rexroth
A Bosch Company

IndraDrive

Axis Linking Functions

Application Manual
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1 Introduction

1.1 About this documentation

Editions of this documentation

Edition	Release date	Notes
01	2018-09	First edition

Tab. 1-1: Record of revisions

Means of representation in this documentation

All important notes are highlighted. Different symbols are used according to the kind of information:

⚠ 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.

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").

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

This symbol highlights useful tips and tricks.

Your feedback

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

In case you want to report errors discovered in this documentation or suggest changes, please send your feedback to the following e-mail address:

Dokusupport@boschrexroth.de

In order that we can handle your feedback, please specify the number indicated under "Internal File Reference".

Introduction

1.2 Overview

Basically, the axis linking topic can be broken down into the following topics:

- The actual command value linking (torque, velocity and position linking). The command value linking depends on the axis mechanics properties.
- Axis group control, with the "open solution" and "subsystem solution" options:
  - Open solution:

    Both axes are commanded by the higher-level control.

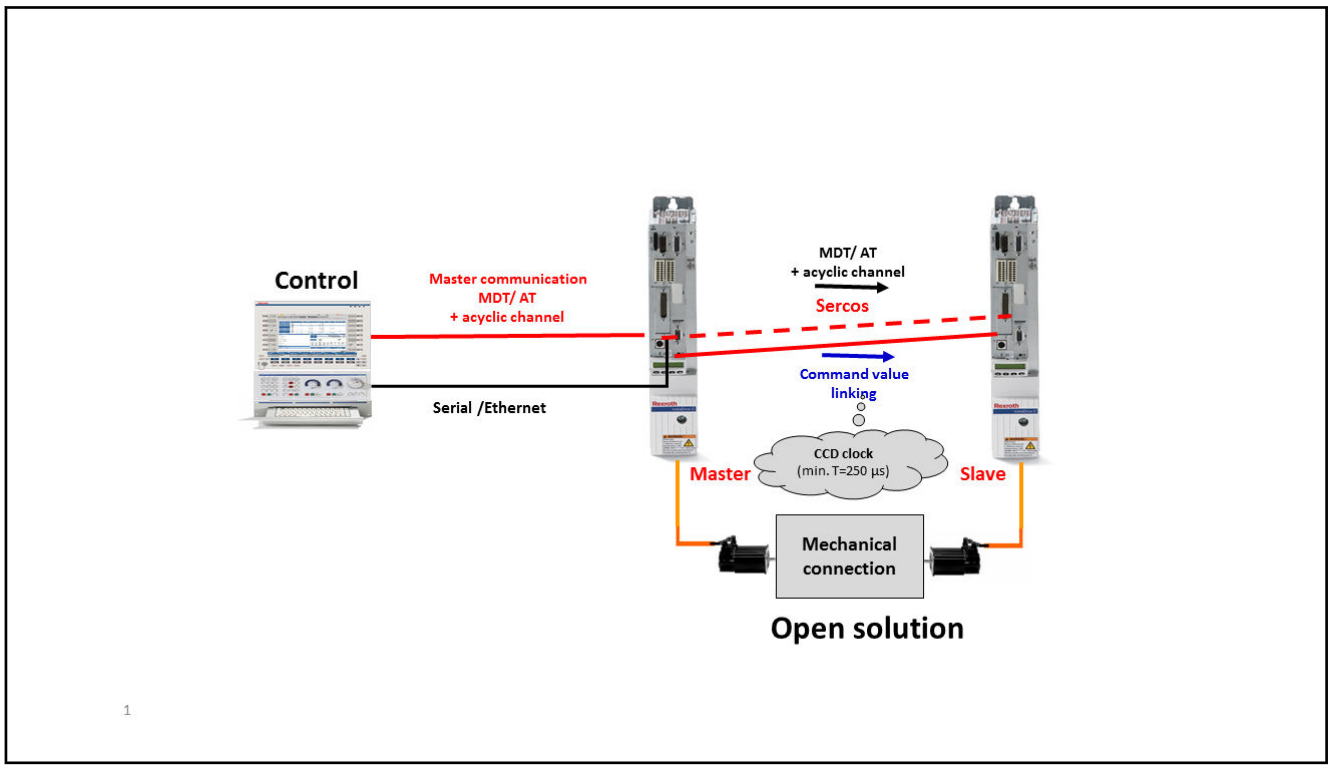

Fig. 1-1: Open solution principle

  - Subsystem solution:

    The higher-level control only comands the master axis, the slave axis is directly and automatically tracked by an MLD program in the master.

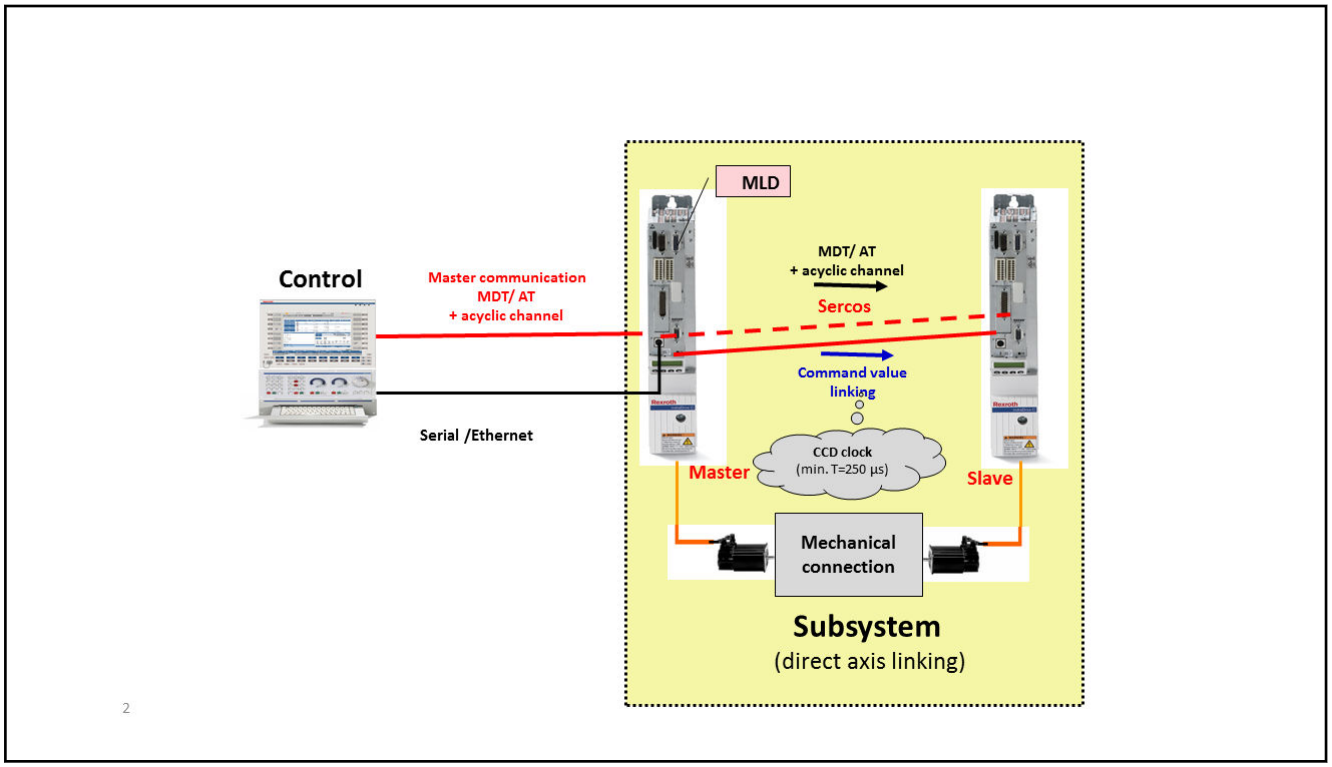

Fig. 1-2: Subsystem solution principle

The individual solutions are made available via loadable parameter files.

1.3 Requirements

1.3.1 Hardware requirements

Using the custom-made axis linking requires the following hardware:

Control section: Master

- CSH02.1B-CC-EC-ET** (FWA-INDRV-MPC18VRS and above)

Control section: Slave

- CSx02.1x-S3** (FWA-INDRV-MPx18VRS and above)
- CSx02.1x-ET** (FWA-INDRV-MPx18VRS and above)

It is recommended to use the same "Advanced" control section design for axis linking in the master and slave. The advantage is that the same axis performance can be set for both axes.

Power section:

- Inverter: HMS0*.1-W0xxx
- Converter: HCS0*.1-W0xxx

It is recommended to use the same power section for axis linking in the master and slave.

Motors:

- For axis linking, it is recommended to use the same motor types at the master and slave axis.

- The different types of linking make varying demands on the encoder system. For torque linking and velocity linking, a single-turn encoder at the slave axis is sufficient. For position linking, however, an absolute value encoder at the axes (master and slaves) is obligatory to avoid position jumps due to the homing procedure each time the drive is switched on.
- For torque linking, the motors of master and slave have to comply with the same performance class. This is because the master transmits a percentage-based torque command value to the slave, and both axes likewise are to have an effect on the mechanical axis group.

See also functional description "Synchronous motors, type code"

1.3.2 Firmware requirements

Control section: Master

- Advanced firmware (MPC18VRS and above)

Subsystem solution

For the subsystem solution, order the "ML", "TF" or "MA" option in the master when ordering the firmware. If the optional expansion package "ML", "TF" or "MA" is ordered subsequently, this requires so-called additional licensing; i.e. the PLC functionality is subsequently enabled or licensed by the user.

Control section: Slave

- FWA-INDRV-MPx18VRS and above

See also functional description "Firmware type codes"

See also functional description "Functional packages"

See also functional description "Enabling functional packages"

1.4 General notes on parameterization and application

Use the IndraWorks commissioning tool to parameterize the axes. The connection to all axes is established via the CCD master. After the CCD communication has been set in the master, all slaves can be parameterized from the master. The Engineering Port of the master axis can be used for this purpose.

Observe the following points regarding the parameterization in the master and slave:

- same performance settings for the same dynamics (cf. P-0-0556)
- same control loop settings for the same dynamics (S-0-0100, S-0-0101, etc.)
- The position data scaling has to be performed in the master axis and in the save axis. Mechanical damage may occur in the case of incorrect parameterization.
- The setting of the error reaction has to be adjsuted to the existent mechanics and parameterized at both axes (see also "Axis linking error reaction").
- For position linking make sure that the same operation mode (lagless or with lag error) is set in both axes.
- Drive-controlled homing is not possible if multiple motors have to be controlled in a coordinated way when moving an axis, since the axes are rigidly connected via the axis mechanics. In this case, it is best to establish the position data reference of the axis using the "set absolute position procedure", because it does not require axis motion. Therefore, design the motor encoders (encoder 1) as encoders to be evaluated in absolute form!

2 Important directions for use

2.1 Appropriate use

2.1.1 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 appropriate way. If they are not used in the appropriate way, situations resulting in property damage and personal injury can occur.

☞ Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate 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 appropriate 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 appropriate 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.

2.1.2 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.

Important directions for use

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.).

2.2 Inappropriate 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 "inappropriate 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.

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3 Safety instructions for electric drives and controls

3.1 Definitions of terms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Qualified personnel for handling functionally safe products

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

User

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

3.2 General information

3.2.1 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.

3.2.2 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.

Safety instructions for electric drives and controls

- 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)

Safety instructions for electric drives and controls

3.2.3 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!

3.3 Instructions with regard to specific dangers

3.3.1 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.

Safety instructions for electric drives and controls

- Install the covers and guards provided for this purpose before switching on.
- Never touch any electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

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

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

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

Tab. 3-1: Minimum cross section of the equipment grounding connection

Safety instructions for electric drives and controls

3.3.2 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").

3.3.3 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.

3.3.4 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.

Safety instructions for electric drives and controls

- 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.

3.3.5 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.

3.3.6 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!

3.3.7 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.

3.3.8 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.

Safety instructions for electric drives and controls

3.4 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.

4 Connection to the higher-level master communication

4.1 General information

The chapters below describe the linking with regard to control from the higher-level control unit (e.g., PLC). Two ways are basically described:

- Open solution

  The master axis and slave axis are controlled from the higher-level control. The control can access the slave axis.

- Subsystem solution

  The higher-level control only commands the master axis. Only the master axis needs to be configured in the control. The slave axis is tracked by an MLD program in the master axis.

4.2 Open solution

General information

In the "linked mode", the slave is firmly connected to the master via command value linking. However, master and slave can be commanded and moved separately and directly, that is to say by the external control alone. To move both axes separately, the operation mode only has to be switched in the slave. This is done by setting the respective operation mode bits in the control word. Configuring the command values required for the respective operation mode in the cyclic data allows the respective command value to be changed in the slave drive.

PROFIBUS / PROFINET / EtherNet/IP / Sercos / EtherCAT SoE

The open solution for PROFIBUS, PROFINET, EtherNet/IP, Sercos and EtherCAT SoE is implemented using the CCD system mode.

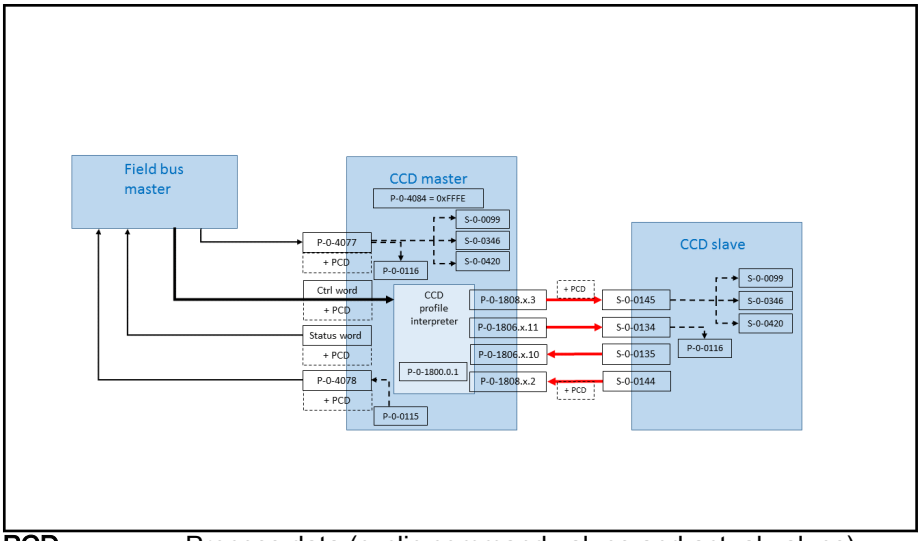
See also functional description "Cross communication CCD"

In the CCD system mode, the higher-level (external) master has control over the CCD slaves. Thus, commanding and input of process data take place via the external master (e.g., field bus interfaced PLC).

System structure (does not apply to Sercos, EtherCAT SoE)

The figure below shows the system structure of the CCD system mode with field bus master communication. The figure only contains the commanding and the process data of the external control. It does not show the data between the CCD master and the CCD slaves.

Connection to the higher-level master communication



PCD	Process data (cyclic command values and actual values)
S-0-0099	C0500 Reset class 1 diagnostics
S-0-0144	Signal status word
S-0-0145	Signal control word
S-0-0346	Positioning control word
S-0-0420	C0400 Activate parameterization level procedure command
S-0-0134	Master control word
S-0-0135	Drive status word
P-0-0115	Device control: Status word
P-0-0116	Device control: Control word
P-0-1800.0.1	CCD: Configuration
P-0-1806.x.11	CCD: Resource-Control (C-Res)
P-0-1806.x.10	CCD: Resource-Status (S-Res)
P-0-1808.x.2	CCD: Signal status word
P-0-1808.x.3	CCD: Signal control word
P-0-4077	Field bus: Control word
P-0-4078	Field bus: Status word
P-0-4084	Application: Profile type

Fig. 4-1: Process data (cyclic command values and actual values)

In the cyclic data channel, the CCD master axis receives input via the parameters P-0-4077 and P-0-4078. For each logic field bus slave (CCD slave), the CCD master splits up the field bus control word for the respective CCD slave into a master control word (S-0-0134) and a signal control word (S-0-0145) for the CCD slave and implements the control words. The higher-level master thereby has full control over the slaves (e.g., enabling signal, operation mode selection).

Configuration with sercos

As a standard, the Sercos slaves are parameterized in the higher-level control unit with reference to the master-side master communication. The cyclic data are configured via the parameters "S-0-1050.x.1, Sercos Connection: Connection setup" and "S-0-1050.x.6, Sercos Connection: Configuration list" for the CCD master and also for the CCD slaves in the control unit configuration.

Configuration with EtherCAT SoE

As a standard, the EtherCAT SoE slaves are parameterized in the higher-level control unit with reference to the master-side master communication. The cyclic data are configured via the parameters "S-0-0016, Configuration list of AT" and "S-0-0024, Configuration list of MDT" for the CCD master and also for the CCD slaves in the control unit configuration.

Connection to the higher-level master communication

Analog interface

The open solution for analog interface is implemented using the CCD basic mode.

See also functional description "Cross communication CCD"

In the CCD basic mode, the higher-level (external) master has control over the CCD slaves. Thus, commanding and input of process data take place via the external master (e.g., PLC).

The master axis is controlled via the parameters P-0-4028 or P-0-0115. These parameters have to be applied to the digital I/Os. To control the slave axis, the parameters P-0-1806.x.10 and P-0-1806.x.11 have to be applied to the digital I/Os in the master.

System structure

The figure below shows the system structure of the CCD basic mode with field bus master communication. The figure only contains the commanding and the process data of the external control. It does not show the data between CCD master and CCD slaves.

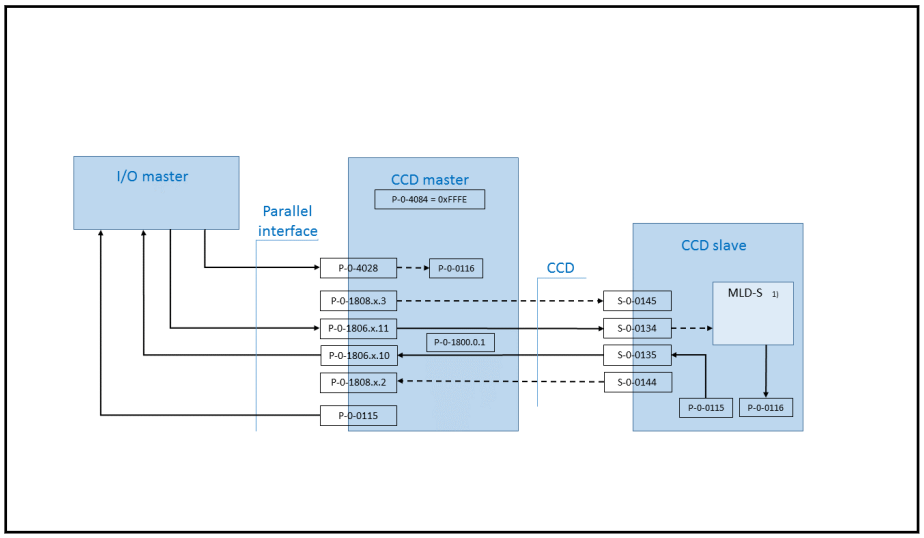


Fig. 4-2: Process data (cyclic command values and actual values) with parallel I/Os in CCD basic mode

The master axis is controlled via the parameters P-0-4028 or P-0-0115. These parameters have to be applied to the digital I/Os. To control the slave axis, the parameters P-0-1806.x.10 and P-0-1806.x.11 have to be applied to the digital I/Os in the master.

CANopen

The open solution for CANopen interface is implemented using the CCD basic mode.

See also functional description "Cross communication CCD"

In the CCD basic mode, the higher-level (external) master has control over the CCD slaves. Thus, commanding and input of process data take place via the external master (e.g., field bus interfaced PLC).

System structure

The figure below shows the system structure of the CCD basic mode with field bus master communication. The figure only contains the command triggering and the process data of the external control unit. It does not show the data between CCD master and CCD slaves.

Connection to the higher-level master communication

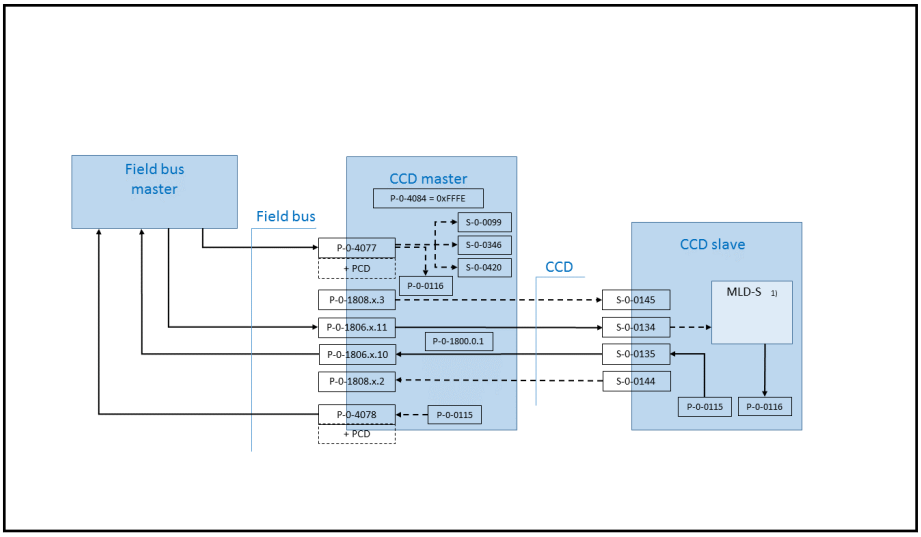


Fig. 4-3: Process data (cyclic command values and actual values) with CANopen in CCD basic mode

In the cyclic data channel, the master axis receives input via the parameters P-0-4077 and P-0-4078. To control the slave axis, it is necessary to access the parameters P-0-1806.x.10 and P-0-1806.x.11 via the cyclic data channel in the master.

4.3 Subsystem solution

4.3.1 General information

This solution can be used for all field bus types. In this case, the higher-level control, using the field-bus-specific standards, only controls the master. In the CCD master, MLD commands the slave axis. The CCD group is operated in the "CCD basic mode".

See also functional description "Cross communication CCD"

For this solution, the corresponding parameter files have to be loaded to the master axis and slave axis. The parameter file of the master axis contains an MLD program that has the following tasks:

- Controlling the slave axis
- Generating the collective status of the axis group
- Monitoring the position difference
- Generating diagnostic messages

The parameterization of the limit values and axis-specific data at both axes have to be configured during commissioning. If required, the cyclic CCD data channel may be extended. As needed, other cyclic data may be added that are required in the respective application. However, the parameters set by the parameter file should not be modified.

4.3.2 Describing the MLD functionality

This paragraph describes the functionality of the master axis MLD programm.

Slave control

To control the slave drive, the MLD program switches the "Drive Halt", "drive enable" and "Drive ON" signals. Furthermore, the "clear error" functionality is supported.

The following bits are transmitted in the master axis from MLD to the slave axis:

Significance of the bit	Set in master via	Target parameter in slave
Clear error	P-0-1808.2.3, bit 0 CCD: Signal control word, slave 1	"S-0-0099, Clear error command" via "S-0-0145, Signal control word", bit 0 see fig. 5-1
Drive Halt	P-0-1806.2.10, bit 13	"S-0-1134, Master control word", bit 13
Drive enable	P-0-1806.2.10, bit 14	"S-0-1134, Master control word", bit 14
Drive ON	P-0-1806.2.10, bit 15	"S-0-1134, Master control word", bit 15

Tab. 4-1: Implementing master control word in CCD slave parameters

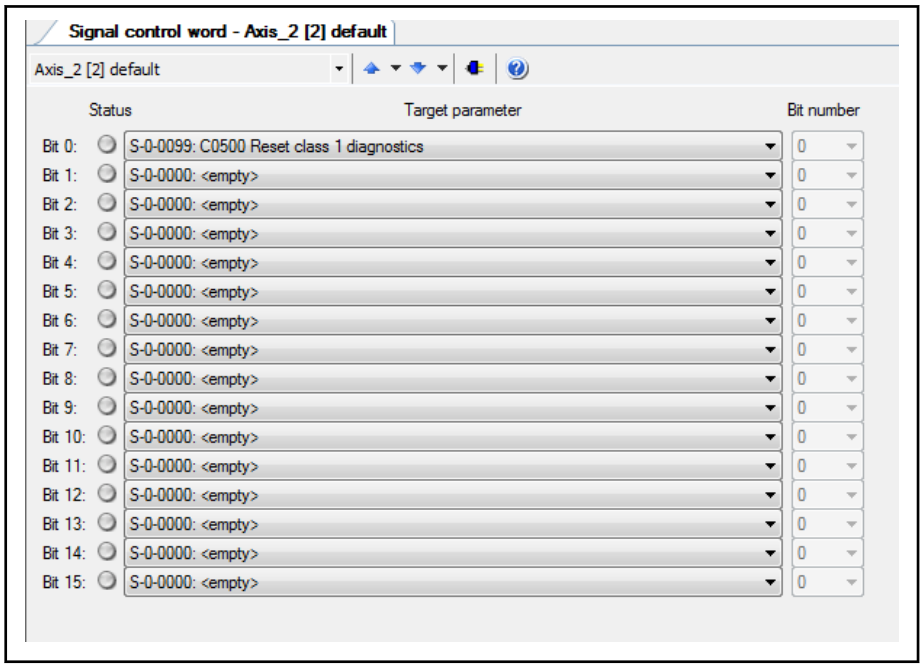


Fig. 4-4: Signal control word P-0-1808.2.3/S-0-0145 assignment of slave for subsystem solution

Extending the cycl. data and control bits

For the subsystem solution it is possible to add other cyclic data that are required in the respective application. Other control bits, that have been configured in the signal control word of the slave, may be written via P-0-1390 in the master, or by configuration into the MDT through the higher-level control. The data and bits set by the parameter file, however, should not be modified.

Control word of axis linking

"P-0-1391, Control word of axis linking"

Defined functions can be switched on and off using the control word of axis linking (P-0-1391).

Bit	Designation/function
0	"Activate retracting function" 0: Deactivate retracting function 1: Activate retracting function

Connection to the higher-level master communication

Collective status word of axis linking

P-0-1410, Collective status word of axis linking

In the parameter P-0-1410, MLD generates a collective status word of the axis group. The axis group state can be read using this collective status word. If required, this parameter can be transmitted to the higher-level control via the AT of the CCD master.

Bit	Designation/function
0	**Collective message "drives follow the command values"** AND operation of bits 3, 14 and 15 from parameter P-0-0115 of the CCD axes 0: No reaction to command value input 1: The drives follow the command values of the control.
1	**Collective message "n_act=0"** **(cf. S-0-0331, bit 0)** 0: |S-0-0040| > S-0-0124 1: |S-0-0040| < S-0-0124
2	**Collective message "axis group has been homed"** **Position feedback value status of reference encoders (encoder 1 or 2) (cf. S-0-0403, bit 0)** 0: Relative 1: Homed
3	**Collective message "status of command value processing" (cf. P-0-0115, bit 7) active** 1: Primary or secondary operation mode and initialization completed, otherwise 0
5	**Collective message "command change bit" (cf. P-0-0115, bit 5)** 0: No change in command state 1: Change in command state
6	**Message "position difference monitoring, warning"** Status of position difference between the axes. Position difference < P-0-1370 0: Position difference within the allowed tolerance. 1: Position difference outside of the allowed tolerance ->E2012 in master axis display
7	**Message "position difference monitoring, error"** Status of position difference between the axes. Position difference < P-0-1371 0: Position difference within the allowed tolerance. 1: Position difference outside of the allowed tolerance
8	**Message "retracting function active"** Status of retracting function 0: Retracting function not active 1: Retracting function active

Bit	Designation/function
12	**Collective message "warning in CCD group"** 0: No drive has a warning 1: At least one drive has a warning
13	**Collective message "error in CCD group"** 0: No error in the CCD group 1: Error in the CCD group or error message via the module bus
14/15	**Collective message "ready for operation" (cf. P-0-0115, bit 14/15)** 00: Control sections / power sections not ready for operation (e.g., error is present) 01: Control sections ready for operation 10: Control sections and power sections ready for operation 11: At least 1 drive is with torque

Tab. 4-2: P-0-1410, Collective status word of axis linking

Use

Bit	Designation/function
0	This bit is used to check the status of command value processing. The bits 3, 14 and 15 of parameters P-0-0115 and P-0-1806.2.10 are checked with an AND operation
1	The bit shows whether both axes are within the parameterized standstill window "S-0-0124, Standstill window". For this purpose, the parameters S-0-0331 of the master and slave are checked by an AND operation.
2	The position status of the group is checked with an AND operation of parameter S-0-0403, bit 0 of master and slave. 1 is set if both axes are in reference.
3	The bit is set if the primary or secondary operation modes of the CCD axes are active and initialized. Otherwise, the status is 0. AND operation of bit 7 of the parameters P-0-0115 and P-0-1806.2.10
5	The bit is set if the command state has changed in both drives.
6	The bit is set if the position feedback value difference of the axes is greater than the value entered in P-0-1370. When the bit is set, the warning E2012 is output in the display of the master axis.
7	The bit is set if the position feedback value difference of the axes is greater than the value entered in P-0-1371. When the bit is set, the error message F2012 is output in the display of the master axis.
8	The bit is set if the retracting function has been activated (see also Retracting function)
12	This bit becomes 1 if bit 12 of parameter S-0-0135 er P-0-1806.2.10 has been set.

Connection to the higher-level master communication

Bit	Designation/function
13	This bit becomes 1 if bit 13 of parameter S-0-0135 or P-0-1806.2.10 has been set.
14/15	These bits result from an AND or OR operation of the bits 14/15 of parameters S-0-0135 and P-0-1806.2.10.

Tab. 4-3: Functionality of the bits

Position difference monitoring and retracting function

Due to the MLD function, it is possible to monitor the position differences between the master axis and slave axis. The limits of the allowed deviations are entered in the parameters P-0-1370 and P-0-1371. Critical and fatal position differences are thereby distinguished.

P-0-1370 – position difference warning limit

This parameter defines the allowed position difference between master and slave. If the position difference is greater than the entered value, the warning E2012 is output at the master and the bit 6 is set in P-0-1410. If the value in the parameter P-0-1370 = 0, the monitoring function is not active.

P-0-1371 – position difference error limit

This parameter defines the allowed position difference between master and slave. If the position difference is greater than the entered value, the error F2012 is output at the master and the bit 7 is set in P-0-1410. The error reaction is carried out in accordance with the parameterization. If the value in the parameter P-0-1371 = 0, the monitoring function is not active.

P-0-1372 – Retracting difference limit

This parameter defines the allowed position difference between master and slave at which the retracting function is possible. If the position difference of the two axes is smaller than P-0-1372, the retracting function can be activated via the parameter P-0-1391, bit 0 = 1. (Status message "Retracting function activated" P-0-1410, bit 8).

After the retracting function has been activated, the error "F2012 **position difference monitoring, error**" can be cleared and the drive can be moved to take it out of the error situation. The possibly present warning "E2012 **position difference monitoring, warning**" persists. Select the value of P-0-1372 (Retracting difference limit) in such a way that the mechanics at the machine cannot be damaged.

Diagnostic message

E2011 – warning in slave axis

E2011 – A warning is present in the slave axis. The bit 12 is set in the device status word -> E2011 in the master axis diagnostics.

E2012 – master-slave position difference > P-0-1370

E2012 – The position difference between the two axes (is generated and evaluated by the MLD program) has exceeded the value entered in P-0-1370.

F2012 – master-slave position difference P-0-1371

F2012 – The position difference between the two axes (is generated and evaluated by the MLD program) has exceeded the value entered in P-0-1371. The system carries out the parameterized error reaction.

5 Axis linking

5.1 General information

Via CCD (Cross Communication Drives), a command value is transmitted from the CCD master to the CCD slaves. There are the following options:

- Torque linking (e.g., master-slave)
- Velocity linking (e.g., anti backlash)
- Position linking (e.g., Gantry group)

Select the type of linking using the decision chart below:

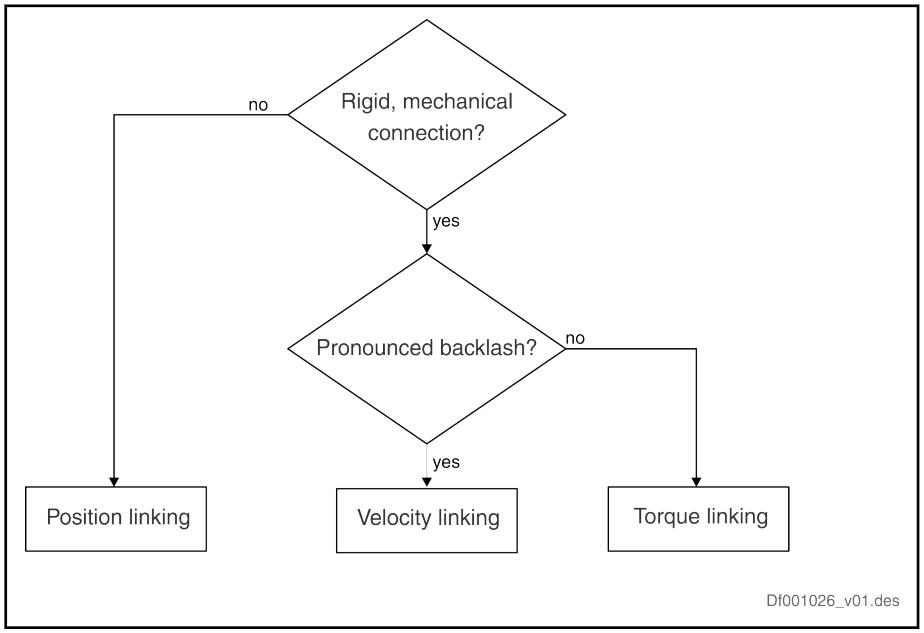


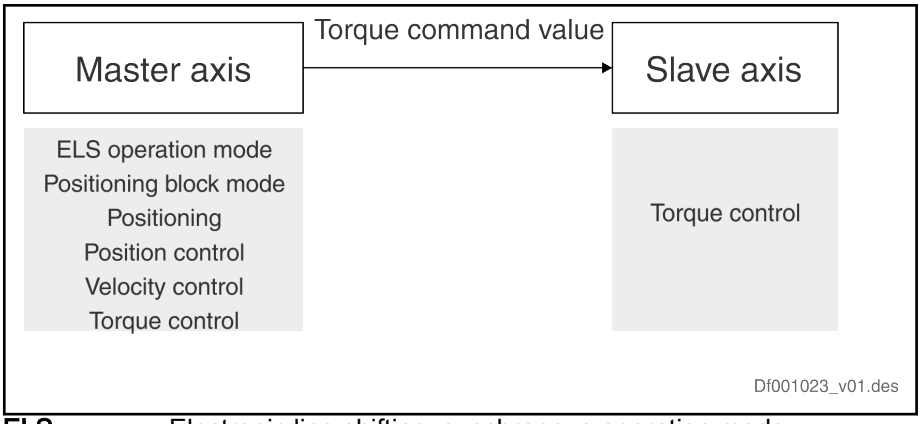
Fig. 5-1: Decision chart for type of linking

5.2 Torque command value linking (e.g., master-slave)

Use Torque linking is appropriate wherever there is a rigid mechanical connection between both axes, and no backlash or a low degree of backlash is present in the axes.

Principle The control only supplies the master axis with command values (target position, position command value, speed command value) and the effective torque command value (actual value, as may be the case) of the master axis is transmitted as the command value to the slave. Any operation mode may be selected for the master axis. The slave axis always is in the "torque control" mode.

Axis linking



ELS Electronic line shifting, synchronous operation mode

Fig. 5-2: Possible operation modes in the CCD master axis in the case of torque linking

Notes on commissioning and application

In the case of torque command value linking of the CCD axes, the effective torque/force command value (P-0-0049) of the master axis is copied to the torque/force command value (S-0-0080) in the slave axis.

If the acceleration feedforward is used in the master axis, the acceleration feedforward actual value (P-0-0455) also has to be copied from the master axis to the "additive torque/force command value" (S-0-0081) parameter of the slave axis.

☞ Transmitting the torque/force feedback value (S-0-0084) to the torque/force command value (S-0-0080) of the slave axis might possibly produce a better result. In each individual case, this has to be considered and directly checked with the connected mechanics. In this case, the acceleration feedforward actual value (P-0-0455) cannot be transmitted from the master axis to the slave axis.

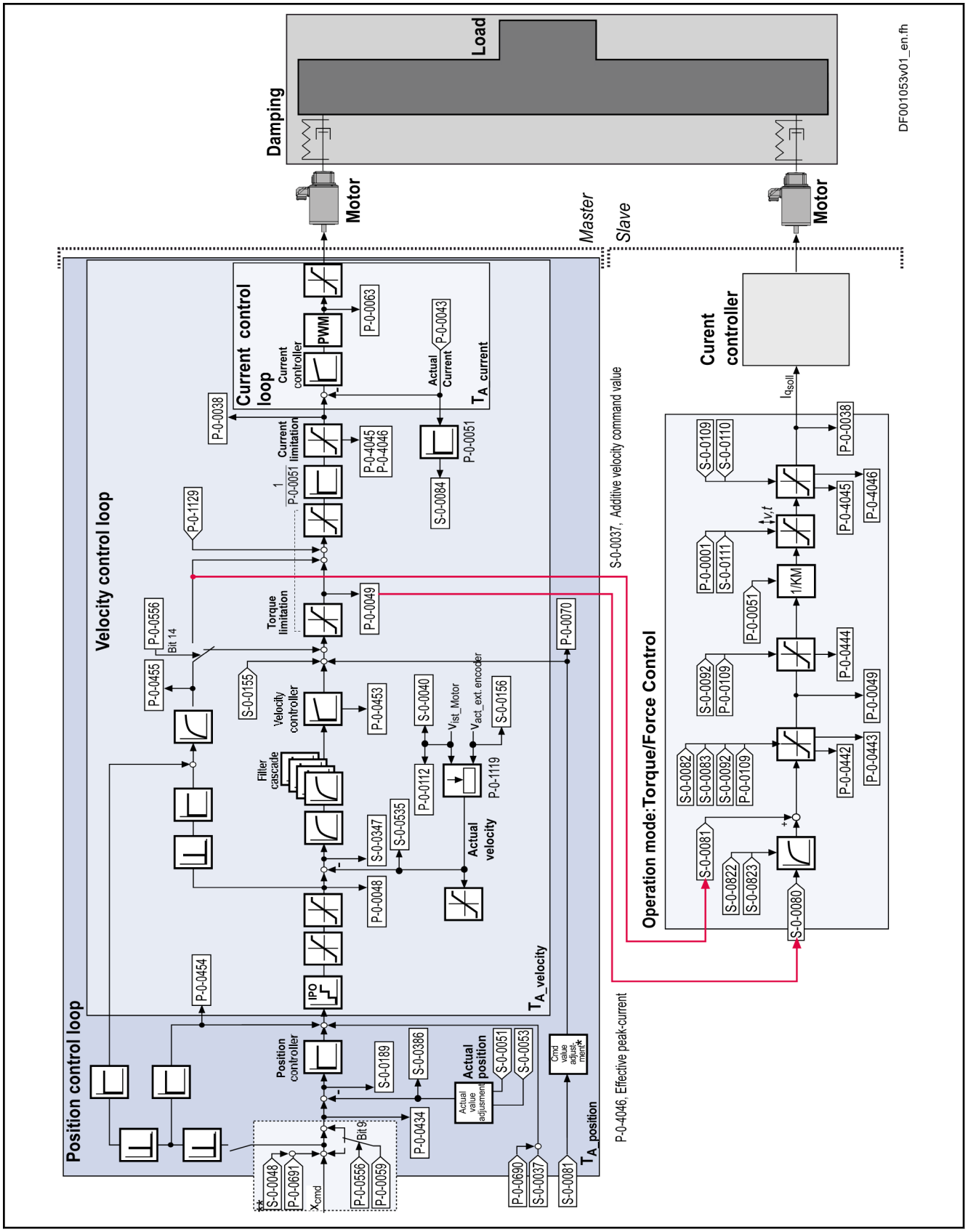


Fig. 5-3: Control loop structure of torque linking

Axis linking

- Dead time compensation is not possible in the case of torque linking
- Minimum CCD cycle time (P-0-1800.0.10) is T_{CCD} = 250 µs (MPx18VRS and above) and depends on the controllers and firmware types used (Economy, Basic or Advanced) and the control performance (P-0-0556) that has been set. The smallest possible cycle time that can be set should be set for torque linking. In the example, the CCD: Cycle time P-0-1800.0.10 = 0 µs has been parameterized. This corresponds to the default value. Thus, a CCD: Cycle time T_{CCD} = 2000 µs is set internally. Please set the cycle time in accordance with the hardware used.
- The velocity controller proportional gain is halved.

Application example of torque command value linking

The following application example is a mere example, i.e. Bosch Rexroth does not provide any warranty for possible problems of compatibility with future firmware products. Furthermore, the user shall not be entitled to updates or extensions of the released application examples!

The custom-made application example is made available as a loadable parameter file. The parameters set by the file may only be extended or modified to a limited extent.

The parameter files differ with regard to:

- Type of axis linking (torque, velocity and position linking)
- CCD master or CCD slave
- Open or subsystem solution
- Master communication used (Sercos, PROFIBUS etc.)

Overview of parameter files for torque linking

	CCD master				
	PROFIBUS PROFINET	EtherNet/IP	Sercos EtherCAT SoE	CANopen	Parallel/ Analog
Open solution	FWS_xxDBPx_**ACMTQ1**_02Vxx_D0_MPxx.par			FWS_xxDBPx_**ACMTQ2**_02Vxx_D0_MPxx.par	
Subsystem solution	FWS_MLDBPx_**ACMTQx**_02Vxx_D0_MPxx.par				

Tab. 5-1: Parameter files for master axis, torque command value linking

	CCD slave
Open solution	FWS_MLDBPx_**ACSTQ3**_02Vxx_D0_MPxx.par
Subsystem solution	FWS_MLDBPx_**ACSTQx**_02Vxx_D0_MPxx.par

Tab. 5-2: Parameter files for slave axis, torque command value linking

Overview of the configuration

All of the following settings are automatically configured by loading the parameter file.

Command values and actual values between master and slave

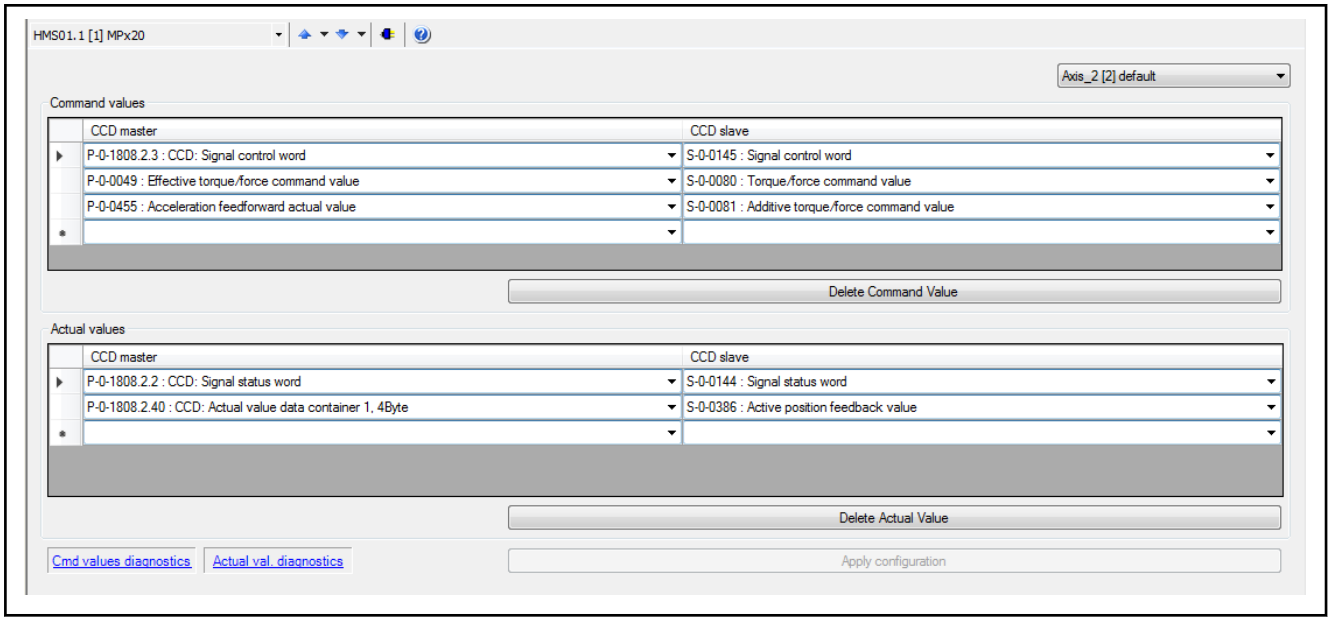


Fig. 5-4: IndraWorks dialog for configuring the command values and actual values between master and slave

The cyclic data shown by "fig. 5-4 " IndraWorks dialog for configuring the command values and actual values between master and slave" on page 31" are configured in this way for the subsystem solution, since some evaluations are generated in MLD (position difference monitoring, slave control, etc.).

For the open solution, only the command values required for linking are set (P-0-0049 to S-0-0080 and P-0-0455 to S-0-0081). For the open solution, as well as for the subsystem solution, it is possible to add other cyclic data required in the respective application. The parameters configured by the parameter file may neither be modified nor deleted.

Slave operation mode

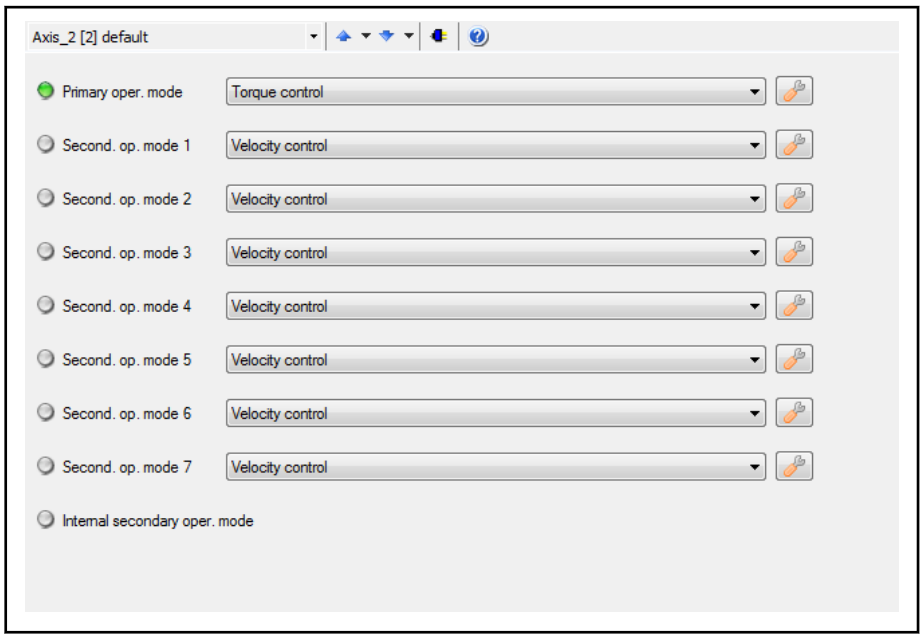


Fig. 5-5: IndraWorks dialog for setting the operation mode for the slave axis

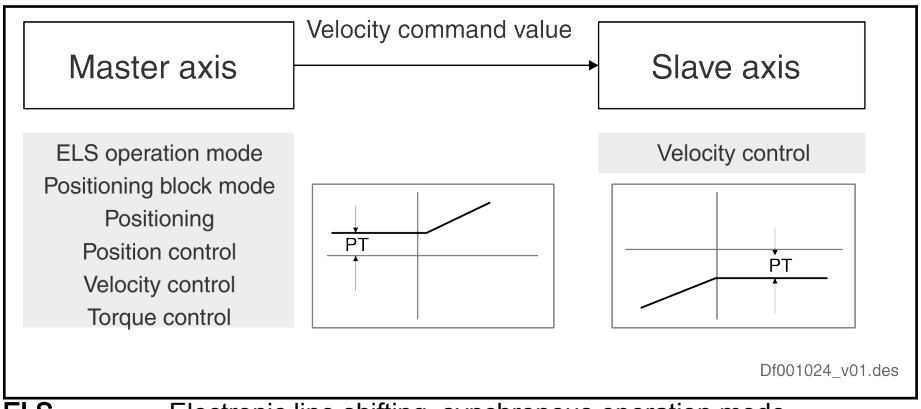
Axis linking

In the case of torque command value linking, the slave axis has to be operated in the "torque control" mode. This primary operation mode may not be changed.

5.3 Velocity command value linking (e.g., anti backlash)

Use Velocity command value linking is appropriate wherever there is a rigid mechanical connection between both axes and pronounced backlash is present in the axes.

Principle The control only supplies the master axis with command values (target position, position command value, speed command value) and the effective velocity command value (or actual value) of the master axis is transmitted as the command value to the slave. Any operation mode may be selected for the master axis. The slave axis always is in the "velocity control" mode.



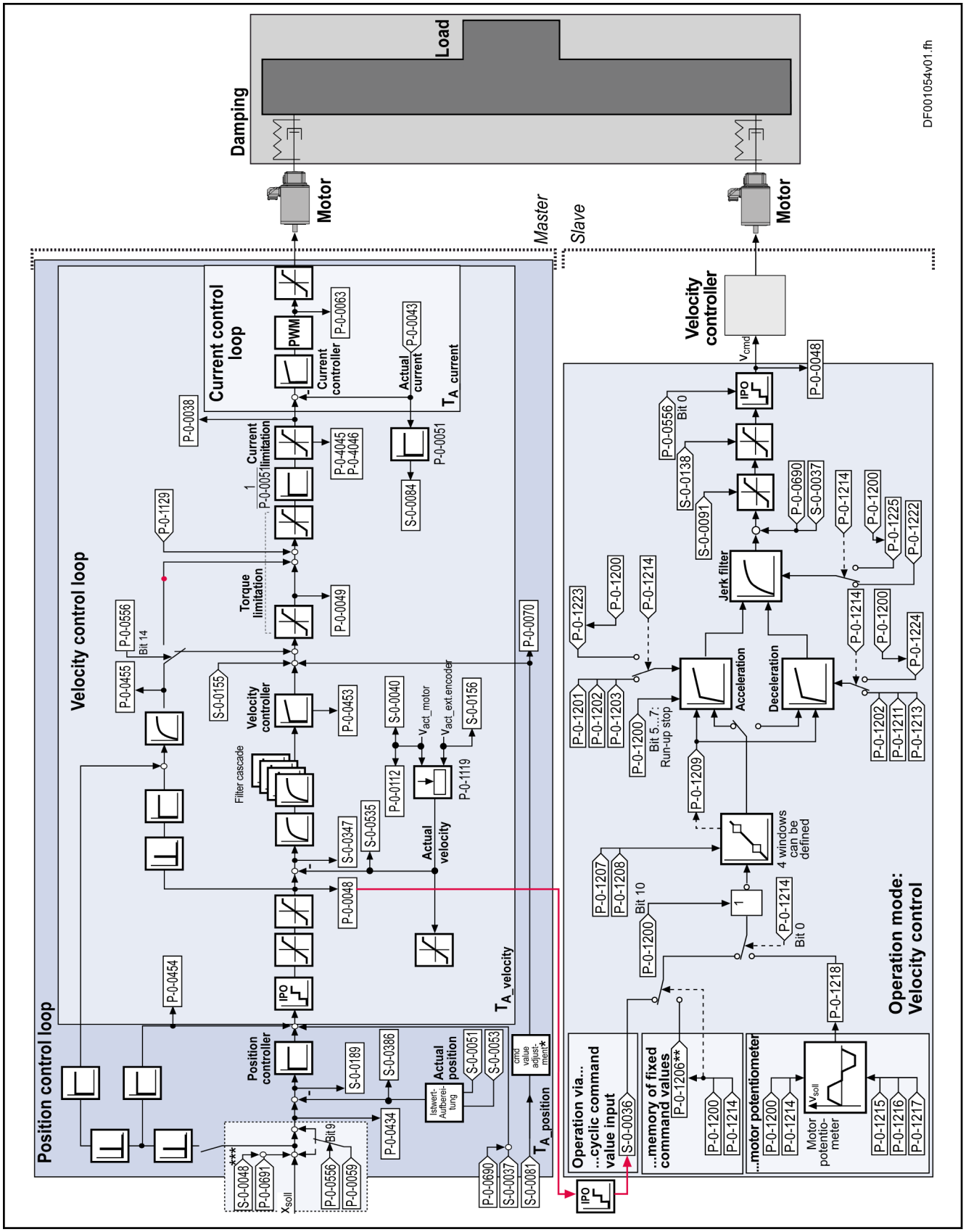
ELS Electronic line shifting, synchronous operation mode
PT Pretension torque

Fig. 5-6: Possible operation modes in the CCD master axis in the case of velocity linking

Notes on commissioning and application In the case of velocity command value linking of the CCD axes, the effective velocity command value (P-0-0048) of the master axis is copied to the velocity command value (S-0-0036) of the slave axis.

☞ Transmitting the velocity feedback value (S-0-0040) to the velocity command value (S-0-0036) of the slave axis might possibly produce a better result. In each individual case, this has to be considered and directly checked with the connected mechanics.

Axis linking



* only in position control mode (cyclic command value input)

Axis linking

** The additive command values take effect depending on the operation mode, see descriptions of the parameters S-0-0048, P-0-0059, P-0-0691 and table "Additive command values depending on the operation mode", in the chapter "Additive command values and options for accessing outer control loops" (functional description)

*** Choose between 31 fixed command values

Fig. 5-7: Control loop structure of velocity control

- Dead time compensation is not possible in the case of velocity linking
- Minimum CCD cycle time (P-0-1800.0.10) T_{CCD} = 250 µs (MPx18VRS and above) and depends on the controllers and firmware types used (Economy, Basic or Advanced) and the control performance (P-0-0556) that has been set. The smallest possible cycle time should be set for velocity linking. In the example, the CCD: Cycle time P-0-1800.0.10 = 0 µs has been parameterized. This corresponds to the default value. Thus, a CCD: Cycle time T_{CCD} = 2000 µs is set internally. Please set the cycle time in accordance with the hardware used.

Application example of velocity command value linking

The application example (free of charge) described here is a mere example, i.e. Bosch Rexroth does not provide any warranty for possible problems of compatibility with future firmware products. Furthermore, the user shall not be entitled to updates or extensions of the released application examples! The custom-made application example is made available as a loadable parameter file. The parameters set by the file may only be extended or modified to a limited extent.

The parameter files differ with regard to

- Type of axis linking (torque, velocity and position linking)
- CCD master or CCD slave
- Open or subsystem solution
- Master communication used (Sercos, PROFIBUS etc.)

Overview of parameter files for velocity linking

	CCD master				
	PROFIBUS PROFINET	EtherNet/IP	Sercos EtherCAT SoE	CANopen	Parallel/ Analog
Open solution	FWS_xxDBPx_**ACMVE1**_02Vxx_D0_MPxx.par			FWS_xxDBPx_**ACMVE2**_02Vxx_D0_MPxx.par	
Subsystem solution	FWS_MLDBPx_**ACMVEx**_02Vxx_D0_MPxx.par				

Tab. 5-3: Parameter files for master axis, velocity command value linking

	CCD slave
Open solution	FWS_MLDBPx_**ACSVE3**_02Vxx_D0_MPxx.par
Subsystem solution	FWS_MLDBPx_**ACSVEx**_02Vxx_D0_MPxx.par

Tab. 5-4: Parameter files for slave axis, velocity command value linking

Overview of the configuration

All of the following settings are automatically configured by loading the parameter file.

Command values and actual values between master and slave

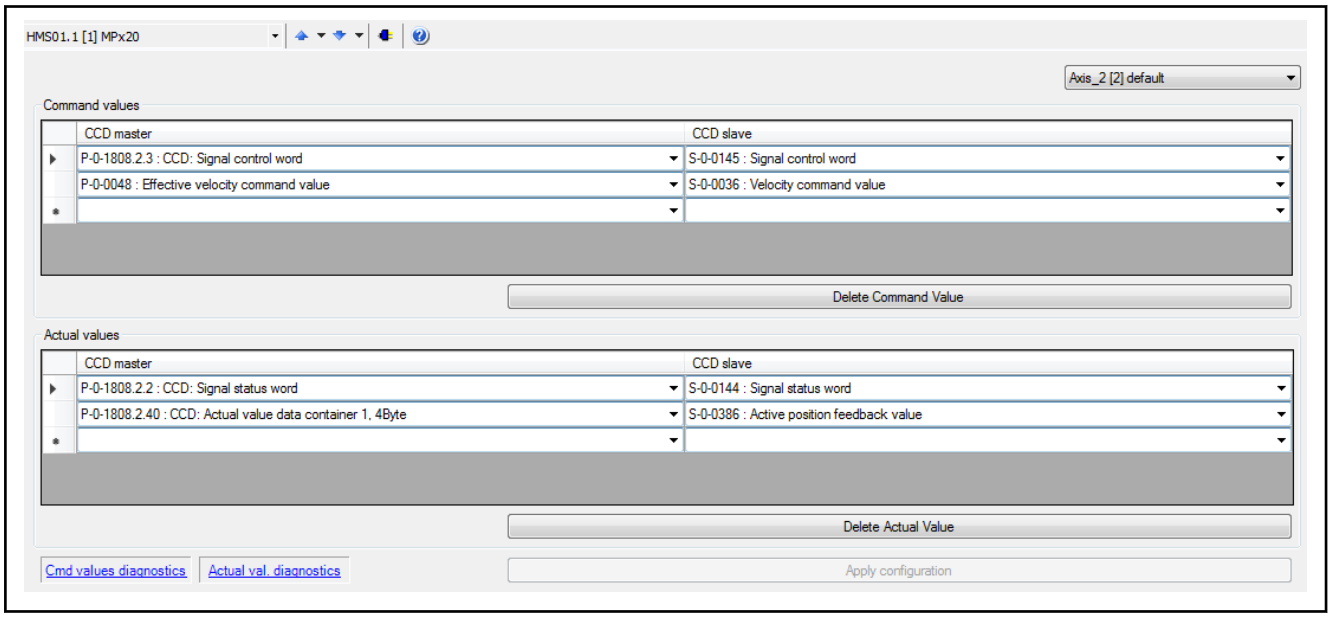


Fig. 5-8: IndraWorks dialog for configuring the command values and actual values between master and slave

The cyclic data shown above are configured in this way for the subsystem solution, since some evaluations are made in MLD (position difference monitoring, slave control, etc.).

For the subsystem solution, it is possible to add other cyclic data required in the respective application. However, the configurations set by the parameter file may not be deleted.

Slave operation mode

Axis linking

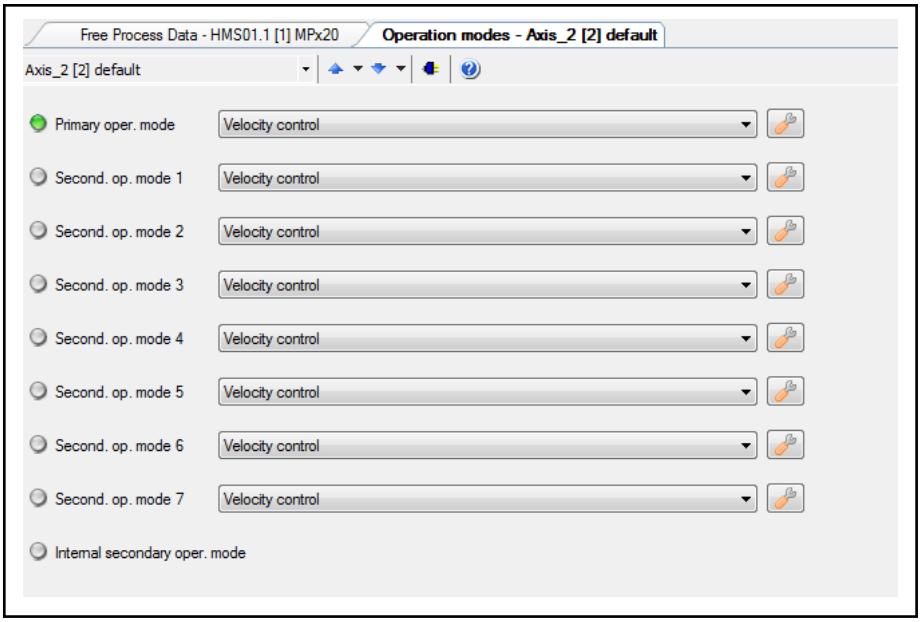


Fig. 5-9: IndraWorks dialog for setting the operation mode of the slave axis

In the case of velocity command value linking, the slave axis has to be operated in the "velocity control" mode. This primary operation mode may not be changed.

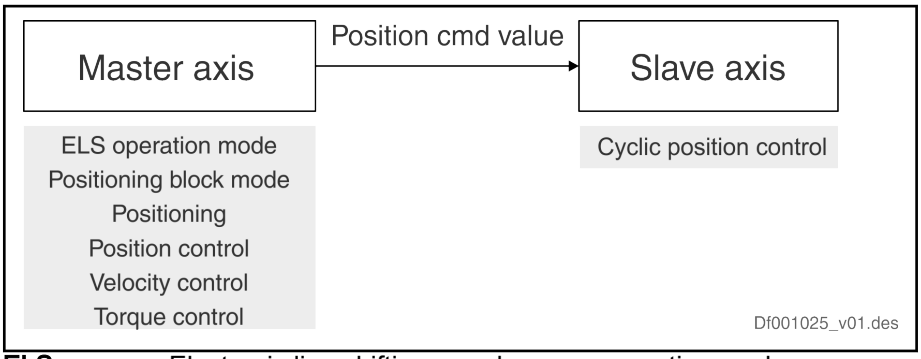
5.4 Position command value linking (e.g., Gantry group)

Use

Position command value linking is appropriate wherever there is no rigid mechanical connection between both axes, and no backlash or a low degree of backlash is present in the axes.

Principle

The control only supplies the master axis with command values (target position, position command value, speed command value) and the position command value of controller (actual value) of the master axis is transmitted as the command value to the slave. Any operation mode may be selected for the master axis. The slave axis always is in the operation mode position control drive-controlled lagless, encoder 1.



ELS Electronic line shifting, synchronous operation mode

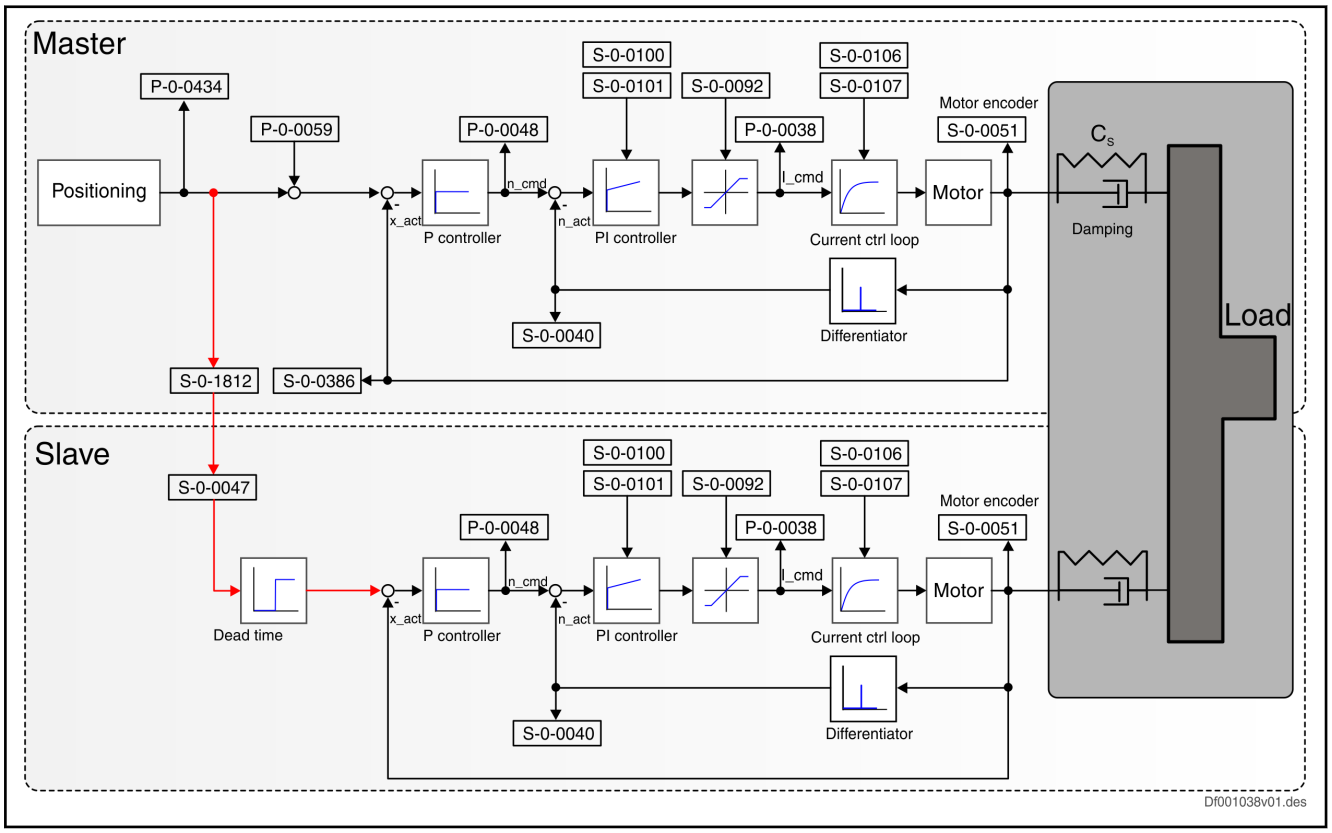
Fig. 5-10: Possible operation modes in the CCD master axis in the case of position linking

Notes on commissioning and application

In the case of position command value linking of the CCD axes, the position command value generator (P-0-0457) of the master axis is copied to the position command value (S-0-0047) in the slave axis.

The dead time compensation is achieved by way of position command value delay, see also fig. 5-13 "Dead time compensation by way of command value

delay" on page 39. The position command value generator (P-0-0457) is the input value of the "command value delay" function, the position command value of controller (P-0-0434) is the output value. The output value can be delayed by up to 32 position clocks. This is done using the position command value "delay" (P-0-0456) that defines the number of position clocks to be delayed. The default setting is "0", which means that the position command value delay function is not active by default.



C_s Spring constant

Fig. 5-11: Control loop structure of position linking

- In the case of position linking, dead time compensation by position command value delay is possible and thus has to be used!
- In the case of position linking, make sure that lagless operation or operation with lag error has been set in both axes, since otherwise the profiles might be traveled differently. This possible position feedback value difference may damage the axis group mechanically!
- Use identical motors with absolute value encoder for position linking, since the homing of such an axis group is difficult and position command value jumps must not occur at the master and slave.

Axis linking

Application example of position linking

The application example (free of charge) described here is a mere example, i.e. Bosch Rexroth does not provide any warranty for possible problems of compatibility with future firmware products. Furthermore, the user shall not be entitled to updates or extensions of the released application examples!

The custom-made application example is made available as a loadable parameter file. The parameters set by the file may only be extended or modified to a limited extent.

The parameter files differ with regard to

- Type of axis linking (torque, velocity and position linking)
- CCD master or CCD slave
- Open or subsystem solution
- Master communication used (Sercos, PROFIBUS etc.)

Overview of parameter files for position command value linking

The functionality contained in the parameter files may be read from the type code, see fig. 3-2

	CCD master				
	PROFIBUS PROFINET	EtherNet/IP	Sercos EtherCAT SoE	CANopen	Parallel/ Analog
Open solution	FWS_xxDBPx_**ACMPO1**_02Vxx_D0_MPxx.par			FWS_xxDBPx_**ACMPO2**_02Vxx_D0_MPxx.par	
Subsystem solution	FWS_MLDBPx_**ACMPOx**_02Vxx_D0_MPxx.par				

Tab. 5-5: Parameter files for master axis, position command value linking

	CCD slave
Open solution	FWS_MLDBPx_**ACSPO3**_02Vxx_D0_MPxx.par
Subsystem solution	FWS_MLDBPx_**ACSPOx**_02Vxx_D0_MPxx.par

Tab. 5-6: Parameter files for slave axis, position command value linking

Overview of the configuration

All of the following settings are automatically configured by loading the parameter file.

Command values and actual values between master and slave

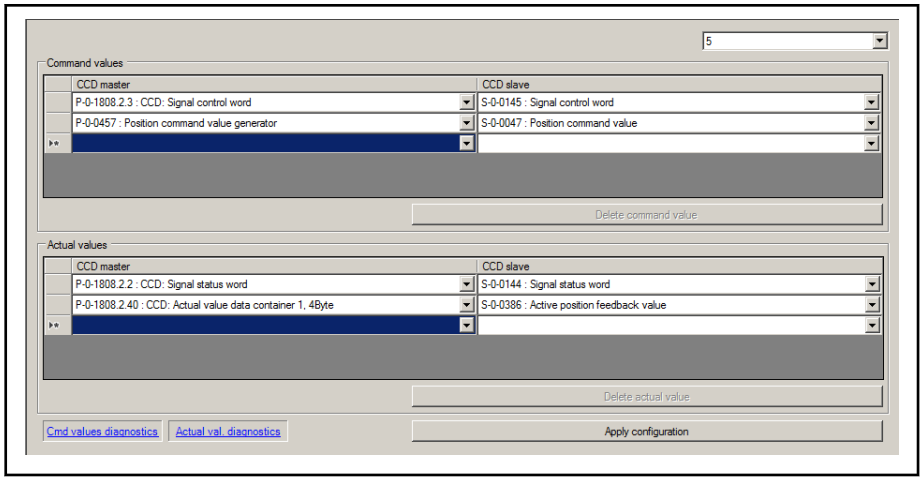


Fig. 5-12: IndraWorks dialog for configuring the command values and actual values between master and slave

Dead time compensation

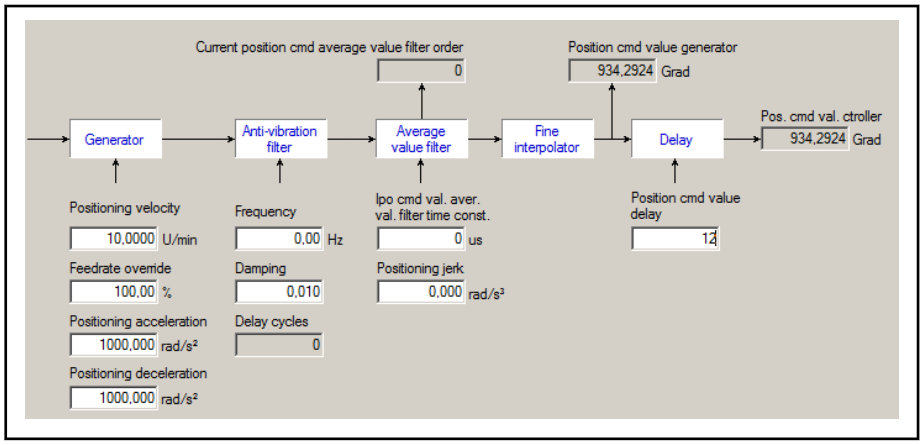


Fig. 5-13: Dead time compensation by way of command value delay

The cyclic data shown by fig. 5-12 "IndraWorks dialog for configuring the command values and actual values between master and slave" on page 39 are configured in this way for the subsystem solution, since some evaluations are made in MLD (position difference monitoring, slave control, etc.).

For the open solution, only the command values required for linking are set (P-0-0457 to S-0-0047).

For the open solution, as well as for the subsystem solution, it is possible to add other cyclic data required in the respective application. The configurations set by the parameter file may neither be modified nor deleted.

Slave operation mode

Axis linking

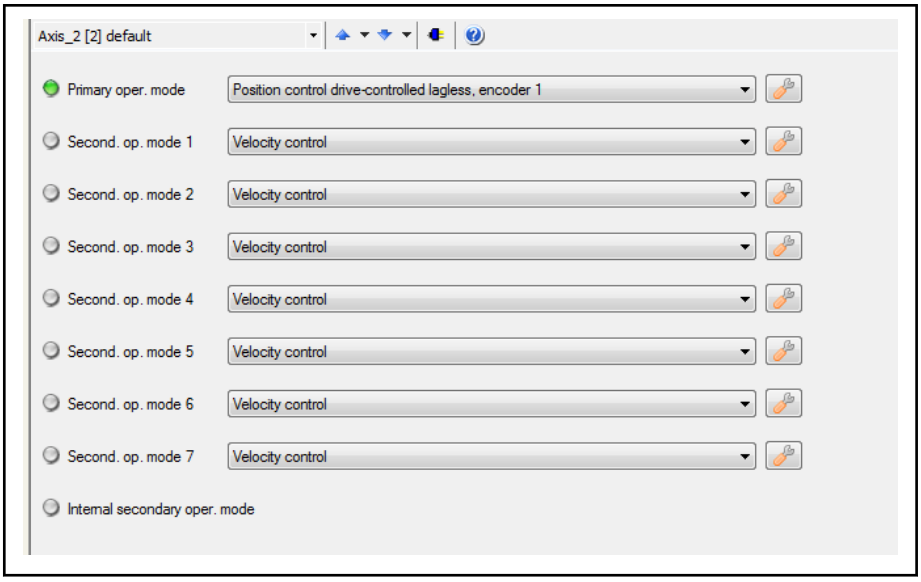


Fig. 5-14: IndraWorks dialog for setting the operation mode for the slave axis

In the case of position command value linking, the slave axis has to be operated in the "cyclic position control…." mode. This primary operation mode may not be changed.

☞ In the "position control drive-controlled lagless, encoder 1" mode, the slaves are synchronized with the master if the axes have different position feedback values (S-0-0051). This means that the position feedback values of the axes have to be compared before drive enable is switched on. If necessary, the position feedback values have to be adjusted via the "set absolute position" function. Otherwise, the mechanics might be damaged.

6 Error reaction

6.1 General information

The paragraphs below explain the recommended error reaction used by the application examples. Two configurations have to be distinghuished for the error reaction:

- Axis error reaction for master and slave
- Collective error reaction of the axis group

The settings of the error reaction have to be adjusted to the available axis mechanics and application, and have to be parameterized at both axes.

(See also functional description "Cross communication CCD")

6.2 Master and slave axis error reaction

The following default error reaction is recommended for master and slave:

Master & slave axis error reaction

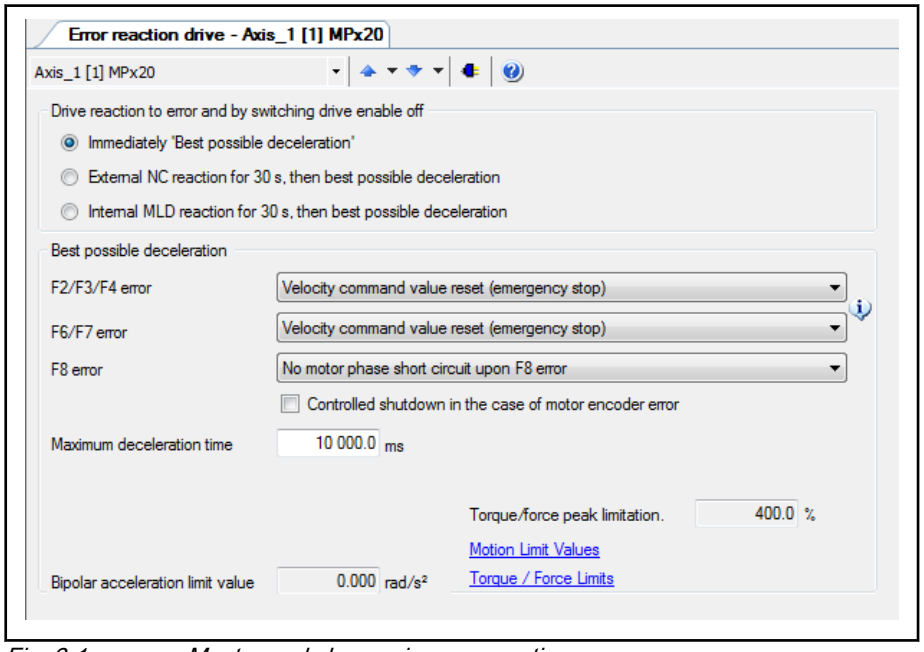


Fig. 6-1: Master and slave axis error reaction

Master & slave axis error reaction

Error reaction

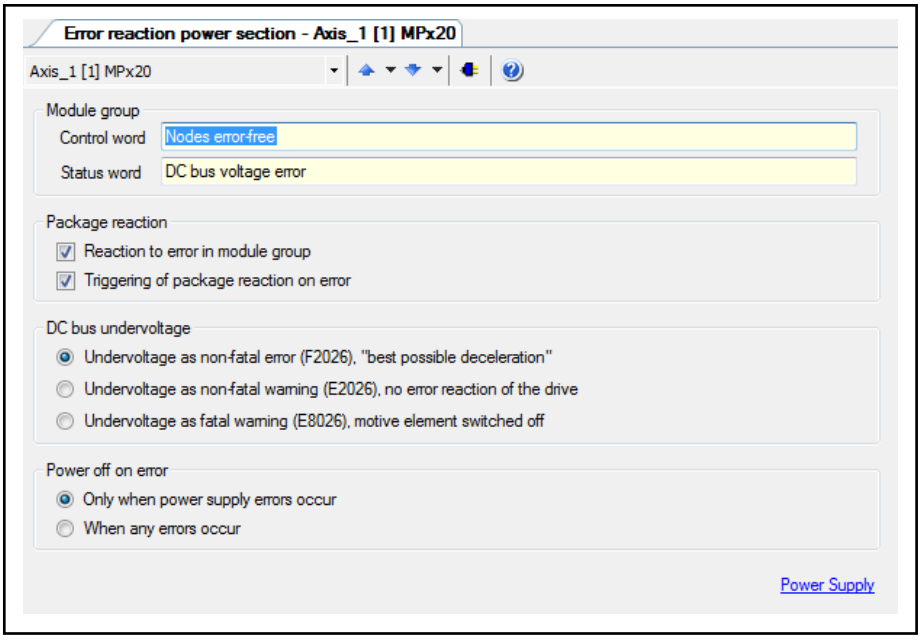


Fig. 6-2: Master and slave axis error reaction

6.3 Collective error reaction of the axis group

With regard to the collective error reaction, the "Master-controlled synchronous reaction" described below is recommended. In the case of this error reaction, there always is an attempt to actively decelerate the axis group if errors occur in the master or slave. The corresponding reaction to F8xxx errors has to be configured as described.

CCD error reaction

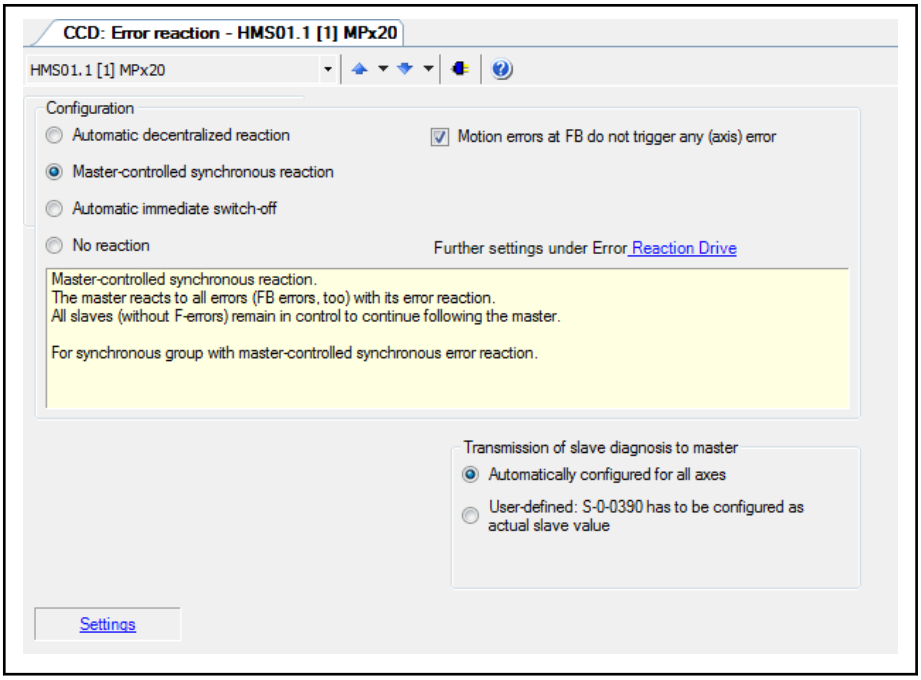


Fig. 6-3: CCD error reaction

The figures below explain the error reactions of the axis group in the case of errors in the master or slave:

CCD error reaction in the case of error in the master

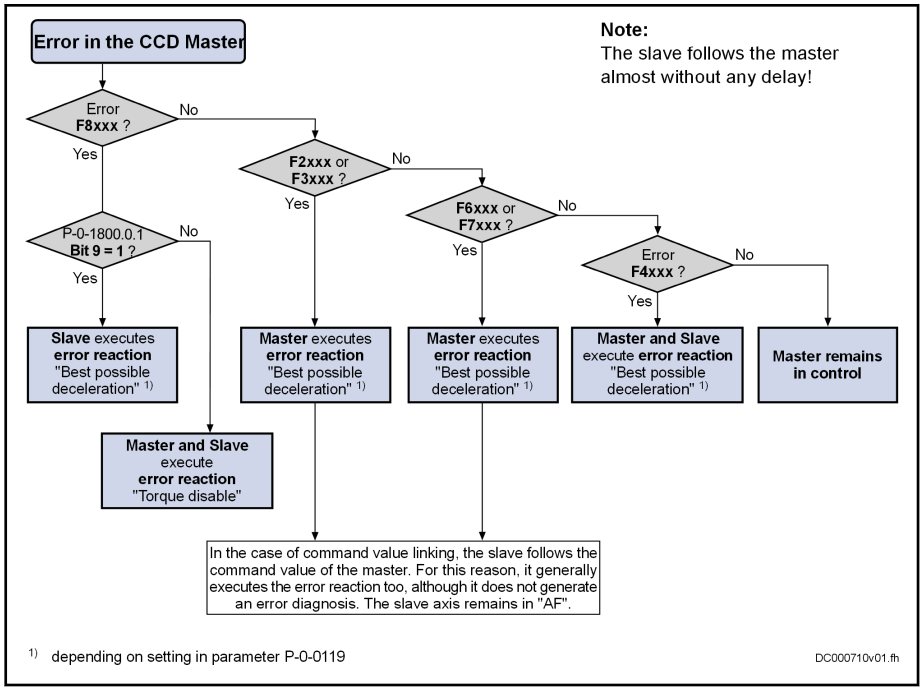


Fig. 6-4: Behavior of the axis group if an error occurs in the master axis

CCD error reaction in the case of error in the slave

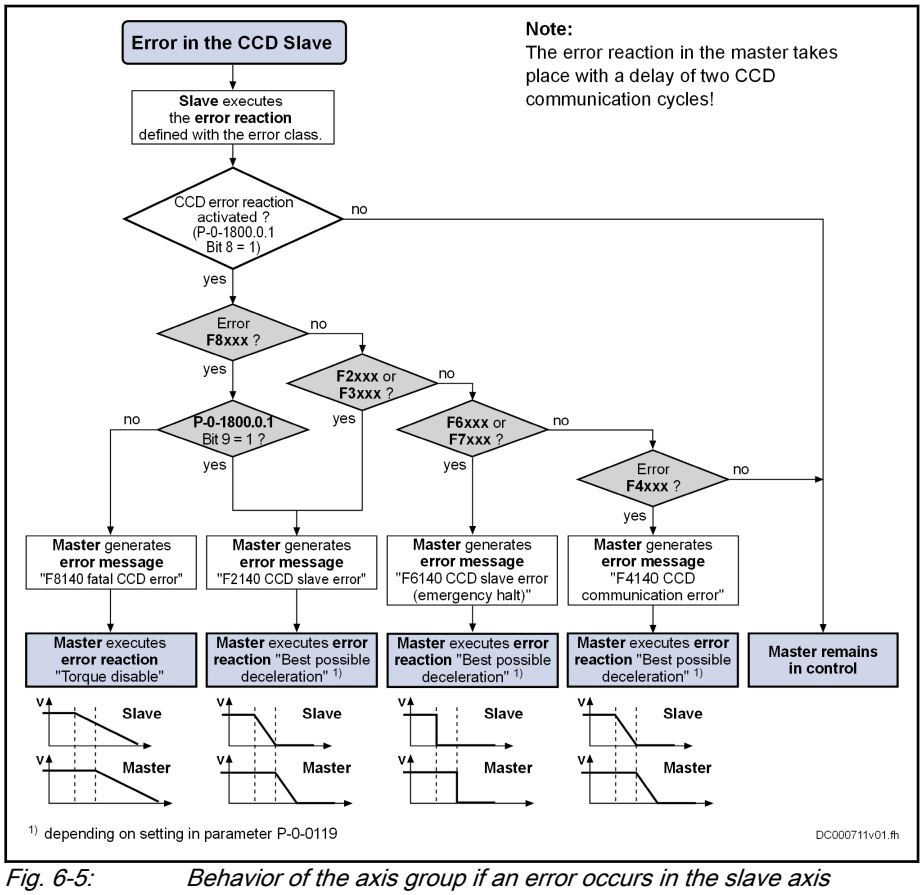


Fig. 6-5: Behavior of the axis group if an error occurs in the slave axis

7 How to proceed when activating the application examples

7.1 General information

The description below shows how and in which order to proceed when activating the application examples:

1. Select the connection to the higher-level master communication via the subsystem solution or open solution (see "Connection to the higher-level master communication"
2. Select the type of linking; position, velocity or torque linking (see "Axis linking")
3. The parameter files to be loaded result from the selection made under items 1 and 2 (see 3.2 "Axis linking type code"). The parameter files can be found under the supplied folder structure, according to the connection to the master communication, type of linking and firmware used. There is one parameter file for the CCD master and one for the CCD slave respectively.
4. Establish the connection to the drive (e.g., connection via Ethernet)
5. Load the parameter file for the CCD master
   - Select the parameter file
   - Select the axis to be loaded

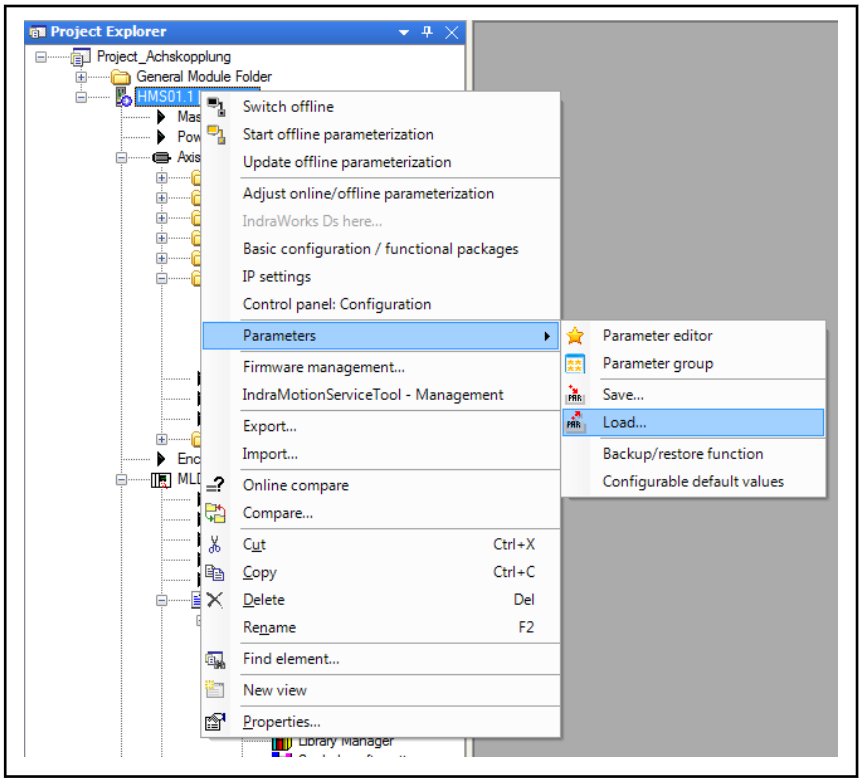


Fig. 7-1: Dialog for loading parameters

☞ If the subsystem solution is used, the functional package "MLD" must have been enabled in the master.

How to proceed when activating the application examples

6. The user has to configure the Sercos slaves, because the axis addresses cannot be predefined in the parameter files.
   - Assign the configured address

   Example of MPx20VRS firmware:

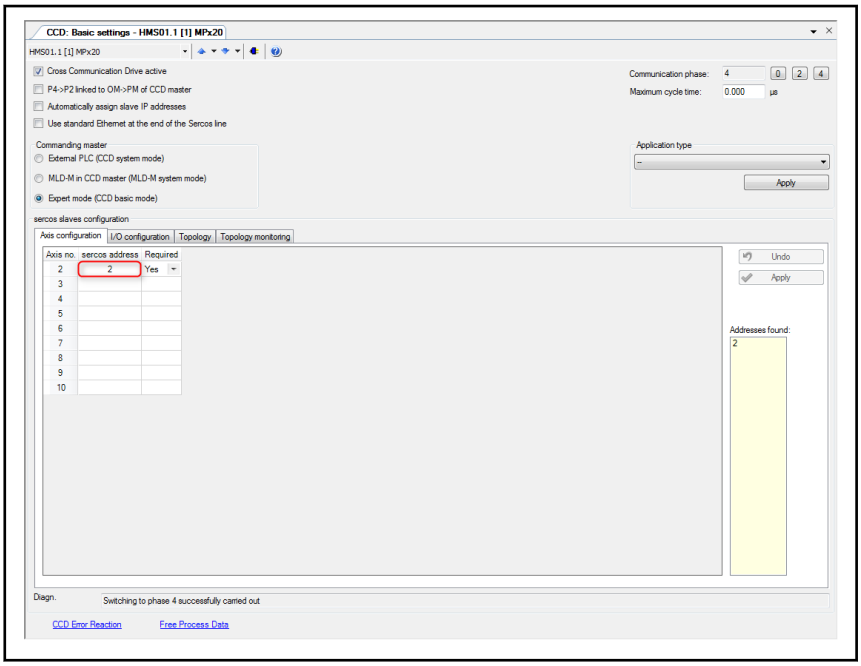


Fig. 7-2: Configuring the Sercos slaves

7. Load the parameter file for the CCD slave (see fig. 5-1)
   - Select the parameter file
   - Select the axis to be loaded
8. Restart the drives
   - Drives have to be restarted so that the drive-based PLC program starts running and the linking takes effect.

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Notes

Notes

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