2 to 0 are relevant for vibration damping
- The bits 6 to 3 are relevant for vibration avoiding

Bit	Description/function	Comment
0	Vibration damping, status 0: Inactive 1: Active	
1	Vibration damping, limitation 0: Inactive 1: Active	
2	Vibration damping, parameterization status 0: No error 1: Error	
3	Vibration avoiding, band-stop filter 0: Inactive 1: Active	
4	Vibration avoiding, anti-vibration filter 0: Inactive 1: Active	In the expert mode under Advanced control sections, the status bit always applies to both anti-vibration filters.
5	Vibration avoiding, average value filter 0: Inactive 1: Active	
6	Vibration avoiding, parameterization status 0: No error 1: Error	
15-7	No function	

Tab. 12-7: Bit assignment

Min./max. value	-/-
Format	DEC_MV
Unit	-

Editable	--
Decimal places	-
Buffered parameter	-
Standard value	-
Updating time	T _{Slow}

Tab. 12-8: Parameter attributes

12.4 P-0-1272, VD - adjusted acceleration feedback value

When vibration damping is used, the adjusted acceleration feedback value can be read out via [P-0-1272](#). With the "Advanced" VD performance level (see [P-0-1370](#)), the display value is updated in the position controller clock.

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0160
Editable	--
Decimal places	S-0-0161 / S-0-0162
Buffered parameter	-
Standard value	-
Updating time	T _{VD}

Tab. 12-9: Parameter attributes

12.5 P-0-1273, VD - control difference

When vibration damping is used, the generated control difference can be read out via [P-0-1273](#). The control difference is generated from the acceleration command value ([P-0-1279](#)) less the adjusted acceleration feedback value ([P-0-1272](#)) (**only available for Advanced control sections**).

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0160
Editable	--
Decimal places	S-0-0161 / S-0-0162
Buffered parameter	-
Standard value	-
Updating time	T _{VD}

Tab. 12-10: Parameter attributes

12.6 P-0-1277, VD - control difference after filter cascade

When vibration damping is used, the filtered control difference can be read out via [P-0-1277](#) (**only available for Advanced control sections**). This filtered value is the input value for the PI(D-T1) controller.

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0160
Editable	--
Decimal places	S-0-0161 / S-0-0162
Buffered parameter	-
Standard value	-
Updating time	T _{VD}

Tab. 12-11: Parameter attributes

12.7 P-0-1278, VD - controller output after limitation

When vibration damping is used, the controller output resulting at the output of the controller after limitation ([P-0-1375](#)) can be read out via [P-0-1278](#).

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	depending on VD target parameter (see P-0-1370)
Editable	--
Decimal places	depending on VD target parameter (see P-0-1370)
Buffered parameter	-
Standard value	-
Updating time	T _{VD}

Tab. 12-12: Parameter attributes

12.8 P-0-1279, VD - acceleration command value

When vibration damping is used, the generated command signal can be read out via [P-0-1279](#) (**only available for Advanced control sections**). For generating the command signal, there are different sources available (see [P-0-1370](#)) which can in addition be delayed for a definable time (see [P-0-1383](#)).

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0160
Editable	--
Decimal places	S-0-0161 / S-0-0162
Buffered parameter	-
Standard value	-
Updating time	T _{VD}

Tab. 12-13: Parameter attributes

12.9 P-0-1298, VD - acceleration feedback value, external

When vibration damping is used, an acceleration feedback value can be directly preset via [P-0-1298](#), e.g. by a superimposed control (see [P-0-1370](#)).

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0160
Editable	++
Decimal places	S-0-0161 / S-0-0162
Buffered parameter	-
Standard value	-
Updating time	T_{VD}

Tab. 12-14: Parameter attributes

12.10 P-0-1300, VA - NC position command value

When vibration avoiding is used (command value filter), the control can transmit its cyclic command value input to the parameter [P-0-1300](#) in the "cyclic position control" mode. For this purpose, the parameter [P-0-1300](#) has to be included in the cyclic data instead of the parameter "S-0-0047, Position command value".

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0076
Editable	++
Decimal places	S-0-0077 / S-0-0078
Buffered parameter	-
Standard value	-
Updating time	T_{Ncyc} , if $T_{Ncyc} \geq T_{Fast}$ $T_{A_POSITION}$, if $T_{Ncyc} < T_{Fast}$

Tab. 12-15: Parameter attributes

12.11 P-0-1301, VA - NC velocity command value

When vibration avoiding is used (command value filter), the control can transmit its cyclic command value input to the parameter [P-0-1301](#) in the "velocity control" mode. For this purpose, the parameter [P-0-1301](#) has to be included in the cyclic data instead of the parameter "S-0-0036, Velocity command value".

Min./max. value	-2147483648 / 2147483647
Format	DEC_MV
Unit	S-0-0044
Editable	++

Decimal places	S-0-0045 / S-0-0046
Buffered parameter	-
Standard value	-
Updating time	T_{Ncyc} , if $T_{Ncyc} \geq T_{Fast}$ $T_{A_POSITION}$, if $T_{Ncyc} < T_{Fast}$

Tab. 12-16: Parameter attributes

12.12 P-0-1316, VD - low-pass filter analog input, cutoff frequency

The parameter [P-0-1316](#) serves as a digital low-pass filter for the analog input that is used. In accordance with the connection configuration ([P-0-1370](#)), the cutoff frequency set in this parameter is converted to the corresponding filter time constant for the input filter of the analog input used and it is written to the respective parameter.

Min./max. value	0/4000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T_{Slow}

Tab. 12-17: Parameter attributes

12.13 P-0-1317, VD - analog input, offset

The parameter [P-0-1317](#) is used to eliminate an offset voltage of the sensor at the analog input. The value entered here is subtracted from the measured voltage value.

Min./max. value	-10.000/10.000
Format	DEC_MV
Unit	V
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T_{Slow}

Tab. 12-18: Parameter attributes

12.14 P-0-1318, VD - analog input, dead zone (bipolar)

The "dead zone" is a symmetrical range of values around 0 V. The value entered in [P-0-1318](#) is the positive and the negative limit value. All input voltage values the absolute value of which is smaller than the value in

P-0-1318 are handled by the function like an input voltage of 0 V. This allows the noise level of the input voltage signal to be suppressed.

Min./max. value	0/10.000
Format	DEC_OV
Unit	V
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-19: Parameter attributes

12.15 P-0-1319, VD - sensor sensitivity (incl. amplifier)

The parameter **P-0-1319** allows the analog input to be scaled for the acceleration value. In **P-0-1319**, enter the conversion factor resulting after the measuring amplifier. The conversion factor is used to convert the voltage value that was read in to an acceleration (linear or rotary).

Min./max. value	0/4294967.295
Format	DEC_OV
Unit	mV/g or mV/(rad/s ²)
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-20: Parameter attributes

12.16 P-0-1320, VD - sensor distance to pivot

When a sensor is used that measures a linear acceleration to be converted to a rotary motion (rotary axis), the distance of the sensor to the pivot has to be specified in **P-0-1320**.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	mm
Editable	++
Decimal places	S-0-0077 / S-0-0078
Buffered parameter	√

Standard value	0
Updating time	T _{Slow}

Tab. 12-21: Parameter attributes

12.17 P-0-1321, VD - torque/force feedback value, scaling factor

The inertia of the system is entered in [P-0-1321](#). In the case of sensorless compensation of the parasitic vibration, i.e. via the torque/force feedback value, this value is required to calculate the acceleration behavior of the mechanics.

If the mechanical data are known, the inertia value can be directly entered. With variable inertia, this value can be corrected to improve control or allow the parasitic vibration to be compensated.

If the value is unknown, it can be determined by a simple experiment (see chapter "Notes on commissioning and operation").

Min./max. value	0/429496.7295
Format	DEC_OV
Unit	gm ² or kg
Editable	++
Decimal places	4
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-22: Parameter attributes

12.18 P-0-1322, VA - anti-vibration filter 2, frequency

For command value filtering, the characteristic frequency of the filter can be set in [P-0-1322](#) when the 2nd anti-vibration filter is used. The filter is inactive if the value "0" has been input.

Min./max. value	0/1000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-23: Parameter attributes

12.19 P-0-1323, VA - anti-vibration filter 2, damping

For command value filtering, the damping degree of the system can be set in [P-0-1323](#) when the 2nd anti-vibration filter is used.

Min./max. value	0/1.000
Format	DEC_OV
Unit	-
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-24: Parameter attributes

12.20 P-0-1324, VA - band-stop filter, center frequency

For command value filtering, the center frequency of the filter can be set in [P-0-1324](#) when the band-stop filter is used. The filter is inactive if the value "0" has been input.

Min./max. value	0/1000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-25: Parameter attributes

12.21 P-0-1325, VA - band-stop filter, bandwidth

For command value filtering, the bandwidth of the filter can be set in [P-0-1325](#) when the band-stop filter is used.

Min./max. value	0/1000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-26: Parameter attributes

12.22 P-0-1326, VA - anti-vibration filter 1, frequency

For command value filtering, the characteristic frequency of the filter can be set in [P-0-1326](#) when the anti-vibration filter is used. The filter is inactive if the value "0" has been input.

Min./max. value	0/1000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-27: Parameter attributes

12.23 P-0-1327, VA - anti-vibration filter 1, damping

For command value filtering, the damping degree of the system can be set in [P-0-1327](#) when the anti-vibration filter is used.

Min./max. value	0/1.000
Format	DEC_OV
Unit	-
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-28: Parameter attributes

12.24 P-0-1290, Error diagnostics Error ID

The current Error ID is displayed in [P-0-1290](#). For the existing IDs, see chapter "[Diagnostic and status messages](#)".

Min./max. value	0/0xFFFFFFFF
Format	HEX
Unit	-
Editable	--
Decimal places	-
Buffered parameter	-
Standard value	-
Updating time	T _{Slow}

Tab. 12-29: Parameter attributes

12.25 P-0-1291, Error diagnostics ErrorIdent: Table

The current error table is displayed in [P-0-1291](#). For the existing tables, see chapter "[Diagnostic and status messages](#)".

Min./max. value	0/0xFFFFFFFF
Format	HEX
Unit	-
Editable	--
Decimal places	-
Buffered parameter	-
Standard value	-
Updating time	T _{Slow}

Tab. 12-30: Parameter attributes

12.26 P-0-1292, Error diagnostics ErrorIdent: Additional 1

[P-0-1292](#) contains the value "Additional 1" used to classify the cause of the error. For an overview of all errors, see chapter "[Diagnostic and status messages](#)".

Min./max. value	0/0xFFFFFFFF
Format	HEX
Unit	-
Editable	--
Decimal places	-
Buffered parameter	-
Standard value	-
Updating time	T _{Slow}

Tab. 12-31: Parameter attributes

12.27 P-0-1293, Error diagnostics ErrorIdent: Additional 2

[P-0-1293](#) contains the value "Additional 2" used to classify the cause of the error. For an overview of all errors, see chapter "[Diagnostic and status messages](#)".

Min./max. value	0/0xFFFFFFFF
Format	HEX
Unit	-
Editable	--
Decimal places	-
Buffered parameter	-

Standard value	-
Updating time	T _{Slow}

Tab. 12-32: Parameter attributes

12.28 P-0-1371, VD - PI(D-T1) controller, proportional gain

The filtered difference of the configured command value and feedback value is multiplied with the value parameterized in [P-0-1371](#) and therefore is the proportional term of the controller output. If the value "0" is set, the P-term and thus the controller are inactive.

Min./max. value	0/42949.67295
Format	DEC_OV
Unit	Nm/(rad/s ²) or N/(m/s ²)
Editable	++
Decimal places	5
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-33: Parameter attributes

12.29 P-0-1372, VD - PI(D-T1) controller, integral-action time

The integral-action time of the controller is set in [P-0-1372](#). The integral term of the controller is calculated using the integral-action time. If the value "0" is set, the I-term is inactive.

Min./max. value	0/6553.5
Format	DEC_OV
Unit	ms
Editable	++
Decimal places	1
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-34: Parameter attributes

12.30 P-0-1373, VD - PI(D-T1) controller, derivative action time

The derivative action time of the controller is set in [P-0-1373](#). The differential term of the controller is calculated using the derivative action time. This D-term can be filtered via a T1 element ([P-0-1374](#)). If the value "0" is set, the D-term is inactive.

Min./max. value	0/6553.5
Format	DEC_OV

Unit	ms
Editable	++
Decimal places	1
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-35: Parameter attributes

12.31 P-0-1374, VD - PI(D-T1) controller, smoothing time constant, D-term

The filter time of the T1 filter of the D-term in μs is set via [P-0-1374](#). This time has to be parameterized considerably smaller than the derivative action time ([P-0-1373](#)). The filter is inactive if the value "0" has been input.

Min./max. value	0/200000.0
Format	DEC_OV
Unit	μs
Editable	++
Decimal places	1
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-36: Parameter attributes

12.32 P-0-1375, VD - PI(D-T1) controller, limitation

The limitation of the controller output can be set in [P-0-1375](#). The limitation acts in a bipolar way and is the positive and the negative limitation. If the output of the controller is limited later on in operation, the integral term is limited at the same time to avoid the anti-windup effect of the I-term.

Min./max. value	0/4294967295
Format	DEC_OV
Unit	According to the selected controller output: P-0-0059: S-0-0076 S-0-0037: S-0-0044 S-0-0081: S-0-0086
Editable	++

Decimal places	According to the selected controller output: P-0-0059: S-0-0077 / S-0-0078 S-0-0037: S-0-0045 / S-0-0046 S-0-0081: S-0-0093 / S-0-0094
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-37: Parameter attributes

12.33 P-0-1376, VD - 2nd order high-pass filter, cutoff frequency

For active vibration damping, the limit frequency for 2nd order high-pass filtering can be parameterized via [P-0-1376](#). The filter takes effect after the control difference has been generated. The filter is inactive if the value "0" has been input.

Min./max. value	0/10000.000
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-38: Parameter attributes

12.34 P-0-1377, VD - 2nd order low-pass filter, cutoff frequency

For active vibration damping, the limit frequency for 2nd order low-pass filtering can be parameterized via [P-0-1377](#). The filter takes effect after the control difference has been generated. The filter is inactive if the value "0" has been input.

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-39: Parameter attributes

12.35 P-0-1378, VD - acceleration feedback value, low-pass filter, cutoff frequency

For active vibration damping, the limit frequency for 1st order low-pass filtering can be parameterized via [P-0-1378](#). The filter takes effect before the control difference is generated. The filter is inactive if the value "0" has been input.

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-40: Parameter attributes

12.36 P-0-1379, VD - band-stop filter, center frequency

A band-stop filter can be parameterized for active vibration damping. The center frequency for the band-stop filter is set by [P-0-1379](#). The filter takes effect after the control difference has been generated. The filter is inactive if the value "0" has been input.

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-41: Parameter attributes

12.37 P-0-1380, VD - band-stop filter, bandwidth

A band-stop filter can be parameterized for active vibration damping. The bandwidth around the center frequency is set for the band-stop filter by [P-0-1380](#). [P-0-1380](#) takes effect in conjunction with "[P-0-1379](#), VD - band-stop filter, center frequency".

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++

Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-42: Parameter attributes

12.38 P-0-1381, VD - acceleration feedback value, band-stop filter, center frequency

Due to the machine's fundamental vibrations, this fundamental vibration sometimes is measured, too, when the acceleration feedback value is generated by a mounted acceleration sensor, although the fundamental vibration does not have any influence on the process quality. Therefore, a band-stop filter can be parameterized for the acceleration feedback value. For this purpose, [P-0-1381](#) is used as the center frequency. The filter is inactive if the value "0" has been input.

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-43: Parameter attributes

12.39 P-0-1382, VD - acceleration feedback value, band-stop filter, bandwidth

[P-0-1382](#) is used as the bandwidth of the band-stop filter for the acceleration feedback value. [P-0-1382](#) takes effect in conjunction with "[P-0-1381](#), VD - acceleration feedback value, band-stop filter, center frequency".

Min./max. value	0/10000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2
Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-44: Parameter attributes

12.40 P-0-1383, VD - acceleration command value delay

With [P-0-1383](#) it is possible to parameterize a delay in ms by which the calculated acceleration command value is delayed before it is used in the summation point of command value and feedback value. A value smaller than T_{Fast} only takes effect with the VD performance level "Advanced" ([P-0-1370](#)).

Min./max. value	0/100.000
Format	DEC_OV
Unit	ms
Editable	++
Decimal places	3
Buffered parameter	√
Standard value	0
Updating time	T_{Slow}

Tab. 12-45: Parameter attributes

12.41 P-0-1384, VD - closing the control loop

The control loop of active vibration damping is closed with [P-0-1384](#). Only then is the controller output written to the respective target parameter. As an aid for commissioning and validation, the calculated controller output can be read out via the parameter [P-0-1278](#) while the control loop is open.

Min./max. value	0/1
Format	BIN
Unit	-
Editable	++
Decimal places	-
Buffered parameter	√
Standard value	0
Updating time	T_{Slow}

Tab. 12-46: Parameter attributes

12.42 P-0-1385, VA - average value filter, frequency

For command value filtering, the characteristic frequency of the filter can be set in [P-0-1385](#) when the average value filter is used. The filter is inactive if the value "0" has been input.

Min./max. value	0/1000.00
Format	DEC_OV
Unit	Hz
Editable	++
Decimal places	2

Buffered parameter	√
Standard value	0
Updating time	T _{Slow}

Tab. 12-47: Parameter attributes

12.43 P-0-1387, Error text display

The PLC's status text / diagnostic text is output via [P-0-1387](#).

Min./max. value	-/-
Format	ASCII
Unit	-
Editable	--
Decimal places	-
Buffered parameter	-
Standard value	-
Updating time	T _{Slow}

Tab. 12-48: Parameter attributes

13 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)

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