



MSD Servo Drive and MSD Single-Axis Servo Drive Compact

Device Help

Servo Drive 2 A to 450 A

Single-Axis Systems and Multi-Axis System



Description of the MSD Servo Drive software functionality (Single-Axis System and Multi-Axis System) as well as MSD Single-Axis Servo Drive Compact

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- V124.35-xx (MSD Single-Axis Servo Drive Compact)
- V124.35-xx (MSD Servo Drive Single-Axis System and Multi-Axis System)
- V174.35-xx (if you need to use hydraulic parameters, see Section "Hydraulic control" on page 182 for details)

The structure of this help, as well as the screenshots used, were taken from Moog DRIVEADMINISTRATOR 5 .

Legal information

Subject to technical change without notice.

This Operation Manual has been prepared based on DIN EN 82079-1. The content was compiled with the greatest care and attention and reflects the latest information available to us.

We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.

Information and specifications may be subject to change at any time. For information on the latest version please visit drives-support@moog.com.

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1 General information

The product CD from Moog contains the complete documentation for the respective product series. The documentation of a product series includes Operation Manual (hardware description), Device Help (software description) and other User manuals (e.g. fieldbus description) and Specifications. These documents are available in PDF format, and some of them are available in .NET and HTML5 format as well.

1.1 Target Group

Dear user,

the documentation is an integral part of the device and contains important information on operation and service. It is aimed at everyone who performs mounting, set-up, commissioning and service tasks on the product.

1.2 Requirements

Important points to be observed when handling the devices from Moog:

- The device documentation must be kept readable, always available, and throughout the product's service life.
- Read and understand the documentation for your device.
- Qualification: To avoid bodily injury and property damage, only qualified personnel with electrical training may work with/on the device.
- Required skills and knowledge:
 - national accident prevention rules (e.g. DGUV V3 in Germany)
 - How to set up, install, commission and operate the device

Work related to other specialised areas, such as transportation, storage and disposal must be performed exclusively by appropriately trained personnel.



NOTE

- This Device Help applies to the Servo Drive MSD Servo Drive and MSD Single-Axis Servo Drive Compact. These instructions are not meant as a replacement for the Operation Manuals for the MSD Servo Drive or MSD Single-Axis Servo Drive Compact.

1.3 Pictograms

The pictograms used in this Device Help have the following meaning for the user:



NOTE

- Useful information or references to other documents.



- Reference to further applicable documents.

Step	Action
1. (Number)	HANDLING INSTRUCTIONS Operating step performed by either the user or the system.

For the pictograms for “safety information and warnings” used in this Device Help, see the Section “Safety information and warnings” on page 16.

1.4 Exclusion of liability

Compliance with the documentation for the devices from Moog is a prerequisite for:

- safe operation and
- attaining the performance characteristics and product characteristics described.

Moog accepts no liability for personal injury, material damage or financial losses arising from disregard of the documentation.

1.5 Applicable documentation

No.	Document	Contents	ID No.:	Format
1	MSD Single-Axis Servo Drive Compact - Operation Manual	Safety, device installation, setup, commissioning, diagnostics, specifications, certifications and applicable standards, technical data	CA97555-001	PDF
2	MSD Servo Drive Single-Axis System - Operation Manual	Safety, device installation, setup, commissioning, diagnostics, specifications, certifications and applicable standards, technical data	CA65642-001	PDF
3	MSD Servo Drive Multi-Axis System- Operation Manual	Safety, device installation, set-up, commissioning, diagnostics, STO, operation with Servo Drive as supply, planning, application example, specifications, certifications and applicable standards, technical data	CA97554-001	PDF
4	MSD Power Supply Unit - Operation Manual	Safety, device installation, setup, commissioning, diagnostics, specifications, certifications and applicable standards, technical data	CA97556-001	PDF
5	MSD Servo Drive Description of the STO safety function	Changes to Operation Manuals MSD Servo Drive (Nos. 1 to 3): Hazard analysis and risk assessment, function description, wiring and commissioning, testing the STO function, safety parameters	CB19388	PDF
6	MSD Servo Drive functional safety Specification	Additions and changes to Operation Manuals MSD Servo Drive (Nos. 2 and 3)	CB38398-001	PDF
7	MSD Servo Drive - Specification second Sin/Cos encoder	Connection, configuration	CA79903-001	PDF
8	MSD Servo Drive - Specification Sin/Cos encoder	Connection, configuration	CB13516-001	PDF
9	MSD Servo Drive - Specification TTL encoder simulation / TTL master encoder	Connection, configuration	CB08758-001	PDF

Table 1.1: Applicable documents

No.	Document	Contents	ID No.:	Format
10	MSD Servo Drive - Specification TTL encoder simulation / TTL master encoder	Connection, configuration	CB32164-001	PDF
11	MSD Servo Drive - Specification SSI encoder simulation	Connection, configuration	CB08760-001	PDF
12	MSD Servo Drive - Specification TTL encoder with commutation signals	Connection, configuration	CB32162-001	PDF
13	MSD Servo Drive - Specification for safe tech option (second safe Sin/Cos encoder + second safe SSI encoder + second safe axis monitoring (Sin/Cos))	Connection, configuration	CC23875-001	PDF
14	MSD Servo Drive MSD PLC function package	Quick installation manual	CC52008-001	PDF
15	MSD PLC Manual	Basic motion library	CB15237-001 (only available in EN)	PDF

Table 1.1: Applicable documents (continue)



NOTE

- For the latest versions of the aforementioned documents, please visit our website at <http://www.moogsoftwaredownload.com/msd.html>.

1.6 Technical Helpline

If you have any technical questions concerning the planning, configuration or commissioning for your device, our Technical Helpline staff will be more than happy to assist you quickly and effectively.

Address:	Moog GmbH Hanns-Klemm-Strasse 28 D-71034 Böblingen
Phone:	+49 7031 622-0
Email:	drives-support@moog.com

If you are looking for support in case of any necessary service, Moog specialists will be glad to help:
Service: Please contact us via

Phone:	+49 7031 622-0
Email:	info.germany@moog.com



NOTE

- For detailed information on our services, please visit our website, www.moog.com/industrial.
-

2 Safety

2.1 Overview

Our devices are designed and built with the latest technology and comply with all recognized safety rules and standards. Nevertheless, there are potential hazards that may arise during their use. In this chapter:

- We provide information regarding the residual risks and hazards posed by our devices when they are used as intended.
- We warn you about foreseeable misuse of our devices.
- We point out that it is necessary to exercise due care and caution and go over measures designed to minimize risk.

2.2 For your own safety



NOTE

- The device must only be installed and commissioned in compliance with the documentation for the corresponding device family!



NOTE

- Please also pay special attention to the safety and warning information in the respective valid operation manual when commissioning the drive!



NOTE

- Pay attention to special safety and warning information which is provided here in the document directly before a specific action and warns the user of a specific danger!

Our devices are designed to be fast and easy to operate. For your own safety and to ensure reliable operation of your machine, take note of the following:

Step	Action
1.	Precautions to avoid injury and damage to property Ensure there is no possibility of bodily injury or damage to the machine when testing and commissioning the device. To this end, make sure to observe Section "Safety information and warnings" on page 16 as well.

2.3 Safety information and warnings

Our devices may pose certain hazards. Accordingly, you must observe the following safety information and warnings.

WARNING!	Risk of injury posed by uncontrolled rotation!
	Improper conduct can lead to serious injury or death. • Before commissioning motors with a feather key at the shaft end, the key must be secured to prevent it from being ejected if this is not already prevented by drive elements such as pulleys, couplings, etc.

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. Before the “Start” step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.

CAUTION!	Damage to the device as a result of incorrect operation!
	Failure to exercise caution or follow proper working procedures may result in damage to the device. The mains voltage for the power supply must not be switched on until after the available mains voltage setting has been configured in the device firmware and the device is restarted (in the event that the mains voltage or the switching frequency has been changed).

- For the risk assessment of the complete machine or system according to EN ISO 12100:2011 and EN ISO 13849-1.

Observe the topic “Electrical equipment of machines” in EN 60204-1:2006 “Safety of machinery”. The safety requirements defined there to be met by electrical machinery are intended to ensure personal safety and the safety of machinery or systems.

The emergency-stop function (to IEC/EN 60204) shuts down the power supply of a machine, which leads to uncontrolled rundown of the drives. In order to prevent hazards, check whether the following will be required:

- Keeping individual motors running.
- Initiating specific safety processes.
- Integrating an emergency stop function (emergency stop function: stopping movement by “switching off the electrical power supply” or STO Safe Torque Off).

2.4 Responsibility

Electronic devices are not fail-safe. The company setting up and/or operating a complete machine or system is responsible:

- For ensuring that the motor will be brought to a safe state if the device fails.
- For the safety of persons and machinery.
- For proper functional capability of the complete machine.

3 Initial commissioning

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Initial commissioning

Brief description

- The initial commissioning for the drive can be carried out with the help of a wizard. The wizard will take you through the process step-by-step, ensuring that the available configuration options are presented in a clear and manageable manner.
- This chapter describes how the initial commissioning wizard works. This wizard is used to set up the initial configuration for the MSD Servo Drive and make it possible to move the connected motor.

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3.1 Initial Commissioning wizard

The wizard guides you through the subject areas that are relevant for the initial commissioning. Correct setting of the parameters permits controlled movement of the drive via the manual mode window (for details see Section "Manual mode" on page 462). Further settings must be made to exactly adapt the drive system to an application.

3.1.1 Hardware requirements

- Correct assembly and installation, in line with the intended use, as per the instructions in the applicable operation manual (see Section "Applicable documentation" on page 13).
- Voltage supplies
 - 24 V control voltage
 - Mains voltage
- Hardware enable
 - Safe Standstill (**ISDSH**)
 - Enable Power (**ENPO**)

3.1.2 Prompt Initial commissioning

If the Moog DRIVEADMINISTRATOR 5 is opened without an existing project, a prompt to undertake initial commissioning appears automatically.

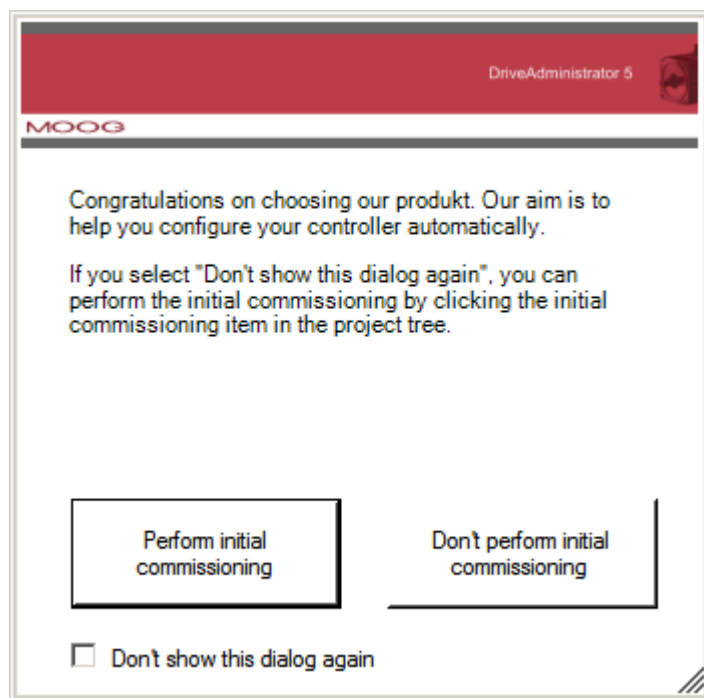


Fig. 3.1: Prompt to activate wizard

If this window does not open automatically, you can also start the wizard manually by double-clicking on the pictogram (see "Chapter overview" in Section "Initial commissioning" on page 18) or via ►Project tree ►Device setup ►Initial commissioning.

3.1.3 Initial commissioning

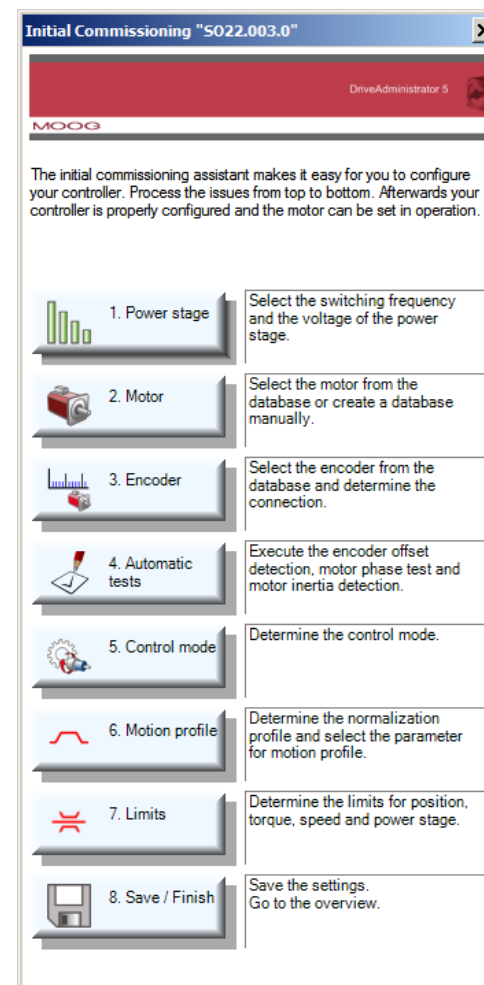


Fig. 3.2: Commissioning wizard

Step	Subject area	Action		Instruction
		Rotary motor	Linear motor	
1.	 Power stage	Set the switching frequency and the voltage supply of the power stage.		Matching the voltage supply to the clock frequency
2.	 Motor	Select the motor type (P 450[0])	Set the motor type (P 450[0]) to "PSM(1) = Permanent magnet synchronous motor"	Selection of motor type
3.	 Motor	Set (P 490[0]) motor movement to "ROT (0) = rotating motor"	Set (P 490[0]) motor movement to "LIN (1) = linear motor"	Selection of motor system
4.	 Motor	Identification: • Measurement of electrical parameters (resistance, inductivity) • Current controller tuning • Calculation of nominal flux Data set calculation: • Complete "Calculation of control settings" screen and start the calculation		Identification or calculation of motor data set
5.	 Motor	• Set the I^2_{xt} monitor • Select of temperature sensor • Characteristic setting		Motor protection
6.	 Encoder	• Encoder selection • Channel selection		Encoder setting

Table 3.1: Instructions for the commissioning wizard

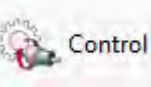
Step	Subject area	Action		Instruction
		Rotary motor	Linear motor	
7.	 4. Automatic tests	• Motor phase test • Determine encoder offset • Determine mass inertia		Automatic tests
8.	 Manual Mode	Open manual mode window • Control type V/Hz (open loop) operation • Move motor at low speed • Check direction		Motor test in manual mode without intervention of a higher-level PLC
9.	 Control	• Optimize current controller (test signal generator). When there is a motor data set the current of the test signal generator is set automatically. • Optimizing the speed controller • Determine mass inertia [J] (basic settings) • Set speed filter: P 0351 CON_SCALC_TF = (0,6 ms) Recommendation for Sin/Cos encoder: 0.2 ms - 0.6 ms Recommendation for resolver: 1 ms - 2 ms Adjust control parameters to suit the mechanism (set stiffness).		Controller setting • Current Controller • Speed controller • Position controller
10.	 Motion profile	Settings: • Units • Reference source • Reference processing • Stop ramps • Homing method		Motion profile setting

Table 3.1: Instructions for the commissioning wizard (continue)

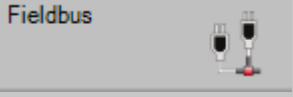
Step	Subject area	Action		Instruction
		Rotary motor	Linear motor	
11.	 Limits	Limits: • Torque • Speed • Position		Define limits
12.	 Fieldbus	Scaling, IOs, field buses: • CANopen • PROFIBUS • SERCOS		Set marginal conditions. For more information refer to the user manuals for the individual bus systems.
13.		Saving the settings and creating a commissioning file		Saving: For more information on data handling refer to the Moog DRIVEADMINISTRATOR 5 help.

Table 3.1: Instructions for the commissioning wizard (continue)

3.2 Automatic test

To be able to run the automatic tests, you will need to read and confirm the safety prompts. Once you are done doing so, you will be able to run the individual tests.

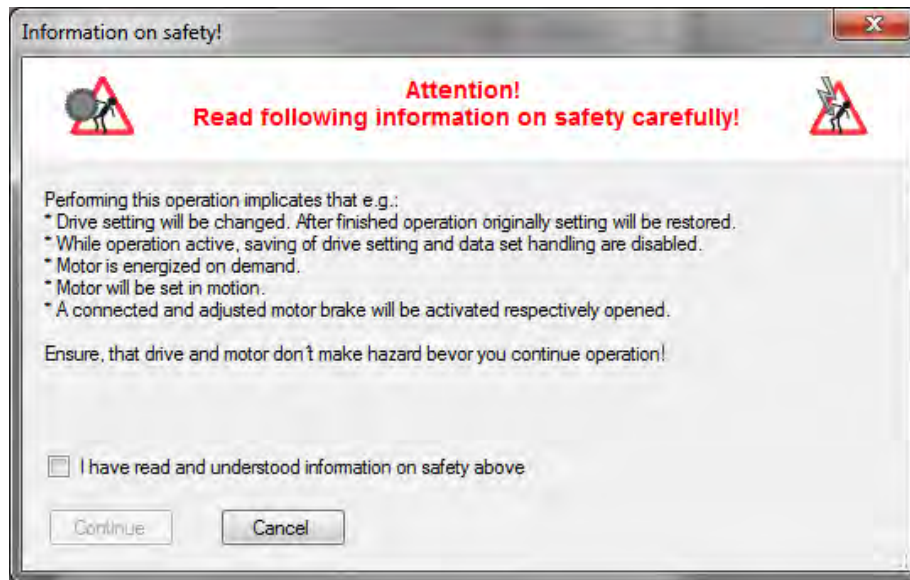


Fig. 3.3: Safety information

Automatic tests:

Motor phase test



Detect encoder offset



Encoder offset:

-0,62313 deg

Automatic inertia detection



Detected inertia:

1,3075E-05 kg m²m

Enhanced >>

A green tick (check-mark) shows the test was successful.

Fig. 3.4: "Initial Commissioning - Automatic tests" screen

Motor phase test

A motor phase check has been implemented which permits monitoring of the motor wiring. It also checks whether the parameter setting of the pulses per revolution of the encoder and the number of pole pairs of the resolver match the number of pole pairs of the motor. When it has been successfully determined, a green tick (check-mark) is displayed. Disable motor brake during the motor phase test.

Determining the encoder offset

Once the safety notice window has been confirmed, the wizard is activated to determine the encoder offset. When it has been successfully determined, a green tick (check-mark) is displayed.

Automatic inertia detection

Once the safety notice window has been confirmed, the wizard is activated to determine the mass inertia. When it has been successfully determined, a green tick (check-mark) is displayed.

See also Section "Automatic inertia detection" on page 118.

Enhanced >>

When you click the "Enhanced >>" button, the wizard provides you with support in setting up the current, torque, speed and position controllers. If further optimization is required, the controller buttons route you to more detailed screens.

3.3 Motor

Motor data and control settings

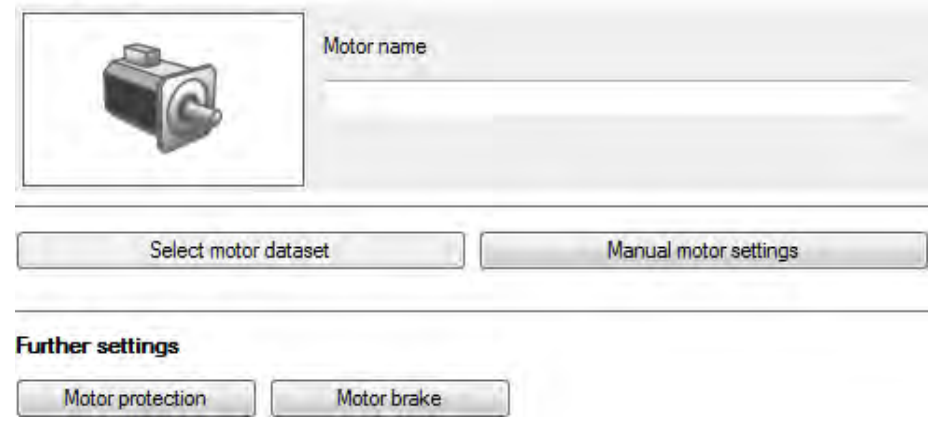


Fig. 3.5: "Initial Commissioning - Motor data and control settings" screen

- You can click on the "**Select motor data set**" to select a motor from Moog .
- If you want to use a different motor, you can configure it by clicking on the "**Manual motor settings**" button. For details see Section "Motor configuration data" on page 34.
- If you need to configure the temperature and current monitoring mechanism, click on the "**Motor protection**" button. For details see Section "Motor protection" on page 42.
- To configure a motor brake, click on the "**Motor brake**" button. For details see Section "Motor brake output" on page 317.

3.4 Encoder

Encoder selection



Fig. 3.6: "Initial commissioning - Encoder selection" screen

- There is a database available for commissioning the encoder. This database can be used to select from a large number of standard models.
- If you are unable to find your encoder model or want to configure additional settings, click on the "**Settings...**" button. For details see Section "Encoder selection" on page 55

3.5 Control

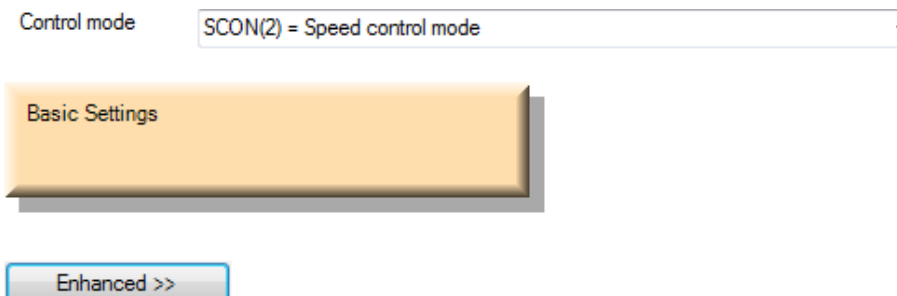


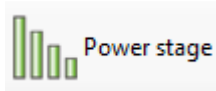
Fig. 3.7: "Initial Commissioning - Control" screen

- You can use this screen to select the control mode for the device.
- To determine the system's inertia and configure position and speed control settings, click on the "**Basic settings**" button. For details see Section "Basic settings" on page 117.
- To access the "Control" screen, click on the "**Advanced >>**" button. For details see Section "Basic settings" on page 117.

4 Power stage

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Power stage

Brief description

This chapter describes the configuration options for the power stage (power supply, switching frequency, power failure bridging).

Contents

4.1 Power stage settings	26
4.2 Power failure bridging	29

4.1 Power stage settings

Mains voltage: 3x400V AC(2) = 3 x 400 V mains
Note: Selected mains will be activated after restart of drive only.

Switching frequency: 8kHz(3) = 8 kHz switching frequency

Online derating of switching frequency: OFF(0) = Function disabled

AC 3ph

Characteristics of power stage:

Rated current of powerstage	6 A
Undervoltage at	210 Vdc
Power stage enable from	260 Vdc
Overvoltage at	685 Vdc
Brake chopper switched on at	650 Vdc

Note: Update of characteristics only after drive-reset or motor control enable.

Fig. 4.1: "Power stage settings" screen AC device

The power stages of the Servo Drive can be operated with different voltages and switching frequencies. The list boxes in the screen are used to adapt the power stage to the application conditions.



NOTE

- Any changes to parameters must be saved in the device.
- The setting is only applied on the device after a power off/on cycle.
- If the power stage parameters are changed, the rated currents, overload values and brake chopper thresholds may also change.

4.1.1 Voltage supply

P 307[0] - CON_VoltageSupply is used to configure the power supply. For single-axis applications only the settings (0) to (5) are allowed. All other settings should be used for multi-axis systems. Not all switching frequencies can be used on higher-powered devices. An excessively high switching frequency setting in conjunction with high powers may result in a power reduction.



NOTE

- A current-limited power supply unit is required for the **P 307[5] DC low voltage supply for the power stage 24 V - 60 V** setting without precharging.

4.1.2 Switching frequency

The switching frequency is set via **P 302[0] - CON_SwitchFreq**. It is advisable to initially operate the servo controller with the factory setting (8 kHz). Increasing the switching frequency can be useful to improve the control dynamism. However, it may under some circumstances result in a temperature-related loss of power. Switching frequency noises will decrease with increasing switching frequency (audible range < 12 kHz).

For an overview of the currents and overload times dependent on the switching frequency, refer to the Operation Manual (see Section "Applicable documentation" on page 13).



NOTE

- Calculate the I^2t shut-down:
 $\text{max. } I^2t \text{ value} \rightarrow (I_{\text{max}}^2 - I_{\text{n}}^2) \cdot \text{overload time (in s)} = \text{max. value [A}^2\text{s]}$
 $\text{max. overload (in s)} = \text{max. value [A}^2\text{s]} / (I_{\text{mot}}^2 - I_{\text{n}}^2)$

4.1.3 Online derating of switching frequency

When **P 752[0] - MON_PWM_SwitchFreqSelect_Sel** = "AUTO(1)", the switching frequency is switched in dependence on the current load conditions. If there is a high load, the operating switching frequency from parameter **P 302 - CON_SwitchFreq** is reduced stepwise and when the load is lower, it is subsequently raised once again via the same steps. Within this context, the system automatically switches to the next lower or higher possible switching frequency. The individual switching frequencies between which automatic switching to a lower or back to a higher frequency is possible depends on the device (!) and on the currently selected operating switching frequency from parameter **P 302 - CON_SwitchFreq**. The switching frequency can be reduced by a maximum of 2 "steps".

In other words, there are the following 3 levels for the switching frequency:

Step0: No reduction of the switching frequency (the operating switching frequency from **P 302** is used).

Step1: 1st reduction step for the switching frequency

Step2: 2nd reduction step for the switching frequency

Via the setting **P 752[0] - MON_PWM_SwitchFreqSelect_Sel**= "MAN(2)" the switching frequency can be reduced "externally" online by one or two levels using the parameter **P 758 - CON_SwitchFreq_selMan** (value 0: no reduction). This reduction is "manual" and is directly controlled online; in this case, the controller does not automatically reduce the value.

4.1.4 Parameters

ID	Index	Name / Setting	Unit	Description
302	0	CON_SwitchFreq		Power stage switching frequency
		2 kHz - 16 kHz (2 kHz only for BG7)		It is advisable to operate the servo controller with the default setting. Increasing the switching frequency can be useful to improve the control dynamism. Temperature-related derating may occur. Switching frequency noise decreases as the switching frequency rises (audible range < 12 kHz).
309	0	CON_EnableWiretest		Enable wire test
409	0	CON_ACT_VDC_TF	ms	Filter time constant for DC link voltage
752	0	MON_PWM_SwitchFreqSelect_Sel		Switching frequency mode selector
		OFF (0)		No function
		AUTO (1)		Automatic switchover
		MAN(2)		Manual switchover limited by P 758[0]
758	0	CON_SwitchFreq_selMan		Manually configurable power stage switching frequency
		(0)2 kHz		2 kHz
		(1)4 kHz		4 kHz
759	0	CON_UnderVoltageThreshold	V	Overwrite default under voltage threshold level
760		MON_VDC_Guard		Monitoring of DC link voltage
760	0	Tfilt_av	ms	Filter time constant for average
760	1	Tfilt_var	ms	Filter time constant for variance
760	2	Max_var	V ²	Max allowed variance
760	3	Max_time	s	Max time with variance threshold exceeded
760	4	Check_time	s	Interval to check return of failed phase
1958	0	CON_FPGA_PWMScale	%	Phase voltage scaling of the fpga current controller (0 = no block modulation)

Table 4.1: "Power stage" parameters

ID	Index	Name / Setting	Unit	Description
307	0	CON_VoltageSupply		Power supply mains voltage
		(-1)1 / 3x 110 V		The device can be connected to the mains with one or three phases.
		(0)1x 230 V		Single-phase device

Table 4.2: "Power stage - AC servo controller" parameters

ID	Index	Name / Setting	Unit	Description
		(1)3x 230 V		Three-phase device
		(2)3x 400 V		Three-phase device
		(3)3x 460 V		Three-phase device
		(4)3x480 V		Three-phase device
425	0	CON_GridVoltageNom	V r.m.s	Mains voltage

Table 4.2: "Power stage - AC servo controller" parameters (continue)

ID	Index	Name / Setting	Unit	Description
307	0	CON_VoltageSupply		Power supply mains voltage
		(5)Safety low voltage 24-60 V		
424	0	CON_VoltageMode		Device power supply mode
425	0	CON_GridVoltageNom	V r.m.s	Mains voltage
426	0	CON_DCLinkVoltageNom	V	DC link voltage (DC low voltage)

Table 4.3: "Power stage - DC drives" parameters

ID	Index	Name	Unit	Description
308	0	CON_VoltageNom	V	Nominal voltage (DC low voltage)

Table 4.4: "Power stage - Low-voltage DC supply" parameters

ID	Index	Name	Unit	Description
425	0	CON_GridVoltageNom	V r.m.s	Mains voltage
2704	0	CON_WideRange		Used to activate the wide voltage range – please contact the manufacturer!

Table 4.5: "Power stage - Mains voltage adaption" parameters

ID	Index	Name	Unit	Description
2940	0	CON_PowerFail_Sel		Power failure bridging: selector
2941		CON_POWF_VCtrl		Power failure bridging
2941	0	Kr	A/V	Power failure bridging: Gain
2941	1	Tn	ms	Voltage control integration time constant
2941	2	imax	A	Voltage control maximum (negative) q-current
2941	3	imax_pos	A	Voltage control maximum q-current
2941	4	n_min	rpm	Minimum speed (abs value) for voltage control
2942		CON_POWF_VLim		Voltage threshold/reference for power fail
2942	0	POWF_VOn	V	Threshold voltage (offset) to start power fail control
2942	1	POWF_VRef	V	Reference voltage (offset) at power fail
2943	0	CON_POWF_RetTime	ms	uzk return time (65535 = infinite)
2944	0	CON_POWF_UdcOffSw	V	Shutdown threshold: Undervoltage
2945	0	CON_POWF_UbcOnSw	V	Switch-on threshold: Braking chopper

Table 4.6: "Power stage - Power failure bridging settings" parameters

**NOTE**

Braking chopper threshold:

- The braking chopper threshold can be reduced using **P 2947 CON_POWF_UbcOnSWLimit**. (-20% possible from power stage data). Care must be taken when setting the mains voltage so that there are no overlaps. The state of the chopper can be checked using the digital output (54) BC_State or using the scope parameter **P 63 Brake Chopper state**.

4.2 Power failure bridging

4.2.1 Detection of a voltage failure

The mains failure support feature detects a failure of at least two phases of the mains supply. If no countermeasures are taken, this failure will cause a drop in the DC link voltage and thus lead to the device being switched off.

In the event of a power failure, the DC link voltage can be supported by using the motor's rotational energy. To this end, the motor will be operated as a generator and decelerated in a controlled manner in the event of a power failure so that a configurable DC link voltage setpoint will be maintained. This function is especially useful when it comes to powering the electronics in drives with magnetic bearings, as this will prevent the assembly from crashing into the safety bearing in the event of a power failure all the way to the lowest possible speeds.

**NOTE**

- Please note that the components which need bridging must be powered via the DC link (DC power supply). In particular, the power supply of the servo controller itself (24 V control voltage) must be ensured.

Selector	SRLWR(1) = Speed reduction as long as possible with restart		
Gain	0.25	A/V	
Integration time constant	15	ms	
Threshold to start powerfail	425.007 V...	+	40 V
Reference voltage at powerfail	425.007 V...	+	20 V
Return time	3000	ms	

Fig. 4.2: Power failure bridging settings screen

4.2.1.1 Functional description

The **P 2940 - CON_PowerFail_Sel** selection parameter can be used to select the following operating modes:

0= (OFF) switched off

1= (Ret) Power failure bridging with power return detection. The system will start up again if the power returns within a configurable period of time.

2= (NoRet) Power failure bridging with power return detection. The system will not start up again.

3= (NoLim) Fastest possible speed reduction without power return detection.

5= (RetAbs) Same as 1=Ret, but with absolute voltage levels and without validation check.

6= (NotRetAbs) Same as 2=NoRet, but with absolute voltage levels and without validation check.

7= (NoRetAbsPulse) Same as 6=NoRetAbs, but with pulse operation.

4.2.1.2 Parametrisation

P 2941 - CON_POWF_VCtrl is used to configure the voltage controller by adjusting the corresponding gain and reset time. Within this context, the specified gain refers to the motor's rated speed. At lower speeds, the gain will be automatically increased in order to maintain a constant dynamic performance in the voltage control circuit.

P 2942 - CON_POWF_VLim is used to configure the threshold voltage for detecting power failures / power returns, as well as the voltage setpoint for the controller. The configured voltage values will not be absolute values, but will instead be added to specific DC link threshold values (based on the operating mode). The corresponding

details are described in the description for each individual mode. The controller will ensure that the configured voltage setpoint is not fallen below as a result of motor deceleration. If, however, the instantaneous DC link voltage becomes higher than the setpoint (e.g. due to the power returning), there will be no control intervention, i.e. the motor will not be accelerated regardless.

4.2.1.3 Modes

Mode 1

Power failure bridging with power return detection. The system will start up again if the power returns within a configurable period of time.

The power failure detection limit is formed by adding together **P 701[12] - u_zkoff** (Software shut-off limit for detection of DC link undervoltage) and **P 2942[0] - POWF_Von**. It should be considerably higher than the shutdown limit (default setting = 40 V).

Likewise, the voltage setpoint is yielded by adding **P 701[12] - u_zkoff** and **P 2942[1] - POWF_VRef**. The voltage setpoint must be lower than the detection limit so that it will be possible to detect when the power returns. Moreover, it should be considerably higher than the shutdown limit (default setting = 20 V).

After a power failure is detected, the controller will control the voltage so that it reaches the configured setpoint. If a power return is detected within the time period set in **P 2943[0] - CON_POWF_RetTime**, the drive will return to its original control state. If power returns after the aforementioned time period has already elapsed, error 34-1 will be triggered. If **P 2943[0] - CON_POWF_RetTime** is set to 65535, there will be no time limit for the drive to return to its original control state after power returns.

If the power does not return, the drive will theoretically decelerate all the way to a stop. Within this context, there will be a specific speed below which it will not be possible to maintain the DC link voltage any longer even with the maximum motor (brake) current. This will result in an undervoltage shutdown.

Mode 2

Power failure bridging with power return detection. The system will not start up again.

Same as mode 1, except the system will not start up again if the power returns. Error 34-1 will always be triggered once the power returns.

Mode 3

Fastest possible speed reduction without power return detection.

In terms of configuring the power failure detection limits, the requirements listed for mode 1 apply here as well. The voltage setpoint is yielded by adding **P 701[17] - u_{bc_on}** (braking chopper threshold) and **P 2942[1] - POWF_VRef**. After a power failure is detected, the controller will control the voltage so that it reaches the configured setpoint. This setpoint will be considerably higher than the power failure detection limit, which will technically ensure that it will not be possible to detect the return of power. This mode is characterized by the fact that the DC link voltage is typically raised all the way over the braking chopper threshold, resulting in the braking energy being converted into braking resistance. Accordingly, the drive will decelerate as quickly as possible.

Mode 4

Only with expanded VFC functionality.

Mode 5

Same as mode 1, but with absolute voltage levels and without a validation check.

P 2942[0] - POWF_VOn is used to define the power failure detection limit. **P 2942[1] - POWF_VRef** is used to define the voltage setpoint. The configured values will not be checked to see if they are valid. The user themselves will be responsible for ensuring that the values entered make sense.

Mode 6

Same as mode 2, but with absolute voltage levels and without a validation check.

P 2942[0] - POWF_VOn is used to define the power failure detection limit. **P 2942[1] - POWF_VRef** is used to define the voltage setpoint. The configured values will not be checked to see if they are valid. The user themselves will be responsible for ensuring that the values entered make sense.

Mode 7

Same as mode 6, but with pulse operation.

P 2942[0] - POWF_VOn is used to define the power failure detection limit. **P 2942[1] - POWF_VRef** is used to define the voltage setpoint. The configured values will not be checked to see if they are valid. The user themselves will be responsible for ensuring that the values entered make sense.

4.2.1.4 Parameters

P No.	Index	Name / Setting	Unit	Function
2940	0	CON_PowerFail		Power failure bridging: selector
		Off (0)		Function disabled
		RET(1)		Function enabled. Return of power allowed if it occurs within defined time; otherwise, trigger error upon return
		NORET(2)		Function enabled. Return of power not allowed - > Trigger error upon return.
		NOLIM(3)		Function enabled. Return of power cannot be detected.
		RETAGS(5)		Same as "RET(1)", bit with absolute voltages and without validation checks.
		NORETAGS(6)		Same as "NORET(2)", bit with absolute voltages and without validation checks.
		NORETAGSPULSE(7)		Same as "NORETAGS(6)", but with pulse operation.
2941		CON_POWF_VCtrl		Power failure bridging
	0	Kr	A/V	Power failure bridging: Gain
	1	Tn	ms	Power failure bridging: Reset time
	2	imax	A	Power failure bridging: Maximum (negative) q current
	3	imax_pos	A	Power failure bridging: Maximum q current
	4	n_min	rpm	Power failure bridging: Minimum speed for voltage controller
2942		CON_POWF_VLim		Voltage limit for power failure
	0	POWF_Von	V	Power failure detection limit
	1	POWF_VRef	V	Voltage reference value
2943	0	CON_POWF_RetTime	ms	Setting of time window in which mains power can be restored
701		MON_ActValues		
	12	u_zkoff	VDC	UZK undervoltage threshold
	17	u_bc_on	VDC	Braking chopper threshold

Table 4.7: "Power failure bridging" parameters

4.2.2 Monitoring for single-phase failure

P No.	Index	Name / Setting	Unit	Function
701	28	VDC_Variance	V^2	DC voltage variance
737		MON_MNCTL		Monitoring control and status word
737	0	MON_MNCTL		Monitoring control word
737	1	MON_MNSTAT		Monitoring status word
760		MON_VDC_Guard		Monitoring of DC link voltage
	0	Tfilt_av	ms	Filter time constant for average
	1	Tfilt_var	ms	Filter time constant for variance
	2	Max_var	V^2	Max allowed variance
	3	Max_time	s	Max time with variance threshold exceeded
	4	Check_time	s	Interval to check return of failed phase

Table 4.8: Parameter - Single-phase failure of the device power supply

In the event of a single-phase failure of the device supply, e.g. a burned-out non-renewable fuse, the DC link voltage is maintained and the device continues to operate for the time being. However, the input rectifier can be damaged at a high output power.

The single-phase power failure detection is set with **P 737[0] MON_MNCTL - bit 3 = 1**.

The quadratic ripple (variance) of the DC link voltage is calculated. If it exceeds the threshold value **P 760[2]-MON_VDC_Guard - MaxVar** for the time **P 760[3]-MON_VDC_Guard - Max_time**, the monitoring is triggered.

The actual value is shown in **P 701[28] - VDC Variance**. Measure this value at maximum output power and proper operation, then use about 5-10 times that as the monitoring threshold.

The monitoring triggers error 54-1 (Emergency code 6100h). See chapter 11.6 Error list.

If the parameter is **P 737[0] MON_MNCTL, bit 4 = 1**, the PowerFail state of the control is initiated. This must therefore be configured. See chapter 4.2.1 Detection of a voltage failure. In this case, the error reaction should be set to "Ignore".

5 Motor

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Motor

Brief description

The following chapter describes the steps used to calculate parameters for, identify, and configure motors, as well as their protection mechanisms and brake.

Contents

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5.4 Asynchronous motor	40
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5.7 Support for motor filters when using PMSM motors	49

5.1 Motor configuration data

Motor data and control settings

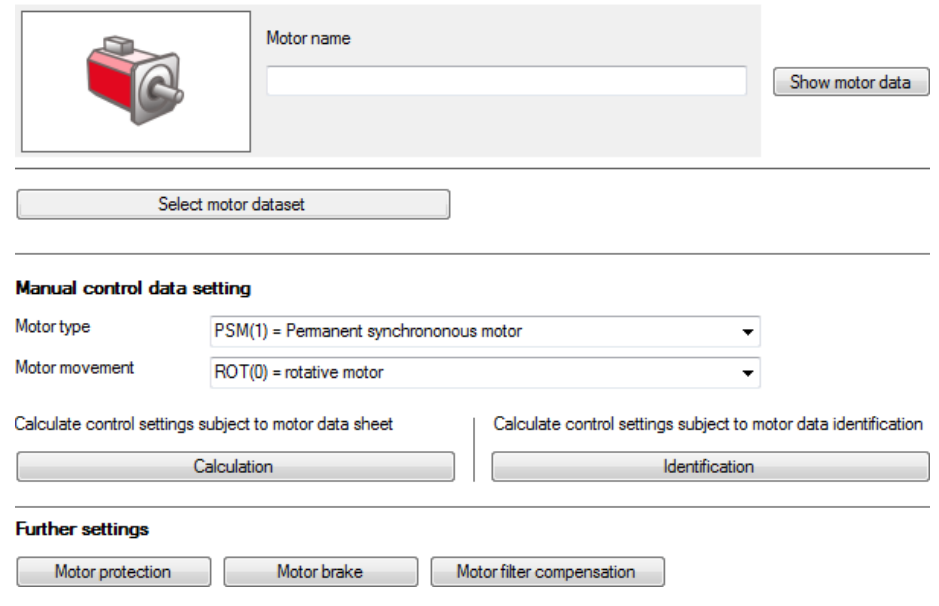
The screenshot shows the "Motor data and control settings" interface. It includes a motor icon, a "Motor name" input field, and a "Show motor data" button. Below this is a "Select motor dataset" button. The "Manual control data setting" section contains dropdown menus for "Motor type" (set to "PSM(1) = Permanent synchronous motor") and "Motor movement" (set to "ROT(0) = rotative motor"). There are two buttons: "Calculation" and "Identification". The "Further settings" section at the bottom has three buttons: "Motor protection", "Motor brake", and "Motor filter compensation".

Fig. 5.1: "Motor data and control settings" screen

Each motor can only be operated if its field model and the control parameters are correctly set. Using the standard motors and encoders from the Moog motors catalogue, a system can be commissioned and put into operation very quickly and easily. Third-party motors can of course be used as well. As the field models of those motors are not known, the motor must be identified by type or calculated. The selection is made with the preceding "Motor data and control settings" screen.

Loading a motor data set

- Motor data and control settings screen
- Select data set
- Enter encoder settings
- Save data

Commissioning a third-party motor

In the case of third-party motors, basic suitability for operation with Servo Drives from Moog must first be verified on the basis of the motor data and the data of any installed encoder. The values of the parameters for adaptation of the Servo Drive must be determined specifically for each motor by calculation or identification. The two methods differ in that when the motor data set is calculated, the impedances must be taken from the data sheet. The impedances are measured automatically during identification. Each motor can only be operated if its field model and the control parameters are correctly set.

On transfer of a standard motor data set the motor name, electrical data and motion mode are loaded. Preset parameters are overwritten. The motor data must then be saved in the device. The motor parameters specified by the manufacturer ensure that a motor can be subjected to load according to its operational characteristic, provided the corresponding power is supplied by the controller.



NOTE

- Each motor can only be operated if its field model and the control parameters are correctly set.

5.2 Synchronous motor

Calculation of control settings for PS motor

Motor name



Rating plate data

Rated voltage V

Rated current A

Rated speed rpm

Rated frequency Hz

☒ Rated frequency Hz **OR** ☐ Pole pairs [Info ...](#)

☒ Rated torque Nm **OR** ☐ Rated power kW [Info ...](#)

Inertia

Motor inertia kg m²

Total inertia kg m² [Info ...](#)

Motor impedances

Stator resistance Ohm

Stator inductance mH [Info ...](#)

[Start calculation](#)

[Show motor parameters](#)

Fig. 5.2: "Synchronous motor settings" screen

There are two ways to create a motor data set for the rotary synchronous motor.

- Variant 1: Motor calculation
- Variant 2: Motor identification (see Section "Motor identification" on page 47)

Variant 1: Motor calculation

- Enter the motor data
The motor data relevant to the calculation must be entered manually from the data sheet.
- Click on “Start calculation”.
- If the moment of inertia of the motor **P 461 - Mot_J** is not known, a value roughly corresponding to the motor's moment of inertia must be applied.
- The calculation process can be monitored in the Moog DRIVEADMINISTRATOR 5 via the menu, View, Messages.
- Calculation of operating point: Flux **P 462 - MOT_FLUXNom**
- Calculation of: current, speed and position control parameters

NOTE



- All existing motor parameters are overwritten.

Calculated values

- Flux settings (including for torque constant)
- Control settings for current controller: the current controller is dimensioned based on the actual switching frequency set.
- Speed controller and position controller gain: here a moderately stiff mechanism and mass inertia matching from load to motor with a ratio of 1:1 is to be assumed.
- V/F characteristic

NOTE



- All existing control parameters are overwritten.

ID	Index	Name	Unit	Description
451	0	MOT_Name		Name of motor parameter set
455	0	MOT_FNom	Hz	Motor rated frequency
456	0	MOT_VNom	V	Motor rated voltage
457	0	MOT_CNom	A	Motor rated current
458	0	MOT_SNom	rpm	Motor rated speed
459	0	MOT_PNom	kW	Motor rated power
460	0	MOT_TNom	Nm	Motor rated torque
461	0	MOT_J	kg m²	Motor inertia
1530	0	SCD_SetMotorControl		Determination of default control settings

Table 5.1: “Synchronous motor” parameters

5.2.1 Synchronous motor electronic data

PS motor electrical parameters

Motor name



Pole pairs

Rated flux

Vs

Motor impedances

Stator resistance

Ohm

Stator inductance

mH

Nonlinear stator inductance due to saturation of the motor

100 %		0 %
100 %	Stator inductance	100 %
100 %	of 1 mH at	200 %
100 %		300 %
		Rated current
		of 0.5 A

Motor torque as function of q-axis current:

0 Nm		0 A
0 Nm		0 A
0 Nm	at	0 A
0 Nm		0 A
0 Nm		0 A

(All electrical values must be entered as phase values.)

ID	Index	Name	Unit	Description
462	0	MOT_FluxNom	Vs	Motor rated flux linkage
463	0	MOT_PolePairs		Motor number of pole pairs
470	0	MOT_Rstat	Ohm	Motor stator resistance
471	0	MOT_Lsig	mH	Motor leakage inductance (ASM) / stator inductance (PSM)
472		MOT_LsigDiff		q-axis stator inductance variation (relative to MOT_Lsig)
472	0	Lsig_q@I0	%	Inductance @ Current I0
472	1	Lsig_q@I1	%	Inductance @ Current I1
472	2	Lsig_q@I2	%	Inductance @ Current I2
472	3	Lsig_q@I3	%	Inductance @ Current I3
472	4	CurrentI0	%	Current I0 relative to MOT_CNom
472	5	CurrentI1	%	Current I1 relative to MOT_CNom
472	6	CurrentI2	%	Current I2 relative to MOT_CNom
472	7	CurrentI3	%	Current I3 relative to MOT_CNom
479		MOT_TorqueSat		Inductor saturation: Motor torque as function of q-axis current (saturation)
479	0	Torque@I0	Nm	Torque @ current I0
479	1	Torque@I1	Nm	Torque @ current I1
479	2	Torque@I2	Nm	Torque @ current I2
479	3	Torque@I3	Nm	Torque @ current I3
479	4	Torque@IMax	Nm	Torque @ current I4
479	5	CurrentI0	A	Current I0
479	6	CurrentI1	A	Current I1
479	7	CurrentI2	A	Current I2
479	8	CurrentI3	A	Current I3
479	9	CurrentIMax	A	Current I4
480	0	MOT_Lsq	mH	Motor stator q-inductance (0=>Lq=MOT_Lsig*MOT_LsigDiff)

Table 5.2: "Synchronous motor electronic data" parameters

Fig. 5.3: "Synchronous motor electronic data" screen

5.3 Linear synchronous motor

Calculation of control settings for linear PS motor

Motor name

Rating plate data

Rated voltage	400 V	Rated current	0.5 A
Maximum speed	2 m/s	Magnet pitch (NN)	20 mm
Rated force	100 N		

Weight

Motor weight (coil)	10 kg	Total weight	10 kg	Info ...
---------------------	------------------------------------	--------------	------------------------------------	--------------------------

Motor impedances

Stator resistance	1 Ohm	Stator inductance	1 mH	Info ...
-------------------	------------------------------------	-------------------	-----------------------------------	--------------------------

Encoder

Encoder period	20 µm
----------------	------------------------------------

[Start calculation](#) [Show motor parameters](#)

Fig. 5.4: "Linear synchronous motor settings" screen

There are two methods of creating a motor data set for the linear synchronous motor.

- Variant 1: Motor calculation
- Variant 2: Motor identification (see Section "Motor identification" on page 47)

Variant 1: Motor calculation

- Enter the motor data
The motor data relevant to the calculation must be entered from the data sheet.
- Click on "Start calculation".
- If the moment of inertia of the motor **P 461 - Mot_J** is not known, a value roughly corresponding to the motor's moment of inertia must be applied.

- The calculation process can be monitored in the Moog DRIVEADMINISTRATOR 5 via the menu, View, Messages.
- Calculation of operating point: Flux **P 462 - MOT_FLUXNom**
- Calculation of: current, speed and position control parameters



NOTE

- **P 490 - MOT_ISLinRot = LIN(1)**: The parameter automatically sets the number of pole pairs for the motor to **P 463 - Mot_PolePairs = 1**. As a result, a North to North pole pitch corresponds to one virtual revolution (**P 492 - Mot_MagnetPitch**).



NOTE

- All existing motor parameters are overwritten.

Calculated values

- Translation of the linear nominal quantities into virtual rotary nominal quantities
- Default values for auto commutation
- Encoder lines per virtual revolution
- Flux settings (including for torque constant)
- Control settings for PI current controller: the current controller is dimensioned based on the actual switching frequency set.
- PI speed controller and position controller gain: A moderately rigid mechanism and moment of inertia matching from load to motor with a ratio of 1:1 is assumed here.
- The default value for speed tracking error monitoring corresponds to 50% of the nominal speed.
- V/F characteristic

ID	Index	Name	Unit	Description
451	0	MOT_Name		Name of motor parameter set
457	0	MOT_CNom	A	Motor rated current
491	0	MOT_CalcLin2Rot		Calculate from linear to rotary motor data
492	0	MOT_MagnetPitch	mm	Width of one motor pole pair
493	0	MOT_SpeedMax	m/s	Motor rated speed
494	0	MOT_ForceNom	N	Motor rated force
496	0	MOT_MassMotor	kg	Mass of motor slide
497	0	MOT_MassSum	kg	Total mass, moved by the motor
498	0	MOT_EncoderPeriod	um	Period of line signals

Table 5.3: "Linear synchronous motor" parameters

5.3.1 Linear synchronous motor electronic data

PS linear motor electrical parameters

Motor name

Rated flux Vs

Motor impedances

Stator resistance OhmStator inductance mH

Nonlinear stator inductance due to saturation of the motor

100 %		0 %
100 %	Stator inductance	100 %
100 %	of 1 mH at	200 %
100 %		300 %
		Rated current
		of 0.5 A

Motor torque as function of q-axis current:

0 Nm		0 A
0 Nm		0 A
0 Nm	at	0 A
0 Nm		0 A
0 Nm		0 A

(All electrical values must be entered as phase values.)

Fig. 5.5: "Linear synchronous motor electronic data" screen

ID	Index	Name	Unit	Description
462	0	MOT_FluxNom	Vs	Motor rated flux linkage
470	0	MOT_Rstat	Ohm	Motor stator resistance
471	0	MOT_Lsig	mH	Motor leakage inductance (ASM) / stator inductance (PSM)
472		MOT_LsigDiff		q-axis stator inductance variation (relative to MOT_Lsig)
472	0	Lsig_q@I0	%	Inductance @ CurrentI0
472	1	Lsig_q@I1	%	Inductance @ CurrentI1
472	2	Lsig_q@I2	%	Inductance @ CurrentI2
472	3	Lsig_q@I3	%	Inductance @ CurrentI3
472	4	CurrentI0	%	Current I0 relative to MOT_CNom
472	5	CurrentI1	%	Current I1 relative to MOT_CNom
472	6	CurrentI2	%	Current I2 relative to MOT_CNom
472	7	CurrentI3	%	Current I3 relative to MOT_CNom
479		MOT_TorqueSat		Inductor saturation: Motor torque as function of q-axis current (saturation)
479	0	Torque@I0	Nm	Torque @ current I0
479	1	Torque@I1	Nm	Torque @ current I1
479	2	Torque@I2	Nm	Torque @ current I2
479	3	Torque@I3	Nm	Torque @ current I3
479	4	Torque@IMax	Nm	Torque @ current I4
479	5	CurrentI0	A	Current I0
479	6	CurrentI1	A	Current I1
479	7	CurrentI2	A	Current I2
479	8	CurrentI3	A	Current I3
479	9	CurrentIMax	A	Current I4

Table 5.4: "Linear synchronous motor electronic data" parameters

5.4 Asynchronous motor

Calculation of control settings for AS motor



Motor name

Name plate data

Rated voltage V Rated current A

Rated speed rpm Rated frequency Hz

☒ Rated frequency Hz OR ☐ Pole pairs [Info ...](#)

☒ Rated torque Nm OR ☐ Rated power kW [Info ...](#)

Inertia

Motor inertia kg m² Total inertia kg m² [Info ...](#)

Motor impedances

Stator resistance Ohm Leakage inductance mH [Info ...](#)

Rotor resistance Ohm X 100%

[Start calculation](#) [Show motor parameters](#)

Fig. 5.6: "Asynchronous motor configuration" screen

There are two methods of creating a motor data set for the asynchronous motor.

- Variant 1: Motor calculation
- Variant 2: Motor identification (For details see Section "Motor identification" on page 47)

Variant 1: Motor calculation

- Enter the motor data
The motor data relevant to the calculation must be entered from the data sheet.
- Click on “Start calculation”.
- If the moment of inertia of the motor **P 461 - Mot_J** is not known, a value roughly corresponding to the motor's moment of inertia must be applied.
- The calculation process can be monitored in the Moog DRIVEADMINISTRATOR 5 via the menu, View, Messages.
- Calculation of operating point: Flux **P 462 - MOT_FluxNom**, **P 340 - CON_FM_Imag**.
- Calculation of: current, speed and position control parameters

NOTE



- All existing motor parameters are overwritten.

Calculated values

- Flux settings (including for torque constant)
- Control settings for current controller:
The current controller is dimensioned dependent on the switching frequency setting.
- Speed controller and position controller gain:
In this, a moderately rigid mechanism and a 1:1 moment of inertia adjustment from the load to the motor are to be assumed.
- V/F characteristic

ID	Index	Name	Unit	Description
451	0	MOT_Name		Name of motor parameter set
452	0	MOT_CosPhi		Motor rated power factor
455	0	MOT_FNom	Hz	Motor rated frequency
456	0	MOT_VNom	V	Motor rated voltage
457	0	MOT_CNom	A	Motor rated current
458	0	MOT_SNom	rpm	Motor rated speed
459	0	MOT_PNom	kW	Motor rated power
460	0	MOT_TNom	Nm	Motor rated torque
461	0	MOT_J	kg m*m	Motor inertia
1530	0	SCD_SetMotorControl		Determination of default control settings

Table 5.5: “Asynchronous motor configuration” parameters

5.4.1 Asynchronous motor electrical data

AS motor electrical parameters

Motor name



Pole pairs

Rated flux

 Vs

Motor impedances

Stator resistance

 Ohm

Leakage inductance

 mH

Rotor resistance

 Ohm

X %
100%

Magnetizing characteristic

Magnetizing current

 A

Main inductance
scaling factor

 %

Rated main inductance 100 mH

Info ...

(All electrical values must be entered as phase values.)

Fig. 5.7: “Asynchronous motor electrical data” screen

ID	Index	Name	Unit	Description
340	0	CON_FM_Imag	A	Magnetizing current (RMS)
462	0	MOT_FluxNom	Vs	Motor rated flux linkage
463	0	MOT_PolePairs		Motor number of pole pairs
470	0	MOT_Rstat	Ohm	Motor stator resistance
471	0	MOT_Lsig	mH	Motor leakage inductance (ASM) / stator inductance (PSM)
472		MOT_LsigDiff		q-axis stator inductance variation (relative to MOT_Lsig)
472	0	Lsig_q@I0	%	Inductance @ CurrentI0
472	1	Lsig_q@I1	%	Inductance @ CurrentI1
472	2	Lsig_q@I2	%	Inductance @ CurrentI2
472	3	Lsig_q@I3	%	Inductance @ CurrentI3
472	4	CurrentI0	%	Current I0 relative to MOT_CNom
472	5	CurrentI1	%	Current I1 relative to MOT_CNom
472	6	CurrentI2	%	Current I2 relative to MOT_CNom
472	7	CurrentI3	%	Current I3 relative to MOT_CNom
473		MOT_LmagTab		Main inductance as a function of isd (0.1*index*LmagIdMax)
473	0	MOT_LmagTab	mH	
473	1	MOT_LmagTab	mH	
473	2	MOT_LmagTab	mH	
473	3	MOT_LmagTab	mH	
473	4	MOT_LmagTab	mH	
473	5	MOT_LmagTab	mH	
473	6	MOT_LmagTab	mH	
473	7	MOT_LmagTab	mH	
473	8	MOT_LmagTab	mH	
473	9	MOT_LmagTab	mH	
473	10	MOT_LmagTab	mH	
474	0	MOT_LmagIdMax	A	Maximum magnetizing current (RMS)
475	0	MOT_LmagScale	%	Motor main inductance, scaling factor
476	0	MOT_Rrot	Ohm	Motor rotor resistance
477	0	MOT_RrotScale	%	Motor rotor resistance, scaling factor
478	0	MOT_LmagNom	mH	Main inductance at nominal magnetizing current

Table 5.6: "Asynchronous motor electrical data" parameters

5.5 Motor protection

5.5.1 Temperature sensors

The device can evaluate different temperature sensors. With **P 732 - MON_MotorPTC** the sensor fitted in the motor and the wiring variant are set (sensor cable routed in resolver or separate). In an evaluation via KTY, the shut-off threshold of the motor temperature can additionally be set.

- KTY(84)-130
- PTC(2) = PTC sensor with short-circuit monitoring
- TSS(3) = Klixon
- PTC(4) = PTC sensor without short-circuit monitoring
- NTC 220 = 220 kohm NTC sensor (MSD Single-Axis Servo Drive Compact and MSD Servo Drive Safety require an NTC adapter). **Please be aware of the type!**
- NTC 1000 = NTC sensor 1000 kOhm (on request)
- NTC 227 = NTC sensor 227 kOhm (on request)

Temperature monitoring:

Temperature monitoring connected via:

Type:

Fig. 5.8: "Temperature monitoring" screen

P No.	Index	P Name / Setting	Unit	Function
731		MON_MotorTempMax		Maximum motor temperature (switch-off value)
	0	TempMax X5	degC	Maximum sensor temperature X5
	1	TempMax X6	degC	Maximum sensor temperature X6
732		MON_MotorPTC		Selection of sensor type
	0	Type		
		Off (0)		No motor temperature sensor
		KTY (1)		KTY84-130 Sensor
		PTC (2)		PTC sensor (three) with short circuit monitoring below 50 ohms or hardware detection
		TSS (3)		Switch (Klixon)
		PTC1 (4)		PTC sensor (one) without short circuit monitoring
		PT100 (5)		PTC100 in line with DIN EN 60751
		NTC220 (6)		NTC Sensor 220 kOhm ¹⁾
		NTC1000 (7)		NTC Sensor 1000 kOhm
		NTC_K227 (8)		NTC Sensor K227 32 kOhm
		KTY83-110 (9)		KTY83-110 Sensor
		NTC50 (10)		NTC sensor 50 kOhm
		NTC10 (11)		NTC Sensor 10 kOhm
		PTC2 (12)		PTC sensor (simple) with short circuit monitoring under 5 ohms
		PT1000 (13)		PT1000 Sensor
2)		PT1000-2 (14)		PT1000-2 sensor, Rx value via internal table with measurement values (from the application)
		PT1000-3 (15)		Rx values over calculated values (from circuit diagram) (no table)
		NTC220 (16)		NTC Sensor 220 kOhm type 2381 640 (interpolation points)
		NTC220 (17)		NTC Sensor 220 kOhm type 2381 640 (using formula)
	1	Contact		Termination variant
		X5(0)		Connection of the sensor to terminal X5
		X6/7(1)		Sensor connection is routed in encoder cable
		X5_X6/7(2)		Use of both inputs possible

Table 5.7: "Temperature monitoring" parameters

P No.	Index	P Name / Setting	Unit	Function
		X8(3)		X8 connector temperature sensor (tech opt module)
		X5_X8(4)		X5 and X8 connector temperature sensor (tech opt module)
	2	Type extended		
		Off (0)		No motor temperature sensor
		KTY (1)		KTY84-130 Sensor
		PTC (2)		PTC sensor (three) with short circuit monitoring below 50 ohms or hardware detection
		TSS (3)		Switch (Klixon)
		PTC1 (4)		PTC sensor (one) without short circuit monitoring
		PT100 (5)		PTC100 in line with DIN EN 60751
1)		NTC220 (6)		NTC Sensor 220 kOhm ¹⁾
1)		NTC1000 (7)		NTC Sensor 1000 kOhm
		NTC_K227 (8)		NTC Sensor K227 32 kOhm
		KTY83-110 (9)		KTY83-110 Sensor
		NTC50 (10)		NTC sensor 50 kOhm
		NTC10 (11)		NTC Sensor 10 kOhm
		PTC2 (12)		PTC sensor (simple) with short circuit monitoring under 5 ohms
		PT1000 (13)		PT1000 Sensor
2)		PT1000-2 (14)		PT1000-2 sensor, Rx value via internal table with measurement values (from the application)
		PT1000-3 (15)		Rx values over calculated values (from circuit diagram) (no table)
		NTC220 (16)		NTC Sensor 220 kOhm type 2381 640 (interpolation points)
		NTC220 (17)		NTC Sensor 220 kOhm type 2381 640 (using formula)
733		MON_MotorI2t		I ² t characteristic setting
	0	INom	%	Rated current of the motor
	1	I0	%	First current interpolation point of motor protection characteristic: Maximum permissible standstill current

P No.	Index	P Name / Setting	Unit	Function
	2	I1	%	Second current interpolation point of the motor protection characteristic referenced to the maximum characteristic current
	3	F1	Hz	First frequency interpolation point of motor protection characteristic
	4	FNom	Hz	Rated frequency
	5	IMax	%	Maximum overload current referenced to rated motor current
	6	Time	s	Time for which the maximum current may be connected
	7	Ttherm	s	Set thermal time constant in seconds
735	0	MON_MotorI2tType		Motor protection module. Selection of I2T monitoring method
		Off(-1)		Protection disabled
		FREQU(0)		Motor frequency-dependent evaluation i(f), default setting
		THERM(1)		Evaluation with thermal time constant i_{Tth} . The thermal time constant is set via parameter P 733[7] in [s]. The shut-off threshold based on measurement tolerances is 110% of the nominal value.

Table 5.7: "Temperature monitoring" parameters (continue)

NOTE



- With a MSD Single-Axis Servo Drive Compact the temperature sensor cable can be connected to both X6 and X7.
- ¹⁾ (MSD Single-Axis Servo Drive Compact and MSD Servo Drive Safety require an adapter)
NTC adapter - 220 kOhm available)
- ²⁾ With MSD Single-Axis Servo Drive Compact

The following table provides an overview of the selection options for sensor types with P 732[0] as well as the connection options for the plug-in connectors X5, X6, X7 and X8 (Tech. option) for MSD Servo Drive and MSD Single-Axis Servo Drive Compact.

		MSD Servo Drive		MSD Single-Axis Servo Drive Compact / MSD Servo Drive Safety			
Sensor type	Parameters	Plug-in connector		Plug-in connector			
		X5	X6	X5	X6 (1)	X7 (1)	X8 (4)
KTY	P 732[0] = 1, 9	X	X	—	X		X
PTC	P 732[0] = 2, 4, 12	X	X	X	X		X
TSS	P 732[0] = 3	X	X	X	X		X
NTC	P 732[0] = 6, 7, 8, 10, 11 ²⁾	—	X	—	X		—
PT	P 732[0] = 5 ³⁾ , 13	X	X	—	X		X

1) X6/X7 bridged internally

2) not MSD Single-Axis Servo Drive Compact

3) only MSD Single-Axis Servo Drive Compact

Table 5.8: Temperature sensor connections with plug-in connectors.

5.5.2 I²t monitoring synchronous motor

A synchronous motor by design has lower loss than an asynchronous motor, because permanent magnets replace the magnetizing current. It is normally not internally cooled, but discharges its heat loss by internal convection. For that reason a synchronous motor has a different characteristic to an asynchronous motor. It is necessary to adapt the I²t characteristic because the factory setting mostly does not exactly map the present motor.

I²t monitoring

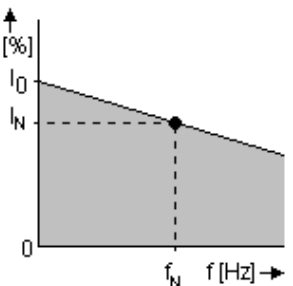
I²t type: FREQ(0) = Output frequency dependant

Permitted continuous current:

Rated motor current (I_N): 100 %

Rated motor frequency (f_N): 50 Hz

1. current interpol. point (I₀): 100 %



Point of switch off:

200 % I_N for 2 s

Thermal time constant: 10 s

Error reactions ... Warning level

Fig. 5.9: "I²T monitoring" screen for a synchronous motor

If the I²t type is set to "THERM(1) = Thermal time constant dependent", all settings apart from the thermal time constant are disabled.

If the integrator exceeds its limit value, the error E-09-01 is triggered. The current value of the integrator is indicated in **P 701[0] - Mon_ActValues**.



NOTE

- The limits are specified in Servo Drive as percentages of the rated quantities (e.g. current, torque, speed,...) of the motor. The defaults relate to 100 % of the rated quantities.

Calculation of capacity utilization via exponential function with thermal time constant of motor:

$$y(t) = \left(1 - e^{-\frac{t}{t_{th}}}\right) * \left(\frac{I_{ist}}{I_{nem}}\right) * 100$$

Setting of I²t type:

- P 735[0]** = "FREQ(0)=Output frequency-dependent": Moog-specific i(f) evaluation
- P 735[0]** = "THERM(1)=Thermal time constant-dependent": Evaluation based on thermal time constant i(T_{th})
- Thermal time constant **P 733[7] - T_{therm}** in [s]
- The shut-off threshold is 110% (reduction in current noise)

5.5.3 Asynchronous motor I²t monitoring

The following diagram shows a typical characteristic setting for an internally cooled asynchronous motor. For third-party motors the motor manufacturer's specifications apply. It is necessary to adapt the I²t characteristic because the factory setting mostly does not exactly map the present motor. For servomotors, it is advisable to set a constant characteristic. The switch-off point defines the permissible current/time area up to switching off **150 % x IN for 120 s**. If the I²t type is set to "THERM(1) = Thermal time constant dependent", all settings apart from the thermal time constant are disabled.

I²t monitoring

I²t type: FREQ(0) = Output frequency dependent

Permitted continuous current:

Rated motor current (I _N)	100 %
Rated motor frequency (f _N)	50 Hz
1. current interpol. point (I ₀)	100 %
2. current interpol. point (I ₁)	100 %
2. frequency interpol. point (F ₁)	25 Hz

Point of switch off:

200 % IN for 2 s

Thermal time constant 10 s

Error reactions ... Warning level

Graph: The graph shows the I²t characteristic curve. The y-axis is labeled [%] and the x-axis is labeled f [Hz]. The curve starts at (0, 10) and rises to a point (I₁, f₁). The area under the curve is shaded. The curve is labeled with I_N and f_N at the end.

Fig. 5.10: "I²T monitoring" screen for an asynchronous motor

If the I²t type is set to "THERM(1) = Thermal time constant dependent", all settings apart from the thermal time constant are disabled.

If the integrator exceeds its limit value, the error E-09-01 is triggered. The current value of the integrator is indicated in **P 701[0] - Mon_ActValues**.



NOTE

- The limits are specified in Servo Drive as percentages of the rated quantities (e.g. current, torque, speed,...) of the motor. The defaults relate to 100 % of the rated quantities.

Calculation of capacity utilization via exponential function with thermal time constant of motor:

$$y(t) = \left(1 - e^{-\frac{t}{t_{th}}}\right) * \left(\frac{I_{ist}}{I_{nem}}\right) * 100$$

Setting of I²t type:

- P 735[0]** = "FREQ(0)=Output frequency-dependent": Moog-specific i(f) evaluation
- P 735[0]** = "THERM(1)=Thermal time constant-dependent": Evaluation based on thermal time constant i(T_{th})
- Thermal time constant **P 733[7] - T_{therm}** in [s]
- The shut-off threshold is 110% (reduction in current noise)

5.6 Motor identification

Calculate control settings subject to motor data identification

Motor name

Name plate data

Rated voltage V Rated current A

Rated speed rpm

☒ Rated frequency Hz **OR** ☐ Pole pairs [Info ...](#)

☒ Rated torque Nm **OR** ☐ Rated power kW [Info ...](#)

Inertia

Motor inertia kg m*m [Info ...](#)

☒ Hold brake applied

[Start identification](#) [Show motor parameters](#)

Fig. 5.11: "Motor identification" screen for a rotary synchronous motor

Calculate control settings subject to motor data identification

Motor name

Rating plate data

Rated voltage V Rated current A

Maximum speed m/s Magnet pitch (NN) mm

Rated force N

Weight

Motor weight (coil) kg Total weight kg [Info ...](#)

Encoder

Encoder period um

[Start identification](#) [Show motor parameters](#)

Fig. 5.12: "Motor identification" screen for a linear synchronous motor

Calculate control settings subject to motor data identification

Motor name

Name plate data

Rated voltage V Rated current A

Rated speed rpm

☒ Rated frequency Hz OR ☐ Pole pairs [Info ...](#)

☒ Rated torque Nm OR ☐ Rated power kW [Info ...](#)

Inertia

Motor inertia kg m² [Info ...](#)

☒ Hold brake applied

[Start identification](#) [Show motor parameters](#)

Calculate motor data from cos(Phi)

cos Phi [Start calculation](#)

Fig. 5.13: "Motor identification" screen for an asynchronous motor

ID	Index	Name	Unit	Description
1531	0	SCD_Action_Sel		Self-commissioning action selection

Table 5.9: "Motor identification" parameters

When the Rating plate data have been entered in the screen, identification is started by clicking the "Start identification" button. A safety notice must be confirmed with a tick (check mark).

5.6.1 Synchronous motor identification (rotary and linear)

- Enter the motor data.
- Click "Identification" button
- Current controller tuning: optimization of the current controller is done automatically.

5.6.2 Asynchronous motor identification

- Current controller tuning
- Measurement of: **P 470[0] - MOT_Rstat**: Stator resistance, **P 476[0] - MOT_Rrot**: Rotor resistance, **P 471[0] - MOT_Lsig**: Leakage inductance
- Maximum effective current **Idmax P 474[0] - MOT_LmagIdNom**
- Operating point calculation: **P 462[0] - MOT_FluxNom**: Nominal flux, **P 340[0] - CON_FM_Imag**: Magnetizing current
- Calculation of: current, speed and position control parameters
- Click the "Start calculation" button to determine the rotor resistance **P 476[0] - MOT_Rrot** and leakage inductance **P 471[0] - MOT_Lsig**.
- Measurement of the saturation characteristic (table values of the stator inductance **P 472 - MOT_LSigDiff**);
Measurements are taken up to four times rated current, provided the power stage current permits it at standstill. If this is not the case, the measurement is made using a correspondingly smaller current.
- **P 340[0] - CON_FM_Imag** Magnetizing current

Current

The inverter output current is equal to the sum of the motor current (i_s) and capacitor current (i_c). Accordingly, (i_c) needs to be taken into account when calculating current setpoints. Disregarding resistances, the following applies to the capacitor current components:

$$i_{sd,Cf} = -2 \cdot \pi \cdot f_s \cdot C_f \cdot u_{sq,mot}$$

$$i_{sq,Cf} = 2 \cdot \pi \cdot f_s \cdot C_f \cdot u_{sd,mot}$$

Voltage

In this case, the motor voltage for the desired current setpoint vector ($i_{sd,ref}$, $i_{sq,ref}$) is calculated using specified motor parameters L_S and Ψ_{si_P} as a function of stator frequency (f_s):

$$u_{sd,mot} = -2 \cdot \pi \cdot f_s \cdot L_S \cdot i_{sq,ref}$$

$$u_{sq,mot} = 2 \cdot \pi \cdot f_s \cdot (L_S \cdot i_{sd,ref} + \Psi_{si_P})$$

Dynamic performance

In addition to the described effect of motor filters on the current phasor in steady-state operation, there is also an effect on the current control circuit's dynamic performance. Among other things, the use of a sine wave filter will result in resonances.

In order to avoid exciting oscillations, the current control circuit's decoupling network is always deactivated when configuring the motor filter support. In addition, the current controller's gain may have to be significantly reduced in order to achieve stability. Because of this, the use of sine wave filters is not recommended for drives that require a high dynamic performance.



NOTE

- Always discuss the use of sine wave filters with your Moog project support representative.

5.7.2 Configuration

Filter selector SINFILT(2) = compensation of sinus filter ▼

Connected inductance 0 mH

Selected capacity (delta connection) 0 nF

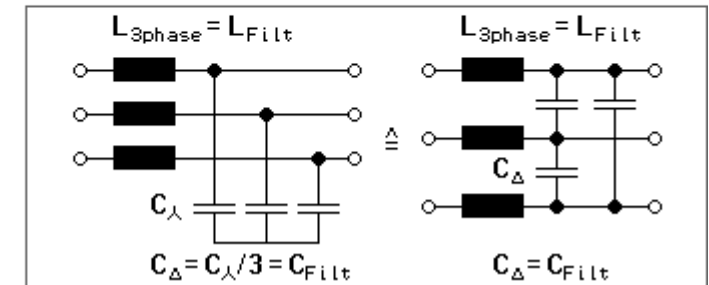


Fig. 5.16: "Motor filter" screen

Filter support can be enabled by setting **P 2900[0] - MOT_Filt_Sel** to one of the following settings:

MOT_Filt_Sel = (OFF)0

No filter compensation. The current controller decoupling network will be active.

MOT_Filt_Sel = (MCHOKE)1

Has no effect on the current setpoint calculation. Instead, it just deactivates the current controller decoupling network. If necessary, the calculated motor terminal voltage components (before the voltage drop caused by the motor choke) can be viewed using scope signals usdmot_SinFilt, usqmot_SinFilt. If there are no negative influences on the current control stability, it is recommended not to use this setting. Instead, you can select **MOT_Filt_Sel** = 0 and add the motor choke's inductance to the value in **MOT_Lsig**.

MOT_Filt_Sel = (SINFILT)2

Ensures that the capacitor current components will be calculated based on the above equations and that they will be added to current setpoint components isdref, isqref. Moreover, the current controller decoupling network will be deactivated. The calculated values of the motor terminal voltage and capacitor current components can be viewed with scope signals usdmot_SinFilt, usqmot_SinFilt and isdpre_SinFilt, isqpre_SinFilt respectively.

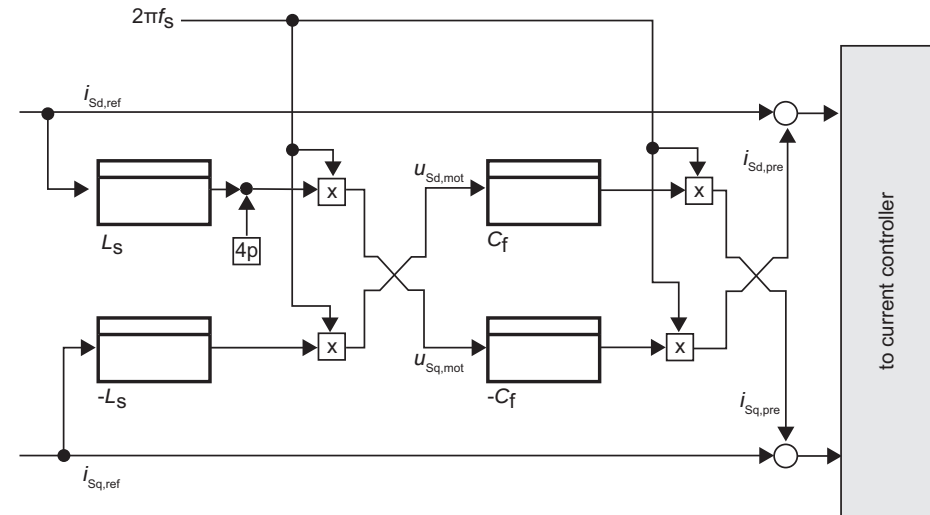


Fig. 5.17: Diagram of additive current setpoint calculation for sine wave filters

5.7.3 Parameters

ID	Index	Name	Unit	Description
462	0	MOT_FluxNom	Vs	
471	0	MOT_Lsig	mH	
2900	0	MOT_Filt_Sel		Motor filter: selector
2901		MOT_Filt_Para		Motor filter: Settings
2901	0	L_Filt	mH	Motor filter: Choke or filter inductance
2901	1	C_Filt	nF	Motor filter: Capacitance (delta configuration)

Table 5.10: "Motor filter" parameters



NOTE

- Filter capacitance **P 2901[1] - C_Filt** is specified as the capacitance value of the capacitors when using a delta configuration! In order to calculate the capacitance per phase as per the circuit diagram above, the device will internally multiply the value by 3 (delta-wye transform). If the capacitors are connected in a wye configuration, or if the capacitance of the single-phase equivalent circuit is known, the corresponding capacitance value must first be divided by 3 and then entered into the parameter.

5.7.4 Scope signals

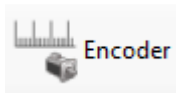
ID	Index	Name	Unit	Description
2500	0	isdpre_SinFilt	A	Calculated filter capacitor current d components (isd _{Cf} in the formula above)
2501	0	isqpre_SinFilt	A	Calculated filter capacitor current q components (isq _{Cf} in the formula above)
2502	0	usdmot_SinFilt	V	Calculated motor terminal voltage d components
2503	0	usqmot_SinFilt	V	Calculated motor terminal voltage q components

Table 5.11: "Motor filter" scope signals

6 Encoder

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Encoder

Brief description

This chapter describes...

1. ... how to select an encoder channel for each of the following control levels (channel selection):
 - MCON (commutation and torque control)
 - SCON (Speed control) and
 - PCON (Position control).
2. ... the encoder selection options for individual encoder channels Ch1 – Ch4 (type selection).

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Chapter overview

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6.1 Introduction

The MSD Servo Drive groups individual encoders (supported encoder interfaces) into what are referred to as “encoder channels”. Within each encoder channel, a maximum of one encoder can be active at any one time, meaning that the number of encoder channels also defines the maximum number of encoders that can be active simultaneously. The encoder channels are Ch1, Ch2, Ch3 and Ch4.

To select a specific encoder for a control level (e.g. for speed control), you must first select an encoder channel for that control level, after which you will be able to select a specific encoder for the selected channel.

The supported encoder interfaces are distributed among the four encoder channels as follows:

- Ch1: X7 (Sin/Cos, TTL, cyclical SSI, cyclical EnDAT, etc.) (500 kHz) (see Section "Channel 1: Interface X7" on page 61)
- Ch2: X6 (resolver, low-frequency Sin/Cos input as well if applicable (up to 1 kHz))
- Ch3: X8 (various option modules, including, but not limited to, various encoder modules) (see Section "Channel 3: Interface X8 (optional)" on page 82)
- Ch4: Virtual encoder

6.1.1 Limiting for EnDat and SSI

“Cyclical EnDat” means a cyclical, purely digital EnDat evaluation without Sin/Cos signal evaluation.

On the MSD Servo Drive, EnDat and SSI can be selected simultaneously only once. Even though there is an additional option for EnDat/SSI at X8, the following cannot be operated simultaneously on the MSD Servo Drive...

- two EnDat encoders
- or two SSI encoders
- or one EnDat encoder and one SSI encoder.

gleichzeitig betrieben werden.

6.1.2 Encoder gearing

The encoder gearing is an integral part of the encoder evaluation system. Whenever, for example, the “Ch1 encoder position” is described below, it already includes the encoder gearing. The relevant encoder position is always delivered together with the encoder gearing ratio to the mechanisms in charge of further processing in the Servo Drive.

The encoder gearing can be used, for example, to make adjustments if the encoder is a motor encoder (commutation encoder) but is not directly on the motor shaft: In this case, it would be necessary to make an adjustment to the pure encoder position in line with the motor’s commutation (pole pair subdivision). In the case of linear motor drives, for instance, this adjustment is required without fail.

The encoder gearing can also be used, for instance, to perform initial scaling for the position as required for the actual application: For example, in cases in which the encoder is not the motor encoder (i.e. in which it is not needed as a commutation encoder), but just a field encoder (another encoder in the field).

For more details regarding the encoder gearing, see Section "Encoder gearing" on page 95.

6.1.3 Actual values at the encoder channel outputs

The relevant encoder positions will be delivered at the encoder channel outputs to the mechanisms in charge of further processing in the Servo Drive. At these points, the actual value will be passed to one parameter per encoder channel. As, strictly

speaking, these actual encoder channel values are not actual position values (in terms of position control), these parameters are assigned to the “Encoder” screen and not the “Actual values” screen.

The parameters for the actual values at the encoder channel outputs are used for indication purposes only and are...

- **P 500 - ENC_CH1_ActVal** for Ch1
- **P 501 - ENC_CH2_ActVal** for Ch2
- **P 502 - ENC_CH3_ActVal** for Ch3
- **P 503 - ENC_CH4_ActVal** for Ch4

The parameters are field parameters with...

- Index 0 (single-turn component) and
- Index 1 (multiturn component)

6.2 Encoder selection

Encoder selection

Encoder for commutation and torque control loop:

CH1(1) = X7 (e.g. SinCos, channel 1)

Encoder offset

0

deg

Options...

Detect

Encoder for speed control loop:

CH2(2) = X6 (e.g. resolver, channel 2)

Options...

Encoder for position control loop:

CH3(3) = X8 (option, channel 3)

Options...

Fig. 6.1: Encoder channel selection screen

The MSD Servo Drive's control is subdivided into three levels...

- MCON (Commutation and Torque control)
- SCON (Speed control) and
- PCON (Position control).

This screen is used to select the encoder channel for each of the control levels.

To assign the encoder channel for...

- Commutation and torque control, use **P 520[0] - ENC_MCon**
- Speed control, use **P 521[0] - ENC_SCon**
- Position control, use **P 522[0] - ENC_PCon**

Once you select an encoder channel for a control level, you can click on the "Options..." button to access the encoder selection menu for that encoder channel.

You can use the lines underneath each selection field to enter your own information for describing the respective encoder channels (maximum of 31 characters). This information will be stored in...

- **P 555[0] - ENC_CH1_Info** for commutation and torque control
- **P 564[0] - ENC_CH2_Info** for speed control
- **P 580[0] - ENC_CH3_Info** for position control

P No.	Index	Name	Unit	Description
520	0	ENC_MCon		Selection of encoder channel for commutation angle
521	0	ENC_SCon		Selection of encoder channel for speed control
522	0	ENC_PCon		Selection of encoder channel for position control
555	0	ENC_CH1_Info		Encoder information Channel 1
564	0	ENC_CH2_Info		Encoder information Channel 2
580	0	ENC_CH3_Info		Encoder information Channel 3

Table 6.1: Encoder channel selection parameters



NOTE

- When you select a specific encoder with the "Options..." button, wire break monitoring will be enabled if the encoder and the encoder interface support wire break monitoring.

Encoder offset

For the encoder for commutation and torque control, **P 349[0] - CON_FM_MConOffset** can be used to set an offset. For details see Section "Encoder offset" on page 57.

6.3 Encoder offset

"Encoder offset" refers to the commutation offset. This offset is the angular offset between the motor's electromechanical layout (U phase orientation) and the zero position of the commutation encoder (depends on the encoder's position and alignment on the motor shaft) in "electrical degrees". If the encoder's zero position is aligned with the direction of the motor's U phase, the commutation offset is 0 degrees.

The "Encoder selection" screen (see Section "Encoder selection" on page 55) will show the currently set commutation offset as the "encoder offset" based on the encoder used for the "commutation and torque control" (MCON) control level.

To determine the offset value again, click on the "Detect" button. In order for this function to work correctly, the selected encoder for "commutation and torque control" must be the motor encoder (commutation encoder).

The process takes about 10 seconds. Then the current value of the offset is entered in the **P 349[0] - CON_FM_MConOffset** and the original parameter setting is restored. In order to store the commutation offset in the device in a non-volatile manner, the device setting must be stored in non-volatile memory.

It is not necessary to determine the commutation offset for standard Moog motors, as the encoders are aligned. In the case of third-party motors that are not aligned, the commutation offset needs to be determined with the help of a wizard. For the definition the motor is run in "Current control" mode (at rated current). For a correct definition it is necessary for the motor to be able to align itself freely.

A connected brake is automatically vented, provided it is connected to the brake output and the output has been configured for use of a brake.



NOTE

- The current used to determine the encoder offset (commutation offset) is specified by **P 457[0] - MOT_CNom**. This value should be reduced if the acceleration has too much jerk.

Check the encoder offset

If a high level of accuracy is required from the commutation offset, you can check it manually before you finish. To do this, accelerate the motor up to a constant speed of e.g. 1000 rpm. At this operating point, an oscilloscope records the d-voltage (usd = **scope parameter 31**) and checks the d-current (isd = **scope parameter 25**). As long as a synchronous motor is not in field-weakening mode, the d-current is always zero. This means the d-voltage is the key value. Once you have determined the value for the d-voltage at 1000 rpm, reverse the motor's direction of rotation. At the operating point -1000 rpm (for example), the amount from the d-voltage should be the same but with an inverted sign. If this is not the case, gradually adjust the encoder offset as appropriate.

6.4 Connections and pin assignments

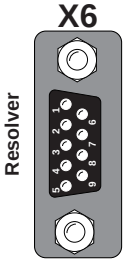


NOTE

- This section only lists the most important connectors and pinouts so as to make commissioning easier.
- For a full description of the encoder connectors (designation, position, pinout, function) for correctly installing the devices, see the “Encoder connection” chapter in the
 - Operation Manual MSD Servo Drive Single-Axis System (ID No.: CA65642-001),
 - Operation Manual MSD Servo Drive Multi-Axis System (ID No.: CA97554-001),
 - Operation Manual MSD Single-Axis Servo Drive Compact (ID No.: CA97555-001),
 - And the MSD Servo Drive Specification on functional safety in the case of Servo Drives with an “integrated safety control” design (ID No.: CB38398-001).
- Please note that the pinouts for evaluating the zero pulse for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact are different from each other.
- If your Servo Drive comes with a technology option with an encoder function (X8 connector), see the corresponding Specification for a description of the encoder connections (see Section “Applicable documentation” on page 13).

6.4.1 Connector for resolver (X6)

CAUTION!	Damage to the device as a result of incorrect motor winding insulation!
	Improper conduct can lead to damage to the motor/device. • The motor temperature sensor must have basic insulation to the motor winding when connected to X5 and reinforced insulation to IEC/EN 61800-5-1 when connected to X6 or X7.

Abb.	Pin	Function
	1	Resolver S3 differential input (reference to pin X6-2)
	2	Resolver S1 differential input (reference to pin X6-1)
	3	Resolver S2 differential input (reference to pin X6-8)
	4	5–12 V supply voltage, internally connected to X7/3
	5	ϑ+ (PTC, NTC, KTY, Klixon) ¹⁾
	6	Ref+ analog excitation
	7	Ref- analog excitation (ground for pin 6)
	8	Resolver S4 differential input (reference to pin X6-3)
	9	ϑ- (PTC, NTC, KTY, Klixon) ^{2) 3)}

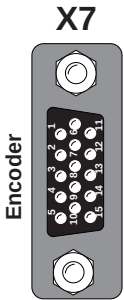
1) Internally connected to X7/10 in MSD Single-Axis Servo Drive Compact.
2) Internally connected to X7/9 in MSD Single-Axis Servo Drive Compact.
3) NTC for MSD Single-Axis Servo Drive Compact with adapter only

Table 6.2: Pin assignment X6 (MSD Servo Drive and MSD Single-Axis Servo Drive Compact)

6.4.2 Connector for high-resolution encoders (X7)



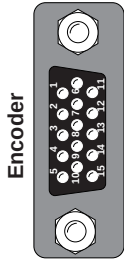
- Please note that the pinouts for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact are different from each other!

Abb.	Pin	Sin/Cos and TTL	Sin/Cos-Absolute value sender SSI/EnDat	Absolute encoder, EnDat (digital)	Absolute encoder, HIPERFACE®
	1	A-	A-	-	REFCOS
	2	A+	A+	-	+COS
	3	+5 VDC ±5%, IOU _T max = 250 mA (150 mA for hardware versions 0–1), monitoring via sensor cable ¹⁾			7 to 12 V (typ. 11 V) maximum 100 mA ¹⁾
	4	-	Data +	Data +	Data +
	5	-	Data -	Data -	Data -
	6	B -	B -	-	REFSIN
	7	-	-	-	U _S - Switch ²⁾
	8	GND	GND	GND	GND
	9	R-	-	-	-
	10	R+	-	-	-
	11	B+	B+	-	+SIN
	12	Sense +	Sense +	Sense +	U _S - Switch ²⁾
	13	Sense -	Sense -	Sense -	-
	14	-	CLK+	CLK+	-
	15	-	CLK -	CLK -	-

1) The total of the currents drawn at X7/3 and X6/4 must not exceed the specified value!
2) After connecting pin 7 to pin 12, a voltage of 11.8 V will appear at X7, pin 3!

Table 6.3: Pin assignment X7 (MSD Servo Drive)

CAUTION!	Damage to the device as a result of incorrect motor winding insulation!
	Improper conduct can lead to damage to the motor/device. The motor temperature sensor must have basic insulation to the motor winding when connected to X5 and reinforced insulation to IEC/EN 61800-5-1 when connected to X6 or X7.

Abb.	Pin	Sin/Cos and TTL	Sin/Cos- Absolute value sender SSI/EnDat	Absolute encoder, EnDat (digital)	Absolute encoder, HIPERFACE®
	1	A-	A-	-	REFCOS
	2	A+	A+	-	+COS
	3	+5 VDC ±5%, IOU max = 250 mA (150 mA for hardware versions 0–1), monitoring via sensor cable ¹⁾			7 to 12 V (typ. 11 V) maximum 100 mA ¹⁾
	4	R+	Data +	Data +	Data +
	5	R-	Data -	Data -	Data -
	6	B -	B -	-	REFSIN
	7	-	-	-	U _S - Switch ²⁾
	8	GND	GND	GND	GND
	9	ϑ- (PTC, KTY, Klixon), internally connected to X6/9 ³⁾			
	10	ϑ+ (PTC, KTY, Klixon), internally connected to X6/5 ³⁾			
	11	B+	B+	-	+SIN
	12	Sense +	Sense +	Sense +	U _S - Switch ²⁾
	13	Sense -	Sense -	Sense -	-
	14	-	CLK+	CLK+	-
	15	-	CLK -	CLK -	-

1) The total of the currents drawn at X7/3 and X6/4 must not exceed the specified value!

2) After connecting pin 7 to pin 12, a voltage of 11.8 V will appear at X7, pin 3!

3) Observe the preceding CAUTION statement!

Table 6.4: Pin assignment X7 (MSD Single-Axis Servo Drive Compact)

6.5 Channel 1: Interface X7

Encoder configuration channel 1 (X7)

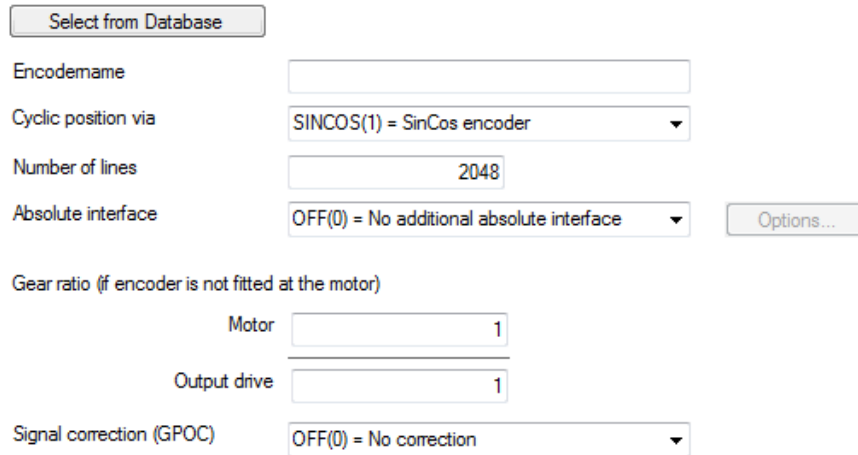


Fig. 6.2: Encoder configuration Channel Ch1 (Interface X7) screen

This screen is used to select the encoder for channel Ch1. This channel uses the encoder's "main interface" to measure position changes periodically and add them up cyclically – this is referred to as "cyclical evaluation".

Encoders with a main interface that only makes it possible to measure the cyclical position incrementally often feature an additional absolute value interface referred to as an "auxiliary interface". For this interface, the absolute position is measured once during the initialization phase and is then used for absolute value initialization purposes.

Select from database

Clicking on this button will open a menu that can be used to select encoders. The data sets for Moog encoders will already be available there by default.

Encoder name

You can use this field to enter your own information for describing the encoder (max. 31 characters) (**P 555[0] - ENC_CH1_Info**).

Cyclic position via

This drop-down menu is used to select the "main interface" (**P 505[0] - ENC_CH1_Sel**).

Pulses per revolution

Once SINCOS(1), TTL(3) or HALL(5) is selected as the "main interface," this field will appear so that you can enter the number of analog Sin/Cos lines per revolution (TTL lines as well).

Absolute interface

This drop-down menu is used to select the "auxiliary interface" (**P 540[0] - ENC_CH1_Abs**).



NOTE

- Selecting an "auxiliary interface" is redundant if, for example, SSI (2) is selected as the "main interface" (corresponds to cyclical evaluation via SSI). In this case, the absolute value initialization will also be carried out via the SSI interface, regardless of the selected "auxiliary interface".

Gear ratio

These fields can be used to define a gear ratio for the encoder (in the output side). For details see Section "Encoder gearing" on page 95.

Signal correction (GPOC)

GPOC is a special Moog online process for improving the quality of Sin/Cos signals before they are used to calculate a position. If "SINCOS(1)" is selected as the "main interface," this process may be useful. For details see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79.

P No.	Index	Name / Settings	Unit	Description
505	0	ENC_CH1_Sel		Encoder type selection
		OFF (0)		Function disabled
		SINCOS(1)		Sin/Cos encoder
		SSI(2)		Digital SSI encoder
		TTL(3)		TTL encoder
		EnDat(4)		Digital EnDat encoder (2.1 or 2.2)
		HALL(5)		Digital Hall sensor
540	0	ENC_CH1_Abs		Absolute position interface selection
		OFF (0)		No additional absolute value interface
		SSI(1)		SSI interface
		ENDAT(2)		EnDat interface
		HIPER(3)		HIPERFACE® interface
		SSI_CONT(4)		SSI-interface with 1ms continuous clock
555	0	ENC_CH1_Info		Encoder information

Table 6.5: Channel Ch1 encoder configuration (X7) parameters

6.5.1 Main parameters for encoder channel Ch1

The following table lists the most important parameters for the Ch1 encoder channel. These parameters are then described in the chapters for selecting a special encoder with **P 505[0] - ENC_CH1_Sel** and **P 540[0] - ENC_CH1_Abs**.

- Some of the parameters are self-explanatory, such as Lines, MultiT and SingleT.

- Code** and **Mode** are used to set SSI modes. If Mode=1, wire break monitoring (if any) will be disabled, for example. If **Mode** = 0, it will be enabled instead (default).
- In the case of linear encoders, **PeriodLen** and **DigitalResolution** will be needed instead of **MultiT** and **SingleT**.

P No.	Index	Name / Setting	Unit	Description
505	0	ENC_CH1_Sel		Main selection on encoder channel Ch1
540	0	ENC_CH1_Abs		Absolute value interface for one-time reading
542	0	ENC_CH1_lines		Number of analog Sin/Cos lines per revolution (TTL lines as well)
543	0	ENC_CH1_MultiT		Number of multi-turn bits for the digital interface
544	0	ENC_CH1_SingleT		Number of single-turn bits for the digital interface
545	0	ENC_CH1_Code		Code selection (for SSI encoders) (binary, Gray)
546	0	ENC_CH1_Mode		Mode selection (for SSI encoders)
547	0	ENC_CH1_MTBBase		Definition of point of discontinuity in multi-turn range
548	0	ENC_CH1_MTEEnable		Enable MultiTurn use (negative logic, 1=MTOff)
551	0	ENC_CH1_EncObsMin		Comparison value for Sin/Cos wire break monitoring
553	0	ENC_CH1_PeriodLen	nm	Linear encoders: Length of an analog Sin/Cos segment in nm (nanometres)
554	0	ENC_CH1_DigitalResolution	nm	Linear encoders: Length of a digital increment in nm (nanometres)
616	0	ENC_CH1_CycleCount		Sampling cycle in: n x 125 µ (microseconds)

Table 6.6: Main parameters for encoder channel Ch1

MTBase, when used with its default setting, will ensure that the absolute value initialization "starts up with plus-minus": I.e. the encoder's multi-turn value range from 0 to max will be mapped to -1/2max to +1/2max; the second half of the measuring range will be initialized as negative; in this case, the point of discontinuity will be found at 1/2max. --- This can be changed with MTBase! --- When MTBase=0, the absolute value initialization will, for example, "start up with zero to max": I.e. the

encoder's multi-turn value range from 0 to max will be mapped to 0 to max; the second half of the measuring range will be initialized as positive; in this case, the point of discontinuity will be found at 0.

If you set **MTEnable** to 1, you can use an available multi-turn encoder as a single-turn encoder (this is only needed for testing purposes).

If you set **EncObsMin** to 0, Sin/Cos wire break monitoring will be disabled. The default value is 0.2 (20%) and stands for a calculated amplitude value (calculated using the two Sin/Cos signals) of $x = \sqrt{a^2 + b^2}$. If the Sin/Cos signals are equal to approx. 1 Vss when compared, approx. 0.8 will be calculated here (approx. 80% magnitude at the A-D converters; approx. 0.25 Vss Sin/Cos will yield approx. 0.2 here (20% magnitude at the A-D converter)). The error threshold can be set with **EncObsMin** within a broad range.



NOTE

- As there are various protocol modes available for SSI encoders (with/without wire break monitoring, with/without parity bit, etc.), consult with your project supervisor or the Helpline provided by Moog before using any special SSI protocol modes.

6.5.2 EnDat (cyclical) X7

Ch1: ENDAT(4) - Cyclical EnDat (2.1 or 2.2)

EnDat is a digital encoder interface developed by HEIDENHAIN. For more details, please visit www.heidenhain.de and go to ► Documentation ► Fundamentals ► Interfaces ► EnDat 2.2..

The software versions required to run the EnDat encoder interface are the standard software versions for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact.



NOTE

- Please note the limitations that apply when running EnDat and SSI encoders (see Section "Limiting for EnDat and SSI" on page 54).

When using linear encoders, **P 554[0] - ENC_CH1_DigitalResolution** is used instead of **P 543[0] - ENC_CH1_MultiT** and **P 544[0] - ENC_CH1_SingleT** (which are used for rotary encoders). The values will be read from the EnDat encoder and written to the aforementioned parameters.

- P 543[0] - ENC_CH1_MultiT**
The number "n" of multiturn bits defines the measuring range in 2^n increments per encoder shaft revolution; maximum travel until overflow; maximum travel within which the absolute value initialization can be unambiguous. In the case of single-turn encoders, MultiT = 0.
- P 544[0] - ENC_CH1_SingleT**
The number "n" of single-turn bits corresponds to the encoder's digital resolution in 2^n increments per encoder shaft revolution.
- P 554[0] - ENC_CH1_DigitalResolution**
This is the length of an increment, in nanometres, of the encoder's digitally transmitted position value. This value is read from the EnDat linear head.

In the case of linear encoders, the number n of transmitted position bits from the encoder will be found in **SingleT** only! $2^n * \text{DigitalResolution}$ yields the maximum travel in nanometres (for the encoder head).

P 640 - ENC_ENDAT is intended for additional information, but is normally *not* needed. This parameter does not have a Ch1 or Ch3 prefix for the encoder channel in the name, as it applies to both encoder channels. Although usually not needed, the parameter is helpful or required in the following cases:

- Special EnDat encoder with diagnostics for evaluation**
In this case, the valuation numbers from the encoder are read cyclically via additional information. Only the valuation numbers that the encoder supports

will be read. During the initialization process, the system will read the encoder to determine which valuation numbers it supports. When **P 640[0] - ENDAT_Select = 1**, the function will be enabled in the controller and the internal diagnostics in the EnDat encoder will be enabled as well. The EnDat encoder will keep this setting even after being powered off. To explicitly disable the internal diagnostics in the EnDat encoder, set **P 640[0] - ENDAT_Select** to 2.

2. Evaluation of internal warnings

In this scenario, certain internal warnings from the encoder will be read from the encoder via additional information. Only the warnings that both the encoder and the Servo Drive's software support will be read. During the initialization process, the system will read the encoder to determine which warnings it supports. When **P 640[0] - ENDAT_Select = 3**, the function will be enabled in the controller.

ID	Index	Name	Unit	Description
505	0	ENC_CH1_Sel = 4		= ENDAT(4)
543	0	ENC_CH1_MultiT		Number of MultiTurn bits (absolute encoder)
544	0	ENC_CH1_SingleT		Number of SingleTurn bits (absolute encoder)
547	0	ENC_CH1_MTBBase		Definition of point of discontinuity in multi-turn range
548	0	ENC_CH1_MTEEnable		1: Use Multi-turn encoder as a single-turn encoder
616	0	ENC_CH1_CycleCount		Position encoder sampling cycle (n x 125 µsec)
598	0	ENC_CH1_Position	inc	Position encoder channel 1
554	0	ENC_CH1_DigitalResolution	nm	Length of one increment (linear absolute encoder)
640		ENC_ENDAT		EnDat additional (additional information)
640	0	ENDAT_Select	0=off	EnDat function selection, 1/2=diagnosis on/off, 3=warnings, FF=lock
640	1	ENDAT_DiagCount	u16	count new diagnosis block header
640	2	ENDAT_BWZ_1	lowbyte	vn1: incremental track
640	3	ENDAT_BWZ_3	lowbyte	vn3: absolute track
640	4	ENDAT_BWZ_4	lowbyte	vn4: position value formation
640	5	ENDAT_Status		EnDat additional status output
640	6	ENDAT_Z1_Sel		EnDat additional information 1 type selection

Table 6.7: Channel 1 encoder configuration (X7) - EnDat parameters

ID	Index	Name	Unit	Description
640	7	ENDAT_Z1_1		Z1 info: dword 1
640	8	ENDAT_Z1_2		Z1 info: dword 2
640	9	ENDAT_Z1_3		Z1 info: dword 3
640	10	ENDAT_Z1_4		Z1 info: dword 4
640	11	ENDAT_Z2_Sel		EnDat additional information 2 type selection
640	12	ENDAT_Z2_1		Z2 info: dword 1
640	13	ENDAT_Z2_2		Z2 info: dword 2
640	14	ENDAT_Z2_3		Z2 info: dword 3
640	15	ENDAT_Z2_4		Z2 info: dword 4
640	16	ENDAT_Mode1	0=off	EnDat additional mode 1 selection
640	17	ENDAT_Mode2		EnDat additional mode 2 selection
640	18	ENDAT_Mode3		EnDat additional mode 3 selection
640	19	ENDAT_Mode4		EnDat additional mode 4 selection
640	20	ENDAT_res1		reserved 1
640	21	ENDAT_res2		reserved 2
640	22	ENDAT_res3		reserved 3
640	23	ENDAT_HwSyncStop	0=SyncOn	EnDat cyclic hw sync, stop/start 1/0
640	24	ENDAT_CyclCount		call counter of cyclic function
640	25	ENDAT_BWZ_Supported		vn supported (bit3=vn4, bit2=vn3, bit0=vn1)
640	26	ENDAT_BWZ1_ThresholdLevel		vn1: bits[7..0] threshold level, bits[31..16] how often number
640	27	ENDAT_BWZ3_ThresholdLevel		vn3: bits[7..0] threshold level, bits[31..16] how often number
640	28	ENDAT_BWZ4_ThresholdLevel		vn4: bits[7..0] threshold level, bits[31..16] how often number
640	29	ENDAT_BWZ_TEST_Overwrite		vn: bits[15..12] 'F', bits[11..8] vn.no., bits [7..0] vn overwrite value

Table 6.7: Channel 1 encoder configuration (X7) - EnDat parameters (continue)

6.5.3 Hall sensor X7

Ch1: HALL(5) - Digital hall signals

Ch1: HALL_TTL(7) - Digital hall signals



NOTE

- The operation and configuration of Hall effect sensors is reserved for special applications. Consult with Moog if needed.

6.5.4 Sin/Cos / TTL X7

6.5.4.1 TTL encoder

Ch1: TTL(3) - TTL signals

TTL encoders are ...

- a. ... usually pure incremental encoders *without* an absolute value interface. In this case, **P 540[0] - ENC_CH1_Abs** must be set to OFF(0).
- b. ... in a few exceptional cases, incremental encoders *with* an SSI absolute value interface. In this case, **P 540[0] - ENC_CH1_Abs** must be accordingly set to SSI(1) (SSI_CONT(4) in special cases), so that it will be possible to read the absolute encoder position for the absolute value initialization routine once during the initialization phase.

6.5.4.1.1 Pure TTL incremental encoder

Set **P 505[0] - ENC_CH1_Sel** to TTL(3) and **P 540[0] - ENC_CH1_Abs** to OFF(0) when using pure TTL encoders, i.e. encoders without an absolute value interface but with a TTL zero pulse.

Linear TTL encoders are run as rotary encoders. For linear motor operation, **P 542[0] - ENC_CH1_Lines** and the encoder gearing (see the "Encoder gearing" section) are used to establish the ratio for the linear motor's pole pair subdivision (North-North) for commutation. 1 x North-North corresponds to one revolution from **Lines**. In this case, the motor pole pair number must be set to 1. Moreover, **P 553[0] - ENC_CH1_PeriodLen** is not used in this case.

The TTL interface accepts various TTL signal types, which can be selected using **P 558[0] - ENC_CH1_TTL_SignalType**:

- (0)AF_B - A/B tracks (forward counting, X4 encoding) - AB
- (1)AR_B - A/B tracks (reverse counting, X4 encoding) - AB_inv

- (2)ABDFN - A: Clock (falling edge), B: Direction (1 = positive) - PulseDir
- (3)ABDRP - A: Clock (rising edge), B: Direction (1 = negative) - PulseDir_inv
- (4)reserved

A maximum interpolation period, in ms (milliseconds), can be configured for the TTL interface using **P 601[0] - ENC_CH1_Period**. Within this context, **Period** is the maximum time of "no activity" since the last TTL counter event:

- Period = 0: Function disabled (default)
- Period > 0 (=n ms): If no counter event is registered in n ms, the speed will be set to 0.

Zero pulse

There is no parameter for activating the zero pulse evaluation here, as this evaluation is controlled exclusively based on the homing mode (see Section "Homing" on page 258). However, setting **P 541[0] - ENC_CH1_NpTest** to 1 provides a test mode that can be used during commissioning in order to be able to activate the zero pulse evaluation even without homing. Scope signals 1014 and 1016 can be used to view a received zero pulse within this context. This test mode must be disabled during normal operation (**P 541[0] = 0**).

Commutation

Motor operation with pure incremental encoders needs for the auto commutation function to be enabled without fail. For details see Section "Synchronous motor auto commutation" on page 165.

6.5.4.1.2 TTL incremental encoder with SSI absolute value interface

See Section "Sin/Cos incremental encoders with absolute value interface" on page 67 and in specialSection "SSI absolute value interface" on page 69.

ID	Index	Name	Unit	Description
505	0	ENC_CH1_Sel = 3		Encoder selection set to TTL(3)
510	0	ENC_CH1_Num		Encoder gearing: Numerator
511	0	ENC_CH1_Denom		Encoder gearing: Denominator
540	0	ENC_CH1_Abs		Selection of absolute value interface
541	0	ENC_CH1_NpTest		ENC CH1, TEST-MODE: Index pulse signal(s) to Scope
542	0	ENC_CH1_lines		Number of lines (Sin/Cos / TTL encoders)
558	0	ENC_CH1_TTL_SignalType		Channel 1: TTL signal selection
601	0	ENC_CH1_Period		Maximum period of interpolation (TTL encoder)
616	0	ENC_CH1_CycleCount		Sampling cycle in: n x 125 µ (microseconds)

Table 6.8: Parameters for Channel 1 (X7) - TTL encoder

6.5.4.2 Sin/Cos encoder

Ch1: SINCOS(1) - Sin/Cos signals

Sin/Cos encoders can ...

- Be pure incremental encoders *without* an absolute value interface. In this case, **P 540[0] - ENC_CH1_Abs** must be set to OFF(0).
- Be incremental encoders *with* an absolute value interface. In this case, **P 540[0] - ENC_CH1_Abs** must be accordingly set to SSI(1), EnDat(2), HIPER(3) or, in special cases, SSI_CONT(4) so that it will be possible to read the absolute encoder position for the absolute value initialization routine once during the initialization phase.

6.5.4.2.1 Purely Sin/Cos incremental encoders

To run these encoders as purely incremental encoders with a zero pulse on encoder channel Ch1 (without an absolute value interface), the approach is basically the same as for purely TTL operation (see Section "TTL encoder" on page 65). The same parameters apply.

However, there are the following differences:

- There are no different signal types for the Sin/Cos signal (always 1 Vss for cosine and sine).
- The zero pulse is the analog zero pulse typical of Sin/Cos encoders (see the "Connection for high-resolution encoders" section in the operation manual MSD Servo Drive Single-Axis System, for example).

6.5.4.2.2 Linear Sin/Cos incremental encoders

Linear Sin/Cos encoders are operated as rotary encoders. For linear motor operation, **P 542[0] - ENC_CH1_Lines** and the encoder gearing (see Section "Encoder gearing" on page 95) are used to establish the ratio for the linear motor's

pole pair subdivision (North-North) for commutation. 1 x North-North corresponds to one revolution from **Lines**. In this case, the motor pole pair number must be set to 1. Moreover, **P 553[0] - ENC_CH1_PeriodLen** is not used in this case.

6.5.4.2.3 Signal correction (GPOC)

The GPOC (gain phase offset correction) routine used for track signal correction purposes for sine/cosine signals is used to compensate for systematic errors. The routine is controlled in encoder channel Ch1 with **P 549[0] - ENC_CH1_Corr** and **P 550[0] - ENC_CH1_CorrVal**. For details see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79

6.5.4.2.4 Sin/Cos incremental encoders with absolute value interface

The following table lists the parameters for cyclical Sin/Cos operation on encoder channel Ch 1 with one-time reading of the absolute encoder position via the absolute value interface, i.e. without a zero pulse:

ID	Index	Name	Unit	Description
505	0	ENC_CH1_Sel = 1		Encoder selection set to SINCOS(1)
510	0	ENC_CH1_Num		Encoder gearing: Numerator
511	0	ENC_CH1_Denom		Encoder gearing: Denominator
540	0	ENC_CH1_Abs		Absolute value interface selection (one-time reading)
542	0	ENC_CH1_lines		Number of Lines (Sin/Cos / TTL encoders)
543	0	ENC_CH1_MultiT		Number of MultiTurn bits (absolute encoder)
544	0	ENC_CH1_SingleT		Number of SingleTurn bits (absolute encoder)
545	0	ENC_CH1_Code		Code selection (SSI encoder) (binary, gray)
546	0	ENC_CH1_Mode		Mode selection (SSI encoder)
547	0	ENC_CH1_MTBase		Definition of point of discontinuity in multi-turn range
548	0	ENC_CH1_MTEnable		Enable MultiTurn use (negative logic, 1=MTOff)

Table 6.9: Parameters for channel 1 (X7) - Sin/Cos encoder

ID	Index	Name	Unit	Description
549	0	ENC_CH1_Corr		Signal correction type
550	0-4	ENC_CH1_CorrVal		Signal correction values
551	0	ENC_CH1_EncObsMin		Encoder monitoring minimum, $\sqrt{a^2+b^2}$
552	0...	ENC_CH1_AbsEncStatus		Error and status codes (absolute encoder)
553	0	ENC_CH1_PeriodLen	nm	Length of signal period (Sin/Cos linear encoder)
554	0	ENC_CH1_DigitalResolution	nm	Length of one increment (linear absolute encoder)
555	0	ENC_CH1_Info		Encoder information
616	0	ENC_CH1_CycleCount		Sampling cycle in: $n \times 125 \mu$ (microseconds)
610	0	ENC_CH1_NominalIncrementA	Sign. per.	Nominal increment A (distance coded abs. encoder)
611	0	ENC_CH1_NominalIncrementB	Sign. per.	Nominal increment B (distance coded abs. encoder)
617	0	ENC_CH1_AbsInitMode		Mode absolute value formation
1900	0	ENC_ETs		ETS mode, electronic nameplate

Table 6.9: Parameters for channel 1 (X7) - Sin/Cos encoder (continue)

The **Sel**, **Num**, **Denom**, **Abs**, **Lines**, **MultiT**, **SingleT** and **CorrVal** parameters are self-explanatory.

The **Code** and **Mode** parameters are described in Section "SSI (cyclical) X7" on page 71.

- **P 547[0] - ENC_CH1_MTBase** = Minimum MultiTurn position
The **MTBase** parameter is used to set a position in the multi-turn encoder's travel path that defines the point of discontinuity (overflow/underflow) for the absolute value initialization (that is, the "multi-turn basis"). Assuming a bipolar encoder measuring range, all position values that fall below **MTBase** will be shifted "up" (the whole MT range will be added to them once). This method makes it possible to place the point of discontinuity at any point within the encoder's entire measuring range. By default, **MTBase** will be set to the lowest possible value for the parameter, i.e. reliably outside of the encoder's value range: In this case, the full bipolar range will remain unaffected, as values will never fall below this **MTBase** threshold (see Section "Channel 1: Interface X7" on page 61).
- **P 548[0] - ENC_CH1_MTEnable** = MultiTurn as SingleTurn
The **MTEnable** parameter makes it possible to use multi-turn encoders as

single-turn encoders for test purposes. Negative logic: Default MTEnable = 0 means "MultiTurn-Enable ON".

- **P 549[0] - ENC_CH1_Corr** = Signal correction type
The GPOC routine used for track signal correction purposes for sine/cosine signals is used to compensate for systematic errors. The routine is controlled with the Corr and CorrVal parameters (see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79).
- **P 551[0] - ENC_CH1_EncObsMin** = Encoder monitoring minimum, $\sqrt{a^2+b^2}$
The parameter **EncObsMin** is used to scale the Sin/Cos wire break monitoring and represents the "downwards threshold" for an error message. The default setting is 0.2, corresponding to approx. 20% of the track signals' amplitude (approx. 80% corresponds to approx. 1 Vss). If EncObsMin is set to 0, Sin/Cos wire break monitoring will be disabled (also see Section "Channel 1: Interface X7" on page 61).
- **P 552[0] - ENC_CH1_AbsEncStatus** = Error and status codes (absolute encoder)
The AbsEncStatus parameter is used to display status information for HIPERFACE encoders. In subindex [0], the read "TypeKey" for the HIPERFACE encoder will be indicated (one byte), for example.
- **P 553[0] - ENC_CH1_PeriodLen** = Sin/Cos linear encoder and
P 554[0] - ENC_CH1_DigitalResolution = linear absolute encoder
are the length of an analog Sin/Cos signal period in nanometres and the length of a digital increment of the position from the absolute value interface in nanometres. Both parameters are used for linear EnDat encoders and linear HIPERFACE encoders (instead of MultiT and SingleT bits (rotary)). In contrast, linear SSI encoders are treated as rotary SSI encoders (in this case, it is impossible to determine that the system is a linear encoder system based on the encoder head). Likewise, linear Sin/Cos encoders without an absolute value interface are treated as "rotary" encoders (if run as commutation encoders, the number of tracks, or lines (**Lines**) and the encoder gearing (**Num, Denom**) must be used to establish the relationship to the linear motor's magn. pole pair subdivision). Only in the case of Sin/Cos encoders

reference marks will the system determine, based on **PeriodLen** > 0, that the encoder system is linear and not rotary.

- **P 555[0] - ENC_CH1_Info** = Encoder Information
This parameter is available to the user so that they can enter a text of their choice (maximum of 31 characters). This text should be used to describe the encoder on channel Ch1
- **P 616[0] - ENC_CH1_CycleCount** = Sampling cycle in: $n \times 125 \mu s$ (microseconds)
The CycleCount parameter can be used to slow down the timing for the cyclical SSI encoder evaluation. By default, CycleCount = 1, i.e. the default setting corresponds to 125 μs sampling and cycles for the encoder evaluation. Different settings must be viewed as special cases and accordingly must only be used when necessary. (see Section "SSI (cyclical) X7" on page 71).
- **P 610[0] - ENC_CH1_NominalIncrementA** = distance coded absolute encoder
P 611[0] - ENC_CH1_NominalIncrementB = distance coded absolute encoder
The **NominalIncrementA** and **NominalIncrementB** parameters make it possible to run Sin/Cos incremental encoders (without an absolute value interface) with analog distance-coded reference marks. For example, if you were using the Heidenhain ROD280C with 18000 Sin/Cos tracks per revolution and 36 distance-coded reference marks, you would need to set NominalIncrementA to 1000 signal periods and NominalIncrementB to 1001 signal periods. This functionality is enabled if **NominalIncrementA** > 0. (see Section "Increment-coded reference marks" on page 112).
- **P 617[0] - ENC_CH1_AbsInitMode** = Mode absolute value formation
AbsInitMode can be used to select various possible settings for the absolute value initialization:
 - DIG_ANA(0)- Standard:
Absolute value initialization using a mix of the digital and analog components (this is the default mode)

- DIG(1) - Digital:
Only the digital component will be used for the absolute value initialization.
 - SEK_SEL37(2) - Automatic:
Digital if ST bits > (LineBits + 8); otherwise standard (criterion applies with HIPERFACE SEKL-37 encoders)
 - SSI_180(3) - Same as Standard, except:
In the case of SSI, the quadrant alignment of the digital value relative to the analog Sin/Cos tracks is not the same as with EnDat, but is instead offset by 180 degrees relative to EnDat, i.e. in the “natural Q alignment” for the digital value relative to the tracks.
- **P 1900[0] - ENC_ETS** = ETS mode, electronic nameplate
The parameter ENC_ETS supports what is referred to as the “Moog electronic rating plate” for HIPERFACE encoders. If this parameter is set to SCAN(0), the motor’s commutation offset will be read from the encoder’s OEM memory and copied to **P 349 - CON_FM_MConOffset**, but only if this offset can be unambiguously identified in the encoder (encoder memory scanning). If the parameter is set to NEVER(0) instead, this functionality will be disabled.

6.5.4.2.5 SSI absolute value interface

If **P 540[0] - ENC_CH1_Abs** = SSI(1), which is the normal setting, the absolute SSI encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental component.

The parameters for the SSI interface are described in Section “SSI (cyclical) X7” on page 71, as are the differences in using the SSI interface with the “cyclical” method and “one-time reading” method.

If **P 540[0] - ENC_CH1_Abs** = SSI_CONT(4), which is a special case, the absolute SSI encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental

component. The reason this is a special case is that the SSI clock will continue to be cyclically output on the SSI clock lines, in contrast to the SSI(1) setting. This means that the connected SSI encoder will continue to cyclically deliver position data on the SSI data lines. However, once the SSI data is read once, the controller will not evaluate any additional SSI data. -- This functionality can be used in the special case if the 485 system is implemented as a bus system on the encoder side so that a third 485 node (e.g. a controller) can “also listen in to” the SSI position data as an SSI clock slave.

6.5.4.2.6 EnDat absolute value interface

If **P 540[0] - ENC_CH1_Abs** = ENDAT(2), the absolute EnDat encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental component.

The parameters for the EnDat interface are described in Section “EnDat (cyclical) X7” on page 63, as are the differences in using the EnDat interface with the “cyclical” method and “one-time reading” method.

6.5.4.2.7 HIPERFACE absolute value interface

If **P 540[0] - ENC_CH1_Abs** = HIPER(3), the absolute HIPERFACE encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental component. The HIPERFACE interface will *not* be used as an alternative to cyclical encoder position acquisition.

HIPERFACE functionality: After an SW reset is carried out from the HIPERFACE encoder as the very first step, the ID byte, referred to as the “TypeKey”, will be read from the encoder and interpreted: If it is equal to FFh, the data for Lines, MultiT and SingleT will be read from the EN (HIPERFACE® electronic rating plate) on the encoder. If it is not equal to FFh, the data for Lines, MultiT and SingleT will be taken from a characteristic table in the controller firmware. In the case of linear encoder

types, the corresponding parameters will be PeriodLen and DigitalResolution. HIPERFACE encoders “unknown at the time of writing” (new: no entry in the firmware characteristic table) are generally not supported! In the case of known encoders, the Lines, MultiT, SingleT, PeriodLen and DigitalResolution parameters will be overwritten with the determined values. After this, the HIPERFACE encoder's internal 4-byte error status memory will be read. Then, the position will be read once from the encoder. If any errors that result in new entries in the internal error memory occur at this point, the error memory will be read again and interpreted accordingly (error message if applicable).

**NOTE**

- Pay attention to the encoder initialization entries in the Moog DRIVEADMINISTRATOR 5 message window. In the event of an error, also check the entries in **P 552 - ENC_CH1_AbsEncStatus**.

With **P 1900 - ENC_ETS**, the HIPERFACE interface also supports what is referred to as the “Moog electronic rating plate.” If this parameter is set to SCAN(0), the motor's commutation offset will be read from the encoder's OEM memory and copied to **P 349 - CON_FM_MConOffset**, but only if this offset can be unambiguously identified in the encoder (encoder memory scanning). If the parameter is set to NEVER(0) instead, this functionality will be disabled.

ID	Index	Name	Unit	Description
505	0	ENC_CH1_Sel = 1		Encoder selection set to SIN/COS(1)
540	0	ENC_CH1_Abs = 3		HIPER(3)
542	0	ENC_CH1_lines		Number of Lines of Sin/Cos encoder
543	0	ENC_CH1_MultiT		Number of MultiTurn bits (absolute encoder)
544	0	ENC_CH1_SingleT		Number of SingleTurn bits (absolute encoder)
552	0	ENC_CH1_AbsEncStatus		Error and status codes (absolute encoder)
553	0	ENC_CH1_PeriodLen	nm	Length of signal period (Sin/Cos linear encoder)
554	0	ENC_CH1_DigitalResolution	nm	Length of one increment (linear absolute encoder)
555	0	ENC_CH1_Info		Encoder information
1900	0	ENC_ETS		ETS mode, electronic nameplate

Table 6.10: Parameters for Channel 1 (X7) - Sin/Cos + HIPERFACE

- P 552 - ENC_CH1_AbsEncStatus** = Error and status codes (absolute encoder)

AbsEncStatus is used to display status information for HIPERFACE encoders. In index [0], the read “TypeKey” for the HIPERFACE encoder will be indicated (one byte). Bytes 1–4 of the HIPERFACE encoder's internal 4-byte error status memory will be shown in indexes [5..8] (00h means “no error”). Index [9] will specify how many error status bytes were read in the last read operation.

ID	Index	Name	Description
552		ENC_CH1_AbsEncStatus	0000h Error and status codes (HIPERFACE encoder)
552	0	Encoder_Type_Key	Encoder type information (ID byte)
552	1	Interface_Status	Error and status codes
552	2	Request_COMMAND_Key	Request command of last transmission
552	3	Response_COMMAND_Key	Response command of last transmission
552	4	Error_Bit_Response_COMMAND	Encoder signals error with last response
552	5	Encoder_Status_1_code	Encoder status information 1 (int. Error stack)
552	6	Encoder_Status_2_code	Encoder status information 2 (int. Error stack)
552	7	Encoder_Status_3_code	Encoder status information 3 (int. Error stack)
552	8	Encoder_Status_4_code	Encoder status information 3 (int. Error stack)
552	9	Communication_index	Index of communication dataset (read counter, status completely)
552	10	Additional_1	Interface additional information 1
552	11	Additional_2	Interface additional information 2
552	12	Additional_3	Interface additional information 3
552	13	Additional_4	Interface additional information 4
552	14	Additional_5	Interface additional information 5
552	15	Bytes_of_last_protocol	highbyte: to encoder, lowbyte: from encoder
552	16	Bytes_of_last_protocol	
552	17...	...	

Table 6.11: Parameters for Channel 1 (X7) - HIPERFACE status

Starting from index [15], the byte sequences for the last command that was transmitted (request to encoder “left” + response from encoder “right”) will be shown completely.

6.5.4.2.8 SSI_CONT absolute value interface

P 540[0] - ENC_CH1_Abs = SSI_CONT(4)

See Section "SSI absolute value interface" on page 69.

6.5.5 SSI (cyclical) X7

Ch1: SSI(2) - Cyclical SSI

The software versions required to run the SSI encoder interface are the standard software versions for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact.



NOTE

- Please note the limitations that apply when running EnDat and SSI encoders (see Section "Limiting for EnDat and SSI" on page 54).

SSI (Synchronous Serial Interface) is a digital encoder interface that is supported by a large number of manufacturers. It is not standardized, meaning that manufacturers are free to support the interface as they like. The pseudo-standard described below has however been established for motor feedback interfaces. Moog supports this version first and foremost.

The following table lists the parameters for cyclical SSI operation on encoder channel Ch 1. It also points out possible differences between the use of the SSI interface with the "cyclical" method and "one-time reading" method when using Sin/Cos encoders with an SSI absolute value interface.

SSI encoder basics and requirements

The SSI interface on the MSD Servo Drive has been designed as an actual motor feedback interface. Accordingly, the connected SSI encoder must meet the following criteria:

- Clock and data inactive level = HIGH
- The current position must be internally stored at the first falling clock edge
- No lengthened calculation time (in first cycle)
- With the first rising clock edge, the encoder must shift the data to the first position bit to be transmitted (MSB)
- 1 Mbps rate
- Data coding = Binary or Gray
- Reading data after the data bits end is permissible
- 125 µs cycle (i.e. internal position refresh rate $\ll$ 125 µs)
- Monoflop time $\geq$ 6 µs
- Data lines driven with logic 0 during monoflop time
- No parity bit
- No error bits or other status bits
- $\leq$ 14 multiturn bits

SSI wire break monitoring (bit monitoring during monoflop time)

If monitoring is enabled, the controller, as the SSI clock master, will read data for one more clock cycle after the data bits (reading data after the data bits end is permissible). The bit that the master reads in addition to the data bits this way comes from the SSI encoder's monoflop time. At the time corresponding to this bit, the SSI encoder must drive the data lines with a logic 0. If the data lines on connector X7 are open, a logic 1 will be read here. The bit monitoring at this point makes it possible to determine whether the SSI data lines are being actively driven with a logic 0 at this point (no "wire break") or are not ("wire break"). SSI wire break monitoring can be disabled by setting **P 546[0] - ENC_CH1_Mode** to 0001h.

Mode parameters and CycleCount parameters

P 546[0] - ENC_CH1_Mode can be used to run a parity evaluation after the data. In addition, **ENC_CH1_Mode** makes it possible to run special SSI encoders that deliver one or more special bits after the data. In this case, the MSD Servo Drive will not evaluate these bits – this mode is meant to make it possible to work with SSI encoders that require for these bits to be sampled. **P 616[0] - ENC_CH1_CycleCount** makes it possible to run slower SSI encoders that cannot handle the required cycle of 125 µs. The control characteristics will deteriorate when using this type of SSI encoder, which is why doing so is *not* recommended.

ID	Index	Name	Unit	Description
505	0	ENC_CH1_Sel = 2		=SSI(2)
543	0	ENC_CH1_MultiT		Number of MultiTurn bits (absolute encoder)
544	0	ENC_CH1_SingleT		Number of SingleTurn bits (absolute encoder)
545	0	ENC_CH1_Code		Code selection (SSI absolute encoder)
546	0	ENC_CH1_Mode		Mode selection (SSI absolute encoder)
547	0	ENC_CH1_MTBBase		Minimum MultiTurn position (SSI absolute encoder)
548	0	ENC_CH1_MTEEnable		Channel 1: Multi-turn as single-turn
598	0	ENC_CH1_Position	inc	Position encoder channel 1
616	0	ENC_CH1_CycleCount		Channel 1: Position encoder sampling cycle (n x 125 µsec)

Table 6.12: Encoder configuration channel 1 (X7) - SSI parameters

The **Sel**, **Lines**, **MultiT** and **SingleT** parameters are self-explanatory.

Other parameters, such as **MTBase** and **MTEEnable**, are described elsewhere (see Section "Sin/Cos incremental encoders with absolute value interface" on page 67).



NOTE

- Linear SSI encoders will be treated as rotary SSI encoders. In this case, it is impossible to determine that the system is a linear encoder system based on the encoder head.

- P 543[0] - ENC_CH1_MultiT** = Number of multiturn bits: 0..14
Due to the design of the cyclical SSI interface as a motor feedback interface, the number of multi-turn bits is limited to 14 (no limit to 14 bits in the case of a Sin/Cos interface with SSI one-time reading).
- P 545[0] - ENC_CH1_Code** = SSI decoding: BINARY(0) or GRAY(1)
Gray decoding will be selected by default. The other option is to use binary decoding.
- P 546[0] - ENC_CH1_Mode** = Available SSI auxiliary settings
This parameter has a 16-bit hex value. With the default setting (0000h), SSI wire break monitoring will be enabled. A value of 0001h will disable SSI wire break monitoring, meaning that one bit less will be read.
Following is a list of what some of the terms in the table below stand for:
 - Data = Sequence of all data bits
 - EncObs = Wire break bit
 - Nothing = No bit
 - POdd = Odd parity bit
 - PEven = Even parity bit
 - Free = A free bit

ID	Value	Name	
546		ENC_CH1_Mode	
	0000h	Data_EncObs	Default: with wire break
	0001h	Data_Nothing	
	0002h	Data_POdd_EncObs	ODD Parity
	0003h	Data_Free_POdd_EncObs	
	0004h	Data_POdd	
	0005h	Data_Free_POdd	
	0006h	Data_Free_EncObs	
	0007h	Data_Free_Free_EncObs	
	000Ch	Data_PEven_EncObs	EVEN Parity
	000Dh	Data_Free_PEven_EncObs	
	000Eh	Data_PEven	
	000Fh	Data_Free_PEven	
	001Fh	Data_Free	Extra data reading
	0020h	Data_Free_Free	
	0021h	Data_Free_Free_Free	
	0022h	Data_Free_Free_Free_Free	

Table 6.13: SSI mode parameters (all other values are reserved)

P 616[0] - ENC_CH1_CycleCount = Sampling cycle in: $n \times 125 \mu\text{s}$ (microseconds): **ENC_CH1_CycleCount** can be used to slow down the timing for the cyclical SSI encoder evaluation. By default, **ENC_CH1_CycleCount** = 1, i.e. the default setting corresponds to $125 \mu\text{s}$ sampling and cycles for the encoder evaluation. Different settings must be viewed as special cases and must only be used when necessary.

Monitoring the position difference

With SSI encoders, the position difference is monitored automatically. The limit value is based on the maximum speed with reference to one scanning step ($125 \mu\text{s}$). The position difference between two scanning steps is restricted to this limit value. In the event of an EMC disturbance, this limits the (incorrectly detected) tracking error and the response of the controller.

6.5.5.1 Alternative SSI setting

Parameters

ID	Index	Name	Unit	Description
2333		ENC_CH1_SSI_AltSupport		Channel 1, SSI: alternate function support
2333	0	Enable		Enable ssi alternate function support (general switch)
2333	1	Mode		Special mode (0=none)
2333	2	ClockBits	bit	Number of physical ssi clocks (master clock bits)
2333	3	PositionBits	bit	Number of position bits
2333	4	PositionClkOffset		Clock index of first position bit (MSB)
2333	5	ParityClkOffset		Clock index of parity bit
2333	6	EncObsClkOffset		Clock index of encobs bit (encoder monitoring (wire break))
2333	7	ErrorClkOffset		Clock index of error bit
2333	8	WarningClkOffset		Clock index of warning bit
2333	9	ParityBit Mode		Position parity mode: (0=off, 1=odd, 2=even)
2333	10	EncObsBit Mode		Encoder monitoring mode: (0=off, 1=enable on high)
2333	11	ErrorBit Mode		Error mode: (0=off, 1=enable on high, 2=enable on low)
2333	12	WarningBit Mode		Warning mode: (0=off, 1=enable on high, 2=enable on low)
2333	13	GrayCode		Position gray coded: (0=binary, 1=gray coded)
2333	14	MTBits	bit	Number of multiturn bits (on index of first position bit)
2333	15	STBits	bit	Number of single-turn bits (on first index after multiturn bits)

Table 6.14: Parameter 2333, alternative SSI setting

This alternative SSI setting (from FW 124.35.00) has been implemented in addition to the familiar SSI interface, which means it is consistently backward-compatible.

The function can be found under the parameter **P 2333[0-15] ENC_CH1_SSI_AltSupport** (Device setting -> Others -> Encoders).

This new configuration option has the advantage that the entire SSI bitstream (raw data **P 500 [4-5]**) which is imported can be masked flexibly.

ID	Index	Name	Unit	Description
500	4	ENC_CH1_ActVal		Bitstream raw data (low)
500	5	ENC_CH1_ActVal		Bitstream raw data (high)

Table 6.15: P 500 [4, 5] raw data

This has the advantage that you can check error and warning bits as you wish before or after the data information. For this there are also 2 new error and warning messages (error numbers 68 and 69) using the corresponding bits.

This example should give a better explanation of the configuration options for this new function:

Info:

- SSI encoder, linear
- 1 error bit, high-active
- 3 empty bits
- 28 position bits, binary, MSB leading
- Wire break monitoring (EncObs) as per data information (1 bit)
- 15 singleturn bits

First, **P 2333[0]-ENC_CH1_SSI_AltSupport_Enable = 1** activates the new function.

ID	Index	Name	Value	Unit	Description
2333		ENC_CH1_SSI_AltSupport			Channel 1, SSI: alternate function support
2333	0	Enable	1		Enable ssi alternate function support (general switch)
2333	1	Mode	0		Special mode 0= none

Table 6.16: Parameter 2333, alternative SSI setting, example

ID	Index	Name	Value	Unit	Description
2333	2	ClockBits	33	bit	Number of physical ssi clocks (master clock bits)
2333	3	PositionBits	28	bit	Number of position bits
2333	4	PositionClkOffset	4		Clock index of first position bit (MSB)
2333	5	ParityClkOffset	0		Clock index of parity bit
2333	6	EncObsClkOffset	32		Clock index of encobs bit (encoder monitoring (wire break))
2333	7	ErrorClkOffset	0		Clock index of error bit
2333	8	WarningClkOffset	0		Clock index of warning bit
2333	9	ParityBit Mode	0		Position parity mode: 0= off, 1= odd, 2= even
2333	10	EncObsBit Mode	1		Encoder monitoring mode: 0= off, 1= enable on high
2333	11	ErrorBit Mode	1		Error mode: 0= off, 1= enable on high 2= enable on low
2333	12	WarningBit Mode	0		Warning mode: 0= off, 1= enable on high, 2=enable on low
2333	13	GrayCode	0		Position gray coded: 0= binary 1= gray coded
2333	14	MTBits	13	bit	Number of multiturn bits (on index of first position bit)
2333	15	STBits	15	bit	Number of single-turn bits (on first index after multiturn bits)

Table 6.16: Parameter 2333, alternative SSI setting, example (continue)

Clock Bits

Clock Bits												
0	1	2	3	4	5-15		16	17	18-30		31	32
ERR	0			MSB.....13 Bit Multiturn				MSB.....15 Bit Singleturn.....LSB				ENC
PositionClkOffset				DATA								OBS

Table 6.17: Clock Bits

If the error bit is set by the encoder, the error message 68-1 is generated.

An error reaction must be configured, just as for all other error numbers.

In warning bit mode (**P 2333[12] = 1**), the error message 69-1 would be generated if a warning bit is set, but only if the corresponding error reaction is not "Ignore (0)" (default).

In addition, a warning is always generated here in the following form:

- Bit 31 in **P 34 ERR_WRN_State** is set. This is a collective bit for the encoder evaluation.
- **P 641 ENC_Warning** contains the error code (2) SSI_WarningBit.
- **P 642 ENC_WarningReset** = (2) Reset_SSI_WarningBit can be used to reset the warning generated this way in both **P 34** and **P 641 ENC_Warning**.
- If the warning bit is still in the SSI bitstream, the warning will be generated again immediately.

6.5.5.2 SSI multiturn function on encoder channel 1

The implementation of the multiturn function (in future also called MTF) is initially restricted to operating an SSI singleturn encoder on encoder channel CH1 (X7). There is the option to subsequently expand to additional encoders on encoder channel CH1 or to encoders on encoder channels CH2 and CH3.



NOTE

- The multiturn function shown here can in no circumstances exactly replicate the multiturn function of a real multiturn encoder. This is because with this function the mechanical multiturn position of the encoder shaft is detected correctly at all times, even if the controller has been switched off and the multiturn position of the encoder shaft has since changed (if the controller is switched off). The MTF is of course unable to do this. The MTF can only ever work within a certain "frame", which has been defined here as follows.

The MTF starts at the position as per the encoder gearing (**P 510/P 511**). The MTF backs up this position whenever the axis changes from "Movement" to "Standstill" (ROT0) (**P 2330**). That means the axis must be in ROT0 (defined by **P 745[1]** or, if this is not defined, by **P 745[0]**) when the servo controller is switched off in order for the MTF to work correctly. If the servo controller is switched off when the axis is moving, the MTF will not work!

While the servo controller is switched off, the axis should not be moved, or only moved as little as possible (significantly less than half a rotation at the encoder gearing output (**P 510/P 511**)). If this condition is met, the previously backed up multiturn position (at the encoder gearing output) will be restored correctly when the servo controller starts up again.

To activate the MTF, all you have to do is set **P 2330[0]**:

--> ENC_CH1_Multiturn_Function[0].Enable=1

ID	Index	Name	Value	Unit	Description
2330		ENC_CH1_Multiturn_Function			Channel 1: multiturn function support
2330	0	Enable	00000000h		Enable multiturn function support (general switch) 1 = enable 0 = none
2330	1	Mode	00000000h		Special mode (0=none)
2330	2	SingleTurnValue	00000000h		Singleturn value
2330	3	MultiTurnValue	00000000h		Multiturn value
2330	4	Valid	00000000h		1: Singleturn/Multiturn values of [2] and [3] are valid
2330	5	ExtWriteEnable	00000000h		1: External write enable to [2], [3] and [4]
2330	6	State	00000000h		Status bits
2330	7	res7	00000000h		reserved 7

Table 6.18: Channel 1: Multiturn function support P 2330

- If [0].Enable=1 is set, the MTF will only become active when the encoder system is reinitialised. (e.g. controller start-up or **P 149**= START(1)).
- Index [1].Mode, [6].Status and [7].res7 do not currently have any functions.
- The position (as per encoder gearing) is backed up in **P 2330 [2].SingleTurnValue** and **P 2330[3].MultiTurnValue**.
- **P 2330[4].Valid** shows whether the value in MultiTurnValue and SingleTurnValue is valid (1) or not (0).
(Valid becomes 0 if the axis is no longer in ROT0.)

Write lock

At first, the MultiTurnValue, SingleTurnValue and Valid values cannot be written with the Moog DRIVEADMINISTRATOR 5. However, the cells are reset by the parameter's factory setting.

If you wish to cancel the write lock for **P 2330[2], [3], [4]**, setting **P 2330[5]** ExtWriteEnable=1 will allow you to do this.

If no SSI singleturn encoder is connected (configured), the MTF will not work. No error message will be generated; instead, there will be a message in the Moog DRIVEADMINISTRATOR 5 message window.



NOTE

- Pay attention to the Moog DRIVEADMINISTRATOR 5 message window!

6.5.6 Encoder gearing



NOTE

- Please read the general information on encoder gearing found in Section "Introduction" on page 54 beforehand.

Encoder channels Ch1 to Ch3 each feature their own encoder gearing, while encoder channel Ch4 (virtual encoders) does not feature *any* encoder gearing.

In the case of encoder channel Ch2, it is assumed that the resolver will always be used as a commutation encoder on the motor shaft. Because of this, the numerator adjustment range is limited to a value of (+1) or (-1), while the denominator is set at a fixed value of (+1), for the Ch2 encoder gearing ratio. This means that the only option available is to invert the encoder signal (direction reversal).

As a whole, the encoder gearing is a scaling factor in the encoder evaluation system and consists of numerator N (ENC_CHx_Num) for the motor side and denominator D (ENC_CHx_Denom) for the encoder side (output side).

The following are used to configure the encoder gearing...

- Ch1 with **P 510[0] - ENC_CH1_Num** and **P 511[0] - ENC_CH1_Denom**,
- Ch2 with **P 512[0] - ENC_CH2_Num** and **P 513[0] - ENC_CH2_Denom**,
- Ch3 with **P 514[0] - ENC_CH3_Num** and **P 515[0] - ENC_CH3_Denom**

P No.	Index	Name	Unit	Description
510	0	ENC_CH1_Num		Denominator of channel 1
511	0	ENC_CH1_Denom		Numerator of channel 1
512	0	ENC_CH2_Num		Denominator of channel 2
513	0	ENC_CH2_Denom		Numerator of channel 2
514	0	ENC_CH3_Num		Denominator of channel 3
515	0	ENC_CH3_Denom		Numerator of channel 3

Table 6.19: Parameters for encoder gearing

Parameters

- **P 500[0] - ENC_CH1_ActVal[0].SingleTurn** and
- **P 500[1] - ENC_CH1_ActVal[1].MultiTurn**

are used, for example, to indicate the current position value at the output for encoder channel Ch1. These parameters can also be used for checking purposes during commissioning.



NOTE

- This value at the encoder channel output...
 - Already contains the encoder gearing ratio factor (N/D)
 - Will be passed into the system in this way (incl. the encoder gearing ratio)
 - I.e. is "the value" from the encoder evaluation system

The encoder gearing ratio has a multiplicative effect on the position progress, i.e. either "expanding" or "compressing".

A distinction can be drawn between an encoder's motor mode and field mode:

- **Motor mode:** The encoder is the motor commutation encoder
- **Field encoder:** The encoder is *not* the motor commutation encoder (instead, it is an additional encoder in the "field", e.g. used for position control purposes)

In motor mode, the encoder gearing is used exclusively to synchronize the motor shaft with the encoder shaft (default: 1:1 if the shaft is the same). In this case, a position progress value will be passed to the system at the encoder channel output. This value will be proportional to the position progress of the motor's commutation (adjusted for the pole pair number).

In field mode, the encoder gearing can be used "freely" for scaling purposes.

6.6 Channel 2: Interface X6

Encoder configuration channel 2 (X6)

Select from Database

Encodename

Encoder type

Number of pole pairs

Gear ratio (if encoder is not fitted at the motor)

Motor

Output drive

Signal correction (GPOC)

Fig. 6.3: Encoder configuration channel 2 (X6) screen

This screen is used to select the encoder for channel Ch2. This channel is used to measure position changes periodically and add them up cyclically – this is referred to as “cyclical evaluation”. Encoder channel Ch2 does not feature an absolute value interface. In addition to evaluating resolvers, this channel can also be used to capture “simple” Sin/Cos signals (up to a max. of 1 kHz and with no zero pulse).

Resolvers must always be evaluated using encoder channel Ch2 (**P 506 - ENC_CH2_Sel** = RES(1)). The resolver pole pairs are set via **P 560[0] - ENC_CH2_Lines**.

Resolver basics and requirements

The connected resolver must meet the following criteria:

- Ccw (positive signal progress corresponds to an anticlockwise direction when looking at the shaft from above)
- No transformation phase shift
- Transformation ratio of approx. 0.5

GPOC is a special Moog online process for improving the quality of Sin/Cos signals before they are used to calculate a position. If Sel = RES(1) or Sel = SINCOS(2), this process may come in handy. For details see Section “Signal correction GPOC (Gain Phase Offset Correction)” on page 79.

P No.	Index	Name / Settings	Unit	Description
506	0	ENC_CH2_Sel		Interface configuration
		OFF (0)		No evaluation
		RES(1)		Resolver evaluation
		SinCos(2)		Resolver excitation shut-off; evaluation of a Sin/Cos encoder (max 1kHz) possible.
512	0	ENC_CH2_Num		Numerator of encoder gearing [-1...+1]
513	0	ENC_CH2_Denom		Denominator of encoder gearing [only +1]
560	0	ENC_CH2_Lines		Number of pole pairs of resolver
561	0	ENC_CH2_Corr		Encoder correction GPOC
562		ENC_CH2_CorrVal		Signal correction settings
	0	Offset S2-S4 track		Offset S2-S4 track
	1	Offset S1-S3 track		Offset S1-S3 track
	2	Gain S2-S4 track		Gain S2-S4 track
	3	Gain S1-S3 track		Gain S1-S3 track
	4	Phase		Phase difference
563	0	ENC_CH2_EncObsMin		Amplitude monitoring Minimum
564	0	ENC_CH2_Info		Encoder name
565		ENC_CH2_LineDelay	µs	Correction of phase shift for cable lengths > 50 m (only after consultation with Moog).

Table 6.20: Encoder configuration channel 2 (X6) parameters

P No.	Index	Name / Settings	Unit	Description
	0	ResExc	us	Exciter signal phase shift
		Delay	us	Compensation for commutation angle delay
566	0	ENC_CH2_Amplitude	±	Correction of amplitude for cable lengths > 50 m (only after consultation with Moog).
567	0	ENC_CH2_EncObsAct		Amplitude of analogue signal

Table 6.20: Encoder configuration channel 2 (X6) parameters (continue)

The **Sel** and **Lines** parameters are self-explanatory.

Other parameters, such as **Num** and **Denom**, are described elsewhere (see Section "Encoder gearing X6" on page 81).

- **P 561[0] - ENC_CH2_Corr** = Signal correction type
The GPOC routine used for track signal correction purposes for sine/cosine signals is used to compensate for systematic errors. The routine is controlled with the **Corr** and **CorrVal** parameters (see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79).
- **P 563[0] - ENC_CH2_EncObsMin** = Encoder monitoring minimum, $\sqrt{a^2+b^2}$
This parameter is used to scale the resolver and Sin/Cos wire break monitoring and represents the "downwards threshold" for an error message. The default setting is 0.2, corresponding to approx. 20% of the track signals' amplitude (approx. 80% corresponds to approx. 1 Vss). If **EncObsMin** is set to 0, the resolver and Sin/Cos wire break monitoring will be disabled (see Section "Channel 1: Interface X7" on page 61 as well).

6.6.1 Compensation for long resolver cables

When using long resolver cables, there will be a phase shift between the controller's exciter output signal and the controller's track input signals (S1-S3 and S2-S4). This phase difference can be compensated for with **P 565[0] - ResExc**: **ResExc** is the time, in μ s (microseconds), by which the resolver excitation will lead. Moreover, **P 565[1] - Delay** can be used to compensate for a commutation dead time, which

can become important in the case of higher rotating field frequencies. When there is an absolute reduction in signal strengths (amplitudes) as a result of the long cables, **P 566[0] - ENC_CH2_Amplitude** can be used to subsequently increase these amplitudes (up to a max. of +10.5%) so that a drive signal level of 80–85% for the track signals is once again attained. This is achieved by adjusting the resolver excitation amplitude. Parameter **P 567[0] - ENC_CH2_EncObsAct** can be used to check the effects of adjusting the compensation settings. It returns the length of the phasor for the track signals ($\sqrt{a^2+b^2}$) and is accordingly a measure of "the amplitude" of the track signals: If the phase shift is properly corrected at the end of the compensation adjustment process, you can save the settings.



NOTE

- This function is not available for the MSD Single-Axis Servo Drive Compact.
- Do not use cable lengths > 50 m without first consulting with Moog.

6.6.2 Signal correction GPOC (Gain Phase Offset Correction)

The resolver and Sin/Cos incremental encoder demonstrate systematic errors that are reflected in the measured position and in the speed calculated from this (gain and phase errors, offset components of the tracking signal). The GPOC method for track signal correction compensates systematic errors. GPOC is available for encoder channels 1 and 2.



Fig. 6.4: Track signals A and B with and without GPOC

Procedure

Step	Action
1.	Open the manual mode window and set speed-controlled mode.
2.	Motor operated at constant speed - Resolver: 1000 rpm - Sin/Cos incremental encoder: 1 to 5 rpm
3.	Set P 549[0] - ENC_CH1_Corr to "ADAPT(2) = Auto correction"
4.	Wait about 1–3 minutes. During this time, the compensation algorithms will reach their steady state. Speed ripple should decrease after about 1 minute. This can be monitored with the actual speed value in the scope or with P 550 - ENC_CH1_CorrVal .
5.	Set P 549[0] - ENC_CH1_Corr to "CORR(1) = Correction with saved values".
6.	Save in the device

Table 6.21: Configuring and activating GPOC



NOTE

- The routine can also be kept enabled permanently. However, this approach is less robust and requires careful testing to determine whether the improved encoder evaluation quality will actually be maintained during continuous operation.
- The GPOC routine will determine the parameters individually for each encoder. If the motor is replaced, the GPOC routine must be activated again.

ID	Index	Name	Unit	Description
549	0	ENC_CH1_Corr		Signal correction type
550		ENC_CH1_CorrVal		Signal correction values
550	0	OffsetA		Offset, track A - cosine
550	1	OffsetB		Offset, track B - sine

Table 6.22: Signal correction (GPOC) parameters for channel 1 (X7)

ID	Index	Name	Unit	Description
550	2	GainA		Gain, track A - cosine
550	3	GainB		Gain, track B - sine
550	4	Phase		Phase difference

Table 6.22: Signal correction (GPOC) parameters for channel 1 (X7) (continue)

6.6.3 Encoder gearing X6

See Section "Encoder gearing" on page 95 The encoder gearing for encoder channels Ch1, Ch2 and Ch3 is described there.



NOTE

- In the case of encoder channel Ch2, it is assumed that the resolver will always be used as a commutation encoder on the motor shaft. Because of this, the numerator adjustment range is limited to a value of (+1) or (-1), while the denominator is set at a fixed value of (+1), for the Ch2 encoder gearing ratio. This means that the only option available is to invert the encoder signal (direction reversal).
- Encoder channel Ch4 (virtual encoders) does not feature any encoder gearing.

6.7 Channel 3: Interface X8 (optional)

Interface X8 can optionally be equipped with a technology option (X8 option) at the factory (this option cannot be retrofitted). There are a variety of optional modules available:

No.	Technology option name	Item designation	MSD Servo Drive	MSD Single-Axis Servo Drive Compact	Documentation
1	Second Sin/Cos encoder	G392/3/4/5/7	X	X	Specification (ID No.: CA79903-001)
2	TTL encoder simulation / TTL master encoder	G392/3/5/7	HW version: Up to .1 SW version: 2.15 or higher	not available	Specification (ID No.: CB08758-001)
3	TTL encoder simulation / TTL master encoder	G392/3/4/5/7	HW version: .2 or higher SW version: All	HW version: .1 or higher SW version: 1.10 or higher	Specification (ID No.: CB32164-001)
4	SSI encoder simulation	G392/3/5/7	X	not available	Specification (ID No.: CB08760-001)
5	TTL encoder with commutation signals	G392/3/4/5/7	X	X	Specification (ID No.: CB32162-001)
6	Second safe Sin/Cos encoder	G392/3/5/7	X	not available	Specification (ID No.: CC23875-001)
7	Second safe SSI encoder	G392/3/5/7	X	Not available	
8	Second safe axis monitoring (Sin/Cos)	G392/3/5/7	X	Not available	

Table 6.23: Options for interface X8

The following X8 options can be used and selected with **P 507[0] - ENC_CH3_Sel** in order to evaluate encoders on encoder channel Ch3:

- No. 1 “Second Sin/Cosencoder”
- No. 3 “TTL encoder simulation / TTL master encoder”
- No. 4 “SSI encoder simulation”
- No. 5 “TTL encoder with commutation signals”



NOTE

- For information on the connector, pinout, technical data, configuration, and the encoder models (if any) that can be evaluated with the included technology option, please consult the Specification specified in the “Documentation” column.
-

The following table shows how the X8 options that can be used for encoder evaluation can be identified and selected.

- **“No.” column**
As per the table above.
- **“Hardware ID” column**
The texts in this column can be viewed in the Moog DRIVEADMINISTRATOR 5 using **P 53[0] - DV_HwOptionX12ID** by going to ► Drive description ► Hardware version if the corresponding technology option is present.
- **“Selection” column**
In certain cases, several different encoder types can be run on a technology option and selected with **P 507 - ENC_CH3_Sel**. Even if a technology option that does not match is equipped, most values can only be selected with **P 507 - ENC_CH3_Sel**. If an impermissible combination is selected, this will be indicated by means of error messages during the initialization phase.

No.	Technology option name	Hardware ID	Selection
0	No module	NONE(0) - No technology option	OFF (0)
1	Second Sin/Cos encoder	SINCOS_V2(10) - 2nd Sin/Cos encoder (V2)	SINCOS(1) - Sin/Cos cyclic *) - Without absolute value interface, Abs=OFF(0), with zero pulse - With SSI one-time reading, Abs=SSI(1) - With EnDat one-time reading, Abs=ENDAT(2) SSI(2) - Cyclical SSI (without analog tracks) TTL(3) - TTL evaluation, with zero pulse ENDAT(4) - Cyclical EnDat (without analog tracks)
3	TTL encoder simulation / TTL master encoder	TTL_ECSIM_V2(9) - TTL Encodersimulation (V2)	TTL(3)
4	SSI encoder simulation	SSI_ECSIM(3) - SSI encodersimulation	SSI(2) - Cyclical SSI (without analog tracks)
5	TTL encoder with commutation signals	TTL_COM(11) - TTL + Hall option	TTL(3) TTL_COM(5)

Table 6.24: Options for X8 interface that can be used to evaluate encoders via encoder channel Ch3

*) SINCOS(1) is set via the **P 507[0] - ENC_CH3_Sel** main interface. The auxiliary interface, **P 570[0] - ENC_CH3_Abs**, can be optionally used to set the one-time reading for the absolute position during initialization.



NOTE

- Only *one* encoder with a purely digital EnDat or SSI interface can be used on connector X8 or X7.
- If two EnDat encoders are used and one of them is purely digital, it is necessary to ensure that the purely digital encoder is connected to X8. This is important, as the EnDat encoder with Sin/Cos tracks must be initialized *before* the purely digital encoder.

To see which technology option your Servo Drive features (if any), go to ►Project tree ►Device setup ►Drive description in Moog DRIVEADMINISTRATOR 5 and check under “Technology option” in the “Hardware” section.

Encoder configuration channel 3 (X8)

Fig. 6.5: Encoder configuration channel 3 (X8) screen

This screen is used to select the encoder for channel Ch3. This channel uses the encoder’s “main interface” to measure position changes periodically and add them up cyclically – this is referred to as “cyclical evaluation”.

Encoders with a main interface that only makes it possible to measure the cyclical position incrementally often feature an additional absolute value interface referred to as an “auxiliary interface”. For this interface, the absolute position is measured once during the initialization phase and is then used for absolute value initialization purposes.

Select from database

Clicking on this button will open a menu that can be used to select encoders. The data sets for Moog encoders will already be available there by default.

Encoder name

You can use this field to enter your own information for describing the encoder (maximum of 31 characters) (**P 580[0] - ENC_CH3_Info**).

Cyclic position via

This drop-down menu is used to select the “main interface” (**P 507[0] - ENC_CH3_Sel**).

Pulses per revolution

Once SINCOS(1), TTL(3) or TTL_COM(5) is selected as the “main interface,” this field will appear so that you can enter the number of analog Sin/Cos tracks per revolution (TTL tracks as well).

Absolute interface

This drop-down menu is used to select the “auxiliary interface” (**P 570[0] - ENC_CH3_Abs**).



NOTE

- Selecting an “auxiliary interface” is redundant if, for example, SSI (2) is selected as the “main interface” (corresponds to cyclical evaluation via SSI). In this case, the absolute value initialization will also be carried out via the SSI interface, regardless of the selected “auxiliary interface”.

Gear ratio

These fields can be used to define a gear ratio for the encoder (in the output side). For more details, see Section “Encoder gearing” on page 95.

Signal correction (GPOC)

GPOC is a special Moog online process for improving the quality of Sin/Cos signals before they are used to calculate a position. If "SINCOS(1)" is selected as the "main interface," this process may be useful. For details see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79.

6.7.1 Main parameters for encoder channel Ch3

The following table lists the most important parameters for the Ch3 encoder channel. These parameters are described in the chapters that go over selecting the various encoders with **P 507[0] - ENC_CH3_Sel** and **P 570[0] - ENC_CH3_Abs**.

The **Lines**, **MultiT** und **SingleT** parameters are self-explanatory.

Code and Mode are used to set SSI modes. If Mode=1, wire break monitoring (if any) will be disabled, for example. If Mode = 0, it will be enabled instead (default).

In the case of linear encoders, **PeriodLen** and **DigitalResolution** will be needed instead of **MultiT** and **SingleT**.

P No.	Index	Name / Setting	Unit	Description
507	0	ENC_CH3_Sel		Main selection on encoder channel Ch3
570	0	ENC_CH3_Abs		Absolute value interface for one-time reading
572	0	ENC_CH3_Lines		Number of analogue Sin/Cos lines per revolution (TTL lines as well)
573	0	ENC_CH3_MultiT		Number of multi-turn bits for the digital interface
574	0	ENC_CH3_SingleT		Number of single-turn bits for the digital interface
575	0	ENC_CH3_Code		Code selection (for SSI encoders) (binary, Gray)
576	0	ENC_CH3_Mode		Mode selection (for SSI encoders)
583	0	ENC_CH3_DigitalResolution	nm	Linear encoders: Length of a digital increment in nm (nanometres)
584	0	ENC_CH3_MTBBase		Definition of point of discontinuity in multi-turn range
585	0	ENC_CH3_MTEEnable		Enable MultiTurn use (negative logic, 1=MTOff)
636	0	ENC_CH3_CycleCount		Sampling cycle in: n x 125 µ (microseconds)

Table 6.25: Main parameters for encoder channel Ch3

- **P 577[0] - ENC_CH3_EncObsMin**

If you set **EncObsMin** to 0, Sin/Cos wire break monitoring will be disabled. The default value is 0.2 (20%) and stands for a calculated amplitude value (calculated using the two Sin/Cos signals) of $x = \sqrt{a^2 + b^2}$. If the Sin/Cos signals are equal to approx. 1 Vss when compared, approx. 0.8 will be calculated here (approx. 80% magnitude at the A-D converters; approx. 0.25 Vss Sin/Cos will yield approx. 0.2 here (20% magnitude at the A-D converter)). The error threshold can adjusted with **EncObsMin**.

- **P 584[0] - ENC_CH3_MTBBase**

When used with its default setting, this parameter will ensure that the absolute value initialization "starts up with plus-minus". I.e. the encoder's multi-turn value range from 0 to max will be mapped to $-\frac{1}{2}$ max to $+\frac{1}{2}$ max. The range from $+\frac{1}{2}$ max to max will be initialized as *negative*; in this case, the point of discontinuity will be found at $\frac{1}{2}$ max. This can be changed with **MTBase**. When MTBase = 0, the absolute value initialization will, for example, "start up with zero to max". I.e. the encoder's multi-turn value range from 0 to max will be mapped to 0 to max. The range from $+\frac{1}{2}$ max to max will be initialized as *positive*; in this case, the point of discontinuity will be found at 0.

- **P 585[0] - ENC_CH3_MTEEnable**

If you set **MTEEnable** to 1, you can use an available multi-turn rotary encoder as a single-turn rotary encoder, which can come in handy for testing purposes.



NOTE

- As there are various protocol modes available for SSI encoders (with/without wire break monitoring, with/without parity bit, etc.), consult with your project supervisor or the Helpline provided by Moog before using any special SSI protocol modes.

As the functionality of the parameters for encoder channel Ch3 is predominantly identical to that of the parameters for encoder channel Ch1, it is recommended to read the description for the Ch1 encoder channel parameters.

Accordingly, the following table starts by listing all the parameters for the Ch3 encoder channel. If the functionality of a parameter is different from that of the corresponding parameter for encoder channel Ch1, the parameter will be described in the chapters that go over selecting a special encoder with (507) ENC_CH3_Sel and (570) ENC_CH3_Abs.

Parameters **Lines**, **MultiT**, **SingleT**, etc. are self-explanatory.

Most of the following parameters are explained in the information for encoder channel Ch1 (see Section "Channel 1: Interface X7" on page 61).

ID	Index	Name	Unit	Description
349	0	CON_FM_MConOffset		Commutation offset
502	0..3	ENC_CH3_ActVal		Current position value at encoder channel Ch3 output
507	0	ENC_CH3_Sel		Main selection on encoder channel Ch3
514	0	ENC_CH3_Num		Encoder gearing: Numerator
515	0	ENC_CH3_Denom		Encoder gearing: Denominator
520	0	ENC_MCon		=3, channel selection for motor commutation
521	0	ENC_SCon		=3, channel selection for speed control
522	0	ENC_PCon		=3, channel selection for position control
570	0	ENC_CH3_Abs		Absolute value interface selection (one-time reading)
571	0	ENC_CH3_NpTest		TEST-MODE: Index pulse signal(s) to Scope
572	0	ENC_CH3_Lines		Number of Lines (Sin/Cos / TTL encoders)
573	0	ENC_CH3_MultiT		Number of MultiTurn bits (absolute encoder)
574	0	ENC_CH3_SingleT		Number of SingleTurn bits (absolute encoder)
574	0	ENC_CH3_Code		Code selection (SSI encoder) (binary, gray)
576	0	ENC_CH3_Mode		Mode selection (SSI encoder)
577	0	ENC_CH3_EncObsMin		Encoder monitoring minimum, sqrt (a ² +b ²) Encoder observation minimum, sqrt (a ² + b ²)
578	0	ENC_CH3_Extended		ENC CH3: Extended
580	0	ENC_CH3_Info		Encoder information channel 3
581	0	ENC_CH3_AbsEncStatus		Error and status codes (absolute encoder)
582	0	ENC_CH3_PeriodLen	nm	Length of signal period (Sin/Cos linear encoder)

Table 6.26: Encoder configuration channel 3 (X8) parameters

ID	Index	Name	Unit	Description
583	0	ENC_CH3_DigitalResolution	nm	Length of one increment (linear absolute encoder)
584	0	ENC_CH3_MTBase		Definition of point of discontinuity in multi-turn range
585	0	ENC_CH3_MTEnable		Enable MultiTurn use (negative logic, 1=MTOff)
586	0	ENC_CH3_Corr		Signal correction type
587	0..4	ENC_CH3_CorrVal		Signal correction values
588	0	ENC_CH3_EncObsAct		Amplitude of analogue signals (vector length)
589	0	ENC_CH3_HallLayout		Hall pattern selection
600	0	ENC_CH3_Position	inc	Position encoder channel 3
602	0	ENC_CH3_Period	ms	Maximum period of interpolation (ttl encoder)
609	0	ENC_CH3_EncOnsActTF	ms	Filter time constant for amplitude of analogue signals
630	0	ENC_CH3_NominalIncrementA	Sign. per.	Nominal increment A (distance coded abs. encoder)
631	0	ENC_CH3_NominalIncrementB	Sign. per.	Nominal increment B (distance coded abs. encoder)
636	0	ENC_CH3_CycleCount		Position encoder sampling cycle (n x 125 µsec)
637	0	ENC_CH3_AbsInitMode		Mode absolute value formation
640	0..29	ENC_ENDAT		EnDat additional
641	0	ENC_Warning		Encoder warning (e.g. from encoder internal memory)
642	0	ENC_Warning		Encoder warning reset (e.g. in encoder internal memory)
643	0	ENC_Error		Encoder error (e.g. from encoder internal memory)
644	0	ENC_ErrorReset		Encoder error reset (e.g. in encoder internal memory)
1900	0	ENC_ETS		ETS mode, electronic nameplate
1902	0	ENC_ETS_CTRL		ETS control, electronic nameplate
1903	0..15	ENC_ETS_STAT		ETS status, electronic nameplate
1904	0..511	ENC_ETS_DATA		ETS data, electronic nameplate
2824	0	ENC_CH3_TTL_SignalType		TTL signal type selection

Table 6.26: Encoder configuration channel 3 (X8) parameters (continue)

6.7.2 Absolute value interfaces X8

The following absolute value interfaces will be available at encoder channel Ch3 depending on the X8 option being used.

- Cyclical Sin/Cos with SSI one-time reading via X8 option: SINCOS_V2(10) - 2nd Sin/Cos encoder (V2)
- Cyclical Sin/Cos with EnDat one-time reading via X8 option: SINCOS_V2(10) - 2nd Sin/Cos encoder (V2)
- Cyclical SSI via X8 options: SINCOS_V2(10) - 2nd Sin/Cos encoder (V2) or SSI_ECSIM(3) - SSI encoder simulation
- Cyclical EnDat via X8 option: SINCOS_V2(10) - 2nd Sin/Cos encoder (V2)

See also table in Section "Channel 3: Interface X8 (optional)" on page 82.

They can be selected with **P 507[0] - ENC_CH3_Sel** and **P 570[0] - ENC_CH3_Abs**. For more details, see Section "Main parameters for encoder channel Ch3" on page 86.

6.7.3 EnDat (cyclical) X8

Ch3: ENDAT(4) - Cyclical EnDat (2.1 or 2.2)

As the EnDat functionality of the parameters for encoder channel Ch3 is predominantly identical to that of the parameters for encoder channel Ch1, it is recommended to read the description for the Ch1 encoder channel parameters (see Section "EnDat (cyclical) X7" on page 63).

The software versions required to run the EnDat interface are the standard software versions for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact.



NOTE

- Please note the limitations that apply when running EnDat and SSI encoders (see Section "Limiting for EnDat and SSI" on page 54).

ID	Index	Name	Unit	Description
507	0	ENC_CH3_Sel = 4		= ENDAT(4)
573	0	ENC_CH3_MultiT		Number of MultiTurn bits (absolute encoder)
574	0	ENC_CH3_SingleT		Number of SingleTurn bits (absolute encoder)
584	0	ENC_CH3_MTBase		Definition of point of discontinuity in multi-turn range
585	0	ENC_CH3_MTEnable		1: Use Multi-turn encoder as a single-turn encoder
636	0	ENC_CH3_CycleCount		Position encoder sampling cycle (n x 125 µsec)
600	0	ENC_CH3_Position	inc	Position encoder channel 3
583	0	ENC_CH3_DigitalResolution	nm	Length of one increment (linear absolute encoder)
640	0..29	ENC_ENDAT		EnDat additional (additional information)

Table 6.27: Channel 3 encoder configuration (X8) - EnDat (cyclical) parameters

6.7.4 Hall sensor X8

Encoder channel Ch3 does not support Hall effect sensors!

6.7.5 Sin/Cos / TTL X8

6.7.5.1 TTL encoder

Ch3: TTL(3) - TTL signals

TTL encoders are ...

- ... usually pure incremental encoders *without* an absolute value interface. In this case, **P 570[0] - ENC_CH3_Abs** must be set to OFF(0).
- ... in a few exceptional cases, incremental encoders *with* an SSI absolute value interface. In this case, **P 570[0] - ENC_CH3_Abs** must be accordingly set to SSI(1) so that it will be possible to read the absolute encoder position for the absolute value initialization routine once during the initialization phase.

6.7.5.1.1 Pure TTL incremental encoder

Set **P 507[0] - ENC_CH3_Sel** to TTL(3) and **P 570[0] - ENC_CH3_Abs** to OFF(0) when using pure TTL encoders, i.e. encoders without an absolute value interface but with a TTL zero pulse.

Linear TTL encoders are run as rotary encoders. For linear motor operation, **P 572[0] - ENC_CH3_Lines** and the encoder gearing (see the "Encoder gearing" section) are used to establish the ratio for the linear motor's pole pair subdivision (North-North) for commutation. 1 x North-North corresponds to one revolution from **Lines**. In this case, the motor pole pair number must be set to 1. **P 582[0] - ENC_CH3_PeriodLen** is not used in this case.

The TTL interface accepts various TTL signal types, which can be selected using **P 2824[0] - ENC_CH3_TTL_SignalType**:

- (0) AF_B - A/B tracks (forward counting, X4 encoding) - AB
- (1) AR_B - A/B tracks (reverse counting, X4 encoding) - AB_inv
- (2) ABDFN - A: Clock (falling edge), B: Direction (1 = positive) - PulseDir
- (3) ABDRP - A: Clock (rising edge), B: Direction (1 = negative) - PulseDir_inv
- (4) reserved

A maximum interpolation period, in ms (milliseconds), can be configured for the TTL interface using **P 602[0] - ENC_CH3_Period**. Within this context, **Period** is the maximum time of "no activity" since the last TTL counter event:

- Period = 0: Function disabled (default)
- Period > 0 (=n ms): If no counter event is registered in n ms, the speed will be set to 0.

Zero pulse

There is no parameter for activating the zero pulse evaluation here, as this evaluation is controlled based exclusively on the homing mode (see Section "Homing" on page 258). However, setting **P 571[0] - ENC_CH3_NpTest** to 1 provides a test mode that can be used during commissioning in order to be able to activate the zero pulse evaluation even without homing. Scope signals 1034 and 1036 can be used to view a received zero pulse within this context. This test mode must be disabled during normal operation (**P 571[0] = 0**).

Commutation

Motor operation with pure incremental encoders needs for the auto commutation function to be enabled without fail. For details see Section "Synchronous motor auto commutation" on page 165.

6.7.5.1.2 TTL incremental encoder with SSI absolute value interface

see Section "Sin/Cos incremental encoders with absolute value interface" on page 90 and in specialSection "SSI absolute value interface" on page 92.

ID	Index	Name	Unit	Description
507	0	ENC_CH3_Sel = 3		Encoder selection set to TTL(3)
514	0	ENC_CH3_Num		Encoder gearing: Numerator
515	0	ENC_CH3_Denom		Encoder gearing: Denominator
570	0	ENC_CH3_Abs		Selection of absolute value interface
571	0	ENC_CH3_NpTest		ENC CH1, TEST-MODE: Index pulse signal(s) to Scope
572	0	ENC_CH3_Lines		Number of lines (Sin/Cos / TTL encoders)
2842	0	ENC_CH3_TTL_SignalType		Channel 3: TTL signal selection
602	0	ENC_CH3_Period		Maximum period of interpolation (ttl encoder)
636	0	ENC_CH3_CycleCount		Sampling cycle in: n x 125 µ (microseconds)

Table 6.28: Parameters for Channel 3 (X8) - TTL encoder

6.7.5.2 Sin/Cos encoder

Ch3: SINCOS(1) - Sin/Cos signals

Sin/Cos encoders can ...

- Be pure incremental encoders *without* an absolute value interface. In this case, **P 570[0] - ENC_CH3_Abs** must be set to OFF(0).
- Be incremental encoders *with* an absolute value interface. In this case, **P 570[0] - ENC_CH3_Abs** must be accordingly set to SSI(1) or EnDat(2) so that it will be possible to read the absolute encoder position for the absolute value initialization routine once during the initialization phase.

6.7.5.2.1 Purely Sin/Cos incremental encoders

To run these encoders as pure incremental encoders with a zero pulse on encoder channel Ch3 (without an absolute value interface), the approach is basically the same as for pure TTL operation (see Section "TTL encoder" on page 88). The same parameters apply.

However, there are the following differences:

- There are no different signal types for the Sin/Cos signal (always 1 Vss for cosine and sine).
- The zero pulse is the analog zero pulse typical of Sin/Cos encoders (see the "Connection for high-resolution encoders" section in the operation manual MSD Servo Drive Single-Axis System, for example).

6.7.5.2.2 Linear Sin/Cos incremental encoders

Linear Sin/Cos encoders are operated as rotary encoders. For linear motor operation, **P 572[0] - ENC_CH3_Lines** and the encoder gearing (see Section "Encoder gearing" on page 95) are used to establish the ratio for the linear motor's pole pair subdivision (North-North) for commutation. 1 x North-North corresponds to one revolution from **Lines**. In this case, the motor pole pair number must be set to 1. **P 582[0] - ENC_CH3_PeriodLen** is not used in this case.

6.7.5.2.3 Signal correction (GPOC)

The GPOC (gain phase offset correction) routine used for track signal correction purposes for sine/cosine signals is used to compensate for systematic errors. The routine is controlled in encoder channel Ch3 with **P 586[0] - ENC_CH3_Corr** and **P 587[0] - ENC_CH3_CorrVal**. For details see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79.

6.7.5.2.4 Sin/Cos incremental encoders with absolute value interface

The following table lists the parameters for cyclical Sin/Cos operation on encoder channel Ch 3 with one-time reading of the absolute encoder position via the absolute value interface, i.e. without a zero pulse:

ID	Index	Name	Unit	Description
507	0	ENC_CH3_Sel = 1		Encoder selection set to SINCOS(1)
514	0	ENC_CH3_Num		Encoder gearing: Numerator
515	0	ENC_CH3_Denom		Encoder gearing: Denominator
570	0	ENC_CH3_Abs		Absolute value interface selection (one-time reading)
572	0	ENC_CH3_Lines		Number of Lines (Sin/Cos / TTL encoders)
573	0	ENC_CH3_MultiT		Number of MultiTurn bits (absolute encoder)
574	0	ENC_CH3_SingleT		Number of SingleTurn bits (absolute encoder)
575	0	ENC_CH3_Code		Code selection (SSI encoder) (binary, gray)
576	0	ENC_CH3_Mode		Mode selection (SSI encoder)
584	0	ENC_CH3_MTBBase		Definition of point of discontinuity in multi-turn range
585	0	ENC_CH3_MTEnable		Enable MultiTurn use (negative logic, 1=MToff)
586	0	ENC_CH3_Corr		Signal correction type
587	0-4	ENC_CH3_CorrVal		Signal correction values
577	0	ENC_CH3_EncObsMin		Encoder monitoring minimum, $\sqrt{a^2+b^2}$
581	0...	ENC_CH3_AbsEncStatus		Error and status codes (absolute encoder)
582	0	ENC_CH3_PeriodLen	nm	Length of signal period (Sin/Cos linear encoder)
583	0	ENC_CH3_DigitalResolution	nm	Length of one increment (linear absolute encoder)
580	0	ENC_CH3_Info		Encoder information
636	0	ENC_CH3_CycleCount		Sampling cycle in: $n \times 125 \mu$ (microseconds)
639	0	ENC_CH3_NominalIncrementA	Sign. per. encoder	Nominal increment A (distance coded abs. encoder)
631	0	ENC_CH3_NominalIncrementB	Sign. per. encoder	Nominal increment B (distance coded abs. encoder)
637	0	ENC_CH3_AbsInitMode		Mode absolute value formation

Table 6.29: Parameters for channel 3 (X8) - Sin/Cos encoder

Some parameters (e.g. Sel, Num, Denom, Abs, Lines, MultiT, SingleT, CorrVal) are self-explanatory.

The Code and Mode parameters are described in Section "SSI (cyclical) X7" on page 71.

- **P 584[0] - ENC_CH3_MTBBase** = Minimum MultiTurn position
The MTBase parameter is used to set a position in the multi-turn encoder's travel path that defines the point of discontinuity (overflow/underflow) for the

absolute value initialization (that is, the "multi-turn basis"). Assuming a bipolar encoder measuring range, all position values that fall below **MTBase** will be shifted "up" (the whole MT range will be added to them once). This method makes it possible to place the point of discontinuity at any point within the encoder's entire measuring range. By default, **MTBase** will be set to the lowest possible value for the parameter, i.e. reliably outside of the encoder's value range: In this case, the full bipolar range will remain unaffected, as values will never fall below this **MTBase** threshold (see Section "Channel 3: Interface X8 (optional)" on page 82 as well).

- **P 585[0] - ENC_CH3_MTEnable** = MultiTurn as SingleTurn
The **MTEnable** parameter makes it possible to use multi-turn encoders as single-turn encoders for test purposes. Negative logic: Default MTEnable = 0 means "MultiTurn-Enable ON".
- **P 586[0] - ENC_CH3_Corr** = Signal correction type:
The GPOC routine used for track signal correction purposes for sine/cosine signals is used to compensate for systematic errors. The routine is controlled with the **Corr** and **CorrVal** parameters (see Section "Signal correction GPOC (Gain Phase Offset Correction)" on page 79).
- **P 577[0] - ENC_CH3_EncObsMin** = Encoder monitoring minimum, $\sqrt{a^2+b^2}$
The parameter **EncObsMin** is used to scale the Sin/Cos wire break monitoring and represents the "downwards threshold" for an error message. The default setting is 0.2, corresponding to approx. 20% of the track signals' amplitude (approx. 80% corresponds to approx. 1 Vss). If EncObsMin is set to 0, Sin/Cos wire break monitoring will be disabled (also see Section "Channel 3: Interface X8 (optional)" on page 82).
- **P 581[0] - ENC_CH3_AbsEncStatus** = Error and status codes (absolute encoder)
- **P 582[0] - ENC_CH3_PeriodLen** = Sin/Cos linear encoder and
P 583[0] - ENC_CH3_DigitalResolution = linear absolute encoder
are the length of an analog Sin/Cos signal period in nanometres and the length of a digital increment of the position from the absolute value interface in nanometres. Both parameters are used for linear EnDat encoders (instead of MultiT and SingleT bits (rotary)). In contrast, linear SSI encoders are

treated as rotary SSI encoders (in this case, it is impossible to determine that the system is a linear encoder system based on the encoder head). Likewise, linear Sin/Cos encoders without an absolute value interface are treated as “rotary” encoders (if run as commutation encoders, the number of tracks, or lines (**Lines**) and the encoder gearing (**Num, Denom**) must be used to establish the relationship to the linear motor’s magn. pole pair subdivision). Only in the case of Sin/Cos encoders with distance-coded reference marks will the system determine, based on **PeriodLen** > 0, that the encoder system is linear and not rotary.

- **P 580[0] - ENC_CH3_Info** = Encoder Information
This parameter is available to the user so that they can enter a text of their choice (max. 31 characters). This text should be used to describe the encoder on channel Ch3
- **P 636[0] - ENC_CH3_CycleCount** = Sampling cycle in: $n \times 125 \mu\text{s}$ (microseconds)
The CycleCount parameter can be used to slow down the timing for the cyclical SSI encoder evaluation. By default, CycleCount = 1, i.e. the default setting corresponds to 125 μs sampling and cycles for the encoder evaluation. Different settings must be viewed as special cases and accordingly must only be used when necessary. (see Section "SSI (cyclical) X8" on page 93).
- **P 630[0] - ENC_CH3_NominalIncrementA** = distance coded absolute encoder
P 631[0] - ENC_CH3_NominalIncrementB = distance coded absolute encoder
The NominalIncrementA and NominalIncrementB parameters make it possible to run Sin/Cos incremental encoders (without an absolute value interface) with analog distance-coded reference marks. E.g. If you were using the Heidenhain ROD280C with 18000 Sin/Cos tracks per revolution and 36 distance-coded reference marks, you would need to set NominalIncrementA to 1000 signal periods and NominalIncrementB to 1001 signal periods. This functionality is enabled if NominalIncrementA > 0. (see Section "Increment-coded reference marks" on page 112).
- **P 637[0] - ENC_CH3_AbsInitMode** = Mode absolute value formation
AbsInitMode can be used to select various possible settings for the absolute

value initialization:

- **DIG_ANA(0)**- Standard:
Absolute value initialization using a mix of the digital and analog components (this is the default mode)
- **DIG(1)** - Digital:
Only the digital component will be used for the absolute value initialization.
- **SEK_SEL37(2)** - Automatic:
Digital if ST bits > (LineBits + 8); otherwise standard
- **SSI_180(3)** - Same as Standard, except:
In the case of SSI, the quadrant alignment of the digital value relative to the analog Sin/Cos tracks is not the same as with EnDat, but is instead offset by 180 degrees relative to EnDat, i.e. in the “natural Q alignment” for the digital value relative to the tracks.

6.7.5.2.5 SSI absolute value interface

If **P 570[0] - ENC_CH3_Abs** = SSI(1), which is the normal setting, the absolute SSI encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental component.

The parameters for the SSI interface are described in Section "SSI (cyclical) X8" on page 93, as are the differences in using the SSI interface with the “cyclical” method and “one-time reading” method.

6.7.5.2.6 EnDat absolute value interface

If **P 570[0] - ENC_CH3_Abs** = ENDAT(2), the absolute EnDat encoder position will be read once during the initialization phase; after this, the cyclical encoder position will be acquired based on the Sin/Cos incremental component.

The parameters for the EnDat interface are described in Section "EnDat (cyclical) X7" on page 63, as are the differences in using the EnDat interface with the "cyclical" method and "one-time reading" method.



NOTE

- Special TTL encoders with commutation tracks can be run on encoder channel Ch3 (X8) by setting **P 507[0] - ENC_CH3_Sel** to **TTL_COM(5)**.

6.7.6 SSI (cyclical) X8

Ch3: SSI(2) - Cyclical SSI

The software versions required to run the SSI encoder interface are the standard software versions for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact.



NOTE

- Please note the limitations that apply when running EnDat and SSI encoders (see Section "Limiting for EnDat and SSI" on page 54).

SSI (Synchronous Serial Interface) is a digital encoder interface that is supported by a large number of manufacturers. It is not standardized, meaning that manufacturers are free to support the interface as they like. The pseudo-standard described below has however been established for motor feedback interfaces. Moog supports this version first and foremost.

The following table lists the parameters for cyclical SSI operation on encoder channel Ch3. It also points out possible differences between the use of the SSI interface with the "cyclical" method and "one-time reading" method when using Sin/Cos encoders with an SSI absolute value interface.

SSI encoder basics and requirements

The SSI interface on the MSD Servo Drive has been designed as an actual motor feedback interface. Accordingly, the connected SSI encoder must meet the following criteria:

- Clock and data inactive level = HIGH
- The current position must be internally stored at the first falling clock edge
- No lengthened calculation time (in first cycle)
- With the first rising clock edge, the encoder must shift the data to the first position bit to be transmitted (MSB)
- 1 Mbps rate
- Data coding = Binary or Gray
- Reading data after the data bits end is permissible
- 125 µs cycle (i.e. internal position refresh rate $\ll$ 125 µs)
- Monoflop time $\geq$ 6 µs
- Data lines driven with logic 0 during monoflop time
- No parity bit
- No error bits or other status bits
- $\leq$ 14 MultiTurn bits

SSI wire break monitoring (bit monitoring during monoflop time)

If monitoring is enabled, the controller, as the SSI clock master, will read data for one more clock cycle after the data bits (reading data after the data bits end is permissible). The bit that the master reads in addition to the data bits this way comes from the SSI encoder's monoflop time. At the time corresponding to this bit, the SSI encoder must drive the data lines with a logic 0. If the data lines on connector X8 are open, a logic 1 will be read here. The bit monitoring at this point makes it possible to determine whether the SSI data lines are being actively driven with a logic 0 at this point (no "wire break") or are not ("wire break"). SSI wire break monitoring can be disabled by setting **P 576[0] - ENC_CH3_Mode** to 0001h.

Mode parameters and CycleCount parameters

P 576[0] - ENC_CH3_Mode can be used to run a parity evaluation after the data. In addition, **ENC_CH3_Mode** makes it possible to run special SSI encoders that deliver one or more special bits after the data. In this case, the MSD Servo Drive will not evaluate these bits – this mode is meant to make it possible to work with SSI encoders that require for these bits to be sampled. **P 636[0] - ENC_CH3_CycleCount** makes it possible to run slower SSI encoders that cannot handle the required cycle of 125 µs. The control characteristics will deteriorate when using this type of SSI encoder, which is why doing so is *not* recommended.

ID	Index	Name	Unit	Description
507		ENC_CH3_Sel = 2		=SSI(2)
573	0	ENC_CH3_MultiT		Number of MultiTurn bits (absolute encoder)
574	0	ENC_CH3_SingleT		Number of SingleTurn bits (absolute encoder)
575	0	ENC_CH3_Code		Code selection (SSI absolute encoder)
576	0	ENC_CH3_Mode		Mode selection (SSI absolute encoder)
584	0	ENC_CH3_MTBBase		Minimum MultiTurn position (SSI absolute encoder)
585	0	ENC_CH3_MTEEnable		Channel 1: Multi-turn as single-turn
600	0	ENC_CH3_Position	inc	Position encoder channel 1
636	0	ENC_CH3_CycleCount		Channel 3: Position encoder sampling cycle (n x 125 µsec)

Table 6.30: Encoder configuration channel 3 (X8) - SSI parameters

The **Sel**, **Lines**, **MultiT** and **SingleT** parameters are self-explanatory.

Other parameters, such as **MTBase** and **MTEEnable**, are described elsewhere (see Section "Channel 3: Interface X8 (optional)" on page 82 and Section "Sin/Cos / TTL X8" on page 88).



NOTE

- Linear SSI encoders will be treated as rotary SSI encoders. In this case, it is impossible to determine that the system is a linear encoder system based on the encoder head.

- P 573[0] - ENC_CH3_MultiT** = Number of multi-turn bits: 0..14
Due to the design of the cyclical SSI interface as a motor feedback interface, the number of multi-turn bits is limited to 14 (no limit to 14 bits in the case of a Sin/Cos interface with SSI one-time reading).
- P 575[0] - ENC_CH3_Code** = SSI decoding: BINARY(0) or GRAY(1)
Gray decoding will be selected by default. The other option is to use binary decoding.
- P 576[0] - ENC_CH3_Mode** = Available SSI auxiliary settings
This parameter has a 16-bit hex value. With the default setting (0000h), SSI wire break monitoring will be enabled. A value of 0001h will disable SSI wire break monitoring, meaning that one bit less will be read.
Following is a list of what some of the terms in the table below stand for:
 - Data = Sequence of all data bits
 - EncObs = Wire break bit
 - Nothing = No bit
 - POdd = Odd parity bit
 - PEven = Even parity bit
 - Free = A free bit

ID	Value	Name	
576		ENC_CH3_Mode	
	0000h	Data_EncObs	Default: with wire break
	0001h	Data_Nothing	
	0002h	Data_POdd_EncObs	ODD Parity
	0003h	Data_Free_POdd_EncObs	
	0004h	Data_POdd	
	0005h	Data_Free_POdd	
	0006h	Data_Free_EncObs	
	0007h	Data_Free_Free_EncObs	
	000Ch	Data_PEven_EncObs	EVEN Parity
	000Dh	Data_Free_PEven_EncObs	
	000Eh	Data_PEven	
	000Fh	Data_Free_PEven	
	001Fh	Data_Free	Extra data reading
	0020h	Data_Free_Free	
	0021h	Data_Free_Free_Free	
	0022h	Data_Free_Free_Free_Free	

Table 6.31: SSI mode parameters (all other values are reserved)

P 636[0] - ENC_CH3_CycleCount = Sampling cycle in: $n \times 125 \mu\text{s}$ (microseconds): **ENC_CH3_CycleCount** can be used to slow down the timing for the cyclical SSI encoder evaluation. By default, **ENC_CH3_CycleCount** = 1, i.e. the default setting corresponds to $125 \mu\text{s}$ sampling and cycles for the encoder evaluation. Different settings must be viewed as special cases and must only be used when necessary.

6.7.7 Encoder gearing



NOTE

- Please read the general information on encoder gearing found in Section "Introduction" on page 54 beforehand.

Encoder channels Ch1 to Ch3 each feature their own encoder gearing, while encoder channel Ch4 (virtual encoders) does not feature *any* encoder gearing.

In the case of encoder channel Ch2, it is assumed that the resolver will always be used as a commutation encoder on the motor shaft. Because of this, the numerator adjustment range is limited to a value of (+1) or (-1), while the denominator is set at a fixed value of (+1), for the Ch2 encoder gearing ratio. This means that the only option available is to invert the encoder signal (direction reversal).

As a whole, the encoder gearing is a scaling factor in the encoder evaluation system and consists of numerator N (**ENC_CHx_Num**) for the motor side and denominator D (**ENC_CHx_Denom**) for the encoder side (output side).

The following are used to configure the encoder gearing...

- Ch1 with **P 510[0] - ENC_CH1_Num** and **P 511[0] - ENC_CH1_Denom**,
- Ch2 with **P 512[0] - ENC_CH2_Num** and **P 513[0] - ENC_CH2_Denom**,
- Ch3 with **P 514[0] - ENC_CH3_Num** and **P 515[0] - ENC_CH3_Denom**

P No.	Index	Name	Unit	Description
510	0	ENC_CH1_Num		Denominator of channel 1
511	0	ENC_CH1_Denom		Numerator of channel 1
512	0	ENC_CH2_Num		Denominator of channel 2
513	0	ENC_CH2_Denom		Numerator of channel 2
514	0	ENC_CH3_Num		Denominator of channel 3
515	0	ENC_CH3_Denom		Numerator of channel 3

Table 6.32: Parameters for encoder gearing

Parameters

- **P 500[0] - ENC_CH1_ActVal[0].SingleTurn** and
- **P 500[1] - ENC_CH1_ActVal[1].MultiTurn**

are used, for example, to indicate the current position value at the output for encoder channel Ch1. These parameters can also be used for checking purposes during commissioning.

NOTE

- This value at the encoder channel output...
 - Already contains the encoder gearing ratio factor (N/D)
 - Will be passed into the system in this way (incl. the encoder gearing ratio)
 - I.e. is "the value" from the encoder evaluation system

The encoder gearing ratio has a multiplicative effect on the position progress, i.e. either "expanding" or "compressing".

A distinction can be drawn between an encoder's motor mode and field mode:

- **Motor mode:** The encoder is the motor commutation encoder
- **Field encoder:** The encoder is *not* the motor commutation encoder (instead, it is an additional encoder in the "field", e.g. used for position control purposes)

In motor mode, the encoder gearing is used exclusively to synchronize the motor shaft with the encoder shaft (default: 1:1 if the shaft is the same). In this case, a position progress value will be passed to the system at the encoder channel output. This value will be proportional to the position progress of the motor's commutation (adjusted for the pole pair number).

In field mode, the encoder gearing can be used "freely" for scaling purposes.

6.8 Channel 4: Virtual encoder

Automatic dimensioning of sensorless control:

1. Design of noise parameter:

Calculation

2. Initializing filter model:

Init. filter model

3. Selection of starting method and design of signal injection:

Controlled

Managed

Manual settings of test signal:☒ off☐ controlled☐ managed

Full signal injection over speed range

100 rpm

Linear increasing signal Amplitude

150 rpm

d-current offset of injected signals

0 A

Frequency of injected sinus

500 Hz

Reference d-Amplitude of injected sinus

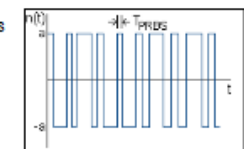
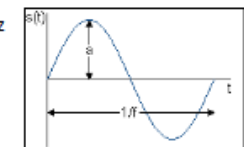
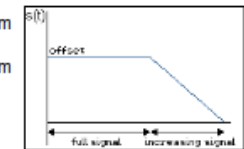
0 A

Time for next PRBS-value

1 ms

Referenced-Amplitude of injected prbs

0 A



Electrical AS motor parameter

Options ...

Fig. 6.6: Virtual encoder screen

6.8.1 Sensorless control synchronous motor



NOTE

- Sensorless control with an expanded Kalman filter requires the following firmware versions:
 - MSD Servo Drive: V123.25-95 or higher
 - MSD Single-Axis Servo Drive Compact: V1.30-98

Value	Value replacement text	Description
0	READY	Waits for input
1	TAKEOVER_ENC CH1	Switches to encoder channel 1 in real-time
2	TAKEOVER_ENC CH4	Switches to encoder channel 4 in real-time
3	PRESET	General initialization for encoder channel 4 with sensorless control; the following are carried out during this initialization routine: • The test signal generator is configured • The Q matrix, R matrix are calculated • The Kalman filter is initialized

Table 6.33: Control word ENC_CH4_Ctrl (P783)

Value	Value replacement text	Description
4	START_KAL	Starts and initializes the Kalman filter without determining the noise covariance matrices and without configuring the test signal generator
5	STOP_KAL	Stop encoder module CH4
6	CALC_RQ	Calculates noise covariance matrices R and Q based on the configured motor parameters

Table 6.33: Control word ENC_CH4_Ctrl (P783) (continue)

P No.	Index	Name	Unit	Description
339		CON_SCON_Kalman		Kalman: Setting
	0	Tf_Kalman	ms	Kalman: Integration time
	1	KpScale_Kalman	%	Kalman: Gain
350		CON_SCALC_SEL		Used to select the speed calculation method
	0	SEL_ObserverMethod		Selection of speed calculation method
508	0	ENC_CH4_Sel		Selection of encoder type
783	0	ENC_CH4_Ctrl		Control
790	0	ENC_CH4_Kalman_R		Sensorless control: R-Matrix
791		ENC_CH4_Kalman_Q		Sensorless control: Q-Matrix
791	0	Q[0,0]		Sensorless control: Q-Matrix (id)
791	1	Q[1,1]		Sensorless control: Q-Matrix (iq)
791	2	Q[2,2]		Sensorless control: Q-Matrix (omega)
791	3	Q[3,3]		Sensorless control: Q-Matrix (epsilon)
791	4	Q[4,4]		Sensorless control: Q-Matrix (T Last)
792		ENC_CH4_Kalman_SigInj		Sensorless control: Test signal generator
792	0	Signal		SC test signal: Signal calculation selection
792	1	Frequency	Hz	SC test signal: Sinusoidal signal frequency

Table 6.34: "Sensorless synchronous motor control" parameters

P No.	Index	Name	Unit	Description
792	2	d-Amplitude sinus	A	SC test signal: d current amplitude of sinusoidal signal
792	3	q-Amplitude sinus	A	SC test signal: q current amplitude of sinusoidal signal
792	4	PRBS time	ms	SC test signal: PRBS signal time
792	5	d-Amplitude PRBS	A	SC test signal: d current amplitude of PRBS signal
792	6	q-Amplitude PRBS	A	SC test signal: q current amplitude of PRBS signal
792	7	Full signal range	rpm	SC test signal: Full test signal amplitude range
792	8	Increasing signal range	rpm	SC test signal: Linear transition range up until which the test signal is reduced to 0
792	9	d-current offset	A	SC test signal: d current offset of sinusoidal signal
794		ENC_CH4_Kalman_ICOM		Sensorless control: Auto commutation
794	0	SettlingTime	ms	SC auto commutation: Rise time
794	1	ICOM_current	A	SC auto commutation: Current offset
794	2	ICOM_time	ms	SC auto commutation: Time (0 = OFF)
794	3	ICOM_1st_L_ident	mH	SC auto commutation: First measured inductance
794	4	ICOM_2nd_L_ident	mH	SC auto commutation: Second measured inductance
796		ENC_CH4_Kalman_isd_add		Sensorless control: Additive load-dependent d current
796	0	Amplitude	A	SC load-dependent d current: Amplitude
796	1	Full signal range	A	SC load-dependent d current: q current at which the maximum d current is injected
796	2	Increasing signal range	A	SC load-dependent d current: Transition range up until which the d current is reduced to 0
796	3	PT1_Tfil	ms	SC load-dependent d current: Filter time for d current (PT1)
797	0	ENC_CH4_Kalman_Compare		Sensorless control: Reference encoder selection

Table 6.34: "Sensorless synchronous motor control" parameters (continue)

6.8.1.1 Auto commutation

When using sensorless control, auto commutation is required in order to ensure that the motor will not align itself towards a direction in an uncontrolled manner. There are two options for commutating the motor when using sensorless operation:

6.8.1.1.1 Mode 1 (default method for non-braked motors)

This mode uses the "Current injection (IENCC)" default auto commutation from **P 390[0] - CON_ICOM**.

If the encoder selection set with **P 520[0] - ENC_MCon**, **P 521[0] - ENC_SCon** and **P 522[0] - ENC_PCon** has been set to channel 4, the commutation angle will be set to 0 at the end of the alignment phase, as the motor will be in the d axis at this point.

6.8.1.1.2 Mode 2

In this auto commutation mode, a positive measuring current and a negative measuring current are injected into the motor in order to take inductance measurements. The measured inductances can then be used to determine whether the motor is in an unstable rest position. The identified values will be entered in **P 794[3] - ICOM_1st_L_ident** and **P 794[4] - ICOM_2nd_L_ident**. It is necessary to ensure that the two values are sufficiently different from each other. If the difference is too small, you can increase the amplitude. However, please note that excessively large amplitudes can result in the motor being demagnetized if auto commutation is used frequently. In case of doubt, ask the motor manufacturer what the maximum permissible current is.

P 792[1] - Frequency and **P 792[2] - d-Amplitude sinus** will be used as the measuring frequency and measuring amplitude. In addition, **P 794[0] - SettlingTime**, **P 794[1] - ICOM_current** and **P 794[2] - ICOM_time** need to be configured.

6.8.1.2 Test signal generator

The test signal generator is required in order to ensure that the Kalman filter will be able to estimate position and speed information even at low speeds (all the way to a stop). There are various signals available for this purpose.

The forms available are a sinusoidal signal and a 32-bit PRBS signal. The frequencies can be freely selected within a range of 100 Hz to 1000 Hz. In addition, there is the option of subjecting the d or q axis to the signals either individually (in an additive manner) or in combination (in a multiplicative manner).

P 792[0] - Signal: 0 = No measuring signal; 1 = Addition; 2 = Multiplication

When using the additive solution, each signal will have its own amplitude. In contrast, when using the combination solution, only the amplitude value of the sinusoidal signal will be used.

In addition, scaling for the test signal amplitudes has been implemented. This ensures that the signal can be applied gradually over a specified speed range. The speed ranges in which the test signal will be applied fully (**P 792[7] - Full signal range**) and in which it will increase (**P 792[8] - Increasing signal range**) can be defined as necessary.

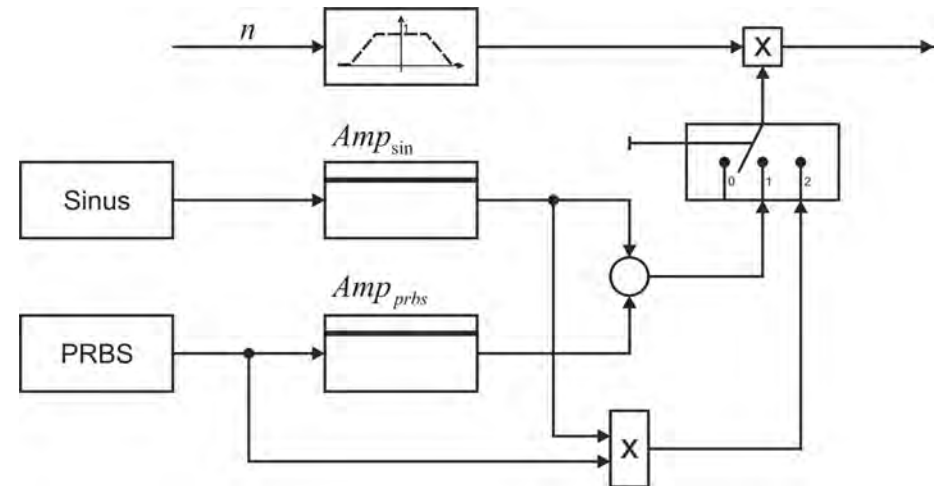


Fig. 6.7: Test signal generators

The following is recommended as a good test signal: A sinusoidal signal with a current amplitude of approx. 10% of the rated current on the d axis with a frequency of approx. 400 Hz. (**P 792[0] = 1; P 792[1] = 400; P 792[2] = 10% Irated**)

In the case of problematic motors, it can be useful to inject an additive d current. This current can be configured to be dependent on the speed (**P 792[9] - d current offset**) or load (796). The following two diagrams use examples to illustrate the influence that the ramp parameters have on the additive d components. Please note, however, that this current will also increase motor losses, meaning it should only be used in exceptional cases.

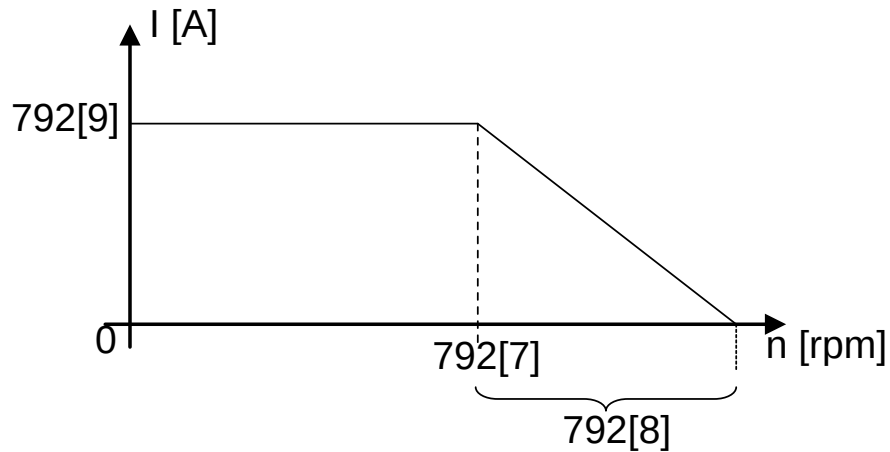


Fig. 6.8: Parameter 792 diagram

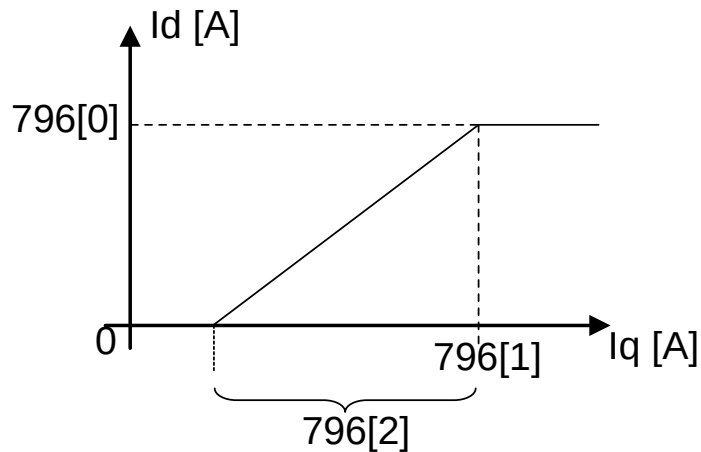


Fig. 6.9: Parameter 796 diagram

6.8.1.3 Expanded speed control circuit

There is the option of setting up an expanded speed control circuit when using sensorless control. The reason for this is that the estimated speed from the Kalman filter cannot be calculated with steady-state accuracy, as parameter inaccuracies are inherent to the model.

Because of this, the speed from the angular derivative is used for “normal” speed control. The angular change describes the difference between two predicted angular positions from consecutive sampling steps. Dividing eps_diff by the observer’s sampling time yields speed n_eps , which, although admittedly noisier than the calculated Kalman filter speed, is accurate in a steady state. However, the heavy noise means that relatively long filter times are required, resulting in the loss of some of the control circuit’s dynamic performance.

In order to be able to use a control scheme with high dynamic performance and steady-state accuracy, a circuit must be put together using two actual speed values (the speed from the angular derivative [n_eps] and the speed from the Kalman filter [n_kal]).

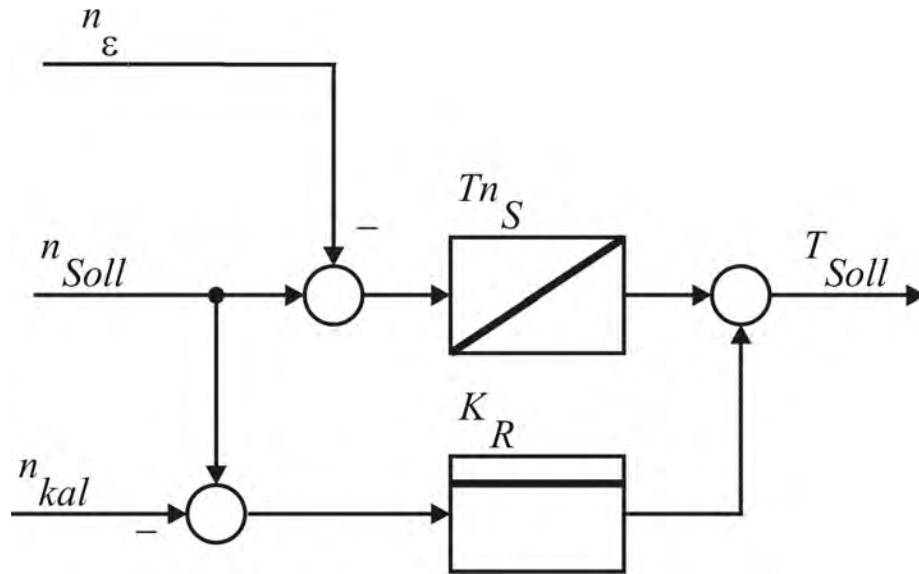


Fig. 6.10: Expanded speed controller layout

The layout for this control scheme is shown in the figure above. It expands the standard speed control circuit in such a way that the deviation between the n_{set} setpoint and the n_{eps} actual value is fed through the integral term. This ensures that the speed control circuit will be accurate in its steady state in regard to the speed. In order to be able to continue using calculated speed n_{kal} , which is less noisy and more dynamic, this speed is used for feed-forward control purposes. To this end, the deviation between n_{set} and n_{kal} is added to the output from the I controller via a proportional term.

Before being fed into the circuit, speeds n_{kal} and n_{eps} can each be smoothed with a filter (**P 351[0]** for n_{eps} and **P 339[0]** for n_{kal}). The expanded speed control circuit can be started with **P 350[0]** ("4" => Kalman)

P 351[1] can be used to implement additional scaling for the speed control proportional term for the feed-forward control.

Measurements have shown that, when using the expanded control circuit, motors with a marked saliency can be operated in a sensorless manner even without a test signal.

6.8.1.4 Commissioning

The first step in commissioning sensorless control is correctly determining the motor data and control parameters and configuring them accordingly. At this point, it is especially important to ensure that the inductance difference between the motor's d and q axes is set correctly. This can be done with **P 480[0] - MOT_Lsq**. If this parameter is not available (older firmware), **P 472[0] - MOT_LsigDiff** can be used to set the difference as a percentage.

In order to obtain an accurate number, the values for the d and q inductances should:

- Be obtained from the motor manufacturer's data sheet or the motor data set OR
- Be requested from the motor manufacturer OR
- Be measured by Moog with an "advanced motor identification" routine OR
- Be determined as an approximation for most motors with the motor identification routine

If none of these options is available, it is possible to start with a rough setting of $L_q = 110\% \cdot L_d$ for a test with a servomotor. However, you must then be ready for limited operation within a narrow speed range.

The inductance difference is important when it comes to sensorless control, as the Kalman filter can determine the position based on the inductance difference in

combination with a test signal when the motor is stopped. In addition, the total moment of inertia resulting from the motor and the connected load must be set as accurately as possible.

The encoder communications will be used to calculate and pass the actual speed and actual position. Accordingly, in order to select the sensorless method, a value of 2 must be set for encoder channel 4 in the selector (**P 508[0] - ENC_CH4_Sel** = 2), and a value of 4 must be set for **P 520[0] - ENC_MCon**, **P 521[0] - ENC_SCon** and **P 522[0] - ENC_PCon**.

The Kalman filter needs to be configured further by following the steps below:

Step	Action
1	Configure noise covariance matrices Q and R. This should be done automatically by setting the control parameter for encoder channel 4 (P 783[0] - ENC-CH4-Ctrl) to a value of 6.
2	Manually configure the test signal generator: Recommendation: Sinusoidal test signal in d axis P 792[09] = 1 P 792[19] = 500 Hz P 792[2] = P 792[9] = 10% of rated motor current P 792[79] = 15% of rated motor speed P 792[89] = 5% of rated motor speed P 792[9] = 30% of rated motor current Set the other values to 0 Or set the control parameter for encoder channel 4 (P 783[0] - ENC-CH4-Ctrl) to a value of 3, which will trigger a general initialization routine in which steps 1 and 2, as well as encoder initialization, will be automatically carried out based on the motor parameters.

Table 6.35: Configuring the Kalman filter for sensorless control

Step	Action
3	Configure the auto commutation function
	Mode 1 As described in Section "Auto commutation" on page 98 or Recommendation: P 390[0] = 1 P 392[0] = 500 P 392[1] = 500 P 392[2] = 500 P 392[3] = 500 P 393[0] = Rated motor current P 393[1] = Rated motor current
	Mode 2 Parameters 792.1 and 792.2 are used as the measuring frequency and measuring amplitude (see step 2) Recommendation: P 794[0] = 100 ms P 794[1] = 50% of rated motor current P 794[2] = 250 ms
4	Starting the expanded speed control circuit is not absolutely necessary, but will result in control with better dynamic performance. The circuit can be started by setting P 350[0] - SEL_ObserverMethod to a value of 4. P 339 - CON_SCON_Kalman can be used for tuning purposes.
5	If necessary, adjust the noise covariance matrices and the filter time constants for the expanded speed control circuit (changes will take effect in real-time).

Table 6.35: Configuring the Kalman filter for sensorless control (continue)

In order to make the encoderless control commissioning process easier, a function used to calculate the position difference between encoderless control and a real encoder can be activated. To use this function, the encoder channel that will be used for the comparison must be selected in **P 797[0] - ENC_CH4_Kalman_Compare**. Make sure that the encoder channel is configured correctly! This also includes the encoder mounting angle **P 349[0] - CON_FM_MConOffset**. In addition to the position difference, the encoder angle is also used to determine the d current and q current as scope variables.

6.8.2 Sensorless asynchronous motor control

In sensorless mode, the other variables (position, speed, torque) are calculated based on characteristic motor data and the measured currents and voltages on the motor. A problem is determining position at standstill or at low speed.

6.8.2.1 Activation of sensorless control for asynchronous motors

Proceed as follows:

No.	Activity
1	Set motor type (P 450[0] - MOT_Type) to "2 (ASM) = asynchronous motor".
2	Enter the motor name (P 451[0] - MOT_Name).
3	Copy the motor variables from the rating plate into the appropriate input box.
4	Start motor identification to identify other motor parameters.
5	In the "Encoder selection" screen (see also section "Encoder selection" on page 55) under "Encoder for commutation and torque control," set P 520[0] - ENC_MCon to "CH4(4) = virtual encoder (Channel 4)".
6	Under "virtual encoder (Channel 4)" "Encoder selection" set (P 508[0] - ENC_CH4_Sel) to "SFC(8) = take values of SFC model".
7	In the "Basic Control Settings" screen (see section "Basic settings" on page 101) set "Speed filter TF" (P 351[0] - CON_SCALC_Tf) to 10 ms.
8	In the "Asynchronous motor control settings identification" screen (see also section "Asynchronous motor" on page 40) enter the "Total moment of inertia" of the system (P 1516[0] - SCD_JSum). Enter a value that is too small rather than too big to avoid a tendency to oscillate. Automatic detection is not advisable due to the control dynamics and accuracy required.
9	In the same screen under "Control design by stiffness" set P 1515[0] - SCD_ConDesign (Stiffness) to 10%.

Table 6.36: Commissioning a sensorless-controlled asynchronous motor

Additional setting parameters

P No.	Index	Name	Unit	Description
351		CON_SCALC_Tf		Speed filter
	0	CON_SCALC_Tf	ms	Filter time const. speed control (motor)
	1	CON_SCALC_Tf	ms	Filter time const. velocity (hydraulic cyl.)
	2	CON_SCALC_Tf	ms	Filter time const. speed from position control.
792		EN_CH4_Kalman_SigInj		Sensorless control: Test signal generator.
	0	Signal		
	7	FullSignalRange	rpm	SC test signal: Linear transition range up until which the test signal is reduced to 0.
	8	IncreasingSignalRange	rpm	SC test signal: Linear transition range up until which the test signal is reduced to 0.
	9	d current offset	A	SC test signal: d current offset of sinusoidal signal.
1959		CON_SFC_Para		SFC Parameter
	0	TF_is	ms	filter time constant of isd/isq.
	1	K_ov	%	Anti-overtuning limitation factor.
	2	K_isd	%	d-axis current control scaling.
	3	Tstart	ms	start-up time (flux settling).
1973		CON_SFC_VoltageError		Settings for SFC voltage errors model. Low voltage characteristic: must be set during the motor identification; may require some coordination effort.
	0	I_err	A	low-voltage characteristic: corner current
	1	V_err	V	low-voltage characteristic: corner voltage.

Table 6.37: Parameter "Sensorless asynchronous motor control"

6.8.2.2 Start-up of a sensorless-controlled asynchronous motor in I/f mode

P No.	Index	Name	Unit	Description
792		EN_CH4_Kalman_SigInj		Sensorless control: Test signal generator
	0	Signal		
	7	FullSignalRange	rpm	SC test signal: Linear transition range up until which the test signal is reduced to 0
	8	IncreasingSignalRange	rpm	SC test signal: Linear transition range up until which the test signal is reduced to 0
	9	d current offset	A	SC test signal: d current offset of sinusoidal signal

Table 6.38: Parameters for start-up of a sensorless-controlled asynchronous motor in I/f mode

An asynchronous motor is not suitable for sensorless positioning due to its design because the rotor does not have a fixed magnetic pole. Moreover, asynchronous motors controlled without sensors tend to have unstable behaviour at low speeds and low torques in generator mode.

First attempt to use the SFC controller in the proximity of the standstill. (**P 792.0 signal = 0**). This allows gentle operation and an optimal torque utilization. Set the standstill behaviour with the error voltage model **P 1973.1 U_err**; generally, a setting of 50% of the original setting yields good results.

It is possible that a flux boost may improve the results at low speeds when a large load is set in motion from a standstill. Set **P 792[0] Signal = 1**, **P 792[7]** to 50 . . . 200 rpm, **P 792[8]** to 200 . . . 500 rpm and **P 792[9]** to the d-current required for starting. If the motor tends to tip, then attempt to limit the permissible slip using **P 1959[1] K_ov**.

If the stability and the torque in the proximity of standstill are inadequate, use the current/frequency mode (I/f). Set **P 792[0] Switch = 2**. Set the speed limits **P 792[7]** and **P 792 [8]** lower than for the use of flux boost. The d current **P 792 [9]** must be adequate to set the maximum possible load in motion when starting.

Bear in mind that a certain control gain K_{isd} is required for the momentary current; for this purpose, observe the scope signals of I_{sd} and I_{sdref} during acceleration.

With **P 792 [0] signal = 3**, the drive also works in I/f control mode at low speeds. When the "full-signal range" speed is attained, then a switch to SFC control takes place at once.

Whether a setting of "2" or "3" is the better choice depends on the application.

6.8.3 EtherCAT® encoder

If you are evaluating encoder information on a PLC and wish to send this information via EtherCAT to the controller, you can do the following:

1. In the project tree, select "Encoder" and open the "Encoder selection" screen. You have to decide which control circuit you wish to use the information for.
2. Example: "Encoder for position control".
Under "Encoder for position control", select CH4(4)= Virtual encoder

(channel 4).

Encoder selection

Select from Database

Encoder for commutation and torque control loop:

CH4(4) = Virtual encoder (channel X4) Options...

Encoder offset deg Detect

Encoder for speed control loop:

OFF(0) = No encoder selected Options...

Encoder for position control loop:

CH4(4) = Virtual encoder (channel X4) Options...

3. Under "Options", you can now choose between:
 - a. a 16-bit encoder value with **P 508 (1)**

Select encoder:

FIELD BUS(1) = Position via Fieldbus

- b. a 32-bit encoder value with **P 508 (10)**

Select encoder:

FIELD BUS32(10) = Fieldbus32

4. The objects you need to describe with the PLC (in increments) are:
 - a. MPRO_402_ComAngle **P 2290** Object for 16-bit encoder value
 - b. MPRO_402_ComAngle32 **P 2298** Object for 32-bit encoder value
5. Finally, you can check the incoming encoder value using **P 503** and then scale it as required.

P No.	Index	Name	Unit	Description
503		ENC_CH4_ActVal		Actual value of encoder channel 4
503	0	ENC_CH4_ActVal		Singleturn
503	1	ENC_CH4_ActVal		Multiturn

6. Table 6.39: P 503 "ENC_CH4_ActVal", incoming encoder value

6.9 Redundant encoder

It is possible to set the position difference between the positioning encoder and a redundant encoder. To do this, the channel of the redundant position encoder must be specified in **P 524[0] - ENC_EncRedPos** and the maximum position tracking error must be specified, in increments, in **P 597[0] - ENC_RedPos_DiffMax**. Monitoring is not active if **P 524[0] = 0** and the drive has been referenced. It is reset when the associated error is acknowledged or homing is executed again.

P No.	Index	Name	Unit	Description
524	0	ENC_EncRedPos		Selection of the channel (1-3) with which the position encoder is to be evaluated.
597	0	ENC_RedPos_DiffMax	inc	Maximum position tracking error setting

Table 6.40: Parameters for monitoring the position difference

6.10 Axis correction

The position value delivered by the encoder system and the actual position value on the axis may vary for a number of reasons. Such non-linear inaccuracies can be compensated by axis error correction (using position- and direction-dependent correction values). For this, a correction value table is filled with values for each of the two directions. The respective correction value is produced from the current axis position and the direction of movement by means of cubic, jerk-stabilized interpolation. The position value is adapted on the basis of the corrected table. Both tables contain 250 interpolation points.

The correction range is within the value range delimited by parameters **P 591 - ENC_ACOR_PosStart** "Start position" and **P 592 - ENC_ACOR_PosEnd** "End position correction". The start position is preset on the user side; the end position is determined on the drive side.

Possible cause of deviations

- Inaccuracy of the measuring system
- Slack in mechanical elements such as the gearing, coupling, feed spindle etc.
- Thermal expansion of machine components.

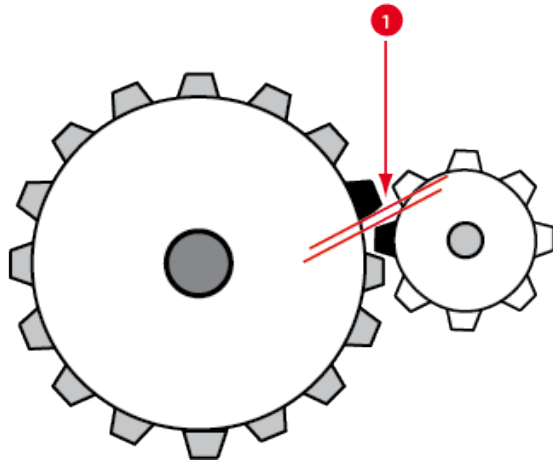


Fig. 6.11: Mechanical system axis correction (① = slack in gearing)

P No.	Index	Name / Setting	Unit	Description
530	0	ENC_Encoder1Sel		Channel selection for the 1st Encoder
531	0	ENC_Encoder2Sel		Channel selection for the 2nd Encoder
590	0	ENC_ACOR_Sel		
		0 (= OFF)		No encoder selected
		1 (= 1. Encoder)		1. encoder selected
		2 (= 2. Encoder)		2. encoder selected
591	0	ENC_ACOR_PosStart		Definition of correction range: The range is defined by parameters P 0591 ENC_ACOR_PosStart Start position and P 0592 ENC_ACOR_PosEnd end position. The start position is user-specified; the end position is determined on the device side from the maximum value of correction table interpolation points used and the interpolation point pitch.
592	0	ENC_ACOR_PosEnd		

Table 6.41: Axis correction parameters

P No.	Index	Name / Setting	Unit	Description
593	0	ENC_ACOR_PosDelta		Interpolation point pitch: The positions at which the correction interpolation points are plotted are defined via parameters P 0593 ENC_ACOR_PosDelta Interpolation point pitch and P 0591 ENC_ACOR_PosStart Start position. Between the correction interpolation points, the correction values are calculated by cubic spline interpolation.
594	0	ENC_ACOR_Val		Actual position
595	0-250	ENC_ACOR_VnegTab		Values of the correction table for negative direction of rotation in user units.
596	0-250	ENC_ACOR_VposTab		Values of the correction table for positive direction of rotation in user units.

Table 6.41: Axis correction parameters (continue)

Step	Action
1.	Use P 530 - ENC_Encoder1Sel to select the channel for SERCOS: 1st Encoder
2.	Use P 531 - ENC_Encoder2Sel to select the channel for SERCOS: 2nd Encoder
3.	Selection of the encoder whose actual position value is to be changed, with P 590 - ENC_ACOR_Sel
4.	Enter interpolation point pitch in P 593 - ENC_ACOR_PosDelta
5.	The correction values are determined using a reference measurement system (e.g. laser interferometer). The interpolation points for the various directions within the desired correction range are approached one after another and the corresponding position error is measured.
6.	The interpolation-point-specific correction values are to be entered manually in the tables P 595 - ENC_ACOR_VnegTab (neg. direction) and P 596 - ENC_ACOR_VposTab (pos. direction).
7.	Save values
8.	Restart the device
9.	P 592 - ENC_ACOR_PosEnd now shows the position end value of the correction range.
10.	Start control (in position control execute homing) and then move to any position.
11.	The momentary correction value is written to P 594 - ENC_ACOR_Val . This value is subtracted from the approached position value. This applies to all positions. End position = interpolation point pitch multiplied by number of interpolation points (table values) + start position (only if start position $\neq 0$).

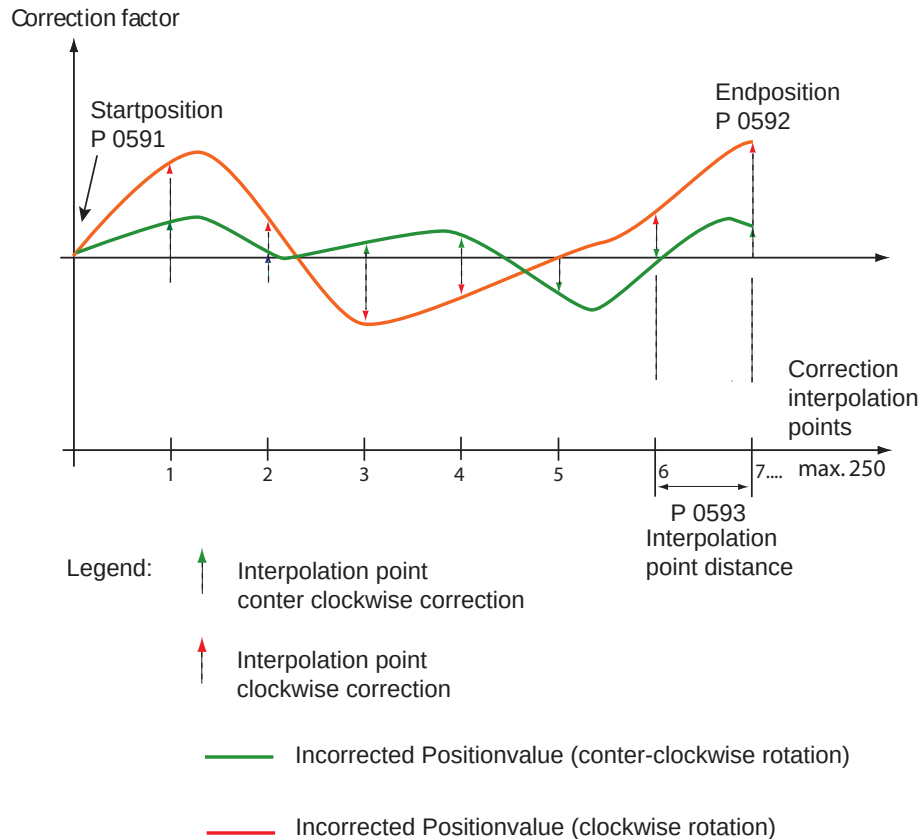
Table 6.42: Axis correction procedure

Position control

The direction of movement is produced when the time-related change in position reference (speed pre-control value) has exceeded the amount of the standstill window in the positive or negative direction.

Speed control

The direction of movement is produced when the speed reference has exceeded the amount of the standstill window in the positive or negative direction.



NOTE

- Parameterization is carried out in the selected user unit for the position as integer values. It is advisable to use the same number of correction interpolation points for the positive and negative directions. The first and last correction values in the table must be zero in order to avoid instability (step changes) of the actual position value. Differing correction values for the positive and negative directions at the same interpolation point will lead to instability in the associated actual position value when the direction is reversed, and so possibly to a step response adjustment to the reference position.
- If the correction value is greater than the position step size **P 593 [0] - ENC_ACOR_PosDelta**, discontinuities can also occur.
- The applied correction value is to be seen as a position tracking error, but is corrected immediately. However, this can also be checked in user units using the scope parameter 1001 (with smoothing) and 1003.

Fig. 6.12: Corrected position value

6.11 Oversampling

Encoder signal oversampling optimizes the accuracy of resolver and Sin/Cos signals. This function can only be used, if necessary, for low-track Sin/Cos encoders and resolvers; using it for high-track Sin/Cos encoders is *not* permissible.

ID	Index	Name	Unit	Description
1956		CON_ACT_Ovrs		Encoder signal oversampling. This function applies only to resolver and Sin/Cos signals
1956	0	active		Switch for activating and deactivating the function
1956	1	pmeas		The percentage measuring time for oversampling dependent on the sampling time.
1956	2	filtershift		Limit frequency for the oversampling filter
1956	3	sourceselect		Signal source for oversampling
1957		CON_ACT_Ovrs_Tracks		Oversampled track signals
1957	0	Track_a		
1957	1	Track_b		

Table 6.43: Oversampling parameters



NOTE

- When oversampling is enabled, instead of the normal A/D signals the oversampled signals for the encoder specified in parameter **P 1956[3] - sourceselect** are used. In the case of high-track Sin/Cos encoders in particular, the low limit frequency of the oversampling filters may result in quadrant errors. If the oversampling units are used, it must always be certain that the encoder does not dramatically exceed the specified limit frequencies.
- Before using oversampling, consult with your project supervisor or the Moog Helpline.

6.12 Multi-turn encoder as a single-turn encoder

By way of parameters **P 548[0] - ENC_CH1_MTEEnable = 1** (for Channel 1) and **P 585[0] - ENC_CH3_MTEEnable = 1** (for Channel 3) a multi-turn encoder can be run as a single-turn encoder. This function is used primarily for testing purposes.

6.13 Increment-coded reference marks

In the case of encoders with increment-coded reference marks, multiple reference marks are distributed evenly across the entire travel distance. The absolute position information, relative to a specific zero point of the measurement system, is determined by counting the individual measuring increments between two reference marks. The absolute position of the scale defined by the reference mark is assigned to precisely one measuring increment. Before an absolute reference can be created or the last selected reference point found, the reference mark must be passed over. In the worst-case scenario this requires a rotation of up to 360°. To determine the reference position over the shortest possible distance, encoders with increment-coded reference marks are supported (e.g. HEIDENHAIN ROD 280C).

The reference mark track contains multiple reference marks with defined increment differences. The tracking electronics determines the absolute reference when two adjacent reference marks are passed over after just a few degrees of rotation.

Number of pulses (P 542)	Number of reference marks	Basic increment G Nominal Increment A (P 610)	Basic increment G Nominal increment B (P 611)
18 x 1000 lines	18 basic marks + 18 coded marks = Σ 36	Reference measure A = 1000 lines corresponding to 20°	Reference measure B = 1001 lines

Table 6.44: Example of a rotary system on encoder channel Ch1

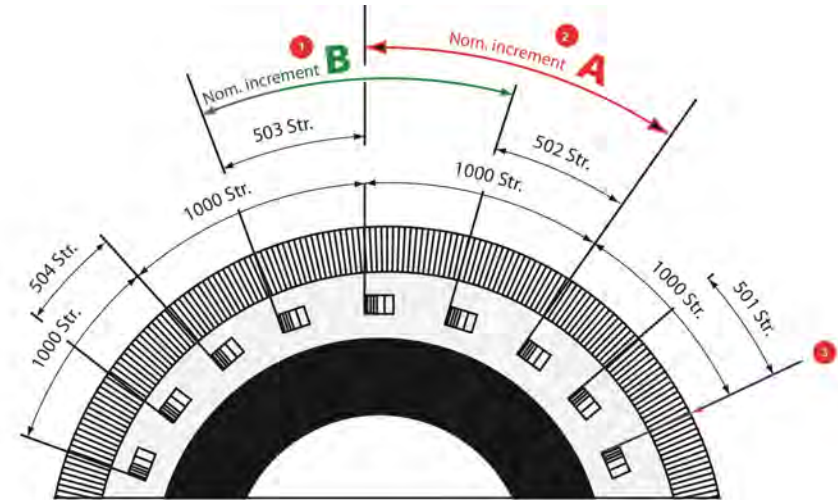


Fig. 6.13: Schematic view of circular graduations with increment-coded reference marks

- ① Increment-coded reference measure B, large increment (1001 lines): **P 611[0] - ENC_CH1_NominalIncrementB**
- ② Increment-coded reference measure A, small increment (1000 lines): **P 610[0] - ENC_CH1_NominalIncrementA**

Zero point: Parameter **P 542[0] - ENC_CH1_Lines** is used to enter the number of lines (e.g. 18 x 1000). A sector increment difference of +1, +2, +3 and +4 is supported. One mechanical revolution is precisely one whole multiple of the basic increment A.

Legend for Schematic view of circular graduations with increment-coded reference marks

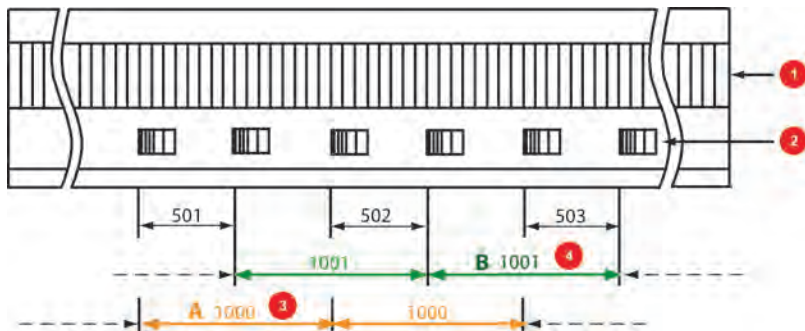


Fig. 6.14: Schematic diagram of a linear scale

- ① Pitch periods (TP): (**P 542[0] - ENC_CH1_Lines**)
- ② Reference marks
- ③ Increment-coded reference measure A (small reference mark interval) (**P 610[0] - ENC_CH1 Nominalinkrement A**)
- ④ Increment-coded reference measure B (large reference mark interval) (**P 611[0] - ENC_CH1 Nominalinkrement B**)

Legend for Schematic diagram of a linear scale

Homing methods for increment-coded encoders

- Method -6: Increment-coded encoders with negative direction of rotation
- Method -7: Increment-coded encoders with positive direction of rotation

6.14 Overflow in multi-turn range

With this function the multi-turn range can be shifted in order to avoid a possible overflow. The function is available for encoder channels 1 and 3.

Example

If a portion of the travel distance is to the left of the threshold (MT Base), it is appended to the end of the travel range (to the right of the 2048) via parameter **P 547[0] - ENC_CH1_MTBase** for encoder channel 1 and **P 584[0] - ENC_CH3_** for encoder channel 3 (unit: increments).

For more information see Section "Main parameters for encoder channel Ch1" on page 62 and Section "Sin/Cos incremental encoders with absolute value interface" on page 67.

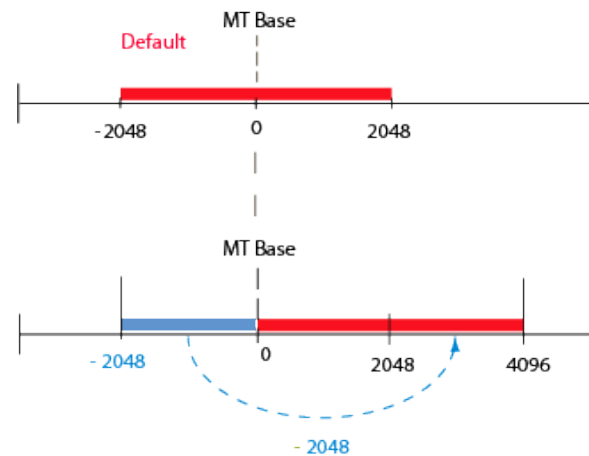


Fig. 6.15: Multi-turn range shifting

P No.	Index	Name	Unit	Description
547	0	ENC_CH1_MTBa		Definition of point of discontinuity in multi-turn range
584	0	ENC_CH3_MTBa		Definition of point of discontinuity in multi-turn range

Table 6.45: Parameters for shifting the multi-turn overflow

6.15 Zero pulse test

To enable evaluation for the zero pulse test, **P 541/P 571 = ON (1)** is set. On the oscilloscope it can then be depicted with the measurement variables CH1/3_Np. To make the zero pulse clearly visible, the measurement variable remains high until the next zero pulse appears. Conversely, the measurement variable remains low until another zero pulse appears. Bear in mind that the pulse width of the scope signal does not match the pulse width of the actual zero pulse.

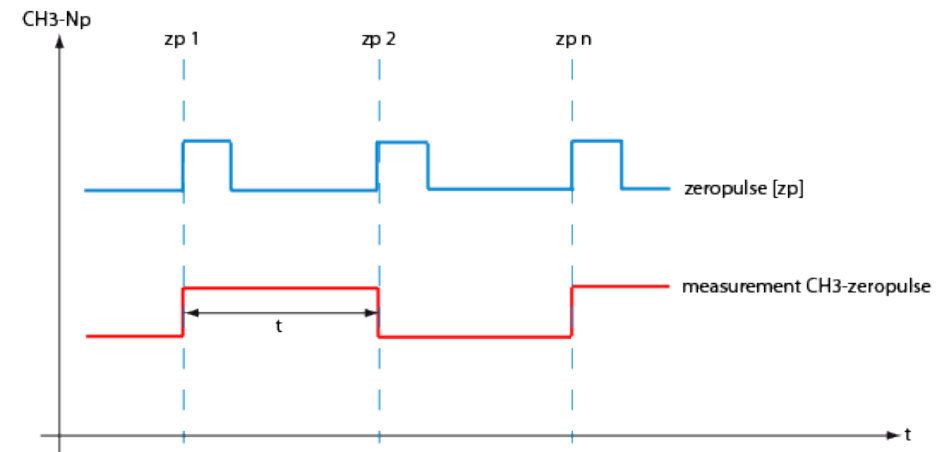


Fig. 6.16: Zero pulse recording via measurement variable CH1/3_Np



NOTE

- When in zero pulse test mode, zero pulse evaluation will *not* be available during homing.
- **Regardless of this**, all zero pulse events will be counted. The zero pulses are counted by counter evaluation **P 411[31]** for channel 1 and **P 411[32]** for channel 3 (under ► Actual values ► All values in the Moog DRIVEADMINISTRATOR 5)

7 Control

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Controller

Brief description

This chapter describes the various control types, settings and optimisation options and recommended procedures.

Contents

7.1 Overview of control structure	115
7.2 Basic settings	117
7.3 Torque controller	120
7.4 Speed controller	138
7.5 Position controller settings	149
7.6 Asynchronous motor field weakening	152
7.7 Field weakening and LookUpTable (LUT), synchronous motor	155
7.8 Synchronous motor auto commutation	165
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7.1 Overview of control structure

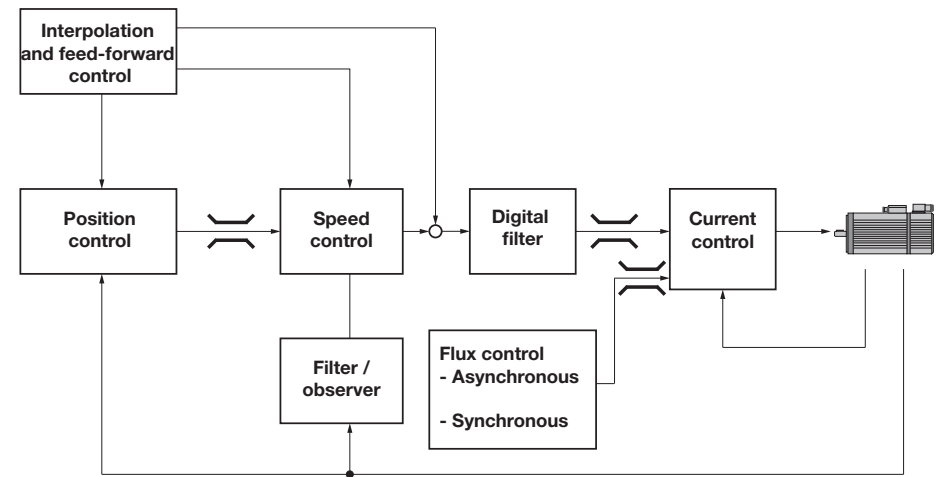


Fig. 7.1: Overview of control structure

Legend for figure Control Structure	
Position Controller/Feed Forward Control	see 7.5 Position controller settings
Position controller	see 7.5 Position controller settings
Speed controller	see 7.4 Speed controller
Digital filter	see 7.4.2 Digital filter
Current Controller	see 7.3 Torque controller
Filter/observer	see 7.3.6 Advanced torque control
Field weakening, asynchronous	see 7.6 Asynchronous motor field weakening
Field weakening, synchronous	see 7.7 Field weakening and LookUpTable (LUT), synchronous motor

Scanning times of the individual control circuits:

Switching frequency	Sampling time		
	Current Controller	Speed controller	Position controller
2 kHz	250 μ s	250 μ s	250 μ s
4 kHz (12 kHz)	125 μ s	125 μ s	125 μ s
8 kHz (default setting)	62.5 μ s	125 μ s	125 μ s
16 kHz	62.5 μ s	125 μ s	125 μ s

Table 7.1: Scanning times of the individual control circuits

The control system is set up in a cascaded configuration. The position, speed and current controllers are configured in sequence. The sequence of controller setup must always be observed in controller optimization.

1. Current controller setup
2. Speed controller setup

3. Setting for position controller / Pre-control

7.1.1 Setting

When using a standard Moog motor data set, the control parameters are preset for the specific motor model (external mass inertia = motor inertia). If using third-party motors, a manual setting must be made for the drive by way of the motor identification or by calculation in order to define the appropriate control parameters for the motor model.

7.1.1.1 Speed control loop

The setting of the speed controller with the associated filters is dependent on the motor parameters (moment of inertia, torque/force constant, load inertia/mass, friction, rigidity of the connection and encoder quality). Consequently, a manual or automatic optimization is often required.

7.1.1.2 Position control loop

The position control loop is dependent on the dynamism of the underlying speed controller, on the setpoint (reference) type and on the jerk, acceleration and interpolation methods.

7.2 Basic settings

The basic settings for the control are selected and parametrized using the "Motor control setup" screen. This screen aids navigation to the basic settings, various controllers and the control mode.

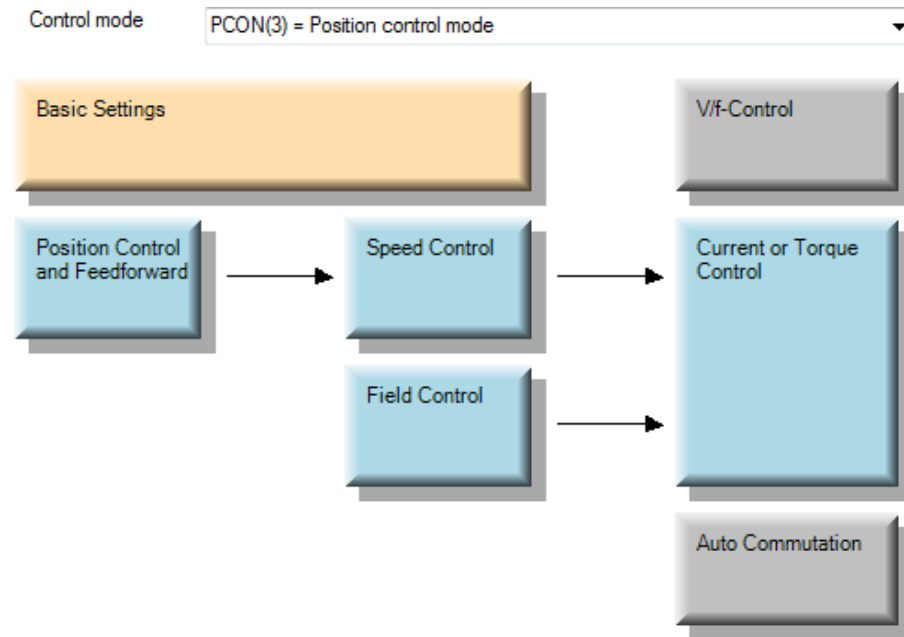


Fig. 7.2: "Motor control settings" screen



NOTE

- **P 300[0] - CON_CfgCon** specifies the control mode with which the drive is to be run. This parameter takes effect online. Uncontrolled online switching can cause an extreme jerk, a very high speed or an overcurrent, which may cause damage to the system.

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. • Before the "Start" step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.

7.2.1 Motor control basic settings

Click on the "Basic settings" button opens the wizard to determine the mass inertia, the rigidity wizard, as well as the speed and position controllers.

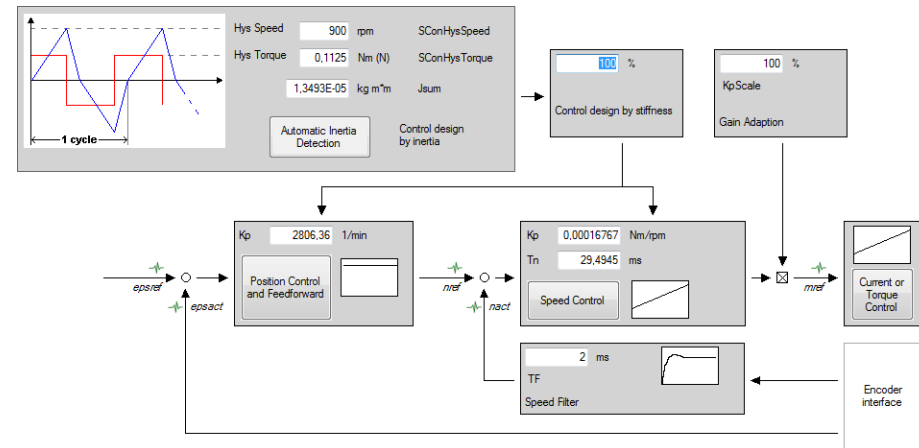


Fig. 7.3: "Motor control basic settings" screen

7.2.1.1 Adjustment of the mass inertia

If the mass inertia value is not known, the wizard can be used to determine it (see Section "Automatic inertia detection" on page 118).



NOTE

- While the mass inertia is being determined the motor executes movements. There is a risk that the system and the motor may be destroyed.

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. • Before the "Start" step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.

7.2.1.2 Adaptation to the rigidity of the drive train

The settings for the speed and position control with feed forward control are determined automatically by setting the rigidity. The rigidity is stated in percent in the wizard.

- The setting < 100% reduces the dynamic performance of the controller setting (e.g. for a toothed belt drive).
- The setting > 100% increases the dynamic performance of the controller setting (low play and elasticity).

The speed controller gain is scaled separately using the percentage value KP Scale. The damping of the control is affected by the speed filter.

Useful settings are:

- Resolver: 1-2 ms
- Sin/Cos encoder (low-track): 0.5 - 1 ms
- Sin/Cos encoder (high resolution): 0.2 - 0.6 ms



NOTE

- After a power-off the speed and position control settings remain stored. The percentage value for rigidity, however, is set to 100% again.

7.2.2 Automatic inertia detection

To define the mass inertia of a motor easily, the "automatic mass inertia definition" function is available. In the standard motor data set, the speed controller is preset for a moderately stiff mechanical system

.The automatic mass inertia definition function is started when the hardware has been enabled. Clicking the "Automatic Inertia Definition" button enters the latest value obtained in SCD_Jsum.

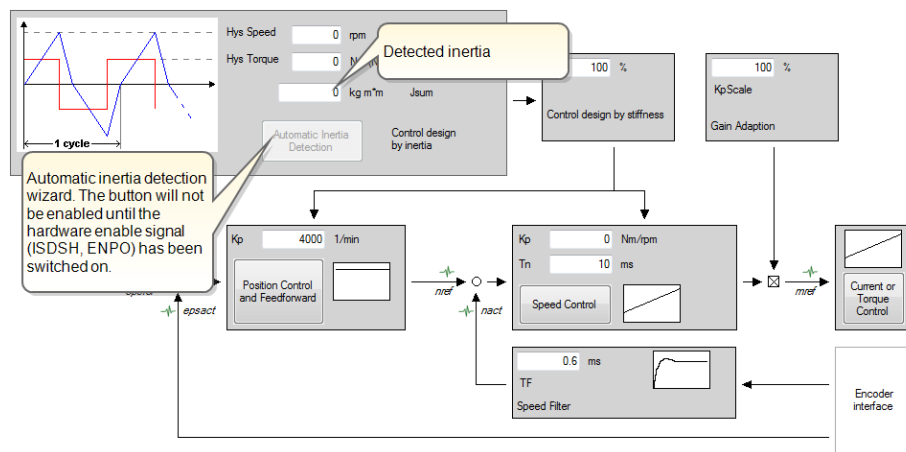


Fig. 7.4: "Determining the mass inertia" screen



NOTE

- In systems with high static friction, the inertia determination can be assigned an additional additive speed setpoint. **P 404[0] - CON_SCON_AddSRamp** can be used for this.



NOTE

- While the mass inertia is being determined the motor executes movements. There is a risk that the system and the motor may be destroyed.

CAUTION!

Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.



Improper conduct can cause damage to your system / machine.

- Before the "Start" step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.



NOTE

- This function is not recommended for horizontal axes. Attention must be paid to the mechanical end stops with this function. This function is only to be used with a freely rotating motor shaft.



NOTE

- If no values are entered for "Hysteresis Speed" and "Hysteresis Torque", 20% of the rated speed and 20% of the rated torque is set. The distance covered results from the preset values.

7.3 Torque controller

The torque controller is executed as a PI controller. The gain (P-component) and the integral-action time (I-component) of the individual controllers are programmable. In order to optimize the current control loop, two rectangular reference steps are preset. The object of the optimization is a current controller with moderate dynamism and the following values:

- Current control time: < 1 ms
- Overshoot: < 5%

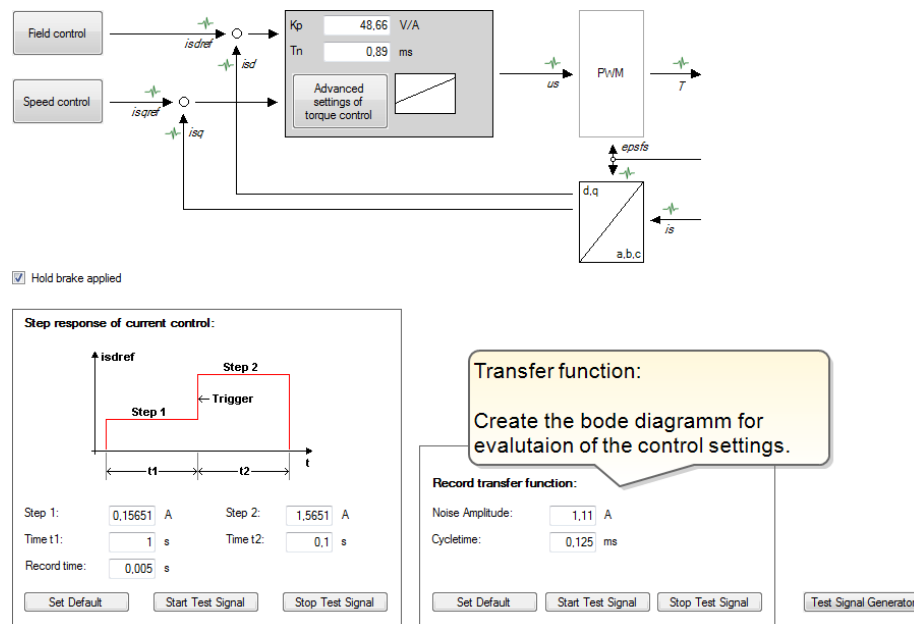


Fig. 7.5: "Current/torque controller settings" screen

7.3.1 Current controller optimization

The faster the actual value approaches the setpoint, the more dynamically the controller is set. The overshoot of the actual value should not be more than 5-10 % of the setpoint (general figure) during the settling process.

- The first step (stage 1, time 1) moves the rotor to a defined position.
- The second step (stage 2, time 2) is used to optimize the torque control (step response). The height of the 2nd step should not be too large, so as to ensure that the voltage setpoint will not go all the way to the limit (low-level signal response required).
- The current and time settings automatically adjust to the motor data. The current is equal to $I_n \cdot \sqrt{2}$.
- ISDSH and ENPO (hardware enable) must be set to "High".
- Click "Start test signal" button
- Observe the safety notice: When you confirm the safety notice a step response is executed.
- The oscilloscope is set automatically.



Fig. 7.6: Current controller optimization

7.3.2 Creating the transfer function

The oscilloscope automatically records the amount and phase response of the controller according to the controller settings. This produces an initial estimate of the control quality. To determine the transfer function the noise amplitude (motor rated current) and the sampling time (default 0.125 ms) must be specified. Click the "Start Test Signal" button.

Record transfer function:

Noise Amplitude: A

Cycletime: ms

Fig. 7.7: "Noise amplitude, sampling time" screen

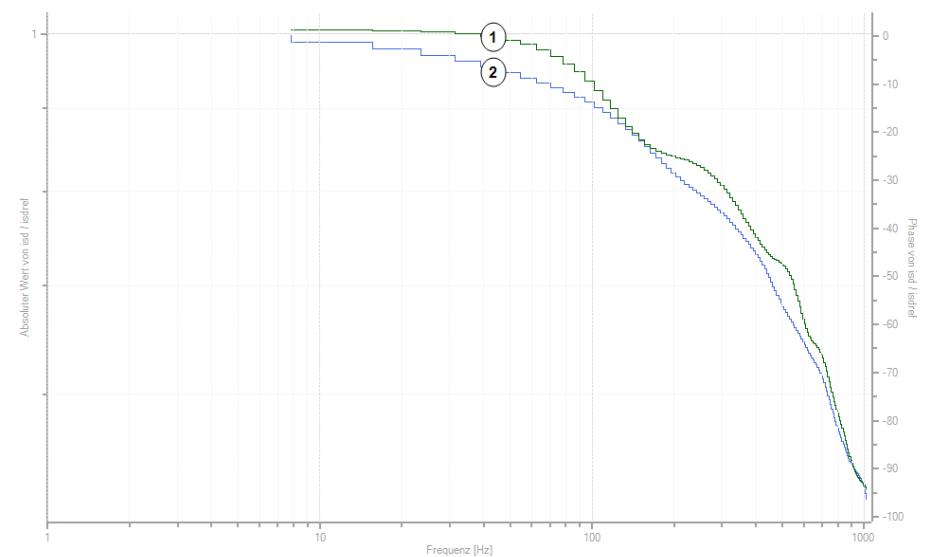


Fig. 7.8: Current controller transfer function

-
- ① Green curve = amount
Y-axis left = absolute value of i_{sd}/i_{sdref}
 - ② Blue curve = phase response
Y-axis right = Phase response i_{sd}/i_{sdref}
-

Legend for Current controller transfer function

7.3.3 Decoupling

The current control has a decoupling of the d- and q-axis by means of feed-forward control of the corresponding coupling voltages. The decoupling depends on the stator inductance **P 471 MOT_Lsig** and can be scaled with parameter **P 434.3**. This is helpful, for example, if the inductance has been estimated inaccurately.

If the decoupling is set too high, current control is unstable.

7.3.4 Current actual value filter

A first-order digital filter (PT1) can be configured in order to smooth the measured "isd" and "isq" actual current values. This is particularly useful when using drives with high speeds.

NOTE



- The control dynamic performance will be reduced when using the current actual value filter. Using the current actual value filter is not advisable for drives that require a high control dynamic performance.

The current actual value filter is configured with **P 1960[0] - CON_ACT_ISDQ_TF**, with the filter time constant being defined in milliseconds.

Filtered actual currents "isd" and "isq" can be visualized with scope signals 25 and 26. The unfiltered values can be visualized using scope signals "isd_unfil" (129) and "isq_unfil" (130).

7.3.5 Detent torque compensation

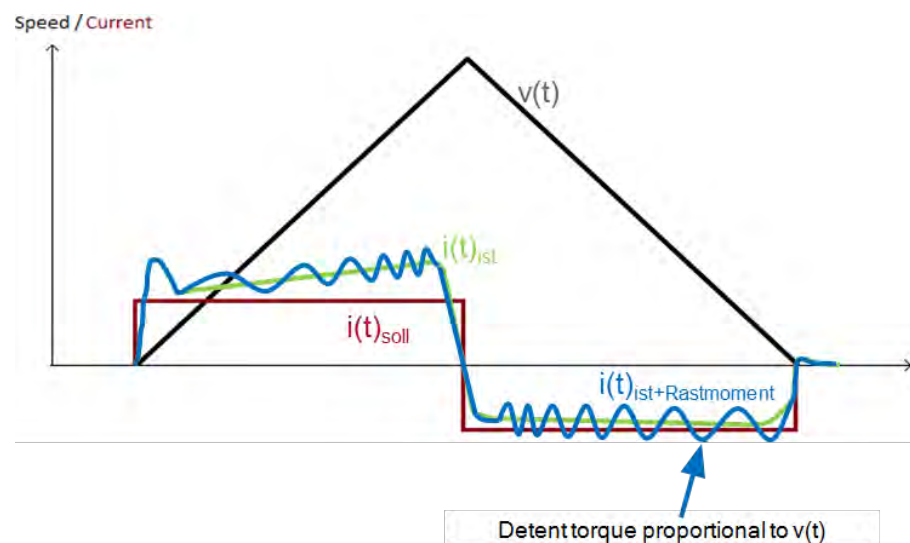


Fig. 7.9: Typical positioning sequence

In speed and position-controlled operation, the ripple of the torque and power causes a current ripple in the q-current. When detent torque compensation is used, these q-current input data are imported to a teach table in the controller (**teaching routine, learning**). The compensation table is created from this (**calculation**) which is then ultimately used for the feed forward control of the q-current in the controller (**compensation**).

In the low speed range, these disturbance torques can be eliminated well by the control system. In the medium to high speed range, the disturbance torques can be reduced very well using the table-based compensation described here. In the high speed range, however, this feed forward control with its finite resolution no longer provides an advantage: the detent torque compensation is eliminated linearly via the fade function (ramp).

In a broader sense, detent torque compensation can always be used when a disturbance torque occurs 'regularly' as a function of the position.

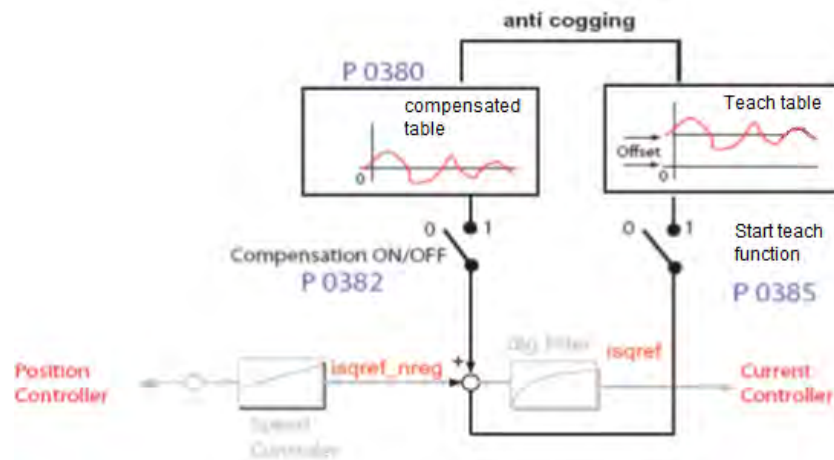


Fig. 7.10: Detent torque compensation schematic

The parameter **P 385[0] - CON_TCoggTeachCon** selects the position source for the teaching and sets the teach modes (including: rotary or absolute): the teaching is activated and the compensation is deactivated. With 'start control' in the speed control mode, the teaching (teaching routine) begins with a slow run: e.g. ≤ 1 rpm (at least one revolution of 'learning' travel).

With the control still operating (and a slow run), the teaching is then stopped by calling the calculation function once: with **P 385[0] - CON_**

TCoggTeachCon=CALC1(3) or with **P 385[0] - CON_TCoggTeach- Con = CALC2 (8)**. It 'calculates' the corresponding compensation table (which can be saved) from the teach table (which cannot be saved): the compensation table is filled in immediately and is ready for the compensation. After the 'calculation' is complete, the parameter **P 385[0]** automatically jumps back to **P 385[0] - CON_**

TCoggTeachCon = READY(0). The teaching and calculation are thus finished. The position source used by the teaching has been stored internally. Now the control system can (should) be stopped. The compensation table still needs to be saved, e.g. using the MDA5 "Save setting persistently in device" button. The position source used by the teaching is also saved. It will later be used for the compensation once again in exactly the same manner.

The compensation (feed forward control) can now be activated using: **P 382[0] - CON_TCoggComp > 0**.

Caution: Of course, not every compensation parametrization fits with every previous teaching parametrization.

The input and output variables can be observed via scope signals during the teaching routine and the compensation. The signal **156_eps_comp** here gives the current raw input position (source) both during the teaching routine and later during the compensation. The signal **157_eps_comp.tune** gives the current input position including the input tuning (only for the functions 1). The table index and the table output can both be accessed via the scope signals **440_CON_TAB_TabIdx** and **446_CON_TAB_OutVal**.



NOTE

- As of firmware V123.60-98, the detent torque compensation function can be used for all control modes. In older versions, this compensation is implemented exclusively for speed and position control.

7.3.5.1 “Detent torque compensation” parameters

ID	Index	Name	Unit	Description
380		CON_TCoggAddTab		Anti cogging compensation table
380	0 to 251	CON_TCoggAddTab	A	
382	0	CON_TCoggComp		Anti cogging enable compensation
385	0	CON_TCoggTeachCon		Anti cogging control word
440	0	CON_TAB_TabIndex		Compensation table: index
441	0	CON_TAB_TabVal	A	Compensation table: Value at CON_TAB index
442	0	CON_TAB_PosStart	specific	Comp. table start position (unit depends on source signal)
443	0	CON_TAB_PosDelta	specific	Compensation table delta position
445	0	CON_TAB_TeachDir		Compensation table teaching direction (sign of speed)
446	0	CON_TAB_OutVal	A	Compensation table: output value
447		CON_TAB_Tune		Compensation table fine-tuning
447	0	TimeDelayComp	specific/rpm	Time delay compensation for speed dependent phase shift
447	1	PosShift	specific	Compensation table position shift
447	2	ScaleFactor		Compensation table amplitude scaling
447	3	FadeOutStart	rpm	Speed value, where cogging compensation fadeout starts
447	4	FadeOutEnd	rpm	Speed value, where cogging compensation fadeout ends

Table 7.2: “Detent torque compensation” parameters

There are two functions each for teaching, calculating and compensation (F1 and F2). This fulfils a series of **different requirements**:

Two tables each for teaching and compensation:

- One small table with 250 elements each and
- One large table with 4000 elements each.

Input mapping diagram: two different methods for the input reference:

- Input reference 'fixed' 32-bit: incremental, '**rotary**' recurring position: The entire width of the 32-bit input position has 'fixed mapping' over the entire 'width' of the

table. →recurring, infinite

Table: index = (inpos inc / 2³² inc) * tabsize, with tabsize = 250 or 4000

- Input reference 'variable' via delta (**): absolute, '**linear**' continuous position: the 32-bit input position has 'variable mapping' to the table via delta (**),

Delta in number of input increments per table section (one index spacing distance).

→ absolute

Table: index = (inpos inc - offset inc(***) / delta inc (**)

(**) **Delta-Parameter P 443[0] - CON_TAB_PosDelta**

(***) Offset Parameter P 442[0] - CON_TAB_PosStart

Input tuning using parameter **P 447[0,1] - CON_TAB_Tune[0,1]**:

- [0].TimeDelayComp: speed dependent index correction, default 0.
- [1].PosShift: absolute index correction, default 0.

Output scaling using parameter **P 447[2] - CON_TAB_Tune[2]**:

- [2]. ScaleFactor: multiplicative output correction, default 1.0.

Output fader using parameter **P 447[3,4] - CON_TAB_Tune[3,4]**:

- [3].FadeOutStart: Fader starting speed, default 0 rpm.
- [4].FadeOutEnd: Fader ending speed, default 0 rpm.

As of the starting speed, the effect of the isq feed forward control is faded out linearly with the increase of the 'slow' speed. A ramp is used which ensures that at the ending speed, the isq feed forward control no longer has any effect (=0). The fader is activated when the starting and ending speeds are >0 and are plausible relative to each other.

Teach direction using parameter **P 445[0] - CON_TAB_TeachDir**:

- Function 2 operates optionally with suppression of the direction of travel (not function 1!). The default setting here is for the teaching in function 2 to only be 'effective' in the positive direction of travel, which means that travel in both directions is possible. However, entries are made in the teach table only in the positive direction of travel in this case; in the negative direction of travel, all entries into the teach table are then suppressed.

Index display: for teaching routine and compensation:

- **P 440[0] - CON_TAB_TabIndex:** Index of the table

The current table index calculated using the input position is output here both during the teaching routine and the compensation. (The parameter is accessible via the scope.)

Table value display: for teaching routine and compensation:

- **P 446[0] - CON_TAB_OutVal:** output value (of the table)

The currently determined table value of the teach table is output here during the teaching routine. The current isq feed forward control value interpolated using the compensation table is output here during the compensation. (The parameter is accessible via the scope.)

Access to the compensation tables

- Access to the small compensation table with 250 elements:

Reading and writing using parameter **P 380[0..251] - CON_TCoggAddTab[0..251]**.

As with other parameters as well, saving takes place in the context of the parameter record being saved in the device's special memory for parameters.

- Access to the large compensation table with 4000 elements:

Offline, i.e. when neither a teaching routine nor compensation are taking place 'online', the individual elements of the large compensation table can be accessed using:

Index: Reading and writing using parameter **P 440[0] - CON_TAB_TabIndex**.

Value: Reading and writing using parameter **P 441[0] - CON_TAB_TabVal**.

Saving takes place in conjunction with the saving of the parameter record in the device's mass memory (limitation of the max. number of storage cycles).

7.3.5.2 Settings for teaching, calculating and compensation

(385) CON_TCoggTeachCon	—
(3)CALC1	= Calc rotary SmallTab, Calc absolute BigTab F1: rotary, small TeachTab to small CompTab F2: absolute, big TeachTab to big CompTab
(8)CALC2	= Calc rotativ BigTab F1: rotary, big TeachTab to big CompTab
(4)RESET	= Reset teach table entries Reset both teach tables to No-Init-Value (1000.0)
(0)READY	= Teaching switched off
(1)TeachEpsRS-1	= Teach epsrs commutation angle (electrical) - F1: Small teach table (250) - F1: Rotary, mapping: fixed 32-bit - F1: Without teaching direction - F1: <u>Without</u> offset and delta, with tuning, with fader Calculation: (385)CON_TCoggTeachCon=(3)CALC1 Compensation: (382)CON_TCoggComp=(1)EPSRS → small CompTab (380)CON_TCoggAddTab
(2)TeachEpsRS-2	= Teach epsrs commutation angle (electrical) as for (1)TeachEpsRS-1
(5)TeachUserRefPos	=Teach (277)MPRO_FG_UserRef Pos:reference position in user units - F2: Big teach table (4000) - F2: Absolute, mapping via (443)CON_TAB_PosDelta - F2: With teaching direction - F2: Without offset and delta, with tuning, <u>without</u> fader Calculation: (385)CON_TCoggTeachCon=(3)CALC1 Compensation: (382)CON_TCoggComp=(2)APSPoS → big CompTab, access via (440) and (441)
(6)TeachEpsM	=Teach epsm mechanical angle (shaft)

Table 7.3: Settings for teaching, calculating and compensation

(385) CON_TCoggTeachCon	—
	Singleturn position from encoder for commutation - F1: Big teach table (4000) - F1: Rotary, mapping: fixed 32-bit - F1: Without teaching direction - F1: <u>Without</u> offset and delta, with tuning, with fader Calculation: (385)CON_TCoggTeachCon=(8)CALC2 Compensation: (382)CON_TCoggComp=(3)EPSM → big CompTab, access via (440) and (441)
(7)TeachPosEncPcon	=Teach posact from pcon encoder Actual position from encoder for position control in reference value normalization, Scope-Signal 152 - F2: Big teach table (4000) - F2: Absolute, mapping via (443)CON_TAB_PosDelta - F2: With teaching direction - F2: Without offset and delta, with tuning, <u>without</u> fader Calculation: (385)CON_TCoggTeachCon=(3)CALC1 Compensation: (382)CON_TCoggComp=(2)APSPPOS → big CompTab, access via (440) and (441)
(9)TeachPconEncPos	=Teach (412)CON_PCON_ActPosition Actual position from encoder for position control in reference value normalization - F2: Big teach table (4000) - F2: Absolute, mapping via (443)CON_TAB_PosDelta - F2: With teaching direction - F2: Without offset and delta, with tuning, <u>without</u> fader Calculation: (385)CON_TCoggTeachCon=(3)CALC1 Compensation: (382)CON_TCoggComp=(2)APSPPOS → big CompTab, access via (440) and (441)

Table 7.3: Settings for teaching, calculating and compensation (continue)

(385) CON_TCoggTeachCon	—
(10)TeachPosEncRed	=Teach posact from redundant encoder Actual position from so called redundant encoder in ref value normalization, Scope-Signal 153 - F2: Big teach table (4000) - F2: Absolute, mapping via (443)CON_TAB_PosDelta - F2: With teaching direction - F2: Without offset and delta, with tuning, <u>without</u> fader Calculation: (385)CON_TCoggTeachCon=(3)CALC1 Compensation: (382)CON_TCoggComp=(2)APSPPOS → big CompTab, access via (440) and (441)
(11)TeachSTPosPcon	=Teach singleturn position from position control Singleturn position of position control - F1: Big teach table (4000) - F1: Rotary, mapping: fixed 32-bit - F1: Without teaching direction - F1: <u>Without</u> offset and delta, with tuning, with fader Calculation: (385)CON_TCoggTeachCon=(8)CALC2 Compensation: (382)CON_TCoggComp=(3)EPSM → big CompTab, access via (440) and (441)
(12)TeachEpsRS-3	=Teach epsrs commutation angle (electrical) - F1: Big teach table (4000) - F1: Rotary, mapping: fixed 32-bit - F1: Without teaching direction - F1: <u>Without</u> offset and delta, with tuning, with fader Calculation: (385)CON_TCoggTeachCon=(8)CALC2 Compensation: (382)CON_TCoggComp=(3)EPSM → big CompTab, access via (440) and (441)

Table 7.3: Settings for teaching, calculating and compensation (continue)

The compensation (feed forward control) is activated using parameter: **P 382[0]** - **CON_TCoggComp** > 0.

- **OFF(0)** = Compensation switched off
- **EPSRS(1)** = Compensation as a function of the electrical angle, Small table with 250 elements, **P 380 - CON_TCoggAddTab**, F1: Compensation function 1 (incremental, 'rotary' recurring)
 - Without offset and delta, with tuning, with fader
 - Teaching → Calculation: (385) = (1), (2) → (3)
- **EPSM(3)** = Compensation as a function of the mechanical angle, Big table with 4000 elements, flash image[4005], F1: Compensation function 1 (incremental, 'rotary' recurring)
 - Without offset and delta, with tuning, with fader
 - Teaching → Calculation: (385) = (6), (11), (12) → (8)
- **ABSPOS(2)** = Compensation as a function of the absolute position, **ENCPOS(4)** = Compensation as a function of the absolute position, Big table with 4000 elements, flash image[4005], F2: Compensation function 2 (absolute, 'linear' continuous)
 - With offset and delta, with tuning, without fader
 - Teaching → Calculation: (385) = (5), (7), (9), (10) → (3)

7.3.5.3 Procedure for detent torque compensation

The following table shows the procedure for detent torque compensation.

No.	Action
1	Open manual mode window
2	Speed control mode control setting (set high rigidity, for smooth running)
3	Set the teaching direction if necessary: P 445[0] - CON_TAB_TeachDir Default: POS(1)= teaching routine in positive direction.
4	Set the offset and delta if necessary using: P 442[0] - CON_TAB_PosStart , default 0 P 443[0] - CON_TAB_PosDelta , default 1000 inc/TabElement
5	Set the input tuning if necessary using: P 447[0] - CON_TAB_Tune.TimeDelay , default 0 P 447[1] - CON_TAB_Tune.PosShift , default 0
6	Start control
7	Run motor at low speed (≤ 1 rpm)
8	Set the position source for teaching, activate teaching: Select P 385[0] - CON_TCoggTeachCon > 0 . → The teaching routine begins (but possibly only with PosStart).
9	Move at least 1 motor revolution in the same direction (internal filter time).
10	With the control still operating, the teaching is then stopped by calling the calculation function once: P 385[0] - CON_TCoggTeachCon = (3)CALC1 or (8)CALC2 . Afterwards, parameter P 385[0] jumps back to READY(0).

Table 7.4: Overall procedure for detent torque compensation

No.	Action
--	- The teaching and calculation are thus finished. - The position source used has been stored internally. - The compensation table is available for use immediately.
11	Stop control
12	Start the compensation: P 382[0] - CON_TCoggComp > 0 After this, the q-current feed forward control becomes active when the control is restarted.
13	Save device data. - The position source used by the teaching is also saved here. It will later be used for the compensation once again in exactly the same manner.

Table 7.5: Overall procedure for detent torque compensation

7.3.5.3.1 Scope recording: speed 'before' and 'after'

A significant improvement in the speed progression is noticeable in the 'yellow' scope signal (13): nact [rpm]: cur. speed from filter.

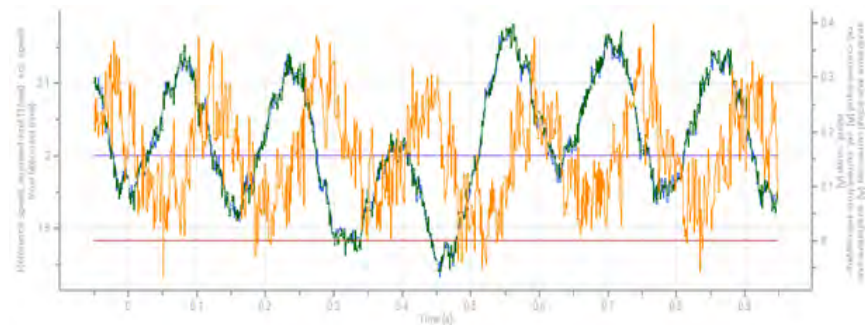


Fig. 7.11: Before detent torque compensation (without)

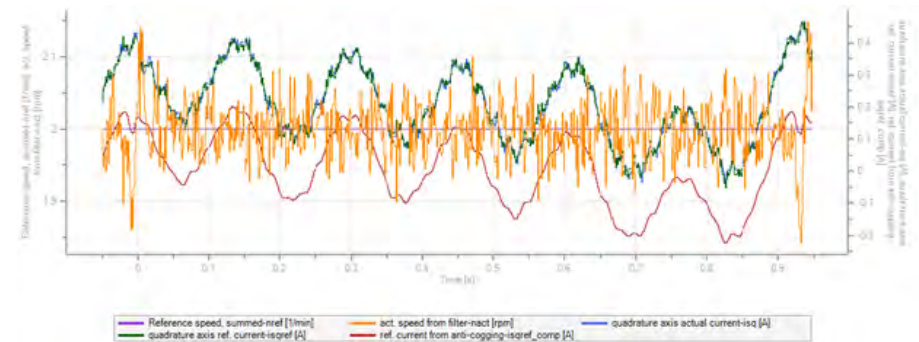


Fig. 7.12: After enabling detent torque compensation (with) (please keep the Y axis scaling in mind!)

Possible monitoring via scope signal (69) isqref_comp [A]: ref. current from anti-cogging --> in 'blue' here

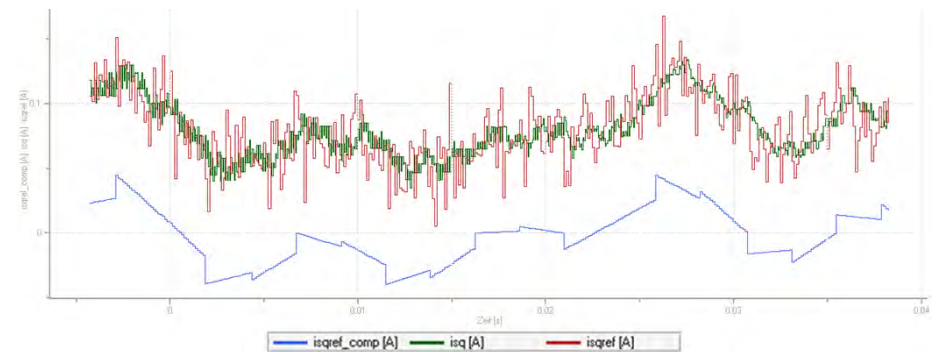


Fig. 7.13: Monitoring with isqref_comp (69)

7.3.5.4 Compensation as a function of the electrical angle (EPSRS), small table

Teaching routine and compensation → small CompTab (250er)

- Incremental, 'rotary' recurring position
- Without offset and delta, with tuning, with fader
- (1) Teach epsrs, commutation angle (electrical)

No.	Action
1	Open manual mode window
2	Speed control mode control setting (set high rigidity, for smooth running)
3	Start control
4	Run motor at low speed (≤ 1 rpm).
5	Set the position source for the teaching, activate teaching: Select P 385[0] - CON_TCoggTeachCon = (1)TeachEpsRS-1 . → The teaching routine begins.
6	Wait until at least 1 motor revolution is completed in the teaching routine (internal filter time).
---	Check P 440[0] - CON_TAB_TabIndex and P 446[0] - CON_TAB_OutVal
7	With the control still operating, the teaching is then stopped by calling the calculation function once: P 385[0] - CON_TCoggTeachCon = (3)CALC1 . This imports all values into the compensation table P 380 - CON_TCoggAddTab (small table with 250 elements).
8	Stop control
9	Start the compensation: P 382[0] - CON_TCoggComp = (1)EPSRS After this, the q-current feed forward control becomes active when the control is restarted.
10	Save device data. - The position source used by the teaching is also saved here. It will later be used for the compensation once again in exactly the same manner.

7.3.5.5 Compensation as a function of the absolute position (ABSPOS)

Teaching routine and compensation → big CompTab (4000)

- Absolute, 'linear' continuous position
- With offset and delta, with tuning, without fader
- (3) Teach (277)MPRO_FG_UserRefPos, reference position in user units
- (7) Teach posact from pcon encoder, actual position from encoder for position control loop in reference scaling, scope signal 152
- (9) Teach (412)CON_PCON_ActPosition, actual position of the position control in reference scaling
- (10) Teach posact from pcon encoder, actual position from so-called redundant encoder in reference scaling, scope signal 153

No.	Action
1	Open manual mode window.
2	Approach start position
3	Speed control mode control setting (set high rigidity, for smooth running)
4	Set the teaching direction if necessary: P 445[0] - CON_TAB_TeachDir Default: POS(1)= teaching routine in positive direction.
5	Set the offset and delta if necessary using: P 442[0] - CON_TAB_PosStart , default 0 P 443[0] - CON_TAB_PosDelta , default 1000 inc/TabElement = e.g. (endpos inc - startpos inc) / 4000 elements
6	Set the input tuning if necessary using: P 447[0] - CON_TAB_Tune.TimeDelay , default 0 P 447[1] - CON_TAB_Tune.PosShift , default 0
7	Start control
8	Run motor at low speed (≤ 1 rpm).
9	Set the position source for teaching, activate teaching: Select P 385[0] - CON_TCoggTeachCon= (5)TeachUserRefPos or Select P 385[0] - CON_TCoggTeachCon= (7)TeachPosEncPcon or Select P 385[0] - CON_TCoggTeachCon= (9)TeachPconActPos or Select P 385[0] - CON_TCoggTeachCon= (10)TeachPosEncRed . → The teaching routine begins (but only with PosStart).
10	Wait until at least 1 motor revolution is completed in the teaching routine (internal filter time).
---	Check P 440[0] - CON_TAB_TabIndex and P 446[0] - CON_TAB_OutVal
11	With the control still operating, the teaching is then stopped by calling the calculation function once. P 385[0] - CON_TCoggTeachCon = (3)CALC1 . This imports all values into the internal compensation table (big table with 4000 elements).

No.	Action
12	Stop control
13	Save device data. - The position source used by the teaching is also saved here. It will later be used for the compensation once again in exactly the same manner.
14	Use the scope to monitor IsqRef_Comp

7.3.5.6 Compensation as a function of mechanical rotation (EPMS)

Teaching routine and compensation → big CompTab (4000)

- Incremental, 'rotary' recurring position
- Without offset and delta, with tuning, with fader
- (6) Teach epsm mechanical angle (shaft), SingleTurn position from encoder for commutation
- (11) Teach singleturn position from position control, SingleTurn position of the position control, + Homing + axis correction
- (12) Teach epsrs, commutation angle (electrical)

No.	Action
1	Open manual mode window
2	Speed control mode control setting (set high rigidity, for smooth running)
3	Start control
4	Run motor at low speed (≤ 1 rpm).
5	Set the position source for teaching, activate teaching: Select P 385[0] - CON_TCoggTeachCon = (6)TeachEpsM or Select P 385[0] - CON_TCoggTeachCon = (11)TeachSTPosPcon . → The teaching routine begins.
6	Wait until at least 1 motor revolution is completed in the teaching routine (internal filter time).
---	Check P 440[0] - CON_TAB_TabIndex and P 446[0] - CON_TAB_OutVal
7	With the control still operating, the teaching is then stopped by calling the calculation function once: P 385[0] - CON_TCoggTeachCon = (8)CALC2 . This imports all values into the internal compensation table (big table with 4000 elements).
8	Stop control
9	Start the compensation: P 382[0] - CON_TCoggComp = (3)EPSM After this, the q-current feed forward control becomes active when the control is restarted.
10	Save device data. - The position source used by the teaching is also saved here. It will later be used for the compensation once again in exactly the same manner.
11	Use the scope to monitor IsqRef_Comp

7.3.5.7 Compensation as a function of the electrical angle (EPSRS), big table

Teaching routine and compensation → big CompTab (4000)

- Incremental, 'rotary' recurring position
- Without offset and delta, with tuning, with fader

- (12) Teach epsrs, commutation angle (electrical)

No.	Action
1	Open manual mode window
2	Set the speed control mode (set high stiffness, for radial true running) Set speed control mode.
3	Start control
4	Run motor at low speed (≤ 1 rpm).
5	Set the position source for teaching, activate teaching: Select P 385[0] - CON_TCoggTeachCon = (12)TeachEpsRS-3 . → The teaching routine begins.
6	Wait until at least 1 motor revolution is completed in the teaching routine (internal filter time).
---	Check P 440[0] - CON_TAB_TabIndex and P 446[0] - CON_TAB_OutVal
7	With the control still operating, the teaching is then stopped by calling the calculation function once: P 385[0] - CON_TCoggTeachCon = (8)CALC2 . This imports all values into the internal compensation table (big table with 4000 elements).
8	Stop control
9	Start the compensation: P 382[0] - CON_TCoggComp = (3)EPSM After this, the q-current feed forward control becomes active when the control is restarted.
10	Save device data. - The position source used by the teaching is also saved here. It will later be used for the compensation once again in exactly the same manner.
11	Use the scope to monitor IsqRef_Comp

7.3.5.8 FadeOut function

At higher speeds it usually makes sense to linearly fade the Q-current feed forward control of the detent torque compensation using the FadeOut function:

P 447[3] - CON_TAB_Tune[3].FadeOutStart: fader starting speed

P 447[4] - CON_TAB_Tune[4].FadeOutEnd: fader ending speed.

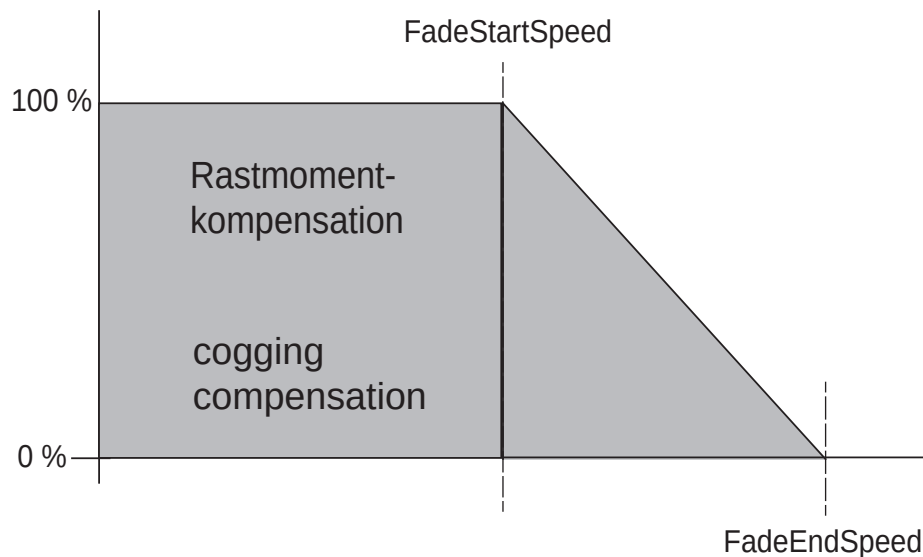


Fig. 7.14: FadeStartSpeed and FadeEndSpeed

7.3.6 Advanced torque control

Torque control is expanded by three functions in order to optimize the control dynamics of the current and speed controllers.

- Adaptation of torque control / Saturation characteristic (see Section "Adaptation of torque control" on page 132).
- Observer system (see Section "Current observer" on page 134)
- Overmodulation: (see Section "Limitation and overmodulation" on page 135)

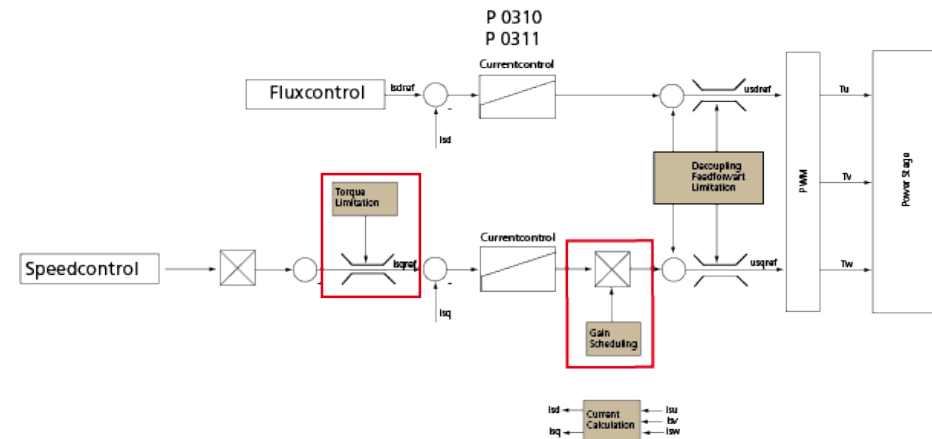


Fig. 7.15: Structure of expanded torque control

7.3.6.1 Adaptation of torque control

7.3.6.1.1 Saturation characteristic

In the overload range, saturation effects reduce the inductance of many motors. As a result, the current controller optimized to the rated current may oscillate or become unstable. In this case the gain of the current controller should be adapted to the load case by way of four interpolation points. The values for the interpolation points are entered in the screen as a percentage of the rated current. On the left are the inductance values, and on the right the values for the overload (> 100% of rated current).

PS motor electrical parameters

Motor name

Pole pairs Rated flux Vs

Motor impedances

Stator resistance Ohm Stator inductance mH

Nonlinear stator inductance due to saturation of the motor

100 %	0 %
100 %	100 %
100 %	200 %
100 %	300 %

Stator inductance of 1 mH at Rated current of 0.5 A

Fig. 7.16: "PS motor electrical parameters" screen

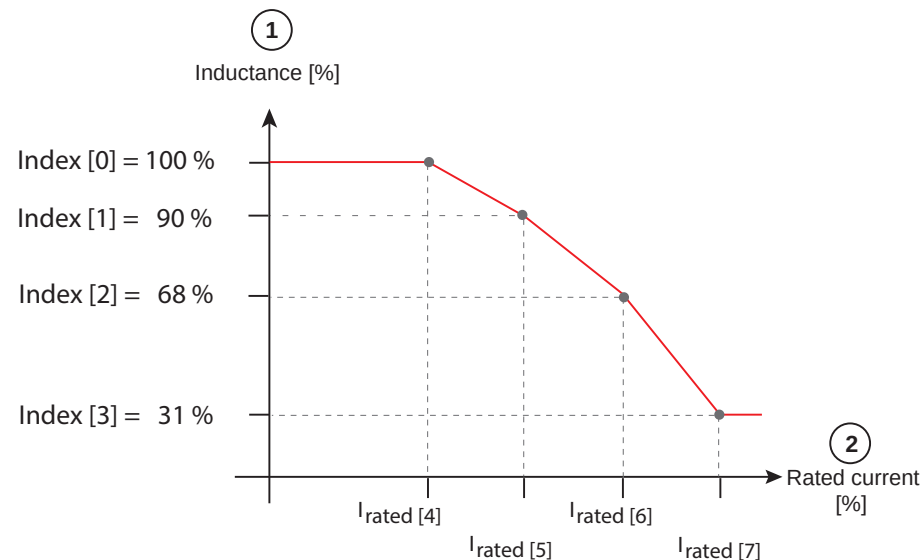


Fig. 7.17: Diagram: "Scaling of q-inductance L in [%]"

① P 472[0] - [3] Lsig_q@lx	Scaling of q-stator inductance in [%]; interpolation points 0 to 3.
② P 472[4] - [7] MOT_Currentlx	Scaling of rated current in [%]; interpolation points 4 to 7.

Legend for Diagram: "Scaling of q-inductance L in [%]"



NOTE

- Between the interpolation points the scaling factor is interpolated in linear mode. The current scaling of the inductance is displayed in the scope variable **74_Is_ActVal**.

ID	Index	Name	Unit	Description
471	0	MOT_Lsig	mH	Motor leakage inductance (ASM) / stator inductance (PSM)
472		MOT_LsigDiff		q-axis stator inductance variation (relative to MOT_Lsig)
472	0	Lsig_q@I0	%	Inductance @ CurrentI0
472	1	Lsig_q@I1	%	Inductance @ CurrentI1
472	2	Lsig_q@I2	%	Inductance @ CurrentI2
472	3	Lsig_q@I3	%	Inductance @ CurrentI3
472	4	CurrentI0	%	Current I0 relative to MOT_CNom
472	5	CurrentI1	%	Current I1 relative to MOT_CNom
472	6	CurrentI2	%	Current I2 relative to MOT_CNom
472	7	CurrentI3	%	Current I3 relative to MOT_CNom

Table 7.6: "Advanced torque control - Saturation characteristic" parameters

7.3.6.1.2 K-T characteristic

In the overload range the output-side torque is reduced due to rising losses (iron/copper losses). This behaviour can be compensated by **P 479[0] - MOT_TorqueSat**.

P No.	Index	Parameter name	Unit	Function
479		MOT_TorqueSat		Motor torque as a function of the current
	0 to 4		Nm	Torque; interpolation points 0 to 4.
	5 to 9		A	Current; interpolation points 5 to 9.

Table 7.7: "K-T characteristic" parameters

7.3.6.2 Current observer

In the current control circuit, the calculation of voltage setpoints and PWM runtime appears as dead time. This is the main factor determining the possible performance of current control. The current observer eliminates this dead time to the greatest possible extent by predicting current by means of a scanning step. In addition, many synchronous servomotors exhibit harmonic components in the current control circuit. The current observer suppresses these harmonic components so that they cannot

be passed on to the current controller. The disadvantage of the current observer is a possible deviation between actual current and observed current. This can lead to an overcurrent shutdown if the maximum current of the device or motor is controlled stepwise.

The current observer is activated by **P 433[0] - CON_CCON_ObsMode = TIME**. Adjust the time constant **P 434[0] - Tf** in the range from 0.062 ms to 0.5 ms. The higher the time constant, the greater the smoothing effect of the observer – however, the greater the possible deviations between actual current and observed current. On the other hand, effects that do not correspond to the model are suppressed for the control.

Another peripheral condition is that the electrical data of the motor must be well defined.

- Synchronous motors: see Section "Synchronous motor identification (rotary and linear)" on page 48.
- Asynchronous motor: see Section "Asynchronous motor identification" on page 48.

Motor inductance (if necessary in connection with the saturation characteristic) should be parameterised slightly too high.

ID	Index	Name	Unit	Description
433	0	CON_CCON_ObsMode		Select current observer mode
434		CON_CCON_ObsPara		Current observer parameters
434	0	Tf	ms	Observer time constant
434	1	Kp	1/s	Proportional feedback gain
434	2	Tn	ms	Integral feedback time constant
434	3	Decoup	%	Scale decoupling
434	4	StatFF	%	Scale static voltage feed-forward
434	5	DynFF	%	Scale dynamic voltage feed-forward
434	6	FilterFF	ms	Filter voltage feed-forward

Table 7.8: "Advanced torque control - Observer" parameters

7.3.6.3 Limitation and overmodulation

Fig. 7.18: “Circle and hexagon voltages” diagram shows the maximum configurable voltage range in the d/q system. The configurable vectors correspond to the DC link voltage U_{ZK} and form a voltage hexagon (red). For most applications, however, the voltage is limited to the inner circle in order to reduce harmonics at higher speeds.

When limiting current control, the d and q axes need to be prioritised. This can be important for machine stability, depending on the parameters and operating status.

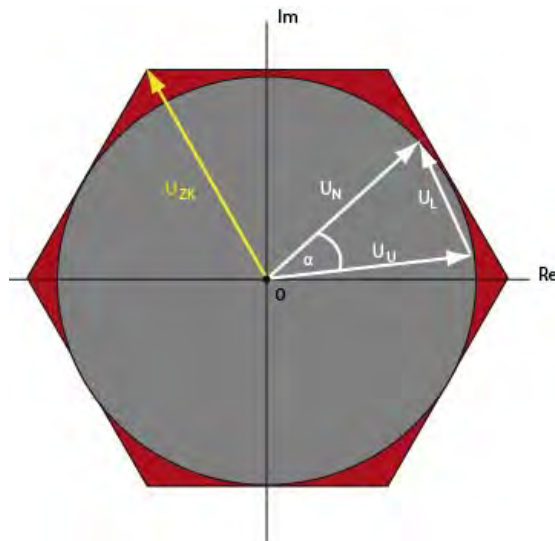


Fig. 7.18: “Circle and hexagon voltages” diagram

U_N Mains voltage

U_L Voltage at the inductor

U_U Inverter voltage

U_{ZK} DC link voltage

α Phase angle

Legend for “Circle and hexagon voltages” diagram

ID	Index	Name	Unit	Description
431	0	CON_CCON_VLimit	%	Voltage limit for first current controller
432	0	CON_CCON_Mode		Select current control / limitation mode

Table 7.9: “Advanced torque control - Overmodulation” parameters

Limitation and overmodulation settings are configured with **P 432 - CON_CCON_**
Mode:

P 432	Limitation	Overmodulation	Usage
0 (PRIO)	Changing d/q priority	no (circuit)	Default setting for asynchronous motors.
1 (PRIO_RES)			Use P 431 Vlimit = 90..95% to improve stability.
5 (PRIO_2)			
2 (PHASE)	phase-correct limitation	no (circuit)	Use this setting if other settings do not work in a stable manner.
3 (HEX_PHASE)	phase-correct limitation	yes (hexagon)	Use this setting to produce a higher voltage at the output. When voltage demand is high, the servo controller will generate a substantial 5th/7th harmonic which strains the machine and produces noise.
4 (D_PRIO) = default	d priority	no (circuit)	Default setting for synchronous servomotors.
			Use P 431 Vlimit = 90..95% to improve stability.

Table 7.10: Setting the limitation and overmodulation with P 432

7.3.7 Torque control with defined bandwidth

The controller gain is determined by activating test signals (Autotuning). The calculations and the relevant autotuning are carried out in the servo controller. The advanced settings are made in **P 1530[0] - SCD_SetMotorControl**, **P 1531[0] - SCD_Action_Sel** and **P 1533[0] - SCD_AT_Bandwidth**.

- The 3dB bandwidth of the closed loop is specified as the bandwidth.
- Advisable bandwidth settings at 8 kHz switching frequency are up to approximately 2000 Hz; at 16 kHz switching frequency up to approximately 3000 Hz.
- The P-gain CCON_Kp is calculated according to the amount optimum.
- The integral-action time CCON_Tn is interpolated between the amount optimum and the symmetrical optimum, so that the I-content is sufficient, resulting in reduced interference response.

P no.	Index	Name / Setting	Unit	Function
1530	0	SCD_SetMotorControl		Torque controller setting with defined bandwidth
		Fault(-1)		Error during calculation
		Ready(0)		Calculation ready
		CALC_CON(1)		Control with motor data calculation
		CALC_ASM(2)		Calculate asm motor from rated data
		BANDWIDTH(3)		Calculate current controller by bandwidth
		DEADBEAT(4)		This setting parameterizes a dead-beat controller. The structure is switched to feedback with observer, the observer is designed (to a specific equivalent time constant – for setting see P 434[0] - CON_CCON_ObsPara – and the speed controller gains are calculated accordingly.
1531	0	SCD_Action_Sel		Start conditions to determine the torque controller settings
		FAULT (-1)		Selected function stopped with fault
		READY (0)		Ready to start function / last call successfully ended

Table 7.11: “Torque control with defined bandwidth” parameters

P no.	Index	Name / Setting	Unit	Function
		ENC_OFFSET (1)		Start encoder offset determination (power stage will be switched on!)
		MOT_ID (2)		Start electrical motor identification (power stage will be switched on!)
		IMP (3)		Measure impedance
		LH_TUNE (4)		Tune Lm characteristics
		ASM_OP (5)		Set operation point for asynchronous motor
		BANDWIDTH (6)		Tune current controller by bandwidth
		MOTPHASE (7)		Check motor/encoder wiring
		COM_ALL (8)		Motorid., enc.-offset and inertia detection, motor phase check
		J_SUM (9)		Identification of whole inertia
		CANCEL (10)		Cancel the current action
1533	0	SCD_AT_Bandwidth	Hz	Bandwidth preset for torque control loop: Range: 10 - 4000 Hz

Table 7.11: “Torque control with defined bandwidth” parameters (continue)

7.3.8 Enhanced feed forward control of voltage

For high-power applications, the current control setting is often limited. If, at the same time, a high bandwidth is required for the control of test signals, for example, feed-forward voltage control is helpful.

ID	Index	Name	Unit	Description
434		CON_CCON_Para		Current observer parameters
434	0	TF	ms	Current observer time constant
434	1	Kp	1/s	Current observer feedback gain
434	2	Tn	ms	Current observer feedback time constant

Table 7.12: Parameter - Enhanced feed forward control

ID	Index	Name	Unit	Description
434	3	Decoup	%	Scale decoupling
434	4	StatFF	%	Scale static voltage feed-forward
434	5	DynFF	%	Scale dynamic voltage feed-forward
434	6	FilterFF	ms	Filter voltage feed-forward
471	0	MOT_Lsig	mH	Motor leakage inductance (ASM) / stator inductance (PSM)
472		MOT_LsigDiff		q-axis stator inductance variation (relative to MOT_Lsig)
472	0	Lsig_q@I0	%	Inductance @ CurrentI0
472	1	Lsig_q@I1	%	Inductance @ CurrentI1
472	2	Lsig_q@I2	%	Inductance @ CurrentI2
472	3	Lsig_q@I3	%	Inductance @ CurrentI3
472	4	CurrentI0	%	Current I0 relative to MOT_CNom
472	5	CurrentI1	%	Current I1 relative to MOT_CNom
472	6	CurrentI2	%	Current I2 relative to MOT_CNom
472	7	CurrentI3	%	Current I3 relative to MOT_CNom
1976	0	CON_CCON_VFF		Select current control / limitation mode

Table 7.12: Parameter - Enhanced feed forward control (continue)

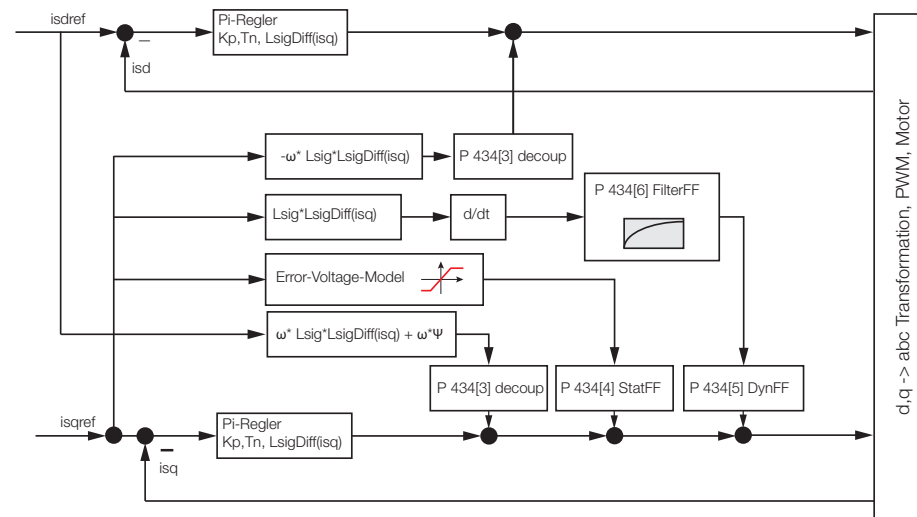


Fig. 7.19: Extended pre-control structure

Fig. 7.19: Extended pre-control structure shows the extended pre-control structure. This is activated with **P 1976 = ON**. This delays the current setpoint by one controller cycle; this is not suitable for high-performance speed control.

The feed forward control of the voltage drop across the stator resistance of the machine depends on **P 470 MOT_Rstat**. The feed forward control of the fault voltage of the power stage depends on **P 302 CON_SwitchFreq**. Both can be subjected to feed forward control and scaled with **P 434.4**.

The voltage to change the current over the stator inductance depends on **P 471 MOT_Lsig**. The feed forward control can be scaled with **P 434.5**.

P 434.6 allows the voltage set by this to be filtered, which reduces noise. Do not set this filter too high, otherwise there will no longer be an increase in bandwidth.

To set these functions, use the test signal generator to apply a sweep signal to the d-current setpoint and record the setpoint and actual values with the scope.

7.4 Speed controller

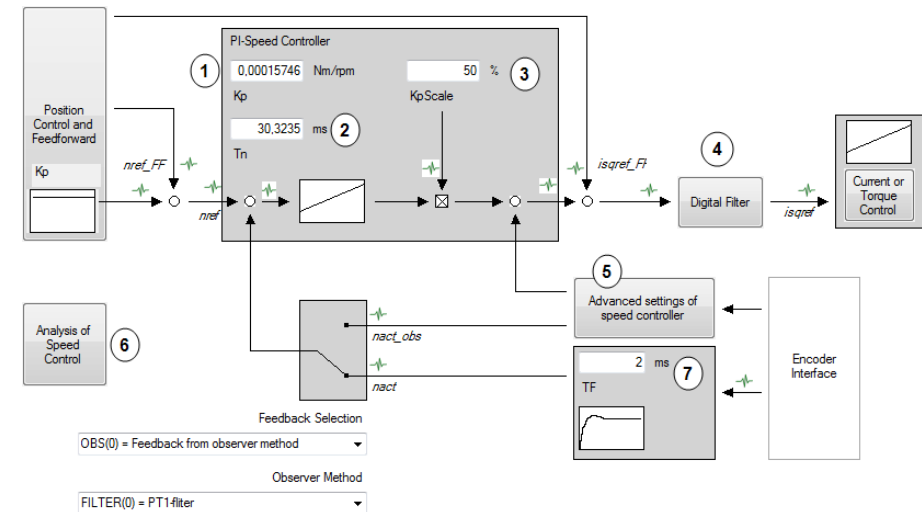


Fig. 7.20: "Speed controller" screen

- ① Gain (K_P)
- ② Integral-action time (I)
- ③ Scaling factor for gain
- ④ With these filters it is possible to filter noise in the actual speed value and increase the attenuation of resonance frequencies.
- ⑤ Advanced speed control (observer), see Section "Advanced speed control" on page 140
- ⑥ Analysis of speed control, see Section "Analysis of Speed control" on page 144
- ⑦ Actual speed filter

Legend for "Speed controller" screen

Adaptation of parameters

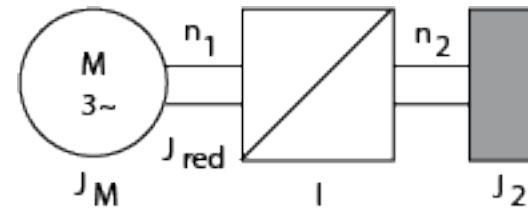
Acceleration and braking phases generate a variation which the speed control has to balance out. With speed pre-control the necessary acceleration or braking moment determined from the change in speed over time is applied to the output of the speed controller.

If the travel range is not limited, it is advisable to optimize the speed controller by means of step responses. In this, the motor model must be adapted precisely to the individual motor. In the standard motor data set, the speed controller is preset for a moderately stiff mechanical system. The speed controller may need to be adjusted to the moment of inertia and the rigidity of the mechanism.

All parameters take effect online. The scaling parameter **P 322[0] - CON_SCON_KpScale** is transferred in defined real time (according to the speed controller sampling time).

The following steps are needed to set the speed control loop depending on the application:

No.	Action
1	Adapt the speed controller gain to the existing external mass inertia. For this, either the known moment of inertia from the motor data can be used directly or the automatic mass inertia definition function in the Motor Identification subject area can be used.
2	If the system's moment of inertia is defined manually, it must be reduced to the motor.



$$J_{red} = \frac{J_2}{i^2} = \frac{J_2}{\left(\frac{n_1}{n_2}\right)^2}$$

Fig. 7.21: Relevant variables

J_M	Moment of inertia of motor
J_{red}	Reduced moment of inertia of system
i	Gear transmission ratio factor
J_2	Reduced moment of inertia

Legend for "Relevant variables"

ID	Index	Name	Unit	Description
2695		CON_SCON_ScaleTF		Scaling filter time constant
2695	0	ScaleMaxSpeedFil	ms	Speed scaling filter time constant
2695	1	ScaleMaxTorqueFil	ms	Torque scaling filter time constant
320	0	CON_SCON_Kp	Nm/rpm	Speed control gain
321	0	CON_SCON_Tn	ms	Speed control integration time constant
322	0	CON_SCON_KpScale	%	Speed control gain scaling factor
351	0	CON_SCALC_TF	ms	Speed calculation filter time constant, speed control
371	0	CON_IP_RefTF	ms	Speed reference filter time constant (SCON mode)

Table 7.13: "Speed controller" parameter

ID	Index	Name	Unit	Description
304	0	CON_SConTS	ms	Speed control sampling time
2939	0	CON_SCON_TorqueTF	ms	Actual torque filter time
		Digital filter		Digital filter / speed controller settings
325		CON_SCON_FilterFreq		Filter frequencies of digital filter
325	0	CON_SCON_FilterFreq	Hz	1st center/cutoff
325	1	CON_SCON_FilterFreq	Hz	1st width
325	2	CON_SCON_FilterFreq	Hz	2nd center/cutoff
325	3	CON_SCON_FilterFreq	Hz	2nd width
326	0	CON_SCON_FilterAssi		Digital filter design assistant
327		CON_SCON_FilterPara		Coefficients of digital filter
327	0	FilterPara b0		$b_0 \cdot x(k)$
327	1	FilterPara b1		$b_1 \cdot x(k-1)$
327	2	FilterPara b2		$b_2 \cdot x(k-2)$
327	3	FilterPara b3		$b_3 \cdot x(k-3)$
327	4	FilterPara b4		$b_4 \cdot x(k-4)$
327	5	FilterPara a1		$a_1 \cdot y(k-1)$
327	6	FilterPara a2		$a_2 \cdot y(k-2)$
327	7	FilterPara a3		$a_3 \cdot y(k-3)$
327	8	FilterPara a4		$a_4 \cdot y(k-4)$
1550	0	SCD_NotchType		Adaptive Notch filter: Method
1551	0	SCD_NotchCntl		Adaptive Notch filter: Control word
1552		SCD_NotchFreq		Adaptive Notch filter: Frequencies
1552	0	SCD_NotchFreq	Hz	Adaptive Notch filter: Frequency
1552	1	SCD_NotchLambda	Hz/min ⁻²	Adaptive Notch filter: Coefficient
1552	2	SCD_NotchMinFreq	Hz	Adaptive notch filter: Minimum frequency
1552	3	SCD_NotchMaxFreq	Hz	Adaptive notch filter: Maximum frequency
1552	4	SCD_NotchDeltaFreq	Hz	Adaptive Notch filter: Maximum frequency change (in each iteration)
		Analysis of speed control		Advanced analysis of the speed controller
401	0	CON_SCON_AddTRef	Nm (N)	Additive torque reference
402	0	CON_SCON_AddSRef	1/min	Additive speed reference value (without ramp)
		Scope signals (advanced)		
		Observer		
		Scope signals (basic)		

Table 7.13: “Speed controller” parameter (continue)

7.4.1 Advanced speed control

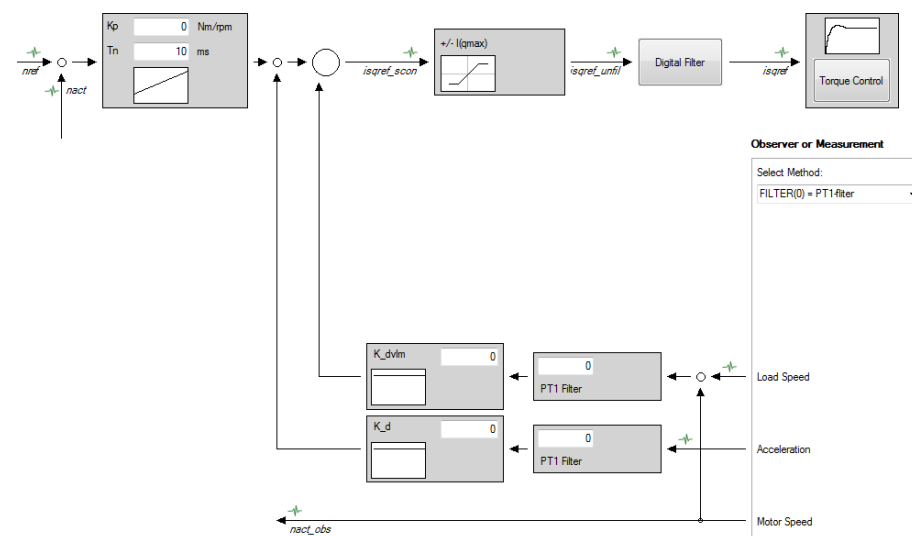


Fig. 7.22: “Speed controller advanced setup” screen

7.4.1.1 Speed observer

The speed observer is a simple model of the path with motor current as input, as estimation of load torque and feedback of the estimated error from encoder position for speed control. The observer generates an estimation of motor speed that is used as an alternative to the measured, filtered speed of the axis.

Procedure for using the observer

- Make sure that the mass inertia of the system (**P 1516[0] - SCD_JSum**) is known. To do so, determine the inertia of the system (see section "Section "Automatic inertia detection" on page 118"), if this has not yet been done.

- Another criterion for a reliable knowledge of mass inertia is functioning torque feed forward control (see Section "Pre-control" on page 149). Multiply the currently configured value of **P 1516[0] - SCD_JSum** by **P 376 - CON_IP_TFFScale** and set **P 376 - CON_IP_TFFScale** back to 100%.
- Set **P 350[0] - SEL_ObserverMethod** = OBS1(1) and **P 354[0] - CON_SCALC_ObsDesignAssi** = DR(2).
- Start the control.

The setting parameter for the observer is the time constant **P 353[0] - Tf**. Use twice the time constant of the previously used speed filter **P 351[0] - CON_SCALC_Tf** as an initial value. Configuration is also a compromise between input signal smoothing and phase shift in the control circuit. However, the observer does not have such a great effect on phase shift in the speed control circuit as a filter.

7.4.1.2 Reduction of gain at low speeds.

With speed controllers set to be very dynamic, undesirable oscillation of the speed controller may occur at low speeds or at zero speed. An appropriate setting of **P 336 - CON_SCON_KpScaleSpeedZero** reduces this tendency to oscillate.

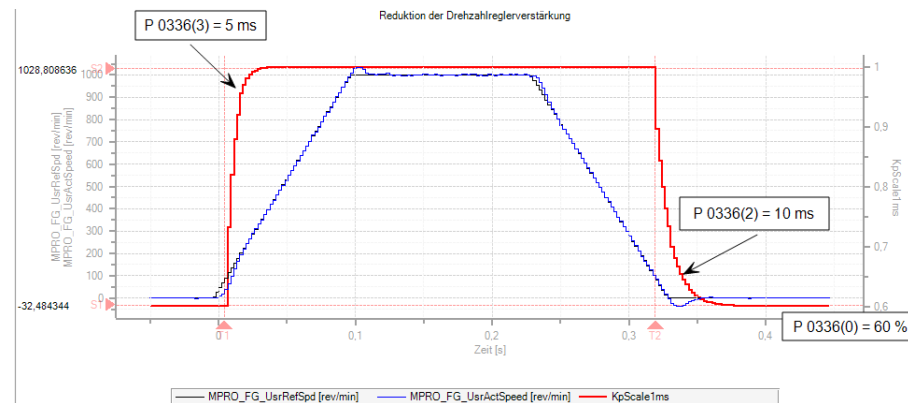


Fig. 7.23: Reduction of gain at low speeds.

7.4.1.3 Quick stop without sensor

In the event of a wire break on the encoder system the drive is shut down in sensorless mode on the preset quick-stop ramp (see Section "Error reactions" on page 336 and Section "Stop ramps" on page 257). Due to the lack of dynamism at low speeds, the sensorless control is very "imprecise". To enable the drive nevertheless to be run down smoothly to speed 0, as from the speed threshold parameterized in **P 355[0] - LowSpeedLimit** the controller switches to a current/frequency (IF) control. For stabilization, an additional, cumulative d-current must be injected that can be set via the **P 355[1] - d-current Injection** parameter. The speed controller gain is reduced by the factor **P 355[2] - SpeedControlGainScale**.

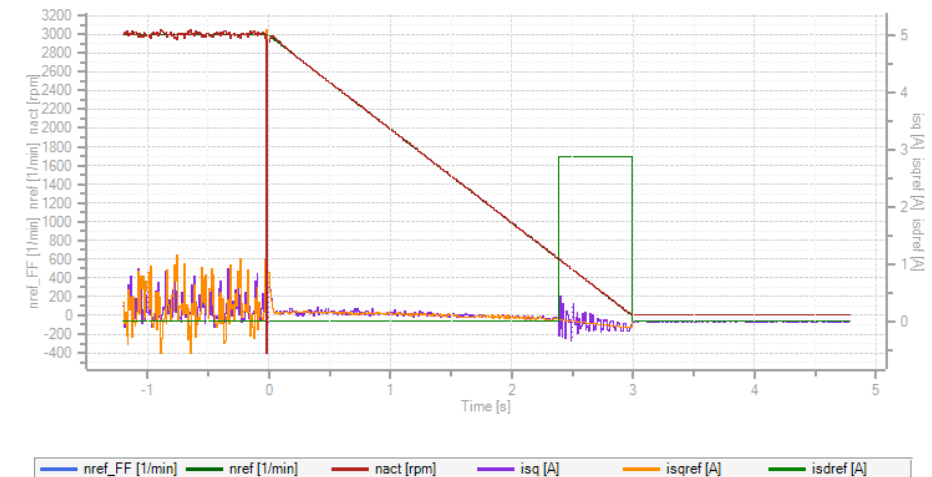


Fig. 7.24: Quick stop without sensor

7.4.1.4 Parameters

ID	Index	Name	Unit	Description
323		CON_SCON_Kd		Advanced control structure gains
323	0	CON_SCON_K_d		D control / acceleration feedback
323	1	CON_SCON_K_dvIm		Speed difference feedback
323	2	CON_SCON_K_dmlm		Torsional torque feedback
323	3	CON_SCON_K_mload		Load torque compensation
324		CON_SCON_TFd		Kalman: Setting
324	0	CON_SCON_TF_d		D control / acceleration feedback
324	1	CON_SCON_TF_dvIm		Speed difference feedback
324	2	CON_SCON_TF_dmlm		Torsional torque feedback
324	3	CON_SCON_TF_mload		Load torque compensation
336		CON_SCON_KpScaleSpeedZero		Adaptation of speed control gain at zero speed
336	0	KpScale_Zero		Speed control gain for low/zero speed
336	1	SpeedLimit	rpm	Speed limit to detect zero speed
336	2	Filter_Zero	ms	Filter time for change from higher to zero speed
336	3	Filter_High	ms	Filter time for change from zero to higher speed
336	4	KvScale_Zero		Position control gain for low/zero speed
339		CON_SCON_Kalman		Kalman: Setting
339	0	Tf_Kalman	ms	Kalman: Integration time
339	1	KpScale_Kalman	%	Kalman: Gain
350		CON_SCALC_SEL		Selection of speed calculation method
350	0	SEL_ObserverMethod		Selection of speed calculation method
350	1	SEL_FeedbackMethod		Select test or operational mode
352		CON_SCALC_ObsPara		Observer parameters (effect depends on CON_SCALC_SEL)
352	0	CON_SCALC_ObsPara		
352	1	CON_SCALC_ObsPara		
352	2	CON_SCALC_ObsPara		
352	3	CON_SCALC_ObsPara		
352	4	CON_SCALC_ObsPara		
352	5	CON_SCALC_ObsPara		
352	6	CON_SCALC_ObsPara		
352	7	CON_SCALC_ObsPara		
352	8	CON_SCALC_ObsPara		

Table 7.14: "Speed controller - Advanced speed control" parameter

ID	Index	Name	Unit	Description
352	9	CON_SCALC_ObsPara		
352	10	CON_SCALC_ObsPara		
352	11	CON_SCALC_ObsPara		
352	12	CON_SCALC_ObsPara		
352	13	CON_SCALC_ObsPara		
352	14	CON_SCALC_ObsPara		
352	15	CON_SCALC_ObsPara		
352	16	CON_SCALC_ObsPara		
352	17	CON_SCALC_ObsPara		
352	18	CON_SCALC_ObsPara		
352	19	CON_SCALC_ObsPara		
352	20	CON_SCALC_ObsPara		
352	21	CON_SCALC_ObsPara		
353		CON_SCALC_ObsDesignPara		Observer design parameters
353	0	TF	ms	Observer time constant
353	1	alpha		Damping coefficient
353	2	load_point		Load torque is applied: (0)at motor, (1)at load, (2)equally
353	3	TF1	ms	Speed filtering time constant
353	4	TF2	ms	Load torque adaptation time constant
353	5	TFosc	ms	Oscillation adaptation time constant
353	6	AccGain	(rpm/s)/V	Acceleration measurement gain
354	0	CON_SCALC_ObsDesignAssi		Observer design assistant
355		CON_SCALC_SensorlessStop		Speed calculation for sensorless stop
355	0	LowSpeedLimit	%	Speed Limit for IF control (in % of SNom)
355	1	d-current Injection	%	d-current for IF control (in % of INom)
355	2	SpeedControlGainScale	%	Scaling of speed control gain
2696	0	CON_SCON_Ctrlword		Control word for speed control
2698	0	CON_SCON_Source_Reset_I		Source for reset of integral part
2699	0	CON_SCON_Slope_Reset_I	A/ms	Slope for reset of integral part

Table 7.14: "Speed controller - Advanced speed control" parameter (continue)

7.4.2 Digital filter

To filter any noise on the actual speed value, or to damp resonance frequencies, various filter combinations can be used. A range of filter variants are available. The coefficients of the transfer function are automatically determined as soon as the values for the middle and limit frequency and the width have been entered.

Select Filter NOTCH_NOTCH(3) = 1. filter=notch, 2.filter=notch

1. Filter

center / cut off (f1) Hz

width (w1) Hz

2. Filter

center / cut off (f2) Hz

width (w2) Hz

Coefficients

$b_0 \cdot x(k)$	0.9922		
$b_1 \cdot x(k-1)$	-3.95657	$a_1 \cdot x(k-1)$	-3.97209
$b_2 \cdot x(k-2)$	5.92877	$a_2 \cdot x(k-2)$	5.92874
$b_3 \cdot x(k-3)$	-3.95657	$a_3 \cdot x(k-3)$	-3.94104
$b_4 \cdot x(k-4)$	0.9922	$a_4 \cdot x(k-4)$	0.98443

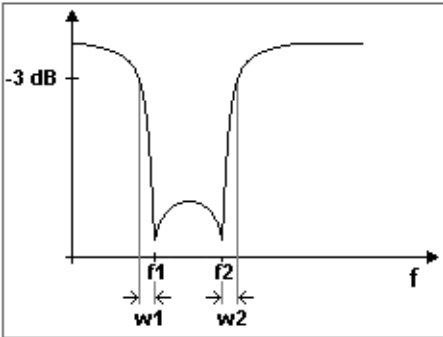


Fig. 7.25: "Speed controller - Digital filter" screen

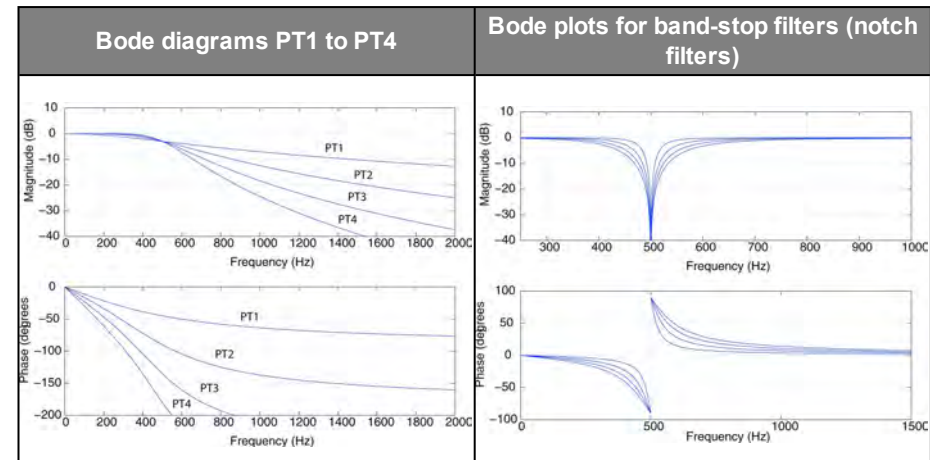


Table 7.15: Filter Bode plots

No.	Action
1	Scope setting: isq (unfiltered, torque-forming current) Set shortest sampling time Create scope plot without notch filtering
2	On the oscilloscope click the "Mathematical functions" > FFT (Fourier analysis) icon. From the following pop-up menu choose isq. Disturbance frequency is displayed.
3	Select filter
4	Enter middle/limit frequency
5	Width: Enter the bandwidth of the limit frequency; the width has no effect when using PTx filters
6	Create scope plot with notch filtering

Table 7.16: Instructions for FFT signal analysis

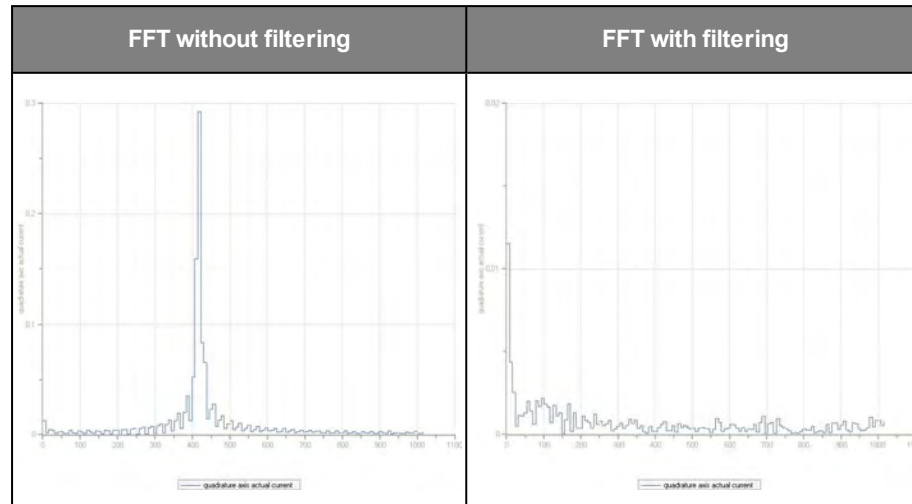


Table 7.17: FFT transformation

**NOTE**

- Note that the filters not only have an effect on the amount but also on the phase of the frequency response. At lower frequencies higher-order filters (PT3, PT4) should not be used, as the phase within the control bandwidth is negatively influenced.
- The coefficients can also be specified directly via parameter **P 327 - CON_SCON_FilterPara**. They take effect directly, so changing them is only recommended when the control is switched off.
- A large bandwidth will result in a lower attenuation of the cut-off frequency.

ID	Index	Name	Unit	Description
325		CON_SCON_FilterFreq		Filter frequencies of digital filter
325	0	CON_SCON_FilterFreq	Hz	1st center/cutoff
325	1	CON_SCON_FilterFreq	Hz	1st width
325	2	CON_SCON_FilterFreq	Hz	2nd center/cutoff
325	3	CON_SCON_FilterFreq	Hz	2nd width
326	0	CON_SCON_FilterAssi		Digital filter design assistant
327		CON_SCON_FilterPara		Coefficients of digital filter
327	0	FilterPara b0		$b_0 \cdot x(k)$
327	1	FilterPara b1		$b_1 \cdot x(k-1)$
327	2	FilterPara b2		$b_2 \cdot x(k-2)$
327	3	FilterPara b3		$b_3 \cdot x(k-3)$
327	4	FilterPara b4		$b_4 \cdot x(k-4)$
327	5	FilterPara a1		$a_1 \cdot y(k-1)$
327	6	FilterPara a2		$a_2 \cdot y(k-2)$
327	7	FilterPara a3		$a_3 \cdot y(k-3)$
327	8	FilterPara a4		$a_4 \cdot y(k-4)$
1550	0	SCD_NotchType		Adaptive Notch filter: Method
1551	0	SCD_NotchCntl		Adaptive Notch filter: Control word
1552		SCD_NotchFreq		Adaptive Notch filter: Frequencies
1552	0	SCD_NotchFreq	Hz	Adaptive Notch filter: Frequency
1552	1	SCD_NotchLambda	Hz/min ²	Adaptive Notch filter: Coefficient
1552	2	SCD_NotchMinFreq	Hz	Adaptive notch filter: Minimum frequency
1552	3	SCD_NotchMaxFreq	Hz	Adaptive notch filter: Maximum frequency
1552	4	SCD_NotchDeltaFreq	Hz	Adaptive Notch filter: Maximum frequency change (in each iteration)

Table 7.18: "Speed controller - Digital filter" parameter

7.4.3 Analysis of Speed control

The speed controller is executed as a PI controller. The gain (P-component) and the integral-action time (I-component) of the individual controllers are programmable. In order to optimize the speed control loop, two rectangular reference steps are preset. For automatic controller optimization the step response and transfer function wizards are available.

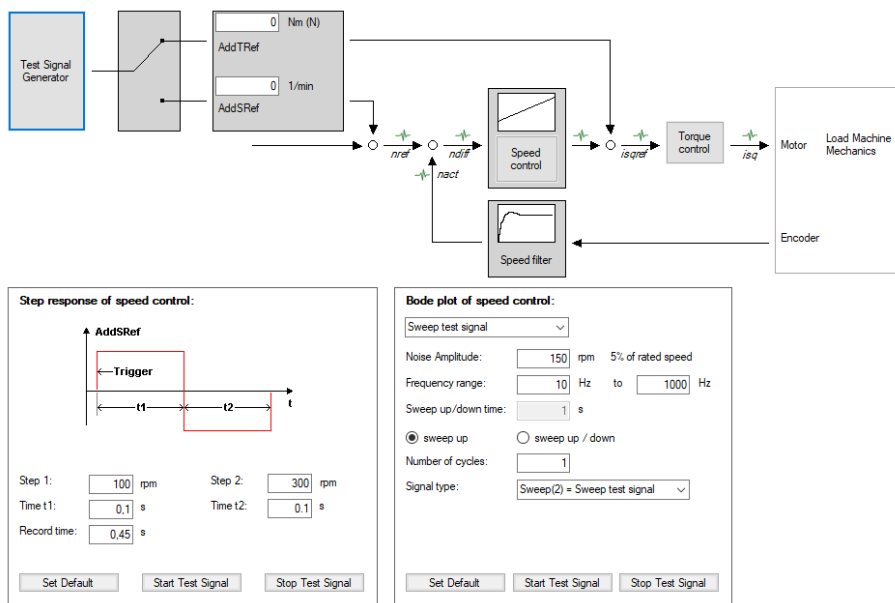


Fig. 7.26: "Advanced analysis of the speed controller" screen

This dialog box provides a test signal generator for analysing speed control. **P 401 [0] - CON_SCON_AddTRef** and **P 402[0] - CON_SCON_AddSRef** can be used to specify a constant speed as setpoint for the controller.

ID	Index	Name	Unit	Description
401	0	CON_SCON_AddTRef	Nm (N)	Additive torque reference
402	0	CON_SCON_AddSRef	1/min	Additive speed reference value (without ramp)

Table 7.19: "Speed controller - Analysis of Speed control" parameter

No.	Action
1	The speed and time settings are generated automatically from the motor data.
2	ISDSH and ENPO (hardware enable) must be set to "High".
3	Click "Start test signal" button
4	Observe the safety notice: When you confirm the safety notice a step response is executed.
5	The oscilloscope is set automatically.
6	The faster the actual value approaches the setpoint, the more dynamically the controller is set. The overshoot of the actual value should not be more than 5-10 % of the setpoint (general figure) during the settling process.

Table 7.20: Instructions for optimization of the speed controller

7.4.3.1 Step response

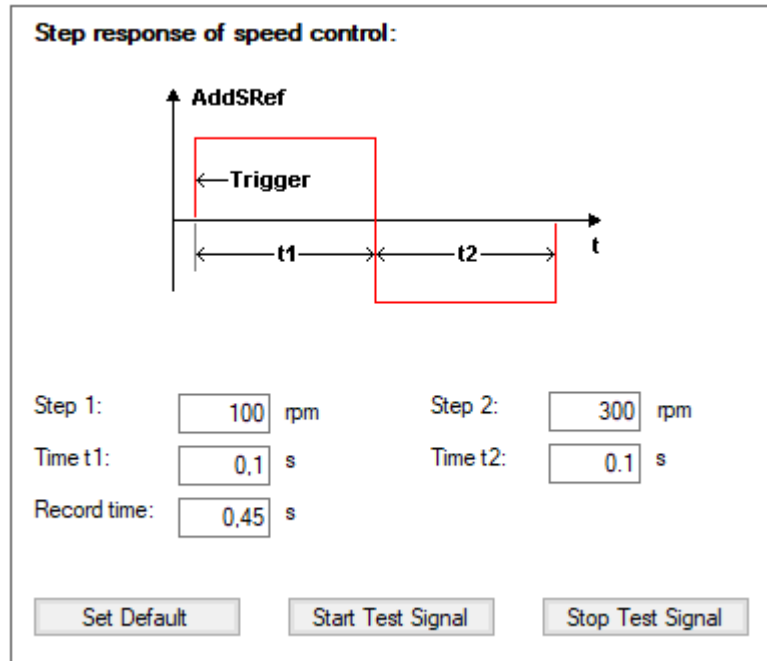


Fig. 7.27: Step response of the speed control

This function is for recording a step response of the speed control loop.

Ensure that the axis can be moved freely and does not reach any mechanical limits.

Set the two speed levels. Neither of the two levels should be zero because the step from and to speed zero could cause non-linear effects due to adhesion and friction. Optionally, the times can also be adapted.

Pressing "Start test signal" switches on the axis and the two speeds are used. The step response of the speed control loop is recorded.

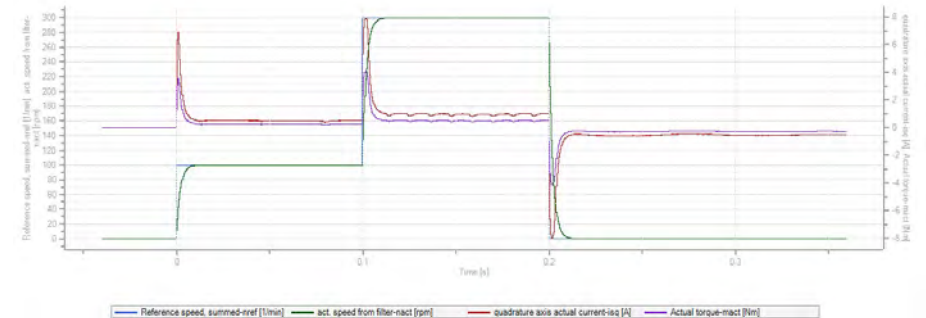


Fig. 7.28: Step response to rated speed

The speed control loop can be evaluated easily based on the step response:

- Increase the gain if the actual speed does not settle in to the new setpoint fast enough.
- Reduce the gain and increase the integration time constant if the actual speed overshoots the new setpoint by too much.
- Decrease the integration time constant if the actual speed initially approaches the new setpoint quickly, but then takes too long to actually reach it.

**NOTE**

- The speed control loop should be evaluated in the linear range. Check to be sure that the torque in the recording does not reach the limitation.
- An overshoot of 40 % is customary for dynamic applications. ("Symmetrical optimum")

7.4.3.2 Creating the transfer function

Bode plot of speed control:

Sweep test signal ▾

Noise Amplitude: rpm 5% of rated speed

Frequency range: Hz to Hz

Sweep up/down time: s

☒ sweep up ☐ sweep up / down

Number of cycles:

Signal type: ▾

Fig. 7.29: Transfer function screen with “Noise amplitude, cycle time”

The oscilloscope automatically records the amount and phase response of the controller according to the controller settings. This produces an initial estimate of the control quality.

The transfer function is measured superimposed onto an axis movement.

A test signal which moves between the frequencies set under **Frequency range** is superimposed onto the movement.

The **noise amplitude** is a measure of how strongly the frequencies are excited. Check this value before the first measurement. Start with a low value and increase it step by step until the frequency response contains enough information. Listen for noises from the mechanical parts to avoid damage.

Press the **“Start test signal”** button to initiate the measurement. The duration required for the measurement is shown in the dialog.

It is helpful to reduce the gain of the position controller (for more on this, see 7.5.1 Pre-control) during the measurement (e.g. 10%) because it otherwise partially compensates the test signal. The threshold for the tracking error must be increased accordingly. Two important characteristic curves can be output on the basis of the measurement: The transfer function of the **open** speed control loop and the transfer function of the **closed** speed control loop.

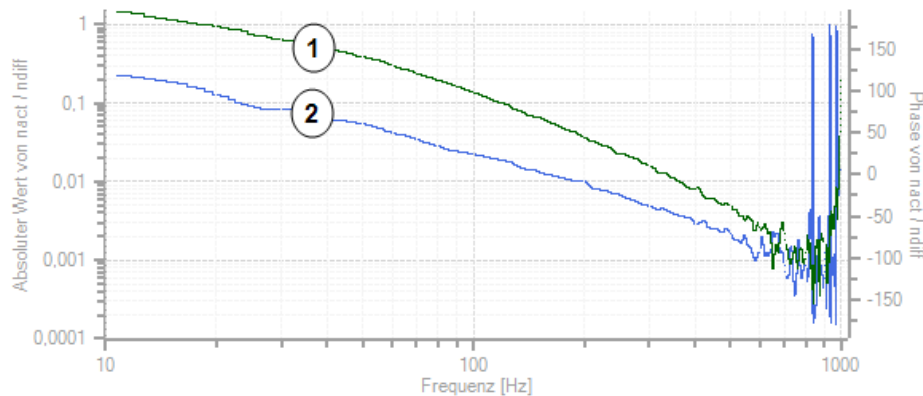


Fig. 7.30: Transfer function of the open speed controller

- ① Green curve = amount
Y-axis left = absolute value of nact/ndiff (amplitude curve)
- ② Blue curve = phase response
Y-axis right = Phase response nact/ndiff

Legend for Transfer function of the open speed controller

For an easy analysis, use the transfer function of the **open** speed control loop (with noise test signal). Note the frequency at which the amplitude curve crosses 0 dB (corresponds to the value 1) and configure the control loop so that the phase curve here is significantly higher than -180° . The point of intersection with 0 dB is also referred to as the bandwidth of the control loop. The distance above -180° is called the phase reserve (should be at least 50°). A large phase reserve increases the stability. In addition, the measurement depicts the mechanical resonance points of the system. Check to see whether the resonances lead to problems in your application. If yes, use digital filters for compensation (for more, see 7.4.2 Digital filter) or the methods of "enhanced speed control" (for more, see 7.4.1 Advanced speed control).

For the final analysis, use the **closed** speed control loop (with sweep test signal). This will then show the resulting behaviour of the control quality.

7.5 Position controller settings

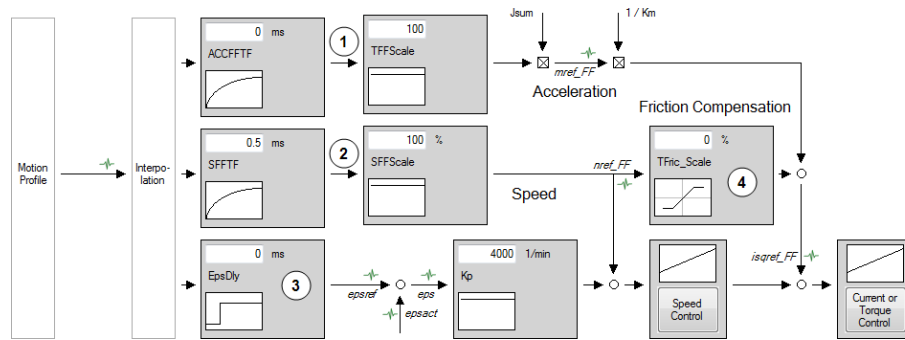


Fig. 7.31: “Configuration of position controller and feed forward control” screen

- ① Delay time and scaling for torque pre-control
- ② Delay time and scaling for speed pre-control
- ③ Delay time for position pre-control
- ④ Scaling of friction torque

Legend for “Configuration of position controller and feed forward control” screen

The higher the dynamism of the speed controller, the more dynamically the position controller can be set and the tracking error minimized. The variables for the pre-control of the speed and position controller are additionally determined either from the change in reference values or alternatively are already calculated and outputted by the motion control. The time-related values for the position, speed and torque are transmitted to the drive control. If the dynamic change in these values is within the limits which the drive is able to follow dynamically, the load on the controllers is significantly reduced. In order to improve the dynamism of the position controller, the following screen is provided to optimize the speed and acceleration pre-control.

ID	Index	Name	Unit	Description
276	0	MPRO_FG_UsrActPos	mDegree	Actual position in user units
277	0	MPRO_FG_UsrRefPos	mDegree	Setpoint position in user units
279	0	MPRO_FG_UsrPosDiff	mDegree	Position tracking error in user units
305	0	CON_PConTS	ms	Position control sampling time
360	0	CON_PCON_Kp	1/min	Position control gain

Table 7.21: “Position controller” parameters

7.5.1 Pre-control

- The pre-control of the acceleration torque relieves the strain on the speed controller and optimizes the control response of the drive. To be able to pre-control the acceleration torque, the mass inertia referred to the motor shaft must be known. If the parameter for the overall mass inertia of the system (**P 1516[0] - SCD_Jsum**) has a value $\neq 0$, that value will be automatically used to pre-control the acceleration torque.
- The pre-control of the speed reference is set to 100% via **P 375[0] - CON_IP_SFF_Scale**. This value should not be changed.
- The acceleration torque pre-control can be optimized with **P 376[0] - CON_IP_TFF_Scale**. Reducing this reduces the pre-control value; conversely, increasing this value also increases the pre-control value.
- The position tracking error can be further reduced by predictive torque and speed pre-control – that is, in advance of the position reference setting. Owing to the time-discrete mode of operation of the control circuits and the limited dynamism of the current control circuit, this prediction is necessary to prevent the individual control circuits from oscillating against one another. Prediction in pre-control is achieved by retarding the references for speed and position controllers.

ID	Index	Name	Unit	Description
372	0	CON_IP_SFFTF	ms	Speed feedforward filter time constant (PCON mode)
374	0	CON_IP_EpsDly	ms	Delay pos. reference by integer no. of cycles CON_PConTS
375	0	CON_IP_SFFScale	%	Scaling of speed feedforward
376		CON_IP_TFFScale		Scaling of torque feedforward
376	0	TFFScale_PCON		Scaling of torque feedforward (PCON mode)
376	1	TFFScale_SCON		Scaling of torque feedforward (SCON mode)
377		CON_IP_EnableFF		Enable feedforward
377	0	CON_IP_EnableFF		Enable feedforward
377	1	CON_IP_EnableFF		Enable feedforward
378	0	CON_IP_ACCFFTF	ms	Acceleration feedforward filter time constant (PCON, SCON mode)
379		CON_IP_FFMode		Feed-forward calculation mode
379	0	PosHighRes		Position high resolution
379	1	Speed		Speed pre-control
379	2	Torque		Torque pre-control
386		CON_SCON_TFric		Dry friction comp., normalized to motor rated torque
386	0	CON_SCON_TFric	%	Friction torque compensation settings The table values 0 to 2 are always applicable while table values 3 to 4 only take effect in the acceleration range.
386	1	CON_SCON_TFric	%	Compensation value 1
386	2	CON_SCON_TFric	%	Compensation value 2
386	3	CON_SCON_TFric	%	Compensation value 3
386	4	CON_SCON_TFric	%	Compensation value 4
387		CON_SCON_TFricSpeed		Friction torque compensation: Speed limits
387	0	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
387	1	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limit 1
387	2	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limit 2
387	3	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limit 3
387	4	CON_SCON_TFricSpeed	rpm	
388	0	CON_SCON_TConst	%	Friction torque compensation: Constant (independent of direction)
1516	0	SCD_Jsum	kg m*m	Total inertia of motor and plant

Table 7.22: "Position controller - Pre-control" parameters



NOTE

- Torque feed-forward control will be disabled if linear interpolation is used.
- The overall moment of inertia in **P 1516[0] - SCD_Jsum** must not be changed to optimize the pre-control, because this would also have an effect on other controller settings!
- In multi-axis applications requiring precise three-dimensional axis coordination, such as in the case of machine tools, the delay of the position signal must be equally set on all axes via **P 374[0] - IP_EpsDly**. Otherwise the synchronization of the axes may suffer, leading to three-dimensional path errors.

7.5.2 Friction torque compensation (friction)

Two types of friction influence the variables of the position tracking error:

- Dry friction (grip), which acts depending on the direction of motion, but independently of the speed's magnitude.
- Fluid friction (viscosity), which acts proportionally to speed.

Friction torque compensation can be used for both types of friction. Both types of friction are described in the compensation table by a function starting from speed = 0 or force = 0 up to a defined speed or force. Above the specified limit, the speed or force remains constant. Compensation is performed as a percentage of rated motor torque and power.

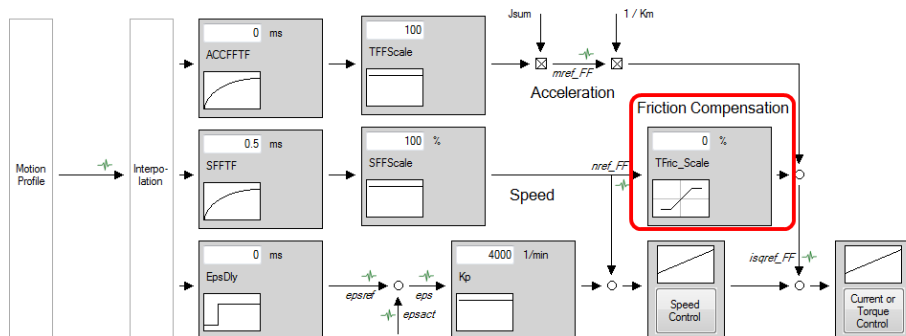


Fig. 7.32: "Position control" screen

ID	Index	Name	Unit	Description
386		CON_SCON_TFric		Dry friction comp., normalized to motor rated torque
386	0	CON_SCON_TFric	%	Friction torque compensation settings The table values 0 to 2 are always applicable while table values 3 to 4 only take effect in the acceleration range.
386	1	CON_SCON_TFric	%	Compensation value 1
386	2	CON_SCON_TFric	%	Compensation value 2
386	3	CON_SCON_TFric	%	Compensation value 3
386	4	CON_SCON_TFric	%	Compensation value 4
387		CON_SCON_TFricSpeed		Friction torque compensation: Speed limits
387	0	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
387	1	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
387	2	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
387	3	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
387	4	CON_SCON_TFricSpeed	rpm	Friction torque compensation: Speed limits
388	0	CON_SCON_TConst	%	Friction torque compensation: Constant (independent of direction)

Table 7.23: "Position controller - Feed-forward control" parameters (friction torque compensation extract)

The screen view can only be used to configure **P 386[0] - CON_SCON_TFric**. In order to access all the friction torque compensation parameters, please switch to the list view by using the "CTRL + L" key combination.

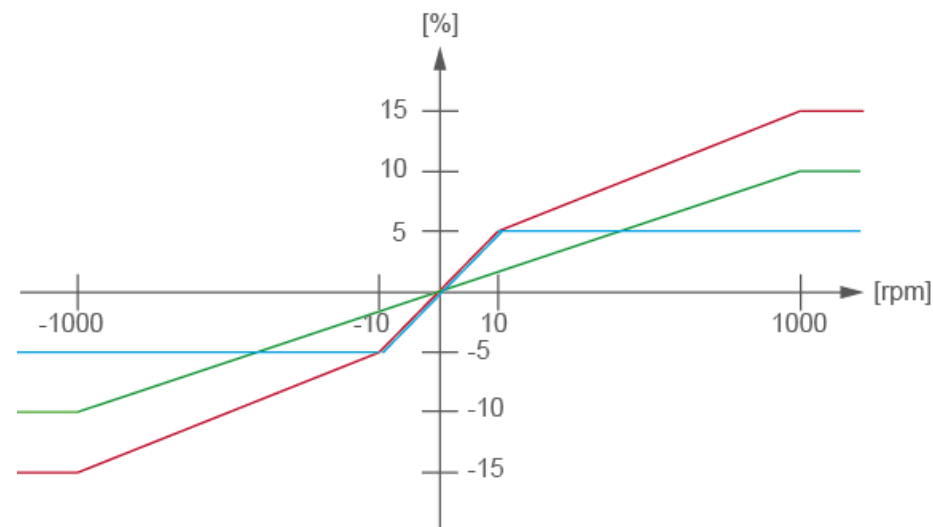


Fig. 7.33: Friction torque compensation for position control

The friction torque compensation is derived from the forward-fed speed **nref_FF**. It has five basic functions, each having the **Torque** and **Speed** parameters. The basic function runs proportionally up to the point (Speed, Torque), the function value remains constant at higher speeds.

7.6 Asynchronous motor field weakening

Up to rated speed the asynchronous motor runs with a full magnetic field and so is able to develop a high torque. Above the rated speed, the magnetic field is reduced because the maximum output voltage of the Servo Drive has been reached. The motor is operated in the field-weakening range at reduced torque.

To use field weakening for asynchronous motors, the motor parameters must be known very accurately. This applies in particular to the dependency of the main inductance on the magnetizing current. The field-weakening mode requires that a motor identification and an optimization in the basic setting range be carried out. In the process, default values for the control circuits and the "magnetic operating point" are set based on the rated motor data and the magnetizing current presetting in **P 340[0] - CON_FM_Imag**. For field weakening when using an asynchronous motor, a characteristic curve is always internally calculated (independently of **P 435[0] - CON_FM_FWMode**) and a voltage controller is superimposed.

Configuring the characteristic curve with **P 341[0] - ImagSLim**:

- Variant 1: **P 341[0] ≠ 0** signifies selection of the 1/n characteristic (default)
- Variant 2: **P 341[0] = 0** signifies selection of the modified 1/n characteristic $isd = f(n)$.

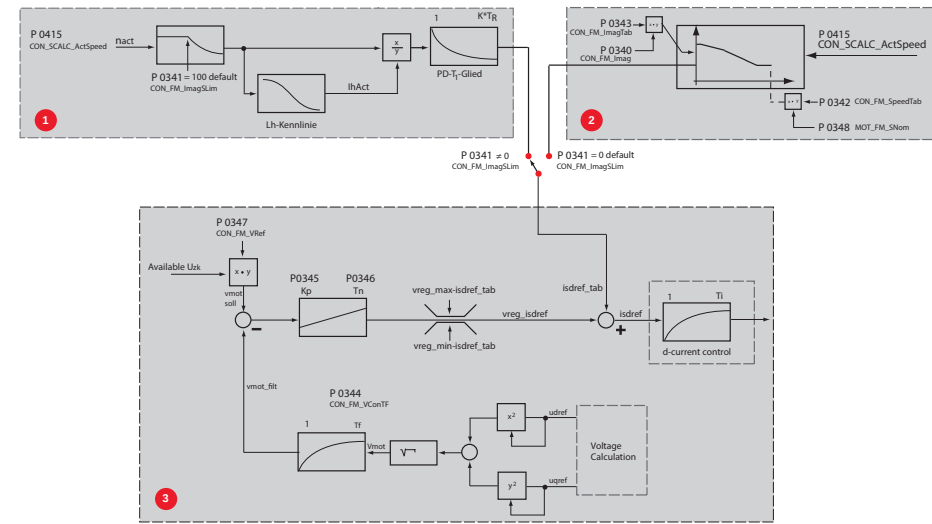


Fig. 7.34: Structure of field weakening for asynchronous motors

7.6.1 Variant 1: Default

Combination of "pre-control via 1/n characteristic" + voltage controller. The motor identification sets the voltage controller so that the voltage supply in a weakened field is adequate. If the Servo Drive is at the voltage limit, it reduces the d-current and thus the rotor flux. The 1/n characteristic curve is calculated with operating speed **SNom * ImagSLim**.

As the Servo Drive has only limited dynamism, and starts to oscillate if larger gain factors are set, it is possible to use variant 2.

7.6.2 Variant 2: Modified characteristic

Combination of "pre-control with modified 1/n characteristic ($i_{sd}=f(n)$) + voltage controller. This characteristic describes the magnetizing current as a percentage of the nominal value of **P 340[0] - CON_FM_Imag** dependent on the speed. The choice between the modified 1/n characteristic and the static characteristic is based on **P 341[0] - CON_FM_ImagSLim**.

The speed is specified relative to the rated speed in **P 458[0] - MOT_SNom**, the d-current relative to the magnetizing current in **P 340[0]**. A constant magnetizing current **P 340[0]** is injected up to the field-weakening speed. The d current will be set as a function of speed based on the configurable characteristic curve. The characteristic curve is configured with **P 342 CON_FM_SpeedTab** and **P 343 - CON_FM_ImagTab**; when using an asynchronous motor, only values 0–7 from **ImagTab** will be relevant; values 8–15 are intended for synchronous motor field weakening

7.6.3 Voltage controller

The superimposed voltage controller will be a PI controller with gain **P 345[0] - CON_FM_VConKp** and reset time **P 346[09] - CON_FM_VConTn**. In addition, the measured DC link voltage can be smoothed with a **P 344[0] - CON_FM_VConTF** PT1 filter. After a motor identification the voltage controller is always active, as the rule parameters are preset. With **P 345[0] - CON_FNVConKp = 0** the voltage controller is deactivated. The voltage setpoint that needs to be achieved is specified using **P 347[0] - CON_FM_VRef**.

Example

Index	P 348 rated speed; P 340 $I_{mag\text{eff}}$	P 342 (0-7) field weakening speed [%]	P 343 (0-7) Magnetising current in field weakening mode [%]
(0)	$I_{\text{rated}} = 1800 \text{ rpm}$ $I_{\text{mag eff}} = 100 \%$	100	100
(1)		110	100
(2)		120	100
(3)		130	100
(4)		140	90
(5)		150	70
(6)		160	55
(7)		170	0

Table 7.24: Example of modified characteristic curve

ID	Index	Name	Unit	Description
430	0	CON_FM_VModel		Weighting of voltage path in field model
340	0	CON_FM_Imag	A	Magnetizing current (RMS)
341		CON_FM_ImagSettings		Settings of magnetizing behaviour
341	0	ImagSLim	%	Speed where field-weakening starts
341	1	Imag0	% Inom	Magnetizing current during start-up
342		CON_FM_SpeedTab		Speed values for magnetizing current scaling
342	0	CON_FM_SpeedTab	%	
342	1	CON_FM_SpeedTab	%	
342	2	CON_FM_SpeedTab	%	
342	3	CON_FM_SpeedTab	%	
342	4	CON_FM_SpeedTab	%	

Table 7.25: "Field-weakening" parameters

ID	Index	Name	Unit	Description
342	5	CON_FM_SpeedTab	%	
342	6	CON_FM_SpeedTab	%	
342	7	CON_FM_SpeedTab	%	
343		CON_FM_ImagTab		Magnetizing current scaling vs. speed
343	0	CON_FM_ImagTab	%	
343	1	CON_FM_ImagTab	%	
343	2	CON_FM_ImagTab	%	
343	3	CON_FM_ImagTab	%	
343	4	CON_FM_ImagTab	%	
343	5	CON_FM_ImagTab	%	
343	6	CON_FM_ImagTab	%	
343	7	CON_FM_ImagTab	%	
343	8	CON_FM_ImagTab	%	
343	9	CON_FM_ImagTab	%	
343	10	CON_FM_ImagTab	%	
343	11	CON_FM_ImagTab	%	
343	12	CON_FM_ImagTab	%	
343	13	CON_FM_ImagTab	%	
343	14	CON_FM_ImagTab	%	
343	15	CON_FM_ImagTab	%	
344	0	CON_FM_VConTF	ms	Voltage control filter time constant
345	0	CON_FM_VConKp	A/V	Voltage control gain
346	0	CON_FM_VConTn	ms	Voltage control integration time constant
347	0	CON_FM_VRef	%	Voltage control reference (relative to maximum voltage)
348	0	CON_FM_SlipCon	%	Slip control gain for field weakening
435	0	CON_FM_FWMode		Mode of field weakening / d-current calculation (PSM)
436	0	CON_FM_FWSpeedScale	%	Speed scaling for field weakening (table mode)
437	0	CON_FM_FWCurrScale	%	q-current scaling for field weakening (table mode)
438	0	CON_FM_FWMaxBackEMF	V	Maximum back-EMF in field weakening mode (DC link voltage)

Table 7.25: "Field-weakening" parameters (continue)

ID	Index	Name	Unit	Description
421		CON_FM_FWTabIdx		Table index for field weakening / reluctance torque utilization
421	0	CON_FM_FWTabIdx		Speed index
421	1	CON_FM_FWTabIdx		Torque index
422	0	CON_FM_FWTabId	A	d-current table entry
423	0	CON_FM_FWTabId	A	q-current table entry

Table 7.26: "Field weakening - Interior permanent magnet synchronous motor (IPMSM)" parameters

7.6.4 Field-weakening of asynchronous motor voltage controller

The voltage controller is superimposed onto the selected characteristic curve. When the voltage controller is used, a part of the available voltage is used as a control reserve. The more dynamic the operation, the more control reserve is required. In this case it may be that the voltage for rated operation is not sufficient, and also that the controller starts to oscillate.

The PI voltage controller can be optimized by adaptation of the gain **P 345[0] - CON_FM_VConKp**, integral-action time **P 346[0] - CON_FM_VConTn** and filter time constant for motor voltage feedback **P 344[0] - CON_FM_VConTF**. **P 347[0] - CON_FM_VRef** sets the voltage reference, though the threshold needs to be reduced in response to rising demands as this maintains a kind of voltage reserve for dynamic control processes.

A certain voltage reserve is necessary for stable operation. It is specified by way of **P 347[0] - CON_FM_VRef** (< 100%). The value should be set high ($\leq 90\%$) where there are high demands in terms of dynamic performance. When using a lower dynamic performance instead, the maximum achievable torque can be optimized in relation to the current by using higher values (> 90%).

P No.	Index	Name	Unit	Description
344	0	CON_FM_VConTF	ms	Time constant of voltage controller actual value filter
345	0	CON_FM_VConKp	A/V	Voltage controller gain factor Kp
346	0	CON_FM_VConTn	ms	Voltage controller integral-action time Tn
347	0	CON_FM_VRef	%	Voltage controller reference (as % of the current DC link voltage) If the value 0 % is set, the controller is not active.
458	0	MOT_SNom	rpm	Motor rated speed

Table 7.27: "Voltage controller" parameters



NOTE

- If the control reserve is too small, the Servo Drive typically shuts off with an overcurrent error.

7.7 Field weakening and LookUpTable (LUT), synchronous motor

LookUp Table, LUT

For better control of motors with a torque reluctance component. For motors with different inductances on the d and q axis, a reluctance torque can contribute to obtaining better utilization of the overall torque. The d and q current have feed forward control in dependence on the target torque and the actual speed by means of tables (LUT). As this approach also subjects the d component of the current to feed forward control in exactly the same manner as the field weakening designed to achieve higher speeds as described below, the LUT usually considers both the torque and the field weakening simultaneously for the d current.

Field weakening

Synchronous motors can also be operated above their rated speed at rated voltage by reducing their voltage consumption through the injection of a current component.

Features

- The method is relatively robust against parameter fluctuations.
- The voltage controller can only follow rapid speed and torque changes to a limited degree.
- A non-optimized voltage controller may cause oscillation; the controller must be optimized.

Conditions

To effectively reduce the voltage consumption, the ratio of stator inductance **P 471[0]** - **MOT_Lsig** multiplied by the rated current **P 457[0]** - **MOT_CNom** to rotor flux **P 462[0]** - **MOT_FluxNom** must be sufficiently large. In contrast to field-weakening of asynchronous motors, synchronous motors can also be operated in the field-weakening range with full rated torque at the nominal value of the q-current. Power beyond the rated power output can therefore be drawn from the machine in field-weakening mode, even at rated current. This must be taken into consideration when configuring the motor.

$$CNom * Lsig > Faktor * FluxNom$$

A value greater than 0.2 is recommended for *Factor*.

Voltage demand

Rotor flux *	Maximum speed (in rad/s)	* Number of pole pairs	$\sqrt{3}$	800 V (400 V devices) 400 V (230 V devices)
P 462[0]	* P 458 [0]	* P 328 [0]	* $\frac{2\pi}{60}$	* P 463[0]
			$\sqrt{3}$	800 V (400 V devices) 400 V (230 V devices)

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. If the speed achieved by field-weakening is so high that the induced voltage exceeds the overvoltage threshold of the device (for 400 V devices approximately 800 V, for 230 V devices approximately 400 V), this will result in destruction of the Servo Drive if no additional external safety measures are applied.

First of all, there are two variants for field weakening with synchronous motors, variants 1 and 2. They can be selected via **P 435[0]** - **CON_FW_FWMode**.

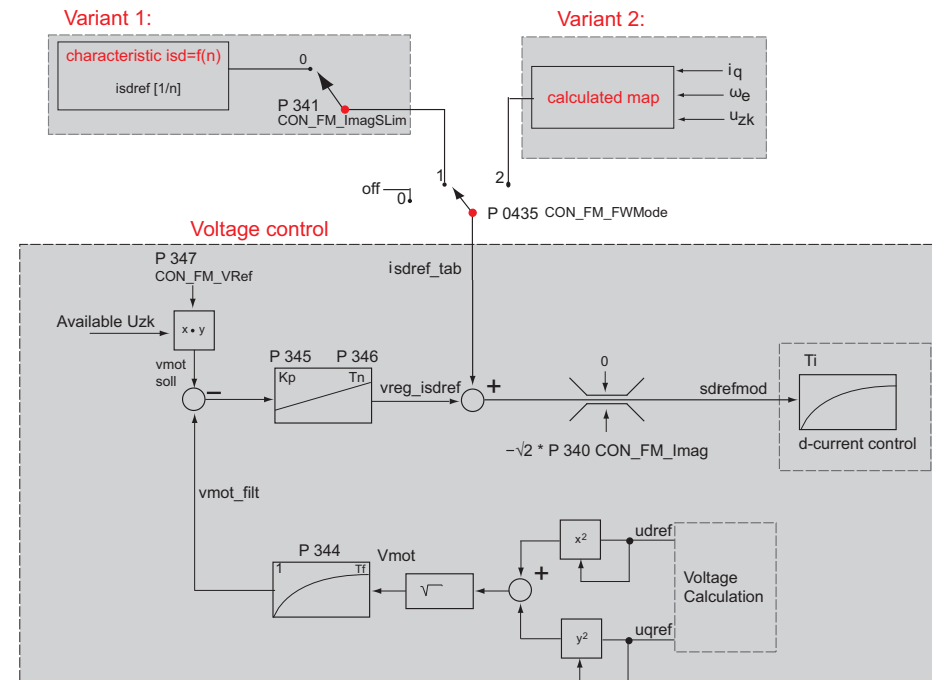


Fig. 7.35: Structure of field-weakening of synchronous motors

Additional modes (corresponding to **P 435[0]** - **CON_FW_FWMode** in the figure at positions 0, 1 and 2) with their feed forward control of the d current are coupled with additional multiplexer settings here as an alternative.

The voltage control implementation is active in all modes! This ensures by means of **P 347 CON_FM_VRef** that adequate voltage reserves are available to maintain a functional speed control at higher speeds.

7.7.1 Variant 1 (Table)

- Deactivate table: **P 340[0] - CON_FM_Imag** = 0
- Select **P 435[0] - CON_FM_FwMode** = **TABLE(1)**
- Run-up slowly to required speeds
- Set scope: $I_{sdref} / \sqrt{2} \cdot I_{mag} = \% = \text{field-weakening speed}$. The maximum amount of the field-weakening d-current is defined by parameter **P 340[0] - CON_FM_Imag** (specification of effective value).
- Enter the values in the table; **P 342[0] - CON_FM_SpeedTab**

Example

The speeds in **P 342[0] - CON_FM_SpeedTab** must continuously increase from index 0 -7.

Index	P 348 Rated speed; P 340 $I_{mag\ rms}$	P 342 (0-7) Field- weakening speed [%]	P 343 (0-7) Magnetizing current in field-weakening mode in [%]
(0)	$I_{rated} = 1800\ rpm$ $I_{mag\ rms} = 100\%$	100	0
(1)		110	55
(2)		120	70
(3)		130	90
(4)		140	100
(5)		150	100
(6)		160	100
(7)		170	100

Table 7.28: Example of speeds in **P 342 - CON_FM_SpeedTab**

7.7.2 Variant 2 (Calc)

In the case of very rapid speed or load changes in the field-weakening range, the setting **P 435[0] - CON_FM_FwMode** = **CALC(2)** must be selected. A characteristic for higher control dynamism is calculated internally.

Features

- Very fast adaptations, with high dynamism, are possible (open-loop control method).
- Motor parameters must be known quite precisely.
- If continuous oscillation occurs (voltage limit) the preset negative d-current value is then not sufficient. Scaling parameter **P 436[0] - CON_FW_SpeedScale** > 100% is used to evaluate the map at higher speeds.

The voltage controller overlaid over the map (setting as described in variant 1).

The set combination of voltage controller and map entails more commissioning commitment, but it enables the best stationary behaviour (highest torque relative to current) and the best dynamic response to be achieved.

ID	Index	Name / Setting	Unit	Function
435	0	CON_FM_FwMode		Selection mode for field-weakening of synchronous motors
		NONE (0) = Field weakening disabled		Field-weakening is off, regardless of other settings.
		TABLE (1) = I_{sd} set by PI controller and table parameter		Field-weakening is effected by a characteristic which specifies the d-current (P 343[0] - CON_FM_ImagTab) dependent on the speed (P 342[0] - CON_FM_SpeedTab).
		CALC (2) = I_{sd} set by PI controller and table parameter		Field-weakening is effected by way of a characteristic which is set internally via the

Table 7.29: Parameters for selecting field weakening

ID	Index	Name / Setting	Unit	Function
				motor parameters. The d-current reference is then calculated dependent on the speed AND the required q-current: $isd = f(n, isq_ref)$. The inaccuracies with regard to the motor parameters, the available voltage etc. can be compensated by way of P 436[0] - CON_FW_SpeedScale .
		REL (3)		Internal LookUp Table (small table)
		TABLE_MOT_GEN(4)		Table with a differentiation for motor or regenerative mode
		TABLE2(5)		Table with 8 data points at equidistant spacing
		LUText(6)		External LookUp Table (large table)
		LUT(7)		reserved

Table 7.29: Parameters for selecting field weakening (continue)

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. - When configuring projects, it must be ensured that the speed NEVER exceeds the value of the product of P 458[0] - MOT_SNom * P 0328_CON_SCON_SMax - It should be ensured as a matter of principle that the induced voltage does not exceed the voltage limits. - The maximum system speed must not be exceeded.

7.7.3 Variant 4 (TableMotGen)

A table that differentiates between motor and regenerative mode is used.

Activate table: **P 435[0] - CON_FM_FWMode = TABLE_MOT_GEN(4)**

Parameter **P-343 CON_FM_ImagTab** can be used to configure 16 elements.

Index 0-7: Motor or classic table,

Index 8-15: Regenerative; the speeds are the same in both cases

The selection concerning as of what power the operation mode is “motor-oriented” or “regenerative” is defined by **P-459 MOT_PNom * P-348 CON_FM_SlipCon (%)**. For small power values, linear interpolation between the tables is employed.

The voltage controller overlaid over the map (setting as described in variant 1).

7.7.4 Variant 5 (TABLE2)

“Table 2” has 8 data points for the field-weakening current component with an equidistant spacing between two limit speeds.

Activate table: **P 435[0] - CON_FM_FWMode = TABLE2(5)**

The lower limit speed is **P 342[0] - CON_FM_SpeedTab[0]**, and the upper limit speed is **P 342[1] - CON_FM_SpeedTab[1]**. Both numerical values for the limits speeds are standardized relative to the nominal speed of the motor (MOT_SNom).

The table values for the field-weakening current component (-id) are specified via **P 343 - CON_FM_ImagTab[0..7]** and standardized to $\sqrt{2} \cdot \text{CON_FM_Imag}$. The interpolation values are calculated using linear interpolation.

P 343 - CON_FM_ImagTab[0] and CON_FM_ImagTab[7] are used for extrapolation outside of the limit speeds.

The voltage controller overlaid over the map (setting as described in variant 1).

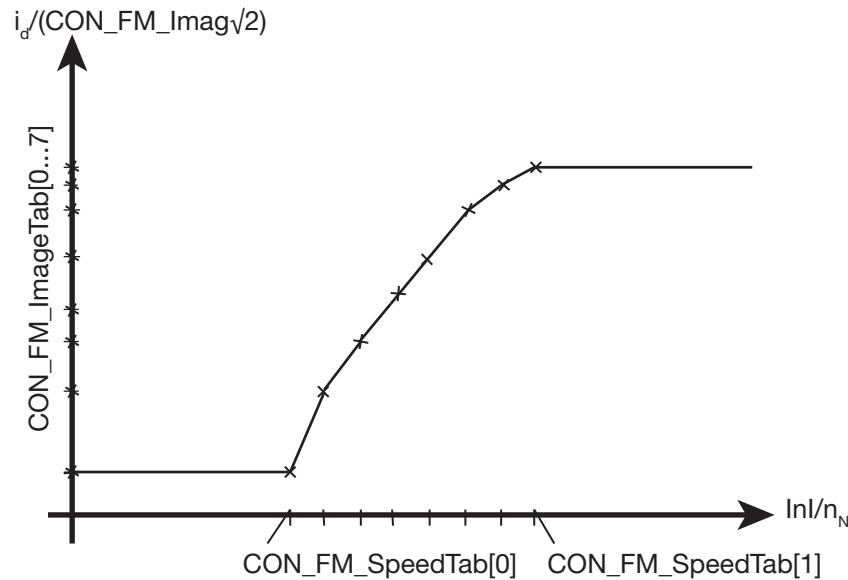


Fig. 7.36: Example of 8 data points with equidistant spacing over the speed

Notes:

1. If you do not want to have field weakening ($i_d=0$) for low speeds $|n| \leq \text{P } 342 - \text{CON_FM_SpeedTab}[0]$, then $\text{P } 343 - \text{CON_FM_ImagTab}[0]$ must be set to 0% (extrapolation below $\text{P } 342 - \text{CON_FM_SpeedTab}[0]$ with a value of 0).
2. The values in $\text{P } 342 - \text{CON_FM_SpeedTab}[2..7]$ and $\text{P } 343 - \text{CON_FM_ImagTab}[8..15]$ are not used in this mode.

7.7.5 Variants 3 and 6 (LUT)

For motors with different inductances on the d and q axis, such as an IPMSM (interior permanent magnet synchronous machine), a reluctance torque which is dependent on the d and q current can be built up. A result of the exploitation of this torque is that the control by means of q current alone (i_d is reduced to 0) (typical for non-salient pole PMSM) is no longer adequate to make use of the machine's full potential.

Consequently, special control structures are implemented in the MSD Servo Drive to ensure optimal control for motors of this nature.

The control works in almost the same way as for the standard control circuit of a PMSM, except that the direct axis ref. current is no longer zero, but instead, both currents are dependent on the reference torque and the actual speed. To accomplish this, the standard control circuit is enhanced to include generation of a current reference value in the form of a LookUpTable (LUT). The current reference value is generated by specifying the associated d and q currents based on the target specification for the torque and the actual speed.

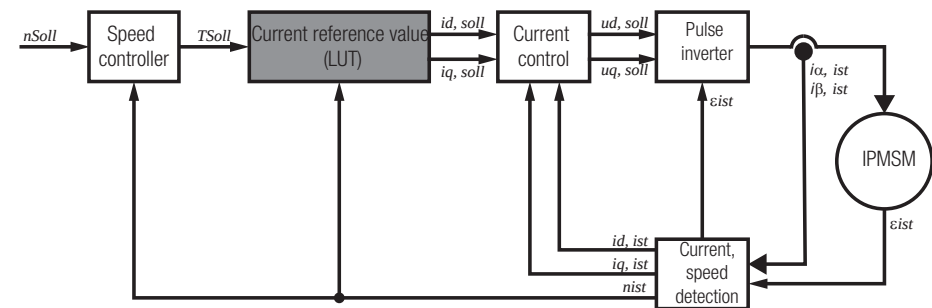


Fig. 7.37: Structure of the field weakening for a synchronous motor LookUp Table

These d and q-current reference values can

- Be calculated internally by the firmware (small table), OR
- Be specified externally, for example using a higher-order control (large table), OR
- Be loaded via the file system (large table)

Two LUTs of different sizes (**small and large table**) are implemented for this purpose. Each of these tables has two performance maps, one for the direct axis ref. current and one for the q-current reference values. Each are dependent on the actual speed 'nact' (x-direction) and the target torque 'Tset' (y-direction): field[x*y].

Small table

The small table has a fixed size for the performance map of [16x40] table entries. It is calculated **internally** by the servo drive. Only positive torques.

Activate small LUT: **P 435[0] - CON_FM_FWMode = REL(3)**

The inductances of the d and q axis must be known in order to calculate the LUT values internally.

ID	Index	Name / Setting	Unit	Function
P 471	0	MOT_Lsig	mH	d axis inductance
P 480	0	MOT_Lsq	mH	q axis inductance

Table 7.30: Specifying the inductances of the d and q axis

The values for the two inductances must be taken from the motor data sheet or can be determined by means of the motor identification (see also section "Motor identification" on page 47)

Large table

The large table has a variable size for the performance map which can be set for a minimum of [3x3] to a maximum of [128x128] table entries. It is **specified externally** to the servo drive. Negative torques are also possible.

Activate large LUT: **P 435[0] - CON_FM_FWMode = LUText(6)**

The size of the map in the large table can be adapted using parameter **P 1965 - CON_FM_LUT_Para[0,1]**.

ID	Index	Name / Setting	Unit	Function
P 1965		CON_FM_LUT_Para		
P 1965	0	LUT: Useof speed		Table size in the speed direction Factory setting: 121 Minimum: 3 Maximum: 128
P 1965	1	LUT: Useof torque		Table size in the torque direction Factory setting: 31 Minimum: 3 Maximum: 128

Table 7.31: Specifying the size of the performance map for the large table

The scaling of the map for the d and q current reference results from the nominal torque TNom and the nominal speed SNom as well as the associated scaling parameters TMax and SMax.

Example:

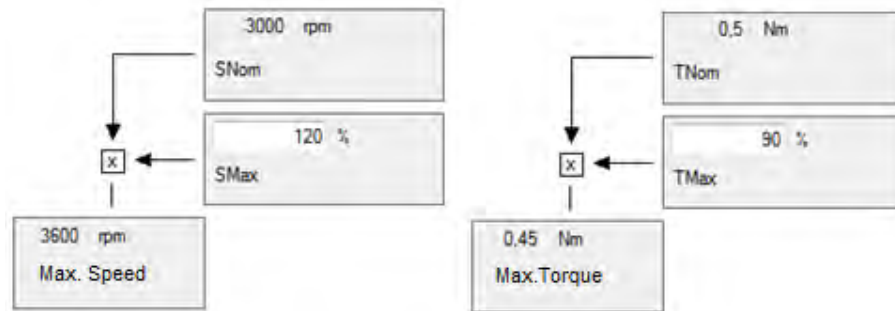


Fig. 7.38: Example

The possible performance maps for the q and d current reference result from this:

Torque	0.45 Nm	0.45 Nm	127						
	...	...	...						
	...	...	...						
	...	0	...						
	...	...	...						
	...	...	...						
	0	-0.45 Nm (*)	0						
				0	1	2	3	...	127
				0 rpm (**)	...	...	...	...	3600 rpm
				Speed					

(*) Map values with negative torques are allowed (large table).

ID	Index	Name / Setting	Description	Unit
P 1966		CON_FM_LUT_Para2		
P 1966	0	LUT: Tab speed maximum	3600	rpm
P 1966	1	LUT: Tab speed minimum	Always 0 (**)	rpm
P 1966	2	LUT: Tab torque maximum	0.45	Nm
P 1966	3	LUT: Tab torque minimum	-0.45 (*)	Nm

Table 7.32: Size of the map for the size of the table

(**) Map values with a negative torque are not supported. (The range of negative torques is mapped on the range of the positive torques by means of sign manipulation.)

7.7.5.1 Internal calculation of the small table

Select: Internal calculation of the small table

Activate small LUT: P 435[0] - CON_FM_FWMode = [REL\(3\)](#)

ID	Index	Name / Setting	Description	Unit
P 435	0	CON_FM_FWMode	3: Internal calculation of the small table	

Table 7.33: Mode selection: Internal calculation of the small table

Performing initialization

Afterwards, an initialization must be performed or the controller must be restarted so that the mode selection takes effect.

Parameter P 149[0] - MPRO_DRVCOM_Init = START(1).

ID	Index	Name / Setting	Description	Unit
P 149		MPRO_DRVCOM_Init	1: Start re-initialization	

Table 7.34: P 149, perform re-initialization

The d/q current values are now calculated and the small table is filled with the results.

Afterwards, access to the table entries of the respective table field is possible.

The small table is not saved to the controller's ROM. Instead, it is re-calculated when the servo drive is started or a re-initialization takes place and the results are saved to RAM.

7.7.5.2 Parameter interface for accessing the d/q current values of the LUT

Access to the values of the LUT can be carried out via parameters **P 421**, **P 422** and **P423**:

Selecting the small table:

Parameter **P 421[2] - CON_FM_FW_TabIdx[2].Table select** = 0 (internal LUT).

Selecting the large table:

Parameter **P 421[2] - CON_FM_FW_TabIdx[2].Table select** = 1 (external LUT).

Selecting the index for the speed:

Parameter **P 421[0] - CON_FM_FW_TabIdx[0].Speed index select**.

Selecting the index for the torque:

Parameter **P 421[1] - CON_FM_FW_TabIdx[1].Torque index select**.

Table value of the LUT for the d current:

Parameter **P 422[0] - CON_FM_FW_TabId** - Id in A.

Table value of the LUT for the q current:

Parameter **P 423[0] - CON_FM_FW_TabIq** - Iq in A.

ID	Index	Name / Setting	Description	Unit
P 421		CON_FM_FWTabIdx		
P 421	0	Speed index select	Selects index for speed	
P 421	1	Torque index select	Selects index for torque	
P 421	2	Table select	0: Selects small table 1: Selects large table	
P421	3	Command	0: None 1: ClearTable 2: WriteToRom	
P 422		CON_FM_FWTabId	d current table entry	A
P423		CON_FM_FWTabIq	q current table entry	A

Table 7.35: Parameter interface for accessing the LUT

The large table is not generated in the servo drive. It must be provided to the servo drive from an external source (referred to as an "external LUT"). This can be accomplished via the parameter interface described here.

For further procedure, see also section "Internal calculation of the small table" on page 161.



NOTE

- During the internal calculation of the small table, only map fields for positive speeds and torques are calculated.

7.7.5.3 Saving the large table to ROM

The large table can be transferred from the volatile RAM memory of the device to the non-volatile FLASH memory in the servo drive in two ways. The next time the device is started up, the reverse process is then carried out so that the large table is available immediately.

A.) Save the parameters, for example via Moog DRIVEADMINISTRATOR 5 (MDA5)

Saving the large table to the flash memory takes place concurrently to the process of saving the device parameters, for example using the “Save setting persistently in device (RAM to ROM)” button in the MDA5.

The parameter behind this procedure is **P 11[0]**:

Parameter **P11[0] - PARA_SetCmd[0].Save** = Active(1)

In contrast to the parameter values that are transferred to the NVRAM in the servo drive, the values of the large table are transferred to the flash memory in the servo drive.

B.) Targeted saving of a special parameter using a save command

Command: Save large table to flash memory:

Parameter **P 421[3] - CON_FM_FW_TabIdx[3].Command** = WriteToROM(2)

This command only works for the large table: Select the table using parameter **P 421[2] - CON_FM_FW_TabIdx[2].Table select** (small or large) is redundant in this case.

CAUTION!

Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.

Improper conduct can cause damage to your system / machine.



- When developing the project, care must be taken to ensure that the function “**Save the large table to ROM**” **is never carried out repeatedly or cyclically**.
- The reason is that saving to the flash memory of the servo drive is subject to a limitation of the overall number of possible save operations.

7.7.5.4 Deleting a table RAM

The table to be deleted must first be selected and can subsequently be deleted in your RAM cells.

1.) Select the table:

Parameter **P 421[2] - CON_FM_FW_TabIdx[2].Table select** = [0, 1]

2.) Delete the table:

Parameter **P 421[3] - CON_FM_FW_TabIdx[3].Command** = ClearTable(1)

7.7.5.5 Loading the large table via the controller's file system

This procedure is only conceived for a special use case: the large LookUp Table (LUT) must be changed continuously during operation (in the RAM memory!). Consequently, the transfer procedure needs to run quickly.

The transfer of an individual LUT can then no longer be carried out via the parameter interface (see 2 sections ago) because that would take too long during the actively running process. The solution that has been created for this is the option of first transferring the entire large table **via ftp as a *.bin file** to the file system of the servo drive in its entirety and then to load it to the RAM cells of the large LUT by means of a “special command.”

The map fields for the LUT can be transferred from one or several .CSV files via a converter (PC program) to the target, which is the *.bin file.

The proper formatting of the *.bin file can be obtained from the manufacturer.

The manufacturer may be able to provide one example of a PC converter program of this nature (“LookUpTabConverter.exe”).

At the end of the preparation process, you will then have the targeted amount of different *.bin files for the process which will run later on.

The 'special command' for transferring the data of the large table from the controller's file system to the RAM cells of the large LUT is:

Parameter **P 2009[0] - COM_CFG_File** = READ_LUT(15)
(Read lookup table data file from RAM disk)

**NOTE**

- Please contact the manufacturer for more information on this special function.

7.7.5.6 CRC redundancy check

One single checksum can be calculated for the entire large table.

Command for one-time calculation and saving of the checksum:

Parameter **P 1965[2] - CON_FM_LUT_Para[2].LUT: Tab CRC control**
= Tab-Crc-NewCalculation(2).

After successful calculation, the parameter automatically switches to the monitoring mode:

Parameter **P 1965[2] - CON_FM_LUT_Para[2].LUT: Tab CRC control**
== Tab-Crc-Monitoring(1).

The calculated checksum is stored in:

Parameter **P 1965[3] - CON_FM_LUT_Para[3].LUT: Tab CRC value**

Now parameter **P1965** should be stored persistently in the device.

The checksum monitoring is carried out one time for each initialization, e.g. when the servo drive is started up.

If the checksum comparison returns a negative response, error 30-7 appears, see *also section "Error list" on page 339*.

For information on the checksum calculation, see *also section "CRC algorithm and C functionality" on page 164*.

ID	Index	Name / Setting	Description	Unit
P 1965		CON_FM_LUT_Para		
P 1965	2	LUT: Tab CRC control	0: None 1: Monitoring active 2: New calculation	
P 1965	3	LUT: Tab CRC value	Checksum value	

Table 7.36: Parameters for cyclical redundancy check

7.7.5.7 Important scope variables in the Moog DRIVEADMINISTRATOR 5

The Moog DRIVEADMINISTRATOR 5 offers a series of useful scope signals for diagnosis and monitoring of the calculated or externally specified values, such as the LUT index currently in use for speed (Scope ID 150) or torque (Scope ID 151).

7.7.5.8 CRC algorithm and C functionality

Checksum calculation

The checksum should be of the type CRC16 generation related to CRC-CCITT.

- Type: CRC16 over one byte stream
- Polynomial: $x^{16} + x^{12} + x^5 + 1$ which equals 1021h
- Starting value: FFFFh
- final XOR: A55Ah

7.7.6 Field-weakening of synchronous motor voltage controller

The voltage controller is superimposed onto the selected characteristic curve. When the voltage controller is used, a part of the available voltage is used as a control reserve. The more dynamic the operation, the more control reserve is required. In this case it may be that the voltage for rated operation is not sufficient, and also that the controller starts to oscillate.

If the voltage controller oscillates, the gain must be reduced. If substantial variations between the q-current reference and actual values occur during run-up to reference speed in the field-weakening range, the Servo Drive may be at the voltage limit. In this case, a check should first be made as to whether the preset maximum value **P 340[0] - CON_FM_Imag** has already been reached and can be increased. If the maximum value has not yet been reached, the voltage controller is not dynamic enough and the gain **P 345[0] - CON_FM_VConKp** must be increased.

If no suitable compromise can be found, the voltage threshold as from which the voltage control intervenes must be reduced by the scaling parameter **P 347[0] - CON_FM_VRef**. If the response with voltage controller is unproblematic and no particular demands are made in terms of dynamism, the available torque can be optimized by setting **P 347[0] - CON_FM_VRef** to values up to 98%.

7.8 Synchronous motor auto commutation

For field-oriented regulation of permanently excited synchronous motors with a purely incremental measuring system, the commutation position must be determined once when the control is started (adjustment of current rotor position to encoder zero [encoder offset]). This procedure is executed by the "Auto commutation" function after initial enabling of the control when the mains voltage has been switched on for the first time. It can also be forced during commissioning by changing a parameter, which causes a complete controller initialization (e.g. change of auto commutation parameters, change of control mode etc.). Owing to the differing requirements arising from the applications, various commutation methods are provided (**P 390[0] - CON_ICOM**).

To check in commissioning whether the auto commutation has been successful, **P 394 - CON_ICOM_Check** is provided. It comprises the current commutation angle error **P 394[1] - ActVal** and a parameterizable limit value **P 394[0] - Limit**. If the commutation angle error exceeds the specified limit value, an error is generated.

CAUTION!	Damage to the device as a result of incorrect operation!
	Failure to exercise caution or follow proper working procedures may result in damage to the device. - The motor can move suddenly during the auto commutation. The mechanism coupled must be designed for this movement. - If the commutation position is not determined correctly, the motor will accelerate in an uncontrolled manner. This can lead to damage to the mechanical system. - Make sure to carefully test the auto commutation function. Vary the start position. Even if autocommutation has not been performed, the drive can be "made to rotate" in up to 50 % of cases. - Enable speed tracking error monitoring (P 744[0] - SDiffMax, Section "Speed- / velocity limits" on page 322). This monitoring function provides extensive protection against uncontrolled movement.

ID	Index	Name / Setting	Unit	Description
365	0	CON_ICOM_AutoOn		auto recommitment after selected event
366	0	CON_ICOM_RefSpeed	rpm	commutation detection: scaling of control gain
390	0	CON_ICOM		Auto commutation: Control word for selection
		Off (0)		Function disabled
		IENCC (1)		Current injection
		LHMES (2)		Saturation of inductance evaluated
		IECSC (3)		<i>Not yet implemented</i>
		IECON (4)		Current injection, minimized movement
		HALLS (5)		<i>Not yet implemented</i>
		HALLSDIGITAL (6)		Digital Hall sensor

Table 7.37: "Auto commutation" parameters

ID	Index	Name / Setting	Unit	Description
		HALLSDIGITAL2 (7)		Digital Hall sensor (alternate process)
391	0	CON_ICOM_KpScale	%	commutation detection: scaling of control gain
392		CON_ICOM_Time		commutation detection: times
392	0	CON_ICOM_Time	ms	
392	1	CON_ICOM_Time	ms	
392	2	CON_ICOM_Time	ms	
392	3	CON_ICOM_Time	ms	
393		CON_ICOM_Current		commutation detection: currents
393	0	CON_ICOM_Current	A	
393	1	CON_ICOM_Current	A	
394		CON_ICOM_Check		Monitoring auto commutation
394	0	LIMIT	degree	Auto commutation: Angle error limit
394	1	ActVal	degree	Auto commutation: Angle error actual value

Table 7.37: "Auto commutation" parameters (continue)

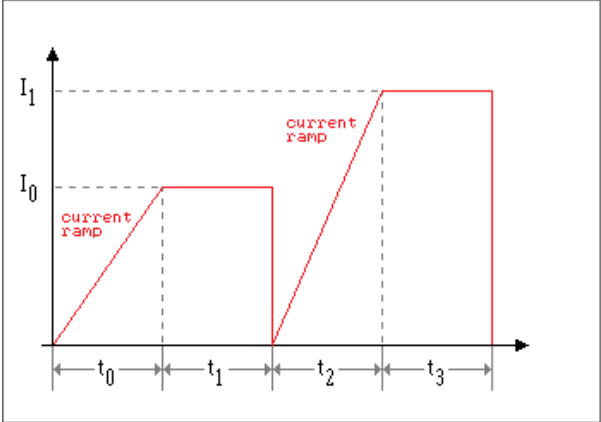
7.8.1 IENCC(1) method

Mode: IENCC(1) = current injection Options ...

Scaling factor: 20 %

Measurement frequency: 0 ms

Speed reference value: 0 rpm



Current I0: 0 A Time t0: 0 ms

Current I1: 0 A Time t1: 0 ms

 Time t2: 0 ms

 Time t3: 0 ms

Reset

Verification

Limit angle for error detection: 30 degree

Actual commutation angle error: 0 degree

Fig. 7.39: "Auto commutation IENCC(1)" screen

In this method the rotor aligns in the direction of the injected current and thus in a defined position. The relatively large movement (up to half a rotor revolution) must be taken into consideration. This method cannot be used near end stops or limit switches! For the injected current it is recommended to use the rated current I_{rated} . The time should be set so that the rotor is at rest during the measurement. For control purposes, the commutation process can be recorded with the Scope function.



NOTE

- Inexperienced users should always choose the rated motor current (amplitude) as the current and a time of at least 2000 ms.
- If the axis is blocked, meaning the rotor is unable to align itself, the method will not work correctly. As a result, the commutation angle will be incorrectly defined and the motor may perform uncontrolled movements.
- When calculating the data sets of linear motors the values for time and current adjust automatically.

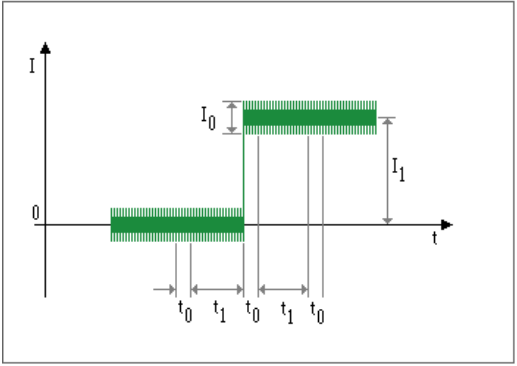
7.8.2 LHMES(2) method

Mode: LHMES(2) = saturation of inductance evaluated Options ...

Scaling factor: 20 %

Measurement frequency: 0 ms

Speed reference value: 0 rpm



Current I0: 0 A Time t0: 1 s

Current I1: 0 A Time t1: 1 s

Reset

When all values are 0 (zero) automatic settings on the basis of motor parameter.

Verification

Limit angle for error detection: 30 degree

Actual commutation angle error: 0

Fig. 7.40: "Auto commutation LHMES(2)" screen

With this method, saturation effects in stator inductance are evaluated. Two test signal sequences are used for this purpose, whereby the position of the rotor axis is

known after the first sequence and the direction of movement after the second. This method is suitable for determining the rotor position with braked rotors or motors with a high mass inertia.

- The test signal period (measurement frequency) is defined with **P 392[2] - CON_ICOM_Time**. If this value is 0, the controller uses a default test signal frequency of 100 Hz (period 10 ms).
- The test signal's amplitude (current I0) is defined with **P 393[0] - CON_ICOM_Current**. If the value is 0, the amplitude is derived from the motor rated current. If an amplitude greater than the switching frequency-dependent power stage current is specified, the amplitude is limited to half the power stage current.
- The test signal's DC component (current I1) is defined with **P 393[1] - CON_ICOM_Current**. If this value is 0, the equal portion is determined from the motor rated current.



NOTE

- A simple parameter setting is obtained by specifying the value 0 for **P 392[2] - CON_ICOM_Time**, **P 393[0] - CON_ICOM_Current** and **P 393[1] - CON_ICOM_Current**. The parameters are then assigned default values which are derived from the motor/power stage current. Then the measurement is performed.
- In order to be able to use the complex LHMES auto commutation method to its full extent, you will need to consult with Moog .

Precondition

The rotor must be securely braked so that it will not be able to move when the rated current is applied. The stator of the machine must be iron-core.

ID	Index	Description	Unit	Value
392	2	Test signal period (Measurement frequency)	ms	3
393	0	Test signal amplitude (Current I0)	A	1
393	1	Test signal direct component (Current I1)	A	3.1

Table 7.38: LHMES configuration example



NOTE

- It is advisable to connect speed tracking error monitoring with the "Power stage off" error reaction (see Section "Error reactions" on page 336). This monitoring feature prevents the motor from racing.

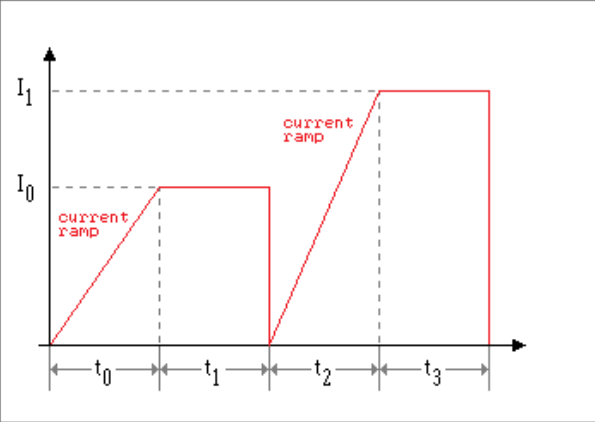
7.8.3 IECON(4) method

Mode: IECON(4) = current injection, minimized movement Options ...

Scaling factor: %

Measurement frequency: ms

Speed reference value: rpm



Current I0: A Time t0: ms

Current I1: A Time t1: ms

Time t2: ms

Time t3: ms

Reset

Verification

Limit angle for error detection: degree

Actual commutation angle error: degree

Fig. 7.41: "Auto commutation IECON(4)" screen

The motor shaft motion can be minimized by a shaft angle controller. The structure and parameters of the speed controller are used for the purpose. The gain can be scaled via **P 391[0] - CON_ICOM_KpScale**. The precondition is a preset speed control loop. Increasing the gain results in a reduction of the motion. An excessively high gain will result in oscillation and noise. In both methods (1) and (4), the flux forming current "Isdref" is injected as a test signal.

7.8.4 Test signal generator

It is possible to form various signal types and transfer them to the control. This function is independent of the control mode and has a direct effect on the control. Signal types can also be combined. The delta signal form is additionally available, though at present it is only accessible via the parameter editor. The parameters are recorded in the parameter list.

7.8.4.1 Overview of test signal generator

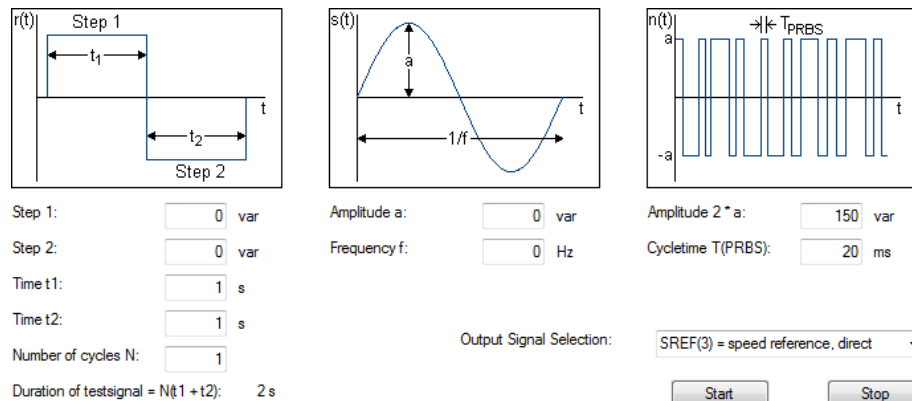


Fig. 7.42: "Test signal generator" screen

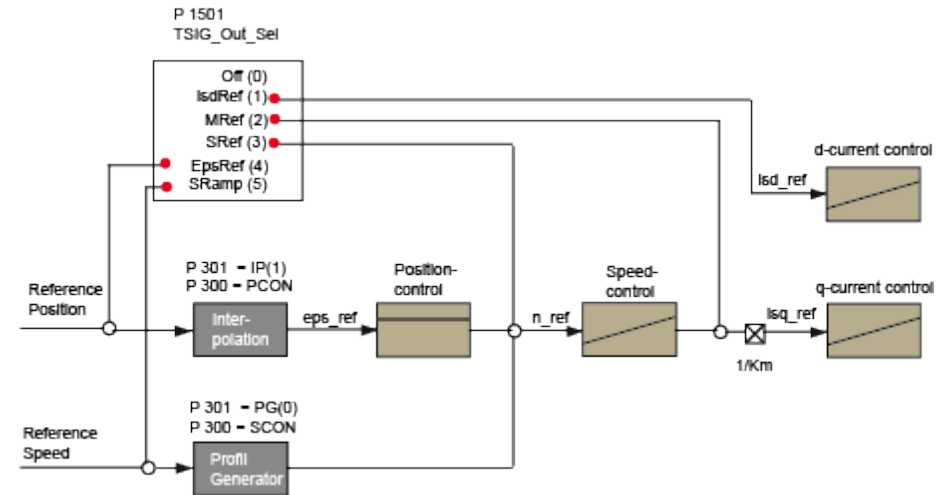


Fig. 7.43: TSIG output: Signal curve of TG

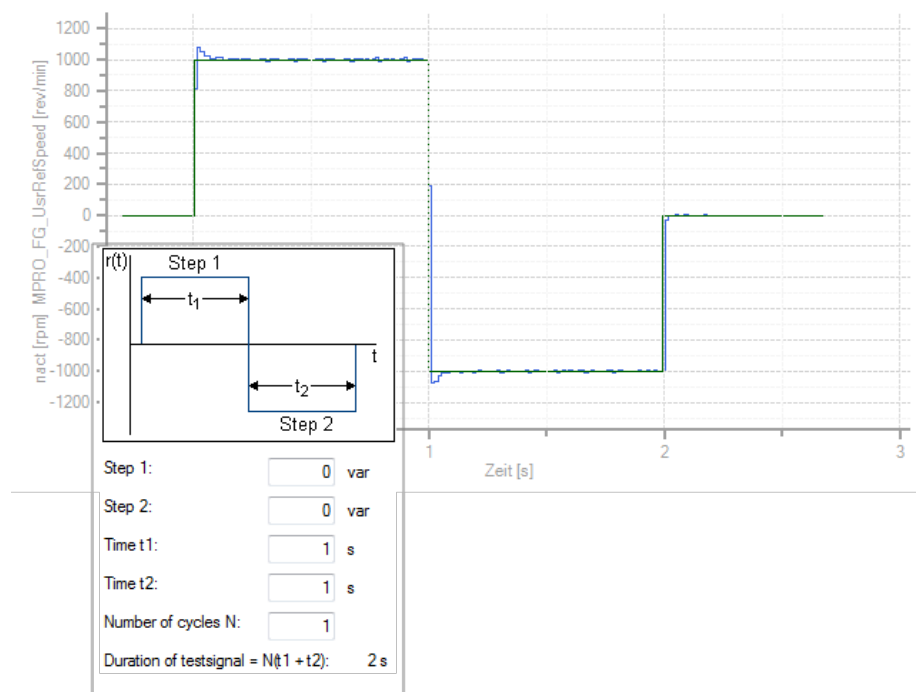


Fig. 7.44: Test signal generator for square signal

ID	Parameter / Setting	Function	Info
1500	SCD_TSIG_Con	Control word of test signal generator	The parameter is reset to the value 0 on completion of the stop procedure.
	OFF (0)	Test signal generator deactivated	
	Stop(1)	Stop test signal	
	Start(2)	Start test signal	
	STOP-Cycle(3)	TG stops at end of current square cycle	
	Stop-Zero(4)	TG stops next time reference value passes through zero	
1501	SCD_TSIG_OutSel	Test signal generator output selector	
	OFF (0)	Not used	
	isdref(1)	Flux-forming current	
	mref(2)	Torque	
	sref(3)	Speed	
	epsref(4)	Position	
	sramp(5)	Speed (ramp)	
	ISQREF(6)	q-current reference	
	ISDQREF(7)	d-current q-current reference	

Table 7.39: Parameters of test signal generator for square and sine signal

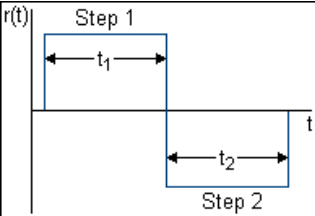
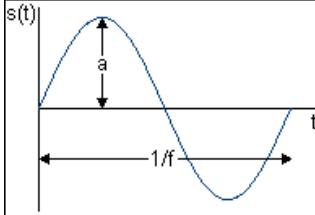
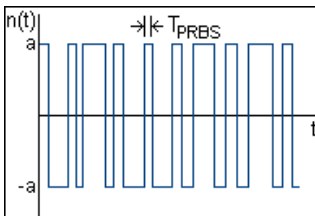
ID	Parameter / Setting	Function	Info
	USDQREF(8)	Setpoint voltage feed-forward control	
	PRCREF(9)	Process controller	
1502	SCD_TSIG_Cycles	Number of repeat cycles	 Step 1: 1000 var Step 2: -1000 var Time t1: 1 s Time t2: 1 s Number of cycles N: 1 Duration of testsignal = N(t1 + t2): 2 s
1503	SCD_TSIG_Offset	Offset of square signal	
	0	Offset of square signal (Stage 1)	
	1	Offset of square signal (Stage 2)	
	2		
	3		
1504	SCD_TSIG_Time	Period of square signal	
	0	Time (t1)	
	1	Time (t2)	

Table 7.39: Parameters of test signal generator for square and sine signal (continue)

ID	Parameter / Setting	Function	Info
1505	SCD_TSIG_Amp	Amplitude of sine signal (a)	 Amplitude a: 50 var Frequency f: 1 Hz
1506	SCD_TSIG_Freq	Frequency of the sine signal (f); Lower frequency of the sweep signal	
1507	SCD_TSIG_SetPhase	Signal phase: Starting phase of current space phasor in VFCON and ICON mode	
1508	SCD_TSIG_PRBSTime	PRBS signal generator, sampling time	 Amplitude 2 * a: 150 var Cycle time T(PRBS): 20 ms
1509	SCD_TSIG_PRBSAmp	PRBS signal generator, amplitude	

ID	Parameter / Setting	Function	Info
1510	SCD_TSIG_SignalType	Signal shape: Sine/delta	
	SINUS(0)	Sine wave generator	
	TRIANGLE(1)	Triangle wave generator	
	Sweep (2)	Sweep signal (sine wave)	
	TriSweep (3)	Sweep signal (triangle wave)	
1511	SCD_TSIG_BreakTime	Break time	
	0	Break (ms) before signal cycle	
	1	Break (ms) between positive and negative signal cycle segment	
1512	SCD_TSIG_SymVal	Symmetry value for delta signal	
1513	SCD_TSIG_Freq2	Upper frequency of the sweep signal (f)	

Table 7.39: Parameters of test signal generator for square and sine signal (continue)

7.8.4.2 PRBS signal

The PRBS signal is suitable for system excitation with high bandwidth using a test signal. A feedback shift register is used to generate a binary output sequence with an amplitude that can be set in **P 1509 - SCD_TSIG_PRBSAmp** and a "random"

alternating frequency.

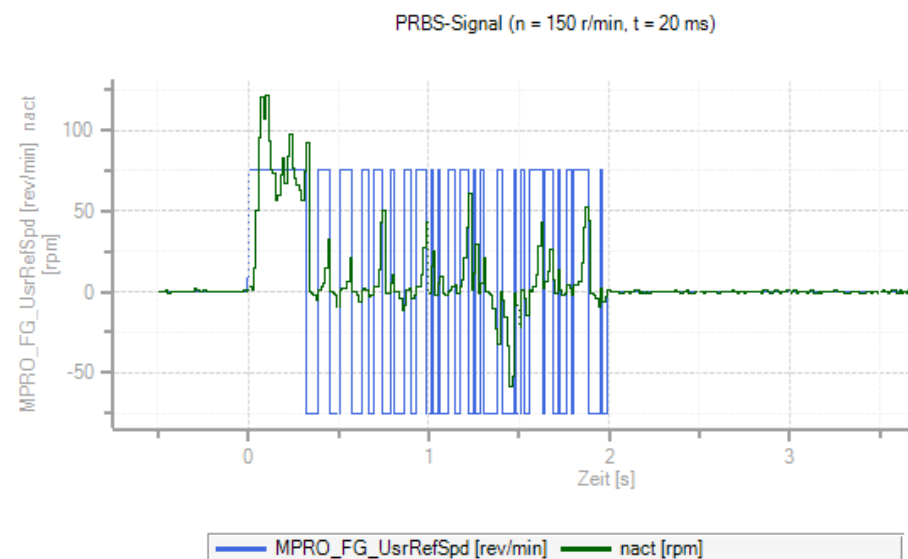


Fig. 7.45: Example of a PRBS signal

7.8.4.3 Sweep signal

Use **P 1510 - SCD_TSIG_SignalType** = Sweep (2) to generate a sine signal of variable frequency.

Define the lower frequency with **P 1506 - SCD_TSIG_Freq** and the upper frequency with

P 1513 - SCD_TSIG_Freq2.

Executing a test signal from the lower to the upper frequency

Set **P 1504[0] - SCD_TSIG_Time** equal to the desired signal duration and **P 1504[1] - SCD_TSIG_Time** = 0. One pass from the lower frequency to the upper frequency is carried out.

Executing a test signal from the lower to the upper frequency and back

Alternatively you can set **P 1504[1] - SCD_TSIG_Time** = **P 1504[0] - SCD_TSIG_Time**. A pass is then made from the lower frequency to the upper frequency and back again to the lower frequency.

For repeating the test signal, use **P 1502 - SCD_TSIG_Cycles**.

Use **P 1510 - SCD_TSIG_SignalType** = TriSweep (3) to generate a triangle signal with the same frequency behaviour.

7.9 V/Hz mode

A simple function test can be carried out in V/Hz mode. This test will show users whether a motor is connected correctly and whether the right direction of movement will be followed. If ...

- The direction of movement is the wrong one
- The motor is at a standstill,
- Uncontrollable motion occurs,

then the connection and the motor data need to be checked.

For testing purposes, a V/Hz control system is implemented in such a way that the closed-loop speed control circuit will be replaced by the V/Hz control. The reference is the speed reference; the actual speed is set equal to the reference. A linear characteristic with two interpolation points is implemented, with a fixed boost voltage setting **P 313[0] - CON_VFC_VBoost** at 0 Hertz. Starting from the rated frequency **P 314[0] - CON_VFC_FNom**, the output voltage will remain constant at **P 315[0] - CON_VFC_VNom**. This means that an asynchronous motor will automatically be driven to field weakening as the frequency rises.

Boost voltage at zero frequency: V

Voltage at nominal frequency: V

Nominal frequency: Hz

Fig. 7.46: "V/Hz mode" screen

ID	Index	Name	Unit	Description
313	0	CON_VFC_VBoost	V	V/Hz characteristic: Boost voltage
314	0	CON_VFC_FNom	Hz	V/Hz characteristic: Nominal frequency
315	0	CON_VFC_VNom	V	V/Hz characteristic: Nominal voltage

Table 7.40: "V/Hz mode" parameters

ID	Index	Name	Unit	Description
19	0	epsRS	Pole width	Rotor/stator electrical angle
20	0	freqRS	Hz	Rotor/stator electrical frequency
21	0	freqFS	Hz	Field/stator electrical frequency
29	0	vmot	V	Current motor voltage
312	0	CON_CCON_VMot	V	Current motor voltage (rms, phase-to-phase)

Table 7.41: Scope signals “V/Hz mode (basic)”

7.10 Process controller

The process controller function enables a measured process variable to be controlled via a PI controller to a reference (setpoint) value.

7.10.1 Features

- Process controller calculation in speed controller cycle
- Process controller as PI controller with Kp adaptation
- Process controller actual value selectable via selector
- Filtering and offset correct of reference and actual values
- Process controller output can be connected to different points in the general control structure
- Process controller is usable in all control modes
- Cycle time: 125 µs (if the switching frequency is 4 kHz: 250 µs)
- The process controller state is changed with a control word
- The process controller state is indicated with a status word
- The process controller's integral term can be reduced in a targeted manner with a control command

7.10.2 Description of control structure

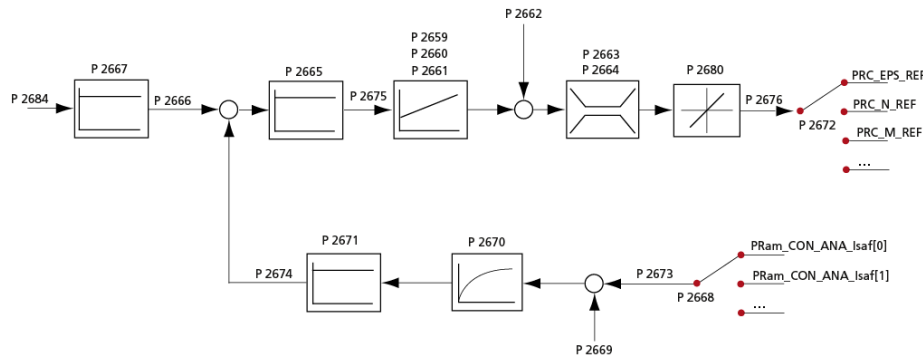


Fig. 7.47: Schematic of process controller

7.10.2.1 Control and status word of process controller

The process controller can be activated either with the control word, **P 2681[0] - CON_PRC_CtrlWord**, or directly via a digital input (for more information on how to select a function for the digital inputs, see Section "Digital inputs" on page 299, "START_PRC(48) = Start process controller" setting).

Bit	Name	Description
0	On	Enabling the process controller
1	Reset	Resets the integral term with a ramp (P 2680[1])

Table 7.42: Control word P 2681[0]

The status word, **P 2682[0] - CON_PRC_StatWord**, indicates the process controller's current state.

Bit	Name	Description
0	On	Process controller active
1	Reset/Ready	Integral term reset complete

Table 7.43: Status word P 2682[0]

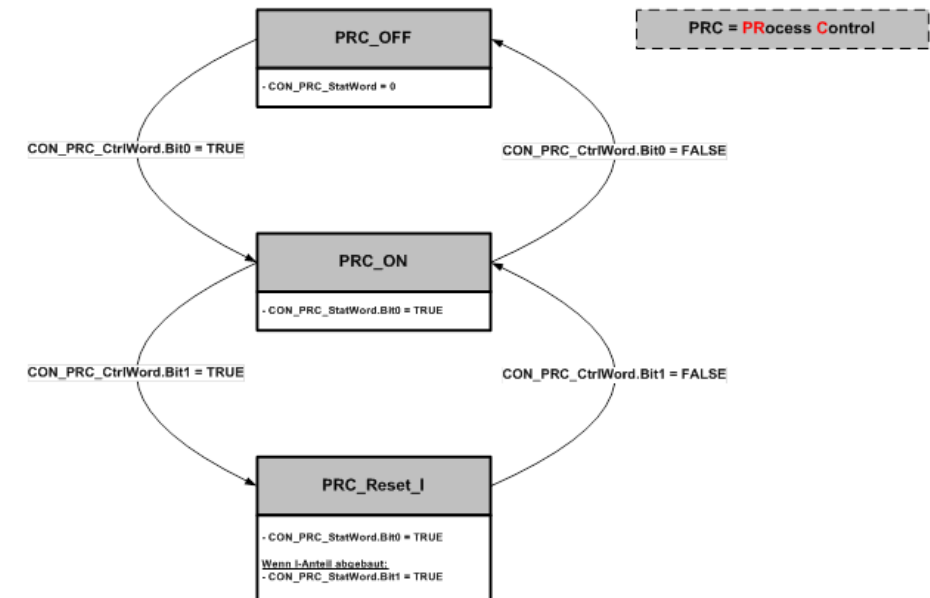


Fig. 7.48: Process controller state machine

In addition to the process controller status word, bit 8 of the device status word, **P 702[0] - MON_State**, will be set when the setpoint is reached. **P 2679[0] - CON_PRC_RefReached** can be used to configure the "Reference value attained" window for this purpose. Bit 8 will be set to TRUE if the process controller's deviation is less than 50% of the configured "Reference value attained" window.

7.10.2.2 Reference values

The process control circuit setpoint can be selected via pre-defined setpoint sources. **P 2683[0] - CON_PRC_REFSEL** can be used to select these setpoint sources.

Setting	Name	Description
0	USER	User input via CON_PRC_REFVAL_User - P2684
1	RPDC	Setpoint for rack and pinion control. Automatic input of transmitted RPDC current value
2	ISA00	Setpoint via analog input ISA00. analog input ISA00 (CON_ANA_Isaf[0])
3	ISA01	Setpoint via analog input ISA01. Analog input ISA01 (CON_ANA_Isaf[1])
4	IEA02	Analog input IEA02.
5	IEA03	Analog input IEA03.

Table 7.44: Selector for reference value source (P 2683[0])

Setting	Name	Description
6	P_REF	Reference pressure. Any analog input (function selector for analog inputs set to a value of -14).
7	P 2981	Mappable parameter P-2981 *
8	P 2982	Mappable parameter P-2982 *
9	P 2983	Mappable parameter P-2983 *
10	P 2984	Mappable parameter P-2984 *
* See Section "Mapping parameters and scope values" on page 178		

Table 7.44: Selector for reference value source (P 2683[0]) (continue)



NOTE

If the target value source is selected, the respective input must also have a function assigned to it.

see also section "Function selectors" on page 313

Once the setpoint source is selected, the process controller setpoint can be set with **P 2666[0] - CON_PRC_REFVAL**. This setpoint can then be scaled further with **P 2667[0] - CON_PRC_REFSCALE** in order, for example, to incorporate decimal places and/or unit conversions.

7.10.2.3 Actual values

The process control circuit actual value can be selected via a number of pre-defined actual value sources. **P 2668[0] - CON_PRC_ACTSEL** can be used to select these actual value sources.

Setting	Name	Description
0	ANA0	Analog input ISA00 (CON_ANA_Isaf[0])
1	ANA1	Analog input ISA01 (CON_ANA_Isaf[1])
2	FIELDBUS	Fieldbus parameter. CON_PRC_ACTVAL_FIELDBUS P 2677
3	REFSPEED	Current speed (internal) Current speed from encoder for unfiltered speed control
4	REFPOS	Actual position (internal) Current position from encoder for unfiltered position control
5	ISQREF_SCON	Present setpoint for current from speed controller
6	IEA02	Analog input IEA02
7	IEA03	Analog input IEA03
8	P_ACT	Actual pressure. Any analog input (function selector for analog inputs set to a value of -13)
9	-	not used
10	-	not used
11	SPEED	Actual speed normalized. Speed in user units.

Table 7.45: Selector for actual value (P 2668[0])

Setting	Name	Description
12	POS	Actual position normalized. Position in user units
13	P 2981	Mappable parameter P-2981 *
14	P 2982	Mappable parameter P-2982 *
15	P 2983	Mappable parameter P-2983 *
16	P 2984	Mappable parameter P-2984 *
* See Section "Mapping parameters and scope values" on page 178		

Table 7.45: Selector for actual value (P 2668[0]) (continue)

**NOTE**

If the actual value source is selected, the respective input must also have a function assigned to it.

see also section "Function selectors" on page 313

The selected actual value will be output in **P 2673[0] - CON_PRC_RAW_ACTVAL**. In addition, a configurable offset, **P 2669[0] - CON_PRC_ACTOFFSET**, can be superimposed on the actual value. The actual value can be smoothed with a configurable PT-1 filter. To use this option, the user can use **P 2670[0] - CON_PRC_ACTTF** to set a filter time in milliseconds. If the filter time is set to 0 ms, the filter will be disabled. Moreover, the filtered actual value can be scaled with **P 2671[0] - CON_PRC_ACTSCALE** in order to incorporate decimal places or unit conversions. The resulting actual value for the process controller will be indicated in **P 2674[0] - CON_PRC_ACTVAL**.

Mapping parameters and scope values

For scope values or other process parameter values, it is possible to carry out a mapping operation for general, readable process parameters (for fieldbus or CoDeSys access). An example would be the mapping of a process value from a parameter list or range list for SERCOS Access as an input value for the process control because no allocation of sub-indexes is possible.

The setting specifying which parameter or scope value is to mapped is made with **P 2980 MPRO_DATA_Map**.

ID	Index	Name	Unit	Description
2980		MPRO_DATA_Map		Data parameter for real-time scope/parameter mapping. Bit 0: 0: Mapping of a process parameter value. 1: Mapping of a scope value. Bit 2..7: Not used. Bits 8..15: Parameter sub ID; not used for mapping a scope value. Bits 16..31: Parameter ID or scope ID (from the scope list) Example, mapping of the device temperature P 704 to P 2981 Bit 0 → Bit 1..7 → Bits 8..15 (Sub-ID: 0) → Bits 16..31 (P704) → Result → 0000 000 0000 0000 0000 0010 1100 0000 0000 0000 0000 0000 0000 0000 0000 0000
2980	1	MAP_REAL_1		Mapping of REAL_1 parameter
2980	2	MAP_REAL_2		Mapping of REAL_2 parameter
2980	3	MAP_REAL_3		Mapping of REAL_3 parameter
2980	4	MAP_REAL_4		Mapping of REAL_4 parameter

Table 7.46: Parameter MPRO_DATA_Map

In dependence on the index of **P 2980 [1...4]** used, automatic allocation is then carried out to the parameters **P 2981.... P 2984 MPRO_DATA_REAL_1..4**.

The following allocation is specified:

P 2980 MPRO_DATA_Map:	P 2981... P 2984 MPRO_DATA_REAL_x
P 2980 [1] MAP_REAL_1	P-2981 MPRO_DATA_REAL_1
P 2980 [2] MAP_REAL_2	P 2982 MPRO_DATA_REAL_2
P 2980 [3] MAP_REAL_3	P 2983 MPRO_DATA_REAL_3
P 2980 [4] MAP_REAL_4	P 2984 MPRO_DATA_REAL_4

Table 7.47: Allocation of P 2980 MPRO_DATA_Map to MPRO_DATA_REAL_x

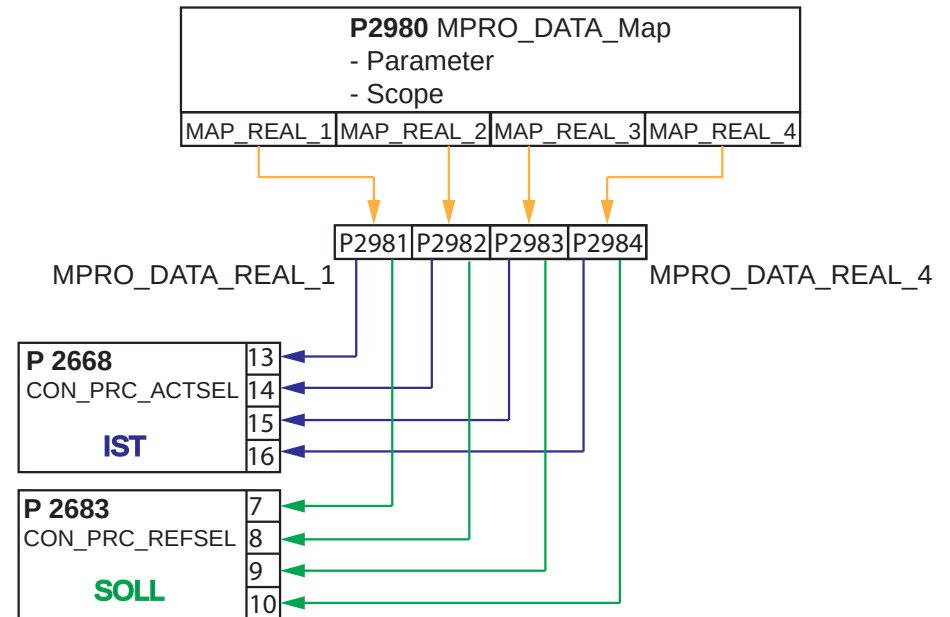


Fig. 7.49: Mapping parameters and scope values

The following parameters cannot be used for mapping.

P-2985..2988 MPRO_DATA_DINT_1..4

P-2989..2992 MPRO_DATA_UDINT_1..4

7.10.2.4 PI process controller

Deviation **P 2675[0] - CON_PRC_CDIFF** will be the difference between the scaled process controller setpoint and the scaled and filtered actual value. The sign for this deviation can be inverted with **P 2665[0] - CON_PRC_CDIFF_SIGN** (**CON_PRC_CDIFF_SIGN** = -1).

This deviation will be passed on to the process controller. This controller is implemented as a PI controller with output limiting and an anti-windup function. Users can set a Kp gain with **P 2659[0] - CON_PRC_KP**, Kp scaling with **P 2660[0] - CON_PRC_KPSCALE** and a reset time with **P 2661[0] - CON_PRC_TN**. If the integral-action time is set to the maximum parameter value, the I-component of the controller is inactive. (**CON_PRC_TN** = 10000 [ms]).

Moreover, an offset can be added to the signal at the controller's output by using **P 2662[0] - CON_PRC_REFOFFSET**. After this, the totalled manipulated variable will be passed through a limiter. The user can parameterize the limitation via parameter **P 2663[0] - CON_PRC_LIMPOS** for the positive limit and **P 2664[0] - CON_PRC_LIMNEG** for the negative limit.

Downstream of the control variable limiter there is another limitation which limits the changes to the control variable per sampling segment. By way of field parameter **P 2680 - CON_PRC_RateLimiter** the limitation of the control variable steepness per millisecond can be parameterized. Subindex 0 is for the limiting used for standard process controller operation and subindex 1 is for reducing the process controller's integral term. For more details on how to set the rate limiting, see Section "Rate Limiter" on page 180.

7.10.2.5 Manipulated variable

The process controller's manipulated variable downstream of the rate limiter (**P 2676[0] - CON_PRC_OUTVAL**) can be mapped to various internal drive setpoint or feed-forward control values. The selection is made via **P 2672[0] - CON_PRC_OUTSEL**.

Setting	Name	Description
0	OFF	No intervention point
1	REFTORQUE	Additive torque reference
2	REFVEL	Additive speed reference value
3	REFPOS	Additive position reference
4	MPPRO	Reference value for MotionProfile via P 2678[0] - CON_OUTSEL_MOPRO
5	REFVEL_RAMP	Additive speed setpoint on ramp

Table 7.48: Selector for mapping manipulated variable P 2676[0]

When selecting the additive setpoints (1-3 and 5), it is important to make sure that they are connected to the respective position in the control structure using internal units (see "Fig. 7.47: Schematic of process controller").

The conversion details for converting internal units to user-specific units must be gathered from the configured user units. These user units can be found under "Motion Profile --> Standardization/Units" in the operating tool. It may be possible to track the conversion between user units and user-specific units depending on whether the user units have been set up as per CiA402, SERCOS, or with a user-specific format. **P 283[0] - MPRO_FG_Type** can be used to view which setup method was used.

7.10.3 Rate Limiter

Downstream of the control variable limiter there is another limitation which limits the changes to the control variable per sampling segment. By **P 2680[0] - CON_PRC_Rate Limiter** the limitation of the control variable steepness per millisecond can be parameterized. By way of index (0) the limitation is active in standard process

controller operation. By way of index (1) reduction of the I-component is activated (see table). With **P 2672[0] - CON_PRC_OUTSEL = 3** the process controller delivers an additive position reference value. The rate limiter limits the possible control variable change. The control variable change each time interval by the process controller results in a speed change on the motor shaft.

Example

The amount of the process controller to change the speed on the motor shaft should not be higher than 100 revolutions per minute. To achieve this, the value of parameter **P 2680[0] - CON_PRC_RateLimiter** must be parameterized with a value corresponding to the user unit. The unit of this parameter is [x/ms]. The x stands for the respective unit of the process controller output variable. In this example the control variable (additive position reference) has the unit "Increments" (see also **P 270[0] - MPRO_FG_PosNorm**). This parameter indicates how many increments correspond to one motor revolution.

Conversion from [rpm] to [Inc/ms]

$$n_{\text{change}} = 100 \text{ rpm}$$

P 270[0] - MPRO_FG_PosNorm in Inc/rev

Internal position resolution = 1048576 inc/rev (default)

To reduce the I-component, the same method is applicable **P 2680[1] - CON_PRC_Rate Limiter** [Inc/ms]).

$$\mathbf{P\ 2680[0] - CON_PRC_Rate\ Limiter} = n_{\text{change}} * 1048576 * 1/60000$$

$$\mathbf{P\ 2680[0] [Inc/ms]} = 100 \text{ [rpm]} * \mathbf{P\ 270[0] [Inc/rev]} * 1/60 \text{ [min/s]} * 1/1000 \text{ [s/ms]}$$

7.10.4 Parameters

ID	Index	Name	Unit	Description
2659	0	CON_PRC_Kp		Process controller: gain
2660	0	CON_PRC_KP_SCALE	%	Process controller: gain scaling
2661	0	CON_PRC_Tn	ms	Process controller: integral action time
2662	0	CON_PRC_REFOFFSET		Offset of the technological controller output
2663	0	CON_PRC_LIMPOS		Positive limitation of the actuator variables
2664	0	CON_PRC_LIMNEG		Negative limitation of the actuator variables
2665	0	CON_PRC_CDIFF_SIGN		Process controller: sign modification
2666	0	CON_PRC_REFVAL		Process controller: setpoint
2667	0	CON_PRC_REFSCALE		Scaling factor for setpoint
2668	0	CON_PRC_ACTSEL		Process controller: selection of the actual value
2669	0	CON_PRC_ACTOFFSET		Input calibration: offset
2670	0	CON_PRC_ACTTF	ms	Process controller: Time constant for filtering the current actual value
2671	0	CON_PRC_ACTSCALE		Scaling of the filtered input signal
2672	0	CON_PRC_OUTSEL		Process controller: Selection of the output variable
2673	0	CON_PRC_RAW_ACTVAL		Actual value of the input signal
2674	0	CON_PRC_ACTVAL		Input signal after scaling and filtering
2675	0	CON_PRC_CDIFF		Process controller: control deviation
2676	0	CON_PRC_OUTVAL		Process controller: output value
2677	0	CON_PRC_ACTVAL_FIELDBUS		Current fieldbus value
2678	0	CON_PRC_OUTSEL_MOPRO		Process controller: output value for motion profile
2679	0	CON_PRC_RefReached	USER	"Reference value reached" window
2680		CON_PRC_RateLimiter		Process controller: rate limiting
2680	0	CON_PRC_RateLimiter	x/ms	Slope limitation (Process)
2680	1	CON_PRC_RateLimiter	x/ms	Process controller: rate limiting, reset I-component

Table 7.49: "Process controller" parameters

ID	Index	Name	Unit	Description
2681	0	CON_PRC_CtrlWord		Process controller: control word
2682	0	CON_PRC_StatWord		Process controller: status word
2683	0	CON_PRC_REFSEL		Process controller: selection of the reference value
2684	0	CON_PRC_REFVAL_User		Process controller: reference value from user

Table 7.49: "Process controller" parameters (continue)

7.10.5 Scope signals

ID	Index	Parameter name	Unit	Function
2675	0	CON_PRC_Cdiff_		Technological controller: control deviation Process control: control deviation
2666	0	CON_PRC_RefVal		Technological controller: setpoint Process control reference value
2673	0	CON_PRC_Raw_ActVal		Istwert des Eingangssignals Actual value of input signal
2674	0	CON_PRC_ACTVAL		Eingangssignal nach Skalierung und Filterung Input signal after scaling and filtering
2676	0	CCON_PRC_Outval		Technological controller: output value Process control output value

Table 7.50: Parameters relevant for visualizing the process control circuit in the scope

7.11 Hydraulic control

Firmware with a version range of V174.xx-xx includes special hydraulic parameters in addition to the standard firmware. These can be used to control pressure, volumetric flow rate, cylinder speed, and cylinder position, making it easy to implement hydraulic system applications. The firmware is available for MSD Servo Drive, MSD Single-Axis Servo Drive Compact and MSD Servo Drive Functional Safety.

The descriptions in this chapter apply to version V174.35-xx and higher.

7.11.1 Basic setting

In order to activate the hydraulic functionality, the following two basic settings need to be configured:

1. Chose the control mode via **P 300[0] - CON_CgfCon**: "TCON(1) = Torque control / Hydraulic control" or "VFCON(0) = V/Hz mode"

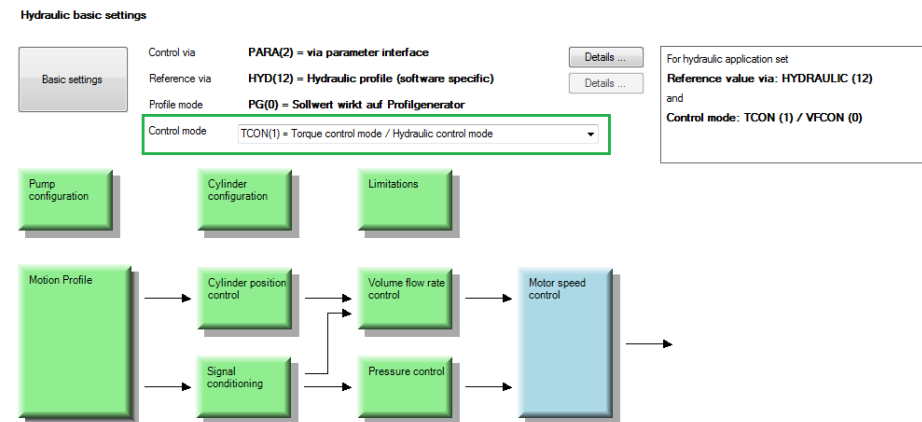


Fig. 7.50: "Hydraulic basic settings" screen

- In the “Hydraulic basic settings” screen, under the “Basic settings” button, set selector **P 165[0] - MPRO_REF_SEL** for the reference setpoint to “HYDRAULIC(12) = Hydraulic application”.

Set control and reference

Control via: PARA(2) = via parameter interface

Reference via: **HYD(12) = Hydraulic profile (software specific)**

Motor control start condition: OFF(0) = Switch off drive first in case of power or fault reset

Fig. 7.51: “Hydraulic basic settings – Basic settings” screen

Possible encoder selections

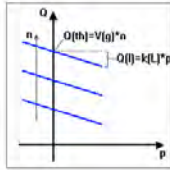
- P 520[0] - ENC_MCon:** Encoder for commutation and torque control
- P 521[0] - ENC_SCon:** Encoder for motor and pump speed control
- P 522[0] - ENC_PCon:** Encoder for cylinder position and cylinder speed control

ID	Index	Value	Name	Description
165	0		MPRO_REF_SEL	Motion profile: Selection
		12	HYDRAULIC	(HYD) = Hydraulic profile (software specific)
300	0		CON_CgfCon	Select control mode
		1	TCON	Torque control / Hydraulic control
520	0		ENC_MCon	Channel selection for motor commutation
521	0		ENC_SCon	Channel selection for speed control
522	0		ENC_PCon	Channel selection for position control

Table 7.51: Parameters for basic setting

7.11.2 Pump setting

Pump configuration

Rated pressure p(n): 100 bar

Rated speed: 3000 rpm

Minimum speed: 0 rpm

Maximum speed: 3000 rpm

Displacement V(q): 100 cm³/rev OR Torque constant: 1.887545 Nm/A

Scale displacement: 1000 0.1 %

Vol. effectiveness: 99 % OR Leakage constant (k_l): 0.15 l/(min·bar)

Pump gear (i): 1 

Pump protection

P2 protection
OFF(0) = Pump protection deactivated

Critical pump speed n(k): 500 rpm

Pressure at standstill p(0): 10 bar

Point to switch off
Rated pressure p(n) at standstill for: 10 s

Actual value
Actual overload integral: 0 %

Pressure dependent speed curve
OFF(0) = Min- / Max limit of pump speed

Minimum pressure pMin: 10 bar

Maximum pressure pMax: 250 bar

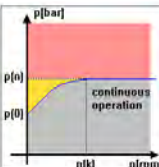
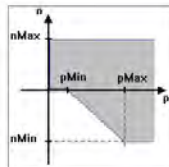
 

Fig. 7.52: “Hydraulic - Pump” screen

The following physical variables and relationships apply to the hydraulic pump:

Physical variables

- Q:** Volumetric flow rate
- p:** differential pressure
- n:** Speed
- M:** Torque

Pump characteristics and data

- V_g : Geometric displacement volume (**P 2851[0]** (ccm/rev))
- $\eta_{Vol,N}$: Volumetric efficiency at the pump's rating point (**P 2851[4]** (%))

Theoretical volumetric flow rate Q_{th} is proportional to the speed:

- $Q_{th} = V_g \cdot n$

Internal pump leakage volumetric flow rate Q_L must be subtracted from the actual volumetric flow rate:

- $Q = Q_{th} - Q_L = V_g \cdot n - Q_L$

It will typically be proportional to the pressure:

- $Q_L = p \cdot k_L(\vartheta)$

However, pump data sheets often do not specify the leakage volume rate constant, but instead specify a "volumetric efficiency" $\eta_{Vol,N}$ for the pump's rated point, in which case:

- $Q_N = V_g \cdot n_N \cdot \eta_{Vol,N}$
- $Q_N [\text{l/min}] = V_g [\text{cm}^3/\text{rev}] \cdot n_N [\text{rev/min}] \cdot \eta_{Vol,N} [100 \%]$



NOTE

- Make sure to convert to SI units!

Example

- $\eta_{Vol,N} = 95 \%$, $n_N = 1500 \text{ rev/min}$, $V_g = 10 \text{ cm}^3/\text{rev} \rightarrow Q_N = 14,2 \text{ l/min}$

If you specify $\eta_{Vol,N}$, the servo controller will internally calculate k_L automatically as follows:

- $k_L = V_g \cdot n_N \cdot (1 - \eta_{Vol,N}) \cdot p_N$

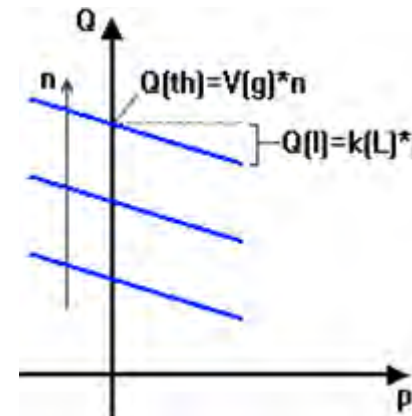


Fig. 7.53: Pump characteristic curves

For the torque at the pump (= motor torque):

- $M = V_g / 2\pi \cdot p + (M_{friction})$; (make sure to use SI units)

The friction torque is normally unknown and negligible ($M_{friction} \sim 0$). This means that a "torque constant" c_M in [Nm/bar] can be calculated using the following formula:

- $c_M [\text{Nm/bar}] = 1/(20\pi) \cdot V_g [\text{cm}^3/\text{rev}] = M [\text{Nm}] / p [\text{bar}]$

Displacement volume V_g is usually specified in data sheets. In contrast, if there is a pressure measurement available, the torque constant is easier to determine experimentally if necessary. In this case, a constant pressure can be built up on the drive in a steady state and the delivered motor torque can be used to calculate the displacement volume.

Example

- Running the pump, e.g. at a low speed “against” the built-up pressure. Scope plot (Moog DRIVEADMINISTRATOR 5) for Scope ID 11 – m_{act} yields a mean value of $M = 15.9$ [Nm]. The built-up pressure at the pressure sensor is $p = 100$ [bar] $\Rightarrow c_M = 0.159$ [Nm/bar] $\Rightarrow V_g = 10$ [ccm/rev]

Accordingly, both parameters (**P 2851[0; 1] - HYD_Pump**) can be set. However, only one of the two values should be set. The other one will be automatically calculated afterwards and will be shown accordingly.

P 2851[2] - HYD_Pump is used to set the nominal pressure. **P 2851[3] - HYD_Pump** specifies the volumetric efficiency at this rating point. This information will then be used to calculate the leakage volumetric flow rate, which is used internally to control the volumetric flow rate.

For pumps with variable-displacement volume, a second pump data set can be created **P 2873 HYD_Pump2**. This can be selected via **P 2863 HYD_TabCtrl** bit 8 for the respective motion block (7.11.6 Hydraulic Motion profile). Alternatively, the displacement volume can also be adjusted online via a pump scaling using **P 2879 [2] Pump1_DisplScalePDO** and **P 2879[3] Pump2_DisplScalePDO**. This allows the displacement volume to be changed variably during the process.

7.11.2.1 Speed limits

The pump's minimum and maximum speeds can be set in **P 2851[4; 5] - HYD_Pump**. The control system will not exceed or fall below the values set there.

Example

- Maximum speed: 3000 [rpm], Minimum speed: 0 [rpm] (pump is not allowed to rotate “backwards”)
- Maximum speed: 3000 [rpm], Minimum speed: -200 [rpm] (pump is only allowed to rotate backwards “slowly”)
- Maximum speed: 3000 [rpm], Minimum speed: -3000 [rpm] (no restriction for negative speeds)

In contrast, the pump protection functions, among other functions, are used to protect the pump against thermal or mechanical destruction at low speeds. As per the corresponding explanations, the configured “critical speed” can definitely be fallen below.

In addition to the pump speed, the pump acceleration and deceleration can be limited. The parameters **P 2855 HYD_PumpAcc** and **P 2856 HYD_PumpDec** can be used to set the maximum permitted ramp for the pump. (see 7.11.6.2 Servo pump speed ramps)

7.11.2.2 Pump protection functions

7.11.2.2.1 P2t shutdown

Pump protection

P2t protection

ON(1) = Use pressAct of control of protection function

Critical pump speed $n[k]$ rpm

Pressure at standstill $p(0)$ bar

Point to switch off

Rated pressure $p(n)$ at standstill for s

Actual value

Actual overload integral %

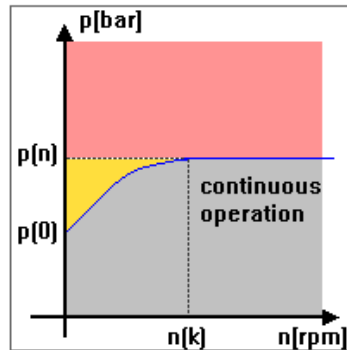


Fig. 7.54: P2t shutdown

P 2851[7; 8] - HYD_Pump can be used to set the critical speed and critical duration. At the nominal pressure, the critical speed should not be fallen below for a time longer than the critical duration. The square of the pressure is included in the calculation here, i.e. at half the pressure, four times the duration will be tolerated. Reason: Leakage losses have an approximately quadratic relationship to the pressure.

Meanwhile, the speed is taken into account linearly, i.e. at half the speed, half the duration will be tolerated.

Reason: The speed / the volumetric flow rate proportional to the speed results in a proportional heat removal.

Usually, the pump needs to be protected against continuous operation with built-up pressure and low speeds. To this end, a critical minimum speed n_crit can be specified so that, at nominal pressure p_N , it will only be allowed to fall below this speed for a critical duration of t_crit . The following critical limit integral is calculated continuously in the servo controller for this purpose:

$$i_G = 1 / \tau_crit \cdot \int ((p/p_N)^2 - n / n_crit) dt$$

This takes into account the power loss that has an approximately quadratic relationship to the pressure, as well as the heat removal that is proportional to the speed. If the nominal pressure were requested in a stopped state ($n = 0$), for example, i_G would increase to a value of 1.0 before t_crit would elapse. At half the critical speed, twice that time would be required. Meanwhile, a different pressure would have a quadratic effect, meaning that half the nominal pressure would be allowed to be present four times the critical duration time.

This function can be used to open a bypass circuit when a configurable limit ($i_G = 0.9$) is reached. Normally, this will result in the pump speed increasing and, after a certain hysteresis ($i_G = 0.8$) is fallen below, the bypass will be closed again in order to reduce the power loss. If i_G increases all the way to 1.0 instead, an error will be triggered and the drive will be stopped in order to protect the pump.

Example

Critical speed: 500 bar, Nominal pressure: 100 bar, Critical time: 10 s.

- This pump can be run at 500 rpm, 100 bar as long as necessary.
- At very low speeds close to a full stop, and with a pressure of 100 bar, it would only be permissible to run the pump for 10 s. After 9 s, the bypass valve (if any) would be opened. If this did not result in the speed increasing,

an error would be triggered one second later and, normally, the drive would be stopped.

If continuous pressure is permissible even at full stop, the corresponding pressure can be entered in **P 2851[10] - HYD_Pump**.

7.11.2.2.2 Pressure-dependent speed regulation characteristic

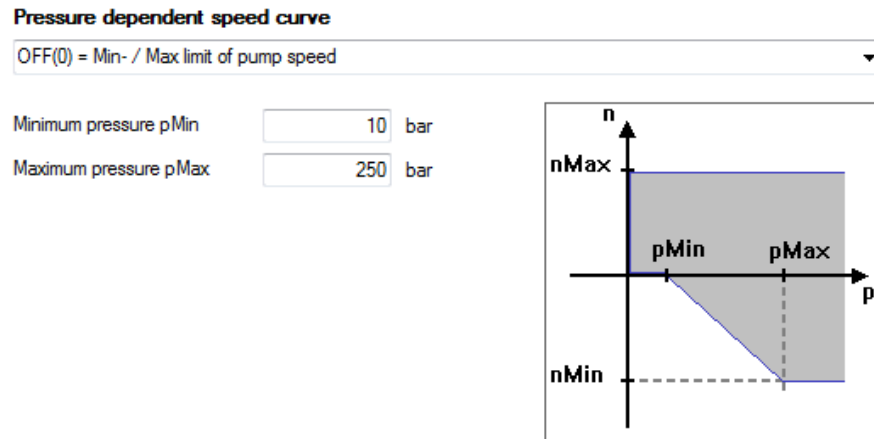


Fig. 7.55: Pressure-dependent speed regulation characteristic

For some types of pumps (e.g. internal-gear pumps), negative speeds for very low pressures (0 bar) are not permitted because in these operating areas, the lubrication of the pump gear can no longer be ensured. This is why it is possible to configure the pump characteristic curve in dependence on pressure, which makes it possible to protect the pump from mechanical destruction (**P 2840.14 PumpSpdProt = 1**). It is nonetheless still possible to quickly relieve a high pressure through a negative pump speed. Using **P 2851[14,15]-HYD_Pump**, it is possible to configure a minimum and maximum pressure for negative speeds. The minimum and maximum

speed (**P 2851.5 nMin** and **P 2851.6 nMax**) from the pump configuration are used for nMin and nMax. Thus, a negative pump speed is permitted as of the set minimum pressure for high pressures. The entire speed range can be utilized above the specified maximum pressure. In the transition range from minimum to maximum pressure, the speed curve is linear. The speed characteristic of the pump then behaves as follows:

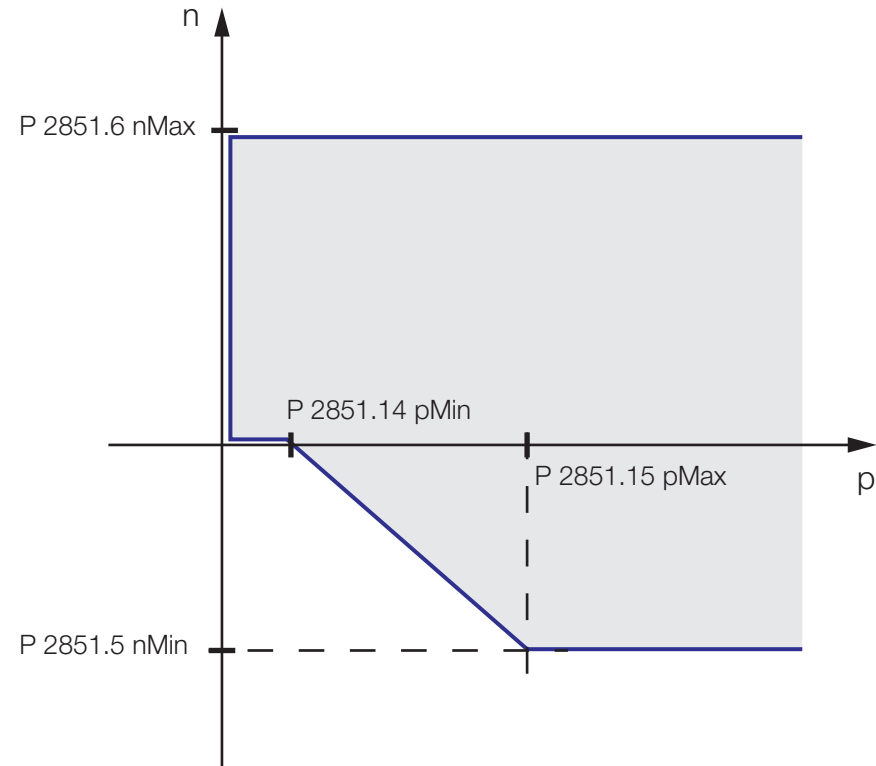


Fig. 7.56: Pressure-dependent speed regulation characteristic

7.11.2.3 Gear ratio between pump and pump motor

If there is gearing between the pump and the pump motor, the gear ratio needs to be entered in **P 2851[9] - HYD_Pump**. If only the direction of rotation needs to be changed (motor turns in a negative direction when the pump turns in the positive, "correct" direction), a factor of "-1" can be entered to correct the direction of rotation.

7.11.2.3.1 Parameters

ID	Index	Name	Unit	Description
2851		HYD_Pump		Pump parameters
2851	0	displ	ccm/rev	Displacement volume
2851	1	cTorque	Nm/bar	Torque constant
2851	2	pNom	bar	Nominal pressure
2851	3	nNom	rpm	Rated speed
2851	4	etaVol	%	Volumetric efficiency at nominal pressure, rated speed
2851	5	nMin	rpm	Minimum speed
2851	6	nMax	rpm	Maximum speed
2851	7	nCritical	rpm	Critical speed (@ nominal pressure)
2851	8	TCritical	s	Max. permissible time at low speed and nominal pressure
2851	9	iGearPump		Gear ratio between pump and motor
2851	10	p0	bar	Max. permissible stationary pressure at a standstill
2851	11	cLeakage	(l/min)/bar	Leakage constant
2851	12	stopramp	(1/min)/s	Stop ramp (during valve switching etc.)
2851	13	tSwValve	ms	Valve switching time
2851	14	pMin	bar	Minimum pressure (depending on pump protection function)
2851	15	pMax	bar	Maximum pressure (depending on pump protection function)

Table 7.52: "Hydraulic - Pump" parameters

7.11.3 Signal setting

7.11.3.1 Selection of signal sources

The signal sources of the actual values can be selected from two analog inputs. These are voltage inputs with a value range from -10 V to 10 V. The function can be selected via the parameters **P 109 - MPRO_INPUT_FS_ISA00** and **P 110 - MPRO_INPUT_FS_ISA01** by means of the function selector. Additional analog inputs for recording actual values are available using the technology option (X8) Multi I/O Card and the parameters **P 2716.0 - IEA04** and **P2716.1 IEA05**. These can be configured either as voltage or current inputs (0; 4...20 mA). A variety of signal sources can be set for the following actual value variables.

- Pressure actual value: HYD_P_ACT(-7) = Actual value of pressure control
- Pressure actual value 2: HYD_P_ACT2(-9) = Hydraulic actual pressure 2nd sensor
- Volumetric flow rate actual value: HYD_Q_ACT(-10) = Hydraulic actual flow
- Actual position value: Enc_ANA(-12) = analog encoder (on channel 4)

Analog standard inputs:

ISA00

Function:

ISA00 filter time: ms

ISA01

Function:

ISA01 filter time: ms

Analog MIO-techoptions inputs:

IEA04

Function:

IEA04 filter time: ms

IEA05

Function:

IEA05 filter time: ms

Fig. 7.57: "Hydraulic signal settings, analog inputs" screen

The signal sources for the reference values, actual values, and signal limits are selected with **P 2840 - HYD_Cfg**. A variety of signal sources can be set for the following variables:

- Pressure reference value (pRefSrc)
- Volumetric flow rate reference value (QRefSrc)
- Pressure actual value (pActCalc)
- Pressure limitation (Minimum/maximum values) (pMinSrc/pMaxSrc)
- Volumetric flow rate limitation (minimum/maximum values) (QMinSrc/QMaxSrc)
- Volumetric flow actual value (QActCalc)
- Leakage volumetric flow rate (QLeakEst)
- Speed reference value (nRefSrc)
- Hydraulic cylinder valve control (CylValveSwSel)

ID	Index	Name / Setting	Unit	Description
2840		HYD_Cfg		Configure Hydraulic System Control
2840	0	Reserved		Reserved
2840	1	pRefSrc		Hydraulics: Selection of pressure reference source
		0: ANA		Setpoint of analogue input
		1: PROFILE		Setpoint from profile
2840	2	QRefSrc		Flow rate, selection of reference source
		0: ANA		Setpoint of analogue input
		1: PROFILE		Setpoint from profile
2840	3	pActCalc		Hydraulic: Pressure actual value calculation method
		0: PACT		pAct will be used for control
		1: PACT2		pAct2 will be used for control
		2: DIFF_PACT_PACT2		pAct-pAct2 will be used for control
		3: PRIO		Both values will be used with Current Priority
		4: PMOTT		Calculation from motor torque
		5: PACTSEL		Selection between pAct and pAct2 per parameter
2840	4	pMinSrc		Minimum pressure source selector
		0: PressCon		Min. pressure value from HYD_PressCon_pMin
		1: Neg_pRef		Min. pressure, negative value from HYD_Val_pRef
		2: Pos_pRef		Min. pressure value from HYD_Val_pRef
2840	5	pMaxSrc		Maximum pressure source selector

Table 7.53: "Selection of signal sources" parameters

ID	Index	Name / Setting	Unit	Description
		0: PressCon		Max. pressure value from HYD_PressCon_pMax
		1: Pos_pRef		Max. pressure value from HYD_Val_pRef
		2: Neg_pRef		Max. negative pressure value from HYD_Val_pRef
2840	6	QMinSrc		Minimum flow rate source selector
		0: PressCon		Min. pressure value from HYD_PressCon_QMin
		1: Pos_QRef		Min. pressure value from HYD_Val_QRef
		2: Pos_QRef		Min. pressure value from HYD_Val_QRef
2840	7	QMaxSrc		Maximum flow rate source selector
		0: PressCon		Max. volume flow value from HYD_PressCon_QMax
		1: Pos_QRef		Max. volume flow value from HYD_Val_QRef
		2: Neg_QRef		Max. negative volume flow value from HYD_Val_QRef
2840	8	QActCalc		Flow rate calculation method
		0: MEAS		From the measurement
		1: CYL		From the cylinder speed
2840	9	QLeakEst		Flow rate leakage estimation method
		0: NONE		No leakage compensation
		1: OBS		Observer
		2: MEAS		Directly measured
		3: CTRL		PI controller
2840	10	nRefSrc		Pump speed reference source selector
		0: ANA		Setpoint from profile
		1: PROFILE		Reference value from profile
2840	11	CylValveSwSel		Function selector for the valve switchover of the cylinder
		0: Para		Manual valve control
		1: Spd		Automatic valve switchover via speed setpoint
		2: Tab		Valve switchover via motion block table
		3: Pos		Automatic valve switching via Pos. Diff.
2840	12	AltPosCon		Alternative position controller
2840	13	AltSpdCon		Alternative cylinder speed controllers
2840	14	PumpSpdProt		Pump speed protection
2840	15	PumpP2tProt		p2t protection for pump
2840	16	AltPressCon		Alternative pressure controller
2840	17	AltPressConLimit		Alternative pressure limit controller

Table 7.53: "Selection of signal sources" parameters (continue)

7.11.3.2 Signal scaling

7.11.3.2.1 Signal scaling, pressure

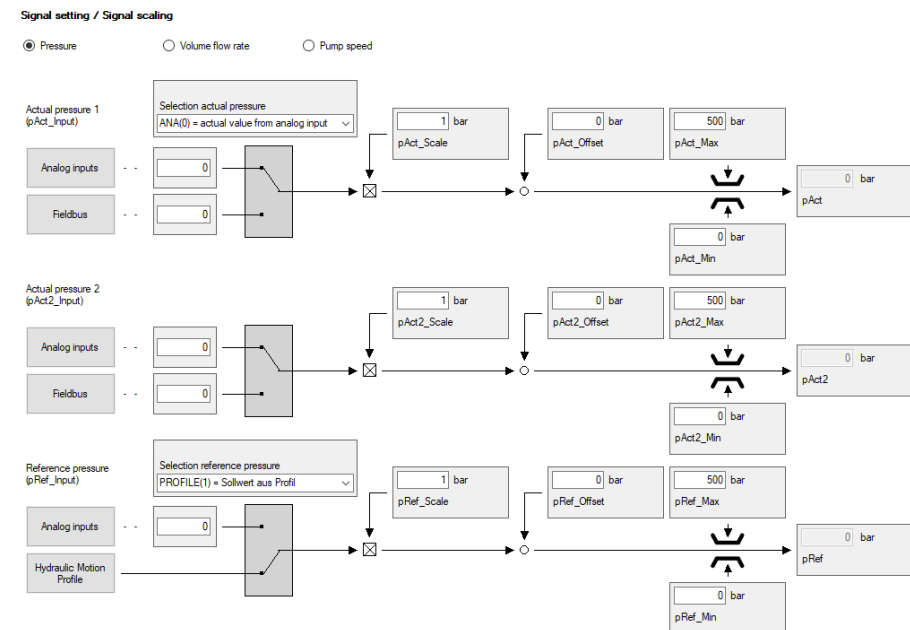


Fig. 7.58: "Hydraulic signal scaling, pressure" screen

P 2845 - HYD_Input_Val will show the unscaled pressure reference and actual values for the pressure control.

Further processing and scaling is carried out in **P 2846 - HYD_Input_Adapt**. A scaling factor, an offset, and a signal limit (min and max) can be set.

There are two scaling paths available for the actual pressure, actual pressure 1 (pact1) and actual pressure 2 (pact2). This allows two sensor signals to be processed. A selection between an analog input or the hydraulic motion profile as the signal source can be made for the reference pressure (pref).

The result after the scaling will be shown in **P 2847 - HYD_Val**. These values will also be used for control purposes.

7.11.3.2.2 Signal scaling, volumetric flow rate

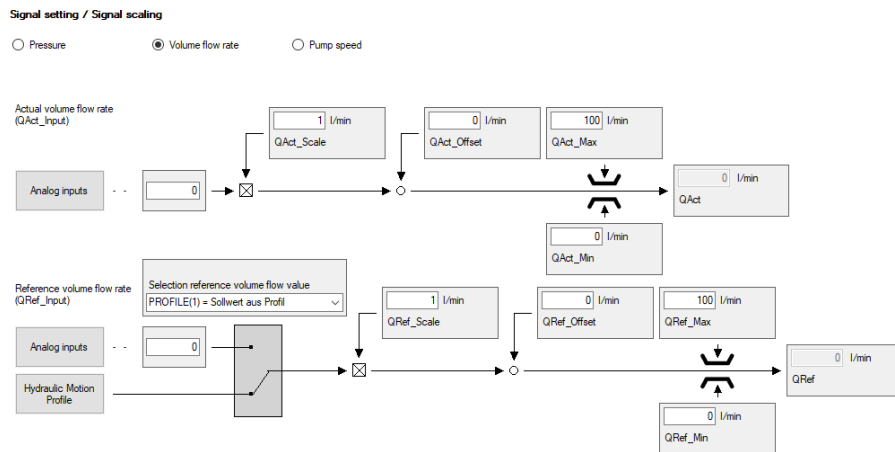


Fig. 7.59: "Hydraulic signal scaling, volumetric flow rate" screen

P 2845 - HYD_Input_Val will show the unscaled volumetric flow rate reference and actual values for the volumetric flow rate control.

Further processing and scaling is carried out in **P 2846 - HYD_Input_Adapt**. A scaling factor, an offset, and a signal limit (QAct_Min and QAct_Max) can be set.

A scaling path is available for the actual volumetric flow rate (QAct). A selection between an analog input or the hydraulic motion profile as the signal source can be made for the reference volumetric flow rate (Qref).

The result after the scaling will be shown in **P 2847 - HYD_Val**. These values are transferred to the controller.

7.11.3.2.3 Signal scaling, pump speed

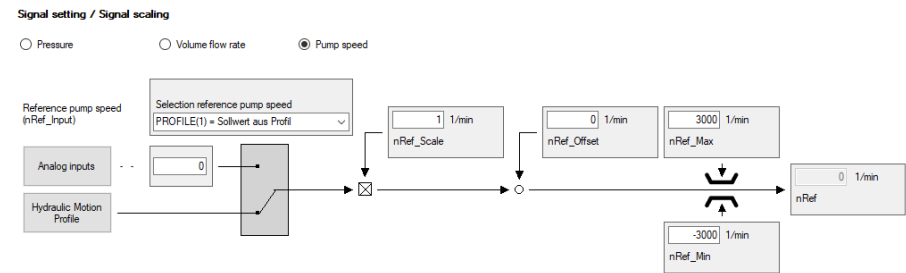


Fig. 7.60: "Hydraulic signal scaling, pump speed" screen

P 2845 - HYD_Input_Val displays the unscaled pump speed reference value of the pump speed control.

Further processing and scaling is carried out in **P 2846 - HYD_Input_Adapt**. A scaling factor, an offset, and a signal limit (nRef_Min and nRef_Max) can be set.

The actual speed is evaluated via the respective encoder input (see Section "Encoder selection" on page 55). A selection between an analog input or the hydraulic motion profile as the signal source can be made for the reference speed (nref).

The result after the scaling will be shown in **P 2847 - HYD_Val**. These values will also be used for control purposes.

The individual parameters for configuring the signals are shown in the following table.

ID	Index	Name	Unit	Description
2845		HYD_Input_Val		Input values for hydraulics system
2845	0	pAct		Hydraulics: Pressure actual value
2845	1	pAct2		Hydraulics: Pressure actual value (sensor2)
2845	2	pRef		Hydraulics: Pressure setpoint
2845	3	QRef		Flow rate, setpoint
2845	4	QAct		Flow rate, actual value
2845	5	nRef		Pump set speed
2846		HYD_Input_Adapt		Adaption of input values
2846	0	pAct_Scale	bar	Scaling
2846	1	pAct_Offset	bar	Offset
2846	2	pAct_Min	bar	Min
2846	3	pAct_Max	bar	Max
2846	4	pAct2_Scale	bar	Scaling
2846	5	pAct2_Offset	bar	Offset
2846	6	pAct2_Min	bar	Min
2846	7	pAct2_Max	bar	Max
2846	8	pRef_Scale	bar	Scaling
2846	9	pRef_Offset	bar	Offset
2846	10	pRef_Min	bar	Min
2846	11	pRef_Max	bar	Max
2846	12	QRef_Scale	l/min	Scaling
2846	13	QRef_Offset	l/min	Offset
2846	14	QRef_Min	l/min	Min
2846	15	QRef_Max	l/min	Max
2846	16	QAct_Scale	l/min	Scaling
2846	17	QAct_Offset	l/min	Offset
2846	18	QAct_Min	l/min	Min
2846	19	QAct_Max	l/min	Max
2846	20	nRef_Scale	1/min	Scaling

Table 7.54: "Signal scaling" parameters

ID	Index	Name	Unit	Description
2846	21	nRef_Offset	1/min	Offset
2846	22	nRef_Min	1/min	Min
2846	23	nRef_Max	1/min	Max
2847		HYD_Val		Hydraulics: Setpoints and actual values
2847	0	pAct	bar	Hydraulics: Pressure actual value Pressure actual value
2847	1	pAct2	bar	Hydraulics: Pressure actual value (sensor2)
2847	2	pRef	bar	Hydraulics: Pressure setpoint
2847	3	QRef	l/min	Flow rate, setpoint
2847	4	QAct	l/min	Flow rate, actual value
2847	5	nRef	1/min	Pump set speed

Table 7.54: "Signal scaling" parameters (continue)

7.11.3.3 Example of application for volume/mass sensors

407	0	CON_ANA_Isaf	0.0112386	Analogue inputs: Values (filt, norm, comp)
407	1	ISA01	0	Compensated, filtered, normalized value
2840		HYD_Cfg		Configure Hydraulic System Control
2845		HYD_Input_Val		Input values for Hydraulic
2845	0	pAct	0.0111063	Pressure Actual
2845	1	pAct2	0	Pressure Actual (Sensor2)
2845	2	pRef	0	Pressure Reference
2845	3	QRef	0	Flow Rate Reference
2845	4	QAct	0.0159094	Flow Rate Actual
2845	5	nRef	0	Pump Speed Reference
2846		HYD_Input_Adapt		Adaptation of input values
2846	0	pAct_Scale	250	Scaling
2846	1	pAct_Offset	-2.8	Offset
2846	2	pAct_Min	-5	Min
2846	3	pAct_Max	250	Max
2846	4	pAct2_Scale	250	Scaling
2846	5	pAct2_Offset	-4.4	Offset
2846	6	pAct2_Min	0	Min
2846	7	pAct2_Max	500	Max
2846	8	pRef_Scale	1	Scaling
2846	9	pRef_Offset	0	Offset
2846	10	pRef_Min	0	Min
2846	11	pRef_Max	180	Max
2846	12	QRef_Scale	1	Scaling
2846	13	QRef_Offset	0	Offset
2846	14	QRef_Min	0	Min
2846	15	QRef_Max	100	Max
2846	16	QAct_Scale	18.8	Scaling
2846	17	QAct_Offset	0	Offset
2846	18	QAct_Min	-1	Min
2846	19	QAct_Max	20	Max
2846	20	nRef_Scale	1	Scaling
2846	21	nRef_Offset	0	Offset
2846	22	nRef_Min	-100	Min
2846	23	nRef_Max	3000	Max
2847		HYD_Val		Values for Hydraulic
2847	0	pAct	0.0179111	Pressure Actual
2847	1	pAct2	0	Pressure Actual (Sensor2)
2847	2	pRef	0	Pressure Reference
2847	3	QRef	0	Flow Rate Reference
2847	4	QAct	0.299497	Flow Rate Actual
2847	5	nRef	0	Pump Speed Reference

This value is from analog input (normalized to amperes with gain 0.02)
=> 1 corresponds 0.02 A

Sensor normalization to volumen:
Datasheet => 400 kg/h at 16 mA (4...20 mA)
=> 6.66kg/min at 16 mA
=> 6.66 kg/min/16 mA = 0.416666 kg/min/mA
=> 0.416666*1000 = 416.667 kg/min/A

After normalization adjust offset
if available an necessary
(negative value of P 2847.4)

P 2847.4 is composite like this:
 $QAct(P2845.4) * QAct_Scale(P2846.16) + QAct_Offset(P2846.17)$

Fig. 7.61: Example of application for volume/mass sensors

7.11.4 Hydraulic Limitations

7.11.4.1 Pressure limit

It is usually necessary to limit the pressure to a maximum permissible value. This can be done either mechanically using an overpressure valve or using the pressure limitation of the servo controller. The pressure limitation allows both the maximum and the minimum permissible reference value of the pressure control to be limited. If

"negative" pressures can also be present in an application with pressure difference measurement, a negative value must also be entered or permitted in the HYD_PressCon.pMin parameter. If these pressure limits are reached, the pump speed is limited accordingly dynamically. In addition, the source of the limiting pressure value can be selected using **P 2840[5] - pMaxSrc** and **P 2840[6] - pMinSrc**.

It is possible to toggle between parameter **P 2850[6] - pMax** and the reference value **P 2843[0] - pRef** by selecting PressCon(0), Pos_pRef(1) and Neg_pRef(2). This allows the pressure limitation to be specified via the analog input of the pressure reference value, for example.

For the purpose of dynamic pressure limitation while the process is running, scaling (**P 2872 HYD_Tab_Limit**) can be used in the respective motion block to influence the preset limitation. If this function is not desired for a pressure direction (positive or negative), it can be switched off using **P 2840[5] - pMaxSrc** and **P 2840[6] - pMinSrc** (PressConWithoutTabLimit).

For the pressure limitation control, **P 2840[17] - AltPressConLimit** can be used to select from the four different structures. In the PressConLimiter_Q1(0) and PressConLimiter_Q1-Q4(2) selection, the same controller parameters **P 2850[0] Kp** and **P 2850[2] Tn** are used as for the pressure control. However, the control structure differs from the standard pressure controller. The PressConLimiter_Q1-Q4_separated_Para and PressConLimiter_Q1_separated_Para settings use the control parameters **P 2850[16] - Kp_Limiter**, **P 2850[17] - KpScale_Limiter** and **P 2850[18] - Tn_Limiter**. This allows different controller settings to be configured for pressure control and pressure limitation control.

The control structure of the pressure limiting controller tends to oscillate when the control is set very dynamically. Consequently, we recommend choosing a setting with low gain factors and then increasing it according to the requirements. In addition, the integral-action time setting (the integral part) is crucial for the function of the limiting controller. Our recommendation is values in the high two-digit or lower

three-digit range. However, these values are only a guideline as every application will have its own requirements for dynamics and accuracy. The optimum setting must be determined during commissioning.

Furthermore, the limitation can be switched to inactive by means of a higher-level control system. The five lower bits of the hydraulic control word are used for this purpose, **P 2841 HYD_Ctrl** bit 11 to bit 15. Setting bit 11 deactivates the pressure limitation. Bits 12 to 15 only switch off the limitation in the respective quadrant of the P/Q coordinate system. (Bit 12 = Q1, bit 13 = Q2, bit 14 = Q3, bit 15 = Q4).

The parameter (**P 2843 HYD_Values**) shows the currently active pressure limitation setpoints (**P 2843[34] pressLimitMax**) and (**P 2843[35] pressLimitMin**).

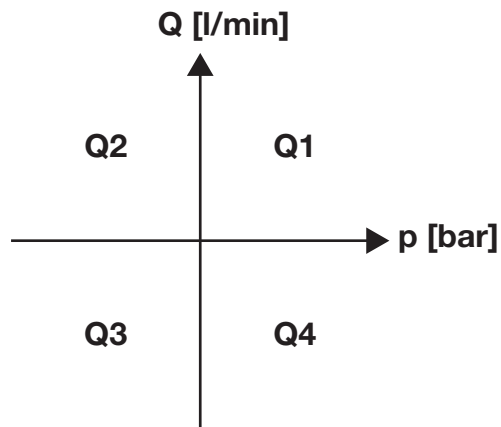


Fig. 7.62: P/Q coordinate system



NOTE

- The limitation controllers are not active in all control modes. The following table shows which limitations can be configured for which control mode.
- Section 7.11.6 Hydraulic Motion profile describes for which control modes the scaling factor can be used.

Control mode	Pressure limit	Volumetric flow rate limit
NPumpCon(4)		
PressCon(0)	x	x
VolCon(5)		x
VolConPlim(1)	x	x
SpdCon(2)		x
- SpdCon		
- SpdCon_plimit	x	
-SpdCon_Pl		
PosCon(3)		
- PosCon_QFF		x
- PosCon		
- PosCon_plimit	x	x
- PosCon_TrackingError	x	

Table 7.55: Hydraulic Limitations

Limitations

☒ Pressure limitation

☐ Flowrate limitation

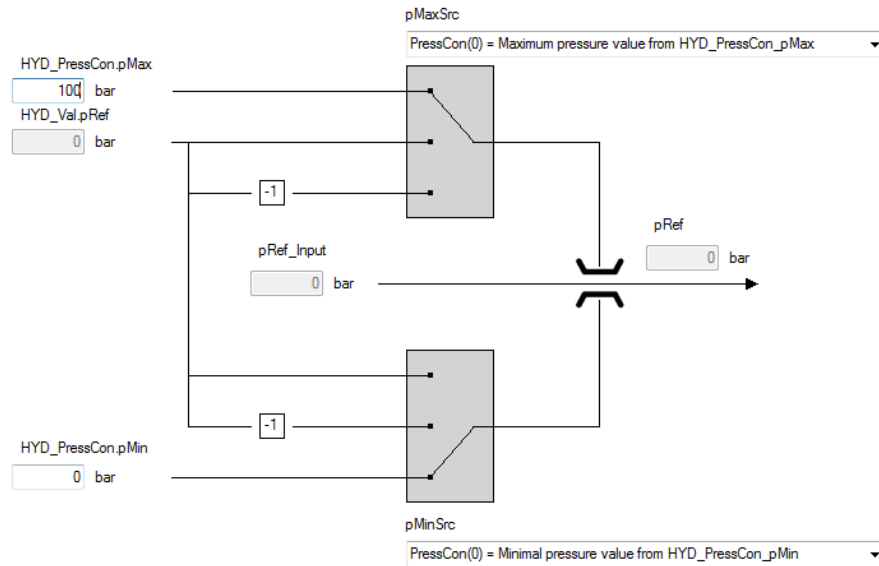


Fig. 7.63: "Pressure limit for single-quadrant operation" screen

Limitations

☒ Pressure limitation

☐ Flowrate limitation

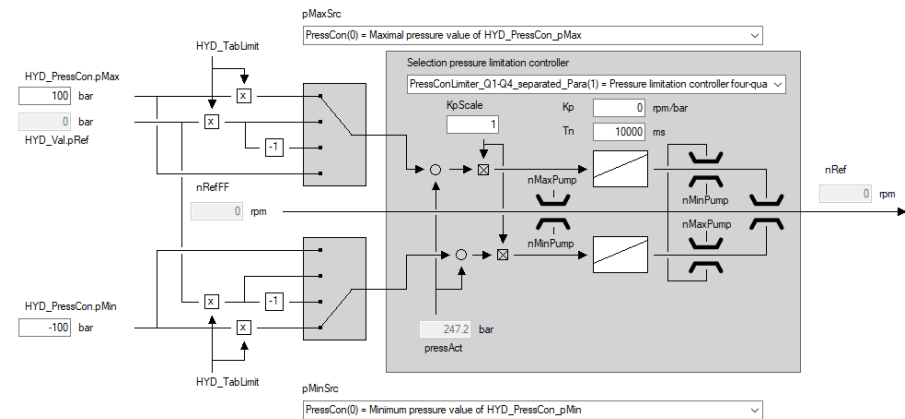


Fig. 7.64: "Pressure limit for four-quadrant operation with separate control parameters" screen

7.11.4.2 Volumetric flow rate limit

The minimum and maximum volumetric flow rate can be limited to suit the system requirements using the volumetric flow rate limit. Once the parametrized volumetric flow rate limits are reached, the pump speed is limited by the motor speed controller. A selection can be made between **P 2850[8] - QMax** and **P 2847[3] - QRef** as the source of the limit value by making a source selection (QMaxSrc). **P 2847[3] - QRef** can be used to specify the limit via the volumetric flow rate value, which, for example, can be set variably using an analog input.

For the purpose of dynamic volumetric flow rate limitation while the process is running, scaling (**P 2872 HYD_Tab_Limit**) can be used in the respective motion

block to influence the preset limitation. If this function is not desired for a flow direction (positive or negative), it can be switched off using **P 2840[5] - pMaxSrc** and **P 2840[6] - pMinSrc** (PressConWithoutTabLimit).

For the purpose of volumetric flow rate limitation during the process or in individual motion blocks, a scaling factor (**P 2872 HYD_Tab Limit**) can be used in some control modes (see table) to influence the preset limitation. (see also section "Hydraulic motion block table" on page 202)

The parameter (**P 2843 HYD_Values**) shows the limitation setpoints (**P 2843[36] QLimitMax**) and (**P 2843[37] QLimitMin**).

**NOTE**

- The limitation controllers are not active in all control modes. The table shows which limitations can be configured for which control mode. See Table 7.55: Hydraulic Limitations

Limitations
☐ Pressure limitation

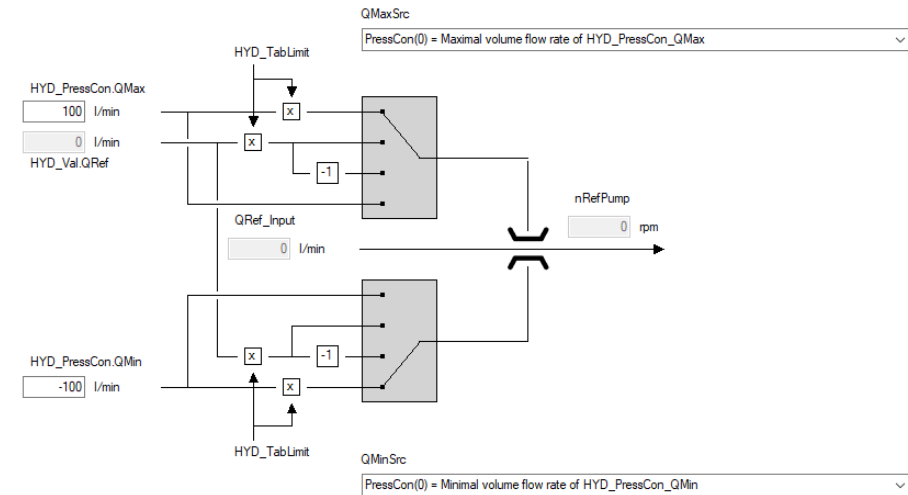
☒ Flowrate limitation


Fig. 7.65: "Volumetric flow rate limit" screen

ID	Index	Name	Unit	Description
2840		HYD_Cfg		Configure Hydraulic System Control
2840	0	Reserved		Reserved
2840	1	pRefSrc		Hydraulic: Selection of the pressure reference values
2840	2	QRefSrc		Flow rate, selection of reference source
2840	3	pActCalc		Hydraulic: Pressure actual value calculation method
2840	4	pMinSrc		Minimum pressure source selector
2840	5	pMaxSrc		Maximum pressure source selector
2840	6	QMinSrc		Minimum flow rate source selector

Table 7.56: Parameters – Configure Hydraulic System Control

ID	Index	Name	Unit	Description
2840	7	QMaxSrc		Maximum flow rate source selector
2840	8	QActCalc		Flow rate calculation method
2840	9	QLeakEst		Flow rate leakage estimation method
2840	10	nRefSrc		Pump speed reference source selector
2840	11	CylValveSwSel		Function selector for the valve switchover of the cylinder
2840	12	AltPosCon		Alternative position controller
2840	13	AltSpdCon		Alternative cylinder speed controllers
2840	14	PumpSpdProt		Pump speed protection
2840	15	PumpP2tProt		p2t protection for pump
2840	16	AltPressCon		Alternative pressure controller
2840	17	AltPressConLimit		Alternative pressure limit controller

Table 7.56: Parameters – Configure Hydraulic System Control (continue)

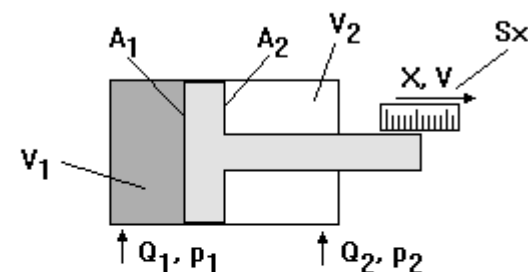
ID	Index	Name	Unit	Description
2850		HYD_PressCon		Hydraulic pressure control parameters
2850	0	Kp	rpm/bar	Gain
2850	1	KpScale		Gain scaling
2850	2	Tn	ms	Integration time constant
2850	3	Tv	ms	Rate time
2850	4	Tp	ms	Integral-action time
2850	5	pMin	bar	Minimum permissible pressure
2850	6	pMax	bar	Maximum permissible pressure
2850	7	QMin	l/min	Minimum flow rate
2850	8	QMax	l/min	Maximum flow rate
2850	9	PressWindow	bar	Pressure control parameters
2850	10	decmpLvl	bar	Level for active decompression
2850	11	decmpRate	bar/s	Rate for active decompression
2850	12	pActScale		Scaling for pAct
2850	13	pAct2Scale		Scaling for pAct2
2850	14	pRange_k	%	Pressure range threshold
2850	15	pRange_midpoint	bar	Pressure range midpoint

Table 7.57: Parameters – Pressure control parameters

7.11.5 Cylinder configuration

If no volumetric flow rate sensor is employed, the volumetric flow rate can be calculated using a linear encoder and the cylinder geometry (P 2840.8 QActCalc). To do so, various different cylinder dimensions must be passed to the servo controller. The different surface areas of the piston and ring side must be kept in mind because either more or less medium is required for the same path depending on the power direction.

Cylinder configuration:



Cylinder geometry:

Cylinder piston area A1: cm²

Cylinder ring area A2: cm²

Encoder resolution Sx: um/rev

Fig. 7.66: "Cylinder configuration" screen

The parameters which must be set are **P 2852[0] - cylArea1** and **P 2852[2] - cylArea2**.

Cylinder piston surface area A1 = cylArea1 = A1 in cm²

Cylinder ring surface area A2 = cylArea2 = A2 in cm²

**NOTE**

- For pumps which only operate with a positive speed (only one direction of rotation) and switch the direction of action of the cylinder via a directional valve, one of the two cylinder surfaces must be specified as negative (Fig. 7.66: "Cylinder configuration" screen). If the pump can be operated in both directions of rotation, this is not necessary.

Since in MSD Servo Drive all encoder input variables are calculated in revolutions, the hydraulics require a relationship between linear and rotary motion for the internal calculations of the cylinder model, cylinder speed and feed-forward control variables. For this purpose, the encoder resolution Sx of the linear encoder in µm per encoder revolution must be known (**Para 2852.7unit_scale**). In this case, one encoder revolution is the singleturn range of the respective position sensor for the cylinder position. This corresponds to 32768 µm/rev for a 16 bit linear encoder with a resolution of 0.5 µm per increment.

If the current position of the cylinder is transferred via the bus interface (**P 2298 ComAngle32**), the single and multiturn range is set to 16 bits each. This corresponds to 65536 µm/rev.

ID	Index	Name	Unit	Description
2852		HYD_SpdCon		Speed control parameters
2852	0	cylArea1	cm^2	Cylinder area
2852	1	lfe_K_scale		Leakage Flow Estimator: Gain scaling
2852	2	cylArea2	cm^2	Cylinder area (option 2, use neg. value for neg.

Table 7.58: Parameters – Pressure control parameters

ID	Index	Name	Unit	Description
				direction)
2852	3	lfe_K_scale2		Leakage Flow Estimator: Gain scaling (option 2)
2852	4	res		Reserved
2852	5	res		Reserved
2852	6	res		Reserved
2852	7	unit_scale	um/rev	Hydraulic physical unit scaling
2852	8	Kp	1/min	Speed control gain
2852	9	Tn	ms	Speed control integration time constant
2852	10	KpScale	%	Speed control gain scaling
2852	11	KpScale2	%	Speed control gain scaling (option2)

Table 7.58: Parameters – Pressure control parameters (continue)

7.11.6 Hydraulic Motion profile

Hydraulic motion profile:

Operation mode: PARA(0) = Table 2860 via parameter
 Valve control: Para(0) = Manuelle Ventilsteuerung

Ramp delay for valve switching:

Valve switching time: 200 ms

Settings hydraulic Setpoint table

Hydraulic control word:

HYD_Ctrl: 0000000000000000b

- ☐ CtrlBit0
- ☐ CtrlBit1
- ☐ CtrlBit2
- ☐ CtrlBit3
- ☐ NewSetPoint
- ☐ use_p_act2
- ☐ SwitchCylOpt
- ☐ Bit7
- ☐ Bit8
- ☐ Bit9
- ☐ Bit10
- ☐ PressLimitOff
- ☐ PressLimitQ1Off
- ☐ PressLimitQ2Off
- ☐ PressLimitQ3Off
- ☐ PressLimitQ4Off

Hydraulic status word:

HYD_State: 0000000000000000b

- ☒ OpModeBit0
- ☒ OpModeBit1
- ☒ OpModeBit2
- ☒ OpModeBit3
- ☒ NewSetPoint
- ☒ SwitchLeakBypass
- ☒ SwitchCylOpt
- ☒ CtrlLimited
- ☒ RampTargetReached
- ☒ CylValvePos
- ☒ CylValveNeg
- ☒ ValveOpt1
- ☒ ValveOpt2
- ☒ InWindow
- ☒ PressLimitOff
- ☒ Bit15

Fig. 7.67: "Hydraulic Motion profile" screen

The various different operating modes for controlling the motion sequences can be selected using **P 2862[0] - OpMode**.

The parameter **P 2840[11] - CylValveSwSel** can be used to set various different modes for controlling the actuating valves. Valve switching can be performed

automatically via the POS(3) mode depending on the position difference or be specified manually for each individual table index. In addition, the valve switching delay can be taken into account; the start of the setpoint ramp is delayed after a valve switchover (**P 2851.13 - tSwValve**). Once the command for the switchover of a valve has been triggered, a timer begins to run which delays the setpoint enable. If the motor still has a speed reference value at the moment of the switchover, it is run down to 0 rpm using the ramp specified in **P 2851.12 - stopRamp**.

Selection of operation mode

- **0 = PARA**
Setpoint setting from table, table index (**P 2860**) set using parameter access (BUS, PLC, Moog DRIVEADMINISTRATOR 5, etc.) (ramp changes are applied when the index changes)
- **1 = TERM**
Setting from table, table index (**P 2860**) will be updated via digital inputs (ramp changes will be applied when the index changes)
- **2 = CTRL1**
Operation via control word. Only parameters from table index 0 are used in the CTRL1 mode. The control mode is set via the control word (CtrlBit 0-3) and the setpoint values can be changed directly in table index 0.
- **3 = CTRL2**
Operation via control word. Parameters from all table indexes can be used in CTRL2 mode. The respective motion block is selected using the control word (CtrlBit 0-3).



NOTE

- In CTRL1 and CTRL2, the setpoint is adopted cyclically independently of NewSetpoint and ramp change with rising edge at NewSetpoint or new table index)

- **4 = TAB**
Setpoint setting from table, table index (**P 2860**) is controlled using the switching condition of the motion block table.

ID	Index	Name	Unit	Description
2862	0	HYD_OpMode		Hydraulic: operation mode

Table 7.59: "Hydraulic - Operation mode" parameters

Selection of the valve control

If the directional valves are to be controlled by the servo controller, the following three modes are available. The respective digital outputs on the servo controller must also be assigned to the correct function. HYD_CYL_POS(76) and HYD_CYL_NEG(77) must be selected for the directional valves. Two additional valves dependent on the motion block table can also be controlled (HYD_VAL_OPT1(74) and HYD_VAL_OPT2(75)).

- **0 = PARA**
Manual valve switching, switchover set using parameter access / control word (BUS, PLC, Moog DRIVEADMINISTRATOR 5, etc.)
- **1 = not defined**
- **2 = Tab**
Valve switching via the motion block table; for each motion block, one valve position can be specified which becomes active when the respective motion block is called.
- **3 = Pos**
Automatic valve switchover via position difference. Depending on the position task, the valve is switched for a positive or negative operating direction.
Once the position window has been reached (**P 2870.0 - PosWindowLo**; **P 2870.1 - PosWindowUp**), the valves are switched off and the cylinder is tensioned. For the control mode SpdCon(2), the valves are switched in dependence on the sign of the cylinder speed.

ID	Index	Name	Unit	Description
2840	11	CylValveSwSel		Function selector for the valve switchover of the cylinder

Table 7.60: "Hydraulic - Operation mode" parameters

For communication with a higher-level controller in the CTRL1 and CTRL2 operating modes, some scaling factors of process variables and control parameters are summarized in **P 2879 HYD_AddProcData**. These parameters are PDO-capable and are created in the int16 format in order to use as little memory space as possible in the process data channel. The unit of the parameters is per mill. The value 1000 therefore corresponds to 100%.

ID	Index	Name	Unit	Description
2879		HYD_AddProcData		Hydraulics: Additional process data (PDO access) (i16)
2879	0	PressCon1_KpScale_Pdo	0.1%	Additional KpScale of press controller 1 (PDO access)
2879	1	PressCon2_KpScale_Pdo	0.1%	Additional KpScale of press controller 2 (PDO access)
2879	2	Pump1_DisplScale_Pdo	0.1%	Displacement scale of pump 1 (PDO access)
2879	3	Pump2_DisplScale_Pdo	0.1%	Displacement scale of pump 2 (PDO access)
2879	4	PosConSw_KpScale1_Pdo	0.1%	Additional KpScale1 of pos controller (PDO access)
2879	5	PosConSw_KpScaleInWin_Pdo	0.1%	Additional KpScale_InWindow of pos controller (PDO access)
2879	6	PosConSw_KiScaleInWin_Pdo	0.1%	Additional KiScale_InWindow of pos controller (PDO access)
2879	7	PressCon1_KiScale_Pdo	0.1%	Additional KiScale of press controller 1 (PDO access)
2879	8	PressCon2_KiScale_Pdo	0.1%	Additional KiScale of press controller 2 (PDO access)
2879	9	reserved 9		reserved 9 (PDO access)
2879	10	reserved 10		reserved 10 (PDO access)
2879	11	reserved 11		reserved 11 (PDO access)

Table 7.61: Parameter P 2879 HYD_AddProcData

7.11.6.1 Hydraulic control word and status word

7.11.6.1.1 Hydraulic Control word

Bit	Operation Mode CTRL1 (Hydraulic Control Mode)	Operation Mode CTRL2 (Table index)
0	0000 Pressure control	Coding corresponds to active table index
1	0001 Volumetric flow rate control (pressure-limited) 0010 Cylinder speed control 0011 Cylinder position control	
2	0100 Pump speed control	
3	0101 Volumetric flow rate control (without pressure limit)	
4	NewSetPoint (ramp change with rising edge or new hydraulic control mode)	
5	use p_act2 (switch to actual pressure value 2)	
6	SwitchCylOpt (switch cylinder areas A1/A2)	
7 - 10	unused	
11	Pressure limitation inactive	
12	Pressure limitation in Q1 inactive	
13	Pressure limitation in Q2 inactive	
14	Pressure limitation in Q3 inactive	
15	Pressure limitation in Q4 inactive	

Table 7.62: Hydraulic control word: What the bits mean

ID	Index	Name	Unit	Description
2841	0	HYD_Ctrl		Hydraulic: system control

Table 7.63: "Hydraulic - Control word" parameters

7.11.6.1.2 Hydraulic status word

Bit	Meaning
0	Hydraulic control mode
1	
2	
3	
4	SetPointAcknowledge (Set if there is a rising edge at NewSetPoint and the setpoint is adopted; cleared if newSetPoint = 0)
5	SwitchLeakBypass (leakage bypass active)
6	SwitchCylOpt; cylinder areas (A1/A2)
7	CtrlLimited; hydraulic limitation active
8	RampTargetReached; preset target reached
9	CylValvePos; valve for positive cylinder direction
10	CylValveNeg; valve for negative cylinder direction
11	ValveOpt1; first optional valve
12	ValveOpt2; second optional valve

Table 7.64: Hydraulic status word: What the bits mean, expand the table

Bit	Meaning
13	InWindow; Setpoint window reached
14	PressLimitOff; pressure limitation switched off
15	Not used

Table 7.64: "Hydraulic status word: What the bits mean, expand the table (continue)"

ID	Index	Name	Unit	Description
2842	0	HYD_State		Hydraulic: Status of the control functions

Table 7.65: "Hydraulic - Status word" parameters

7.11.6.2 Servo pump speed ramps

These settings are active and have priority for every control mode.

Pump acceleration (max. acceleration = 0 = default = without a limit)

ID	Index	Name	Unit	Description
2855		HYD_PumpAcc		Hydraulic: Acceleration of the pump speed
2855	0 to 15	HYD_PumpAcc	rpm/s	

Table 7.66: "Hydraulic - Pump acceleration" parameters

Pump deceleration (max. acceleration = 0 = default = jump)

ID	Index	Name	Unit	Description
2856		HYD_PumpDec		Hydraulic: Deceleration of the pump speed
2856	0 to 15	HYD_PumpDec	rpm/s	

Table 7.67: "Hydraulic - Pump deceleration" parameters

7.11.6.3 Hydraulic motion block table

The motion block table contains 16 motion blocks which can be parametrized (Index 0 to 15). The control mode, reference values and ramps as well as the valve positions and switching conditions can be specified in each motion block.

If the servo controller is to be used as a stand-alone device, it is possible to set up a type of sequence control using the motion block table. To activate the transition of the motion block via the motion block table, the operating mode Tab(2) must be selected in the motion profile **P 2862[0] - HYD_OpMode**. This allows switching between the motion blocks to be control by either timing or an event. This function is enabled in the Tab(2) operation mode.

As an option, it is also possible to use operation mode CTRL2 to switch the motion blocks via a higher-order control system. These can be configured in advance for different control tasks so that during the process only setpoints and the respective table index must be selected or specified by the control system.

Hydraulic setpoint table:

Set number: 0

Mode: Pressure control

Reference value: 0 HYD_UNIT

1. Derivation reference value: 100 HYD_UNIT/s

2. Derivation reference value: 0 HYD_UNIT/s/s

Table control:

Unit scaling: 100 %

Delay time autocode: 0 ms

Sequence motion Time Off: 0

Sequence motion Event Off: 0

Switching condition: ConType: HydValues Subindex (P2843)

Compare value: 0

Active setpoint index: 0

Selection setpoint index: 0

Fig. 7.68: "Hydraulic motion block table" screen

Selecting the hydraulic control mode (Para 2860 HYD_TabConMode):

PressCon(0) = Pressure control

VolConPlim(1) = Volume flow rate control (pressure limited)

SpeedCon(2) = Speed control

PosCon(3) = Position control

NPumpCon(4) = Pump speed control

VolCon(5) = Volume flow rate control (without pressure control)

ID	Index	Name	Unit	Description
2860		HYD_ConMode		(Hydraulic Control Mode)
2860	0...15	HYD_ConMode		(Hydraulic Control Mode)

Table 7.68: "Hydraulic - Control mode" parameters

Hydraulic setpoint

Setpoint for pressure, volumetric flow rate, cylinder speed, cylinder position. The unit (HYD_UNIT) depends on the control mode and corresponds to bar for pressure control, l/min for volumetric flow rate control and rpm for pump speed control. For cylinder position and speed control, the unit corresponds to the UserUnit selected in the scaling (chapter 8.2). This also applies for derivative 1 and 2 or speed and acceleration.

ID	Index	Name	Unit	Description
2857		HYD_Ref		Hydraulic: Setpoint for volumetric flow rate/pressure/speed/position
2857	0..15	HYD_Ref	HYD_Unit	Hydraulic: Setpoint for volumetric flow rate/pressure/speed/position

Table 7.69: "Hydraulic - Reference value" parameters

1st reference value derivative

Rise time/speed of the setpoint

ID	Index	Name	Unit	Description
2858		HYD_dRef		Hydraulic: 1st setpoint derivative
2858	0..15	HYD_dRef	HYD_UNIT/s	Hydraulic: 1st setpoint derivative

Table 7.70: "Hydraulic - 1st setpoint derivative" parameters

2nd setpoint derivative

Setpoint acceleration (this parameter is not active for pressure and volumetric flow rate)

ID	Index	Name	Unit	Description
2859		HYD_d2Ref		Hydraulic: 2nd setpoint derivative
2859	0..15	HYD_d2Ref	HYD_UNIT/s/s	Hydraulic: 2nd setpoint derivative

Table 7.71: "Hydraulic - 2nd setpoint derivative" parameters

Hydraulic control parameters table

For controlling the valve position, switching the position and pressure controller settings and the pump data set and enabling the active decompression, the respective bits can be enabled in this parameter for every motion block. The active decompression stops a motion block from starting if there is still pressure. If the bit is active, the pressure is reduced using a defined ramp (**P 2850.11 decmpRate**) to below a specified pressure level (**P 2850.10 decmpLvl**) before the respective motion block starts.

Bit	Designation	Meaning
0	ZylArea(A1/A2)	Switch cylinder areas
1	Reserved	
2	POS	Extend the hydraulic valve cylinder
3	neg	Retract the hydraulic valve cylinder
4	Opt1	Valve option 1

Table 7.72: Control parameters table

Bit	Designation	Meaning
5	Opt2	Valve option 2
6	PosCon2	Selection for second position-controller setting P 2871 HYD_PosConAdv2
7	Reserved	
8	PumpSet2	Selection for second pump data set P 2873 HYD_Pump2
9	Reserved	
10	AktivDecomp	Active decompression for the respective motion block
11	pLimitOff	Switch off pressure limitation
12	PressCon2	Selection for second pressure-controller setting P 2874 HYD_PressCon2

Table 7.72: Control parameters table (continue)

ID	Index	Name	Unit	Description
2863		HYD_TabCtrl		
2863	0. . 15	HYD_TabCtrl		Hydraulic Table control word

Table 7.73: Parameter "Hydraulic table control word"

Scaling of the hydraulic limits

Using the scaling parameter Hyd_Limit (**P 2872**) allows the respective currently active limit to be scaled for each motion block. This makes it possible to limit each individual process. The scaling is switched over dynamically with the respective control mode that is set. The following table shows for which control modes the scaling function is implemented.

Control mode	Pressure limit	Volumetric flow rate limit
NPumpCon(4)		
PressCon(0)		x
VolCon(5)		
VolConPlim(1)	x	
SpdCon(2)		
- SpdCon_QFF		
- SpdCon_pLimit	x	

Table 7.74: Hydraulic Limitations-

Control mode	Pressure limit	Volumetric flow rate limit
- SpdCon_nFF		
PosCon(3)		
- PosCon_QFF		
- PosCon_nFF		
- PosCon_pLimit	x	
- PosCon_TrackingError	x	

Table 7.74: Hydraulic Limitations- (continue)

ID	Index	Name	Unit	Description
2872		HYD_TabLimit		
2872	0. . 15	HYD_TabLimit		Hydraulic volume/pressure/speed limit

Table 7.75: Parameter "Hydraulic - Limitations table"

Wait time in Auto mode

After expiration of the waiting time, there is a branch to the motion block specified in the "subsequent motion block Time Ctrl" (2865 HYD_TabNextIdx). The respective motion block is only active for the duration of the waiting time, regardless of whether or not the target has been reached.

ID	Index	Name	Unit	Description
2864		HYD_TabWaitTime		
2864	0. . 15	HYD_TabWaitTime		Hydraulic table delay time

Table 7.76: Parameter "Hydraulic table delay time"

Subsequent motion block Time Ctrl

The motion block index provided here becomes active after expiration of the waiting time. (0 ms = No timed transition switching)

ID	Index	Name	Unit	Description
2865		HYD_TabNextIdx		
2865	0 . 15	HYD_TabNextIdx		Hydraulic table next default index

Table 7.77: Parameter “Hydraulic table next default index”

Subsequent motion block Event Ctrl

If the transition switching condition **P 2867 - Hyd_TabCondType** is true, a switchover is made to the motion block specified here.

ID	Index	Name	Unit	Description
2866		HYD_TabAltIdx		
2866	0 . 15	HYD_TabAltIdx		Hydraulic table next alternative index

Table 7.78: Parameter “Hydraulic table next alternative index”



NOTE

- If a subsequent motion block and an alternative motion block are entered, the branch always leads to the motion block for which the condition is met first.

Switching condition

There are two different modes to choose from for the transition switching to the next motion block.

ID	Index	Name	Unit	Description
2867		HYD_TabCondType		
2867	0 . 15	HYD_TabCondType		Hydraulic table state

Table 7.79: Parameter “Hydraulic table state”

Optional comparison value

Comparison value for the transition switching condition (ConAddr)

ID	Index	Name	Unit	Description
2868		HYD_TabCondVal		
2868	0 . 15	HYD_TabCondVal		Hydraulic table comparison state

Table 7.80: Parameter “Hydraulic table comparison state”

7.11.7 Pressure control

The pressure is controlled by a PI pressure controller using **P 2850 - HYD_PressCon** based on the pressure setpoint. Here you can choose between two controller structures using **P 2840 [16] AltPressCon**.

Pressure control with pump speed output:

The selection PressCon_nPump(0) outputs a pump speed at the output of the controller which is directly forwarded to the speed controller (see Fig. 7.69: “Pressure control with pump speed output” screen).

Pressure control with volumetric flow rate output:

The selection PressCon_VolFlow(2) has a volumetric flow rate output in l/min and an underlying volume flow control which takes the displacement volume of the pump into account (see Fig. 7.70: “Pressure control with volumetric flow rate output” screen). This can be helpful for pumps with a variable displacement volume, as this means the control circuit gain remains unchanged and the controller parameters do not need to be adjusted. In addition, the unit of gain changes to (l/min)/bar. This unit then applies to the pressure limiting controller, which influences the manipulated variable in the various control modes.

If during operation of the pressure control one of the specified limit values **P 2850 [7] - Qmin** or **P 2850 [8] - Qmax** is reached due to the pump speed, the actuating variable (motor speed) is limited accordingly. Moreover, the configured speed limits (**P 2851.5 nMin**, **P2851.6 nMax**) for the pump always take priority. In addition, it is possible to set the minimum and maximum system pressure via a pressure

limitation. To take into account the different area ratio of a differential cylinder, the actual pressure values can be scaled to the respective area ratio using UnitScale_pAct and UnitScale_pAct2 (**P 2850.12 pActScale**, **P 2850.13 pAct2Scale**).

For control systems with high dynamic performance, it may be necessary to take into account a pressure-dependent compressibility in the control system. This compressibility will decrease as the pressure increases, i.e. less fluid needs to be pumped for the same pressure change. Accordingly, the pressure controller's gain needs to be reduced at higher pressures in order to maintain a constant pressure control circuit dynamic performance. Because of this, pressure-dependent controller gain scaling has also been incorporated. This scaling can be configured with a characteristic curve (**P 2853 - HYD_PressConScale**).

The pressure controller settings were duplicated in **P 2874 HYD_PressCon2**. With this it is possible to select a different controller setting for a selected table motion block. The second controller data set can be selected in the table motion block using **P 2863 HYD_TabCtr** bit 12.

In order to provide feedback to a higher-order control system, a setpoint window for "Pressure reached" (**P 2850.9 - PressWindow**) can be specified. If the actual value is within this window, the bit "InWindow" (bit 13) is set in the status word (see also section "Hydraulic Motion profile" on page 199). Furthermore, a second KpScale **P 2879[0] PressCon1_KpScalePDO**, **P 2879[1] PressCon2_KpScalePDO** has been introduced for operation via one controller and it can be written cyclically via the PDO channel. It should be noted here that both factors act one after the other and influence each other.

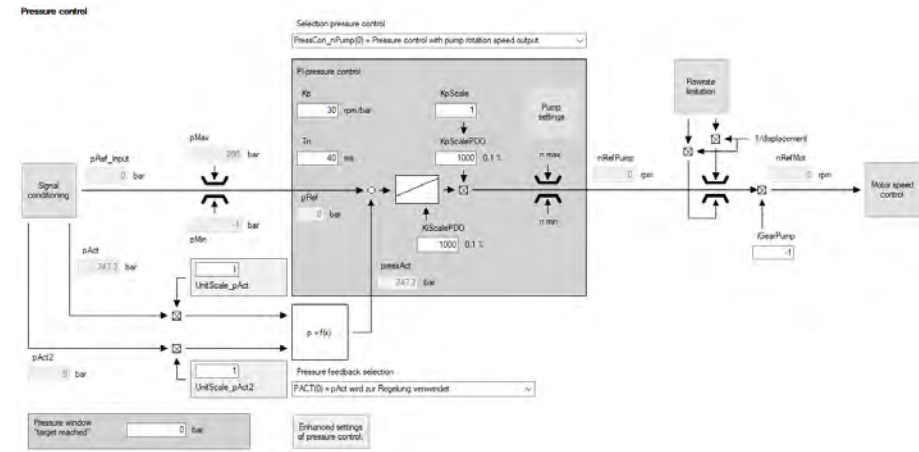


Fig. 7.69: "Pressure control with pump speed output" screen

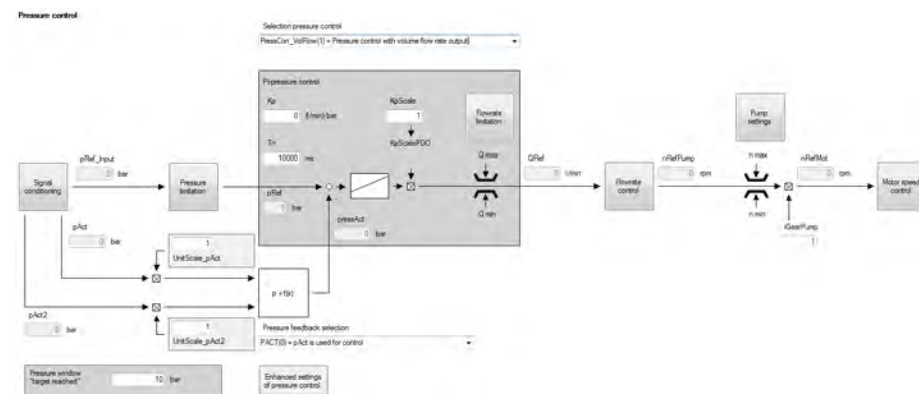


Fig. 7.70: "Pressure control with volumetric flow rate output" screen

Designation	Description	Parameters	Index
pRef	Pressure reference value pRef	2847	2
pressAct	Pressure actual value pAct	2847	0
	Pressure actual value pAct2	2847	1
	One of the two values, selectable using P	2847	0
	2840[3] Pressure difference= pAct - pAct2	2847	1
Qmax	Max. volumetric flow rate limit QMax		8
	Max. volumetric flow rate setpoint QRef	2850	3
	One of the two values, selectable with P 2840[6, 7]	2847	
Qmin	min Volumetric flow rate limit QMin		
	min Volumetric flow rate setpoint QRef	2850	7
	One of the two values, selectable with P 2840[6, 7]	2847	3
Kp, τn	PI(D) pressure controller (derivative term not implemented at the time of writing)	2850	0-4
nRefPump	Pump speed setpoint	2843	9
nmin	Speed limit pressure control	2851	5
nmax		2851	6
nRefMot	Motor speed setpoint	2843	12
PressWindow	Pressure window "Pressure reached"	2850	9

Legend for "Structure of pressure control"

ID	Index	Name	Unit	Description
2850		HYD_PressCon		Hydraulic pressure control parameters
2850	0	Kp	rpm/bar	Gain
2850	1	KpScale		Gain scaling Gain scaling
2850	2	Tn	ms	Integration time constant
2850	3	Tv	ms	Rate time
2850	4	Tp	ms	Integral-action time

Table 7.81: "Hydraulic - pressure control" parameters

ID	Index	Name	Unit	Description
2850	5	pMin	bar	Minimum permissible pressure
2850	6	pMax	bar	Maximum permissible pressure
2850	7	QMin	l/min	Minimum flow rate
2850	8	QMax	l/min	Maximum flow rate
2850	9	PressWindow	bar	Pressure control parameters
2850	10	decmpLvl	bar	Level for active decompression
2850	11	decmpRate	bar/s	Rate for active decompression
2850	12	pActScale		Scaling for pAct
2850	13	pAct2Scale		Scaling for pAct2
2850	14	pRange_k	%	Pressure range threshold
2850	15	pRange_midpoint	bar	Pressure range midpoint
2853		HYD_PressConScale		Scaling of the properties of the pressure control gain
2853	0	pMin	bar	Minimum permissible pressure of the characteristic
2853	1	pMax	bar	Maximum permissible pressure of the characteristic
2853	2	Nval		Number of interpolation points
2853	3	Type		Interpolation type
2853	4	Table0	%	Scaling Table Value 0
2853	5	Table1	%	Scaling Table Value 1
2853	6	Table2	%	Scaling Table Value 2
2853	7	Table3	%	Scaling Table Value 3
2853	8	Table4	%	Scaling Table Value 4
2853	9	Table5	%	Scaling Table Value 5

Table 7.81: "Hydraulic - pressure control" parameters (continue)

7.11.8 Volumetric flow rate control

7.11.8.1 Volumetric flow rate control with pressure limitation

If the reference variable for the volumetric flow rate that needs to be set is

QRefInput, the implemented volumetric flow rate control can be used. Generally, **QRefInput** can be converted to an equivalent motor setpoint speed **nRefPump** using the displacement volume and **QLeak** can be disregarded during the process.

If there are stricter requirements concerning the volumetric flow rate accuracy, **QLeak** must be taken into account as a function of pressure and **nRefPump** must be increased accordingly.

In addition, limiting the pressure upwards to a maximum pressure of **pmax** is usually a requirement. Moreover, a minimum pressure of **pmin** may also be required. An additional pressure limiting control system is set up for this purpose. If the configured pressure limits are reached, the motor speed will be dynamically limited upwards or downwards accordingly.

**NOTE**

- To do so, the pressure regulator must also be parametrized and set.

In addition to the pressure limitation, the minimum and maximum volumetric flow rate can be set via a volumetric flow rate limitation (see Section "Hydraulic Limitations" on page 193).

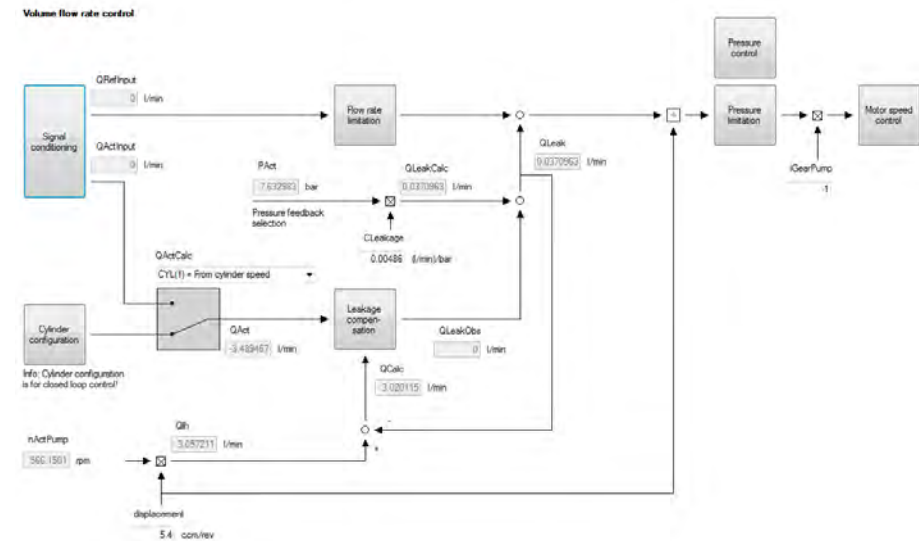


Fig. 7.71: "Volumetric flow rate control" screen

Designation	Description	Parameters	Index
pAct	Pressure actual value pAct	2847	0
	Pressure actual value pAct2	2847	1
	One of the two values, selectable with P 2840[3]		
QRefInput	Volumetric flow rate setpoint QRef	2847	3
pmax	max. pressure limit pMax	2850	6
	max. pressure reference value pRef	2847	2
	One of the two values, selectable with P 2840[4, 5]		

Legend for "Volumetric flow rate control"

Designation	Description	Parameters	Index
pmin	min pressure limit pMin	2850	5
	min Pressure reference value pRef	2847	2
	One of the two values, selectable with P 2840[4, 5]		
	PI(D) pressure controller (derivative term not implemented at the time of writing)	2850	0-4
n*	Pump speed setpoint		
	Comment: Motor speed setpoint (gearing!): Scope ID 6: nref	2843	9
nmin	Speed limit pressure control	2851	5
nmax		2851	6
nActPump	Actual pump speed value		
	Comment: Actual motor speed (gearing!): Scope ID 13: nact	2843	12
QLeakCalc _L	QL _{calc} = Calculated leakage volumetric flow rate	2843	6
QCalc	Q _{calc} 0 Calculated volumetric flow rate	2843	5
Qth	Theoretical volumetric flow rate	2843	14
QLeak	Leakage volumetric flow rate		

Legend for "Volumetric flow rate control" (continue)

7.11.8.2 Volumetric flow rate control without pressure limitation

If there is no need for a pressure limitation, a volumetric flow rate control without pressure limitation (VolCon(5) = volumetric flow rate control (without pressure limitation)) can be selected in **P 2860 - HYD_TabConMode**. This provides the same functions but is not linked to the pressure control. Moreover, the pressure regulator does not need to be parametrized for this control mode.

7.11.8.3 Leakage compensation

If there is a volumetric flow rate sensor available (this can also be determined based on a measured cylinder speed as an alternative), measured value **Qmess** can optionally be used for leakage compensation.

In this case, volumetric flow rate control with steady-state accuracy will be achieved.

ID	Index	Name / Setting	Unit	Description
2840	9	QLeakEst		Flow rate leakage estimation method
		0: NONE(0)= No leakage compensation		No leakage compensation
		1: OBS(1)= Observer		Observer (see leakage volumetric flow rate estimate figure)
		2: MEAS(2)= Directly measured		The measured value will be used directly (this may result in higher dynamic performance than with OBS(1), but heavy noise is also possible!) (TEST IMPLEMENTATION)
		3: CTRL(3)= PI controller		PI controller (Kp: P 2849[2] - lfe_K , Tn: P 2849[3] - lfe_TN)

Table 7.82: Selection of leakage compensation

Leakage compensation

Flow rate leakage compensation method selection:

OBS(1) = Observer

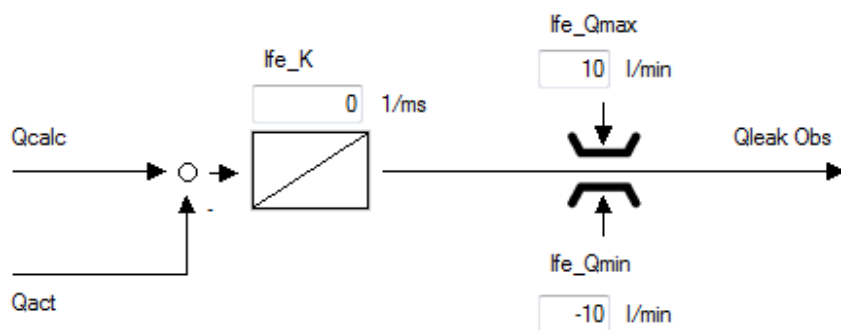


Fig. 7.72: "Leakage compensation" screen

ID	Index	Name	Unit	Description
2849		HYD_Lfe		Leakage flow estimate
2849	0	lfe_Qmin	l/min	Leakage flow estimate: minimum value
2849	1	lfe_Qmax	l/min	Leakage flow estimate: maximum value
2849	2	lfe_K	1/ms	Leakage flow estimate: gain
2849	3	lfe_Tn	ms	Leakage flow estimate: integration time constant
2850		HYD_PressCon		Hydraulic pressure control parameters
2850	0	Kp	rpm/bar	Gain
2850	1	KpScale		Gain scaling
2850	2	Tn	ms	Integration time constant
2850	3	Tv	ms	Differential time constant

Table 7.83: "Hydraulic - Volumetric flow rate" parameters

ID	Index	Name	Unit	Description
2850	4	Tp	ms	Integral-action time
2850	5	pMin	bar	Minimum permissible pressure
2850	6	pMax	bar	Maximum permissible pressure
2850	7	QMin	l/min	Minimum flow rate
2850	8	QMax	l/min	Maximum flow rate
2850	9	PressWindow	bar	Pressure control parameters
2850	10	decmpLvl	bar	Level for active decompression
2850	11	decmpRate	bar/s	Rate for active decompression
2850	12	pActScale		Scaling for pAct
2850	13	pAct2Scale		Scaling for pAct2
2850	14	pRange_k	%	Pressure range threshold
2850	15	pRange_midpoint	bar	Pressure range midpoint

Table 7.83: "Hydraulic - Volumetric flow rate" parameters (continue)

7.11.9 Speed control

The speed of a hydraulic cylinder can be influenced directly with the controlled volumetric flow rate that is flowing in. The cylinder speed can be determined by means of a linear position sensor which is coupled to the cylinder. The values from the cylinder model and the cylinder speed allow the steady-state volumetric flow rate to be set with precision. (**P 2840.13 - AltSpdCon** = 0)

If, in the case of double-acting cylinders, force is to be applied in both directions at will, the simplest application will require at least one changeover valve. In this case, the speed magnitude will continue to be defined via the volumetric flow rate, i.e. via the pump speed. Meanwhile, the force direction will be based on the valve position. Within this context, it is important to take into account that the sign will be reversed in the relationship between the volumetric flow rate and the speed and that, due to the different piston/annulus area, the relationship will change as well. The actuation of a changeover valve, as well as its consideration for the cylinder positioning, are part of the hydraulic package.

The prerequisite for speed control is that the volumetric flow rate control and the leakage compensation be set and parametrized. The SpeedCon(2) control mode must be selected to allow activation of the speed control mode.

In addition, the cylinder geometries (**P 2852[0] - cylArea1**, **P 2852[2] - cylArea2**) must be known and set accordingly.

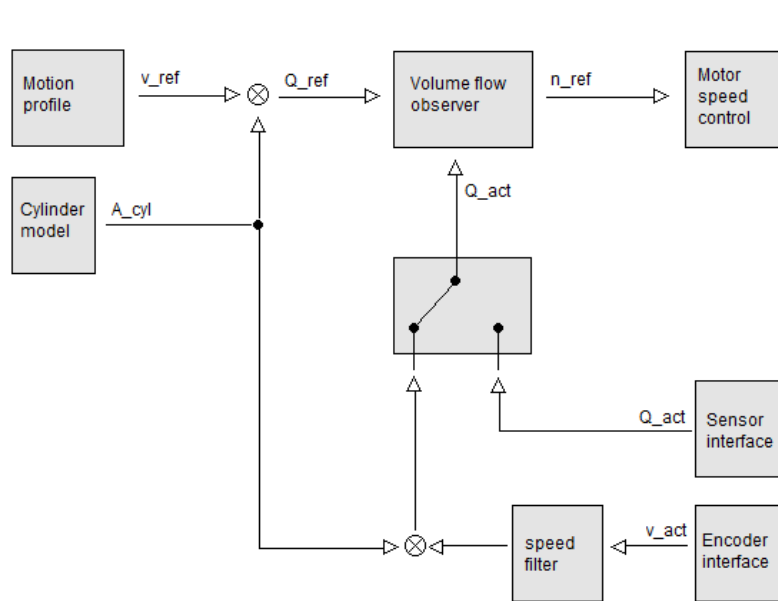


Fig. 7.73: Control structure, cylinder speed control

For cylinder speed control, there is a choice of two further control structures. These two alternative control types are described below.

To provide speed control with pressure limitation, a special mode with a downstream pressure regulator has been implemented. In this case, the pressure limitation as well as the scaling of the pressure limitation are in effect for the individual motion blocks (**P 2840.13 - AltSpdCon = 1**). The prerequisite for cylinder speed control with active pressure limitation is that the pressure control be properly adjusted.

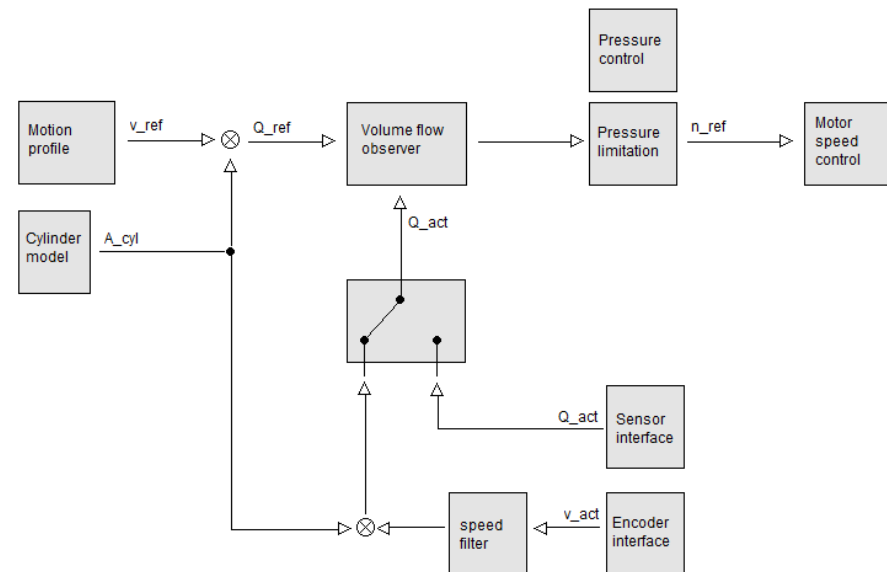


Fig. 7.74: Control structure, cylinder speed control with pressure limitation

A further option is to control the cylinder speed directly via a PI controller (**P 2840.13 AltSpdCon = 2**). In this case, the speed is not calculated using the cylinder model and the displacement volume with feed-forward control, but is governed strictly by the PI controller. In order to take the different cylinder volumes for the ring and piston sides of the cylinder into account, two scaling factors (**P 2852.10 KpScale**, **P**

2852.11 KpScaleNeg) for the positive and negative cylinder directions can be used to influence the gain of the controller. KpScaleNeg becomes active with the bit for the negative cylinder volume (**P 2863 Hyd_TabCtrl Bit 0**).

**NOTE**

- In this control mode, the volumetric flow rate and pressure limitation are not active.

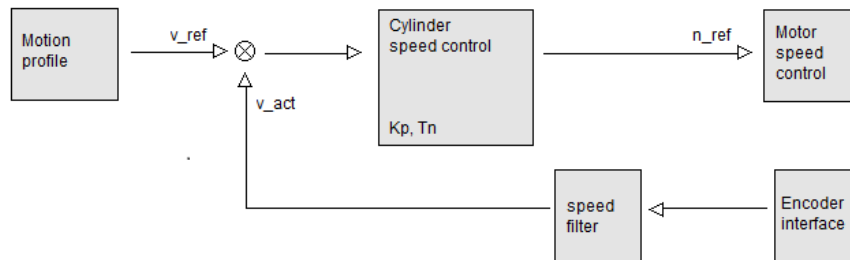


Fig. 7.75: Control structure, cylinder speed control without cylinder model and leakage compensation

ID	Index	Name	Unit	Description
2849		HYD_Lfe		Leakage flow estimation
2849	0	lfe_Qmin	l/min	Leakage Flow Estimator: Min value
2849	1	lfe_Qmax	l/min	Leakage Flow Estimator: Max value
2849	2	lfe_K	1/ms	Leakage Flow Estimator: Gain
2849	3	lfe_Tn	ms	Leakage Flow Estimator: Integrator time constant
2850		HYD_PressCon		Pressure control parameters
2850	0	Kp	rpm/bar	Gain
2850	1	KpScale		Gain scaling

Table 7.84: “Hydraulic - Speed control” parameters

ID	Index	Name	Unit	Description
2850	2	Tn	ms	Integration time constant
2850	3	Tv	ms	Differential time constant
2850	4	Tp	ms	Integral-action time
2850	5	pMin	bar	Minimum permissible pressure
2850	6	pMax	bar	Maximum permissible pressure
2850	7	QMin	l/min	Minimum flow rate
2850	8	QMax	l/min	Maximum flow rate
2850	9	PressWindow	bar	Pressure control parameters
2850	10	decmpLvl	bar	Level for active decompression
2850	11	decmpRate	bar/s	Rate for active decompression
2850	12	pActScale		Scaling for pAct
2850	13	pAct2Scale		Scaling for pAct2
2850	14	pRange_k	%	Pressure range threshold
2850	15	pRange_midpoint	bar	Pressure range midpoint
2852		HYD_SpdCon		Speed Controller Parameters
2852	0	cylArea1	cm ²	Speed control parameter
2852	1	lfe_K_scale		Leakage Flow Estimator: Gain scaling
2852	2	cylArea2	cm ²	Cylinder displacement (option 2, use neg. value for neg. direction)
2852	3	lfe_K_scale2		Leakage Flow Estimator: Gain scaling (option 2)
2852	4	res		Reserved
2852	5	res		Reserved
2852	6	res		Reserved
2852	7	unit_scale	um/rev	Hydraulic physical unit scaling
2852	8	Kp	1/min	Speed control integration time constant
2852	9	Tn	ms	Speed control integration time constant
2852	10	KpScale	%	Speed control gain scaling
2852	11	KpScale2	%	Speed control gain scaling (option2)

Table 7.84: “Hydraulic - Speed control” parameters (continue)

7.11.10 Position control

Position control with volumetric flow feed forward control:

The position of a hydraulic cylinder can be influenced directly with the controlled volumetric flow rate. Cylinder speed and volumetric flow rate are proportional to each other. That means the speed feed-forward control can be calculated using the volumetric flow rate and the cylinder geometry. In turn, the required volumetric flow rate is determined by the pump geometry and pump speed. Alternatively, the feed-forward control variable can also be specified in mm/s via a higher-level control system **P 2881[0] - HYD_AddValues**. For this, selector **P 2880[0] PosCon_RefSpdFF** must be switched to "(1) from EXTERNAL". For better optimization and analysis, the feed forward control value can be viewed in **P 2843 [30] RefSpdFF** as the actual value or can be recorded in the scope. The scaling factor of the feed-forward control variable **P 2842[2] - SFF** remains active. If a position sensor / path measurement system is mounted on the cylinder, it can be used to determine the exact position of the cylinder and the control circuit can be closed. The remaining control difference can then be stabilized accurately using a steady-state PI controller.

If, in the case of double-acting cylinders, positioning is to be performed in both the positive and negative directions, the simplest application will require one changeover valve. Care must be taken to ensure that the force direction and valve position are compatible because otherwise an inadmissibly high volumetric flow rate and pressure will be generated by the position controller due to the unchanged control deviation. The actuating valves can be controlled in different modes (see Section "Hydraulic Motion profile" on page 199). Moreover, the volumetric flow rate control must be parametrized and the cylinder geometries must be configured.



NOTE

- To simplify the control circuit, the I component (**P 2848[1] - Tn**) of the controller must be set to 10000 ms and thereby has no influence on the control. The position control can thus be operated by means of feed forward control and P controller.

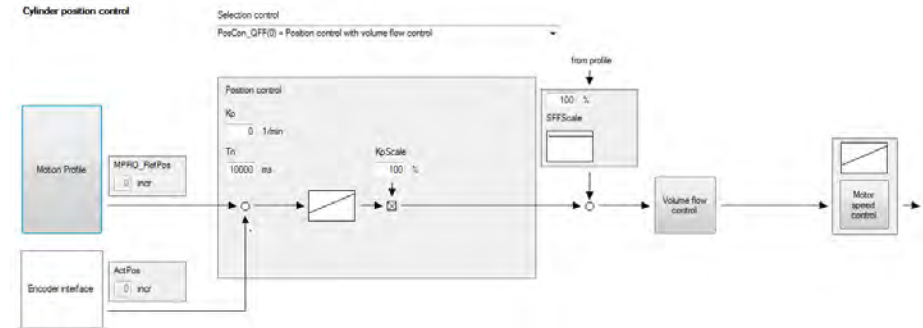


Fig. 7.76: "Hydraulic - position control" screen **PosCon_QFF(0)**

Position control with pressure limitation:

If it is necessary to limit the maximum permissible pressure during the positioning operation, the control structure can be expanded to include a higher-order pressure regulator (**P 2840[12] - AltPosCon = PosCon_pLimit(2)**). The control structure of the pressure limiting controller differs from that of the standard pressure controller, but the same parameters can be used for gain and integral-action time. Alternatively, you can switch to separate controller parameters (see chapter 7.11.4.1 Pressure limit). The controller structure for the pressure control does not allow the controller to be operated without the integrating part. Consequently, it makes sense to work with a gain factor that is not too high so as to avoid exciting the control circuit. If the pressure needs to be restricted for a certain positioning operation, a partial process or an individual motion block, a scaling factor **P 2872 - HYD_TabLimit** can be used to adapt the pressure limitation for each motion block.

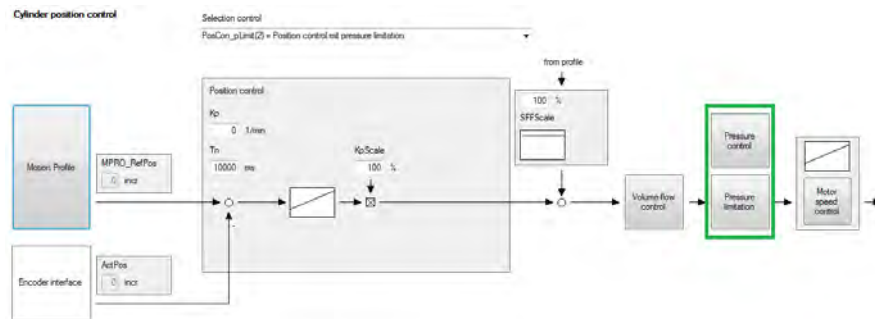


Fig. 7.77: "Hydraulic - position control" screen PosCon_pLimit(2)

Position control without volumetric flow control:

If the cylinder geometry is unknown, then no feed-forward control value can be calculated for the volumetric feed-forward control. In this case, a PI controller and a constant speed feed-forward control can be used to represent the position control (**P 2840[12] AltPosCon = PosCon_nFF(1)**). However, the different surfaces of the cylinder geometry must be taken into account because the different volumes of the cylinder chambers cause different behaviour in the control paths. To do so, the control parameters of the position control must be adapted. The control can be designed to suit the different cylinder surface sizes using parameters **P 2870[3] KpScale** and **P 2870[5] KpScaleNeg**.

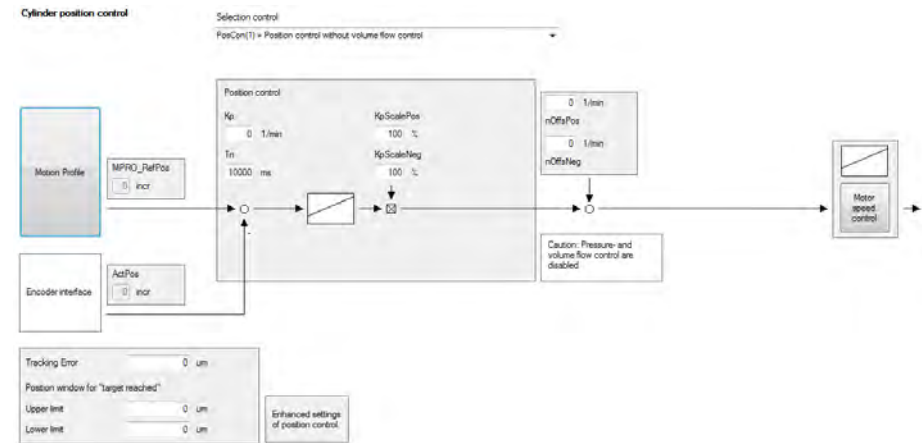


Fig. 7.78: "Hydraulic - position control" screen PosCon(1)

Position control with tracking error switchover:

For special applications, the control parameters can be changed as a function of a tracking error limit. To do so, the switchover limits **P 2878[2] - PosWindowP** and **P 2878[3] - KiScale_InWindow** must be configured. In this range, the controller gain is influenced by the scaling factor **P 2878[1] - KpScale_InWindow** and the I-component by the scaling factor **P 2878[3] - KiScale_InWindow**. The parameter **P 2878[7] - IntegralPreload** can be used to preload the integrator value. The two limits **P 2878[5] - LimitIntegMax** and **P 2878[6] - LimitIntegMin** can be used to limit the I-component as appropriate.

The feed forward control as well as the pressure limitation continue to remain active for this control structure.

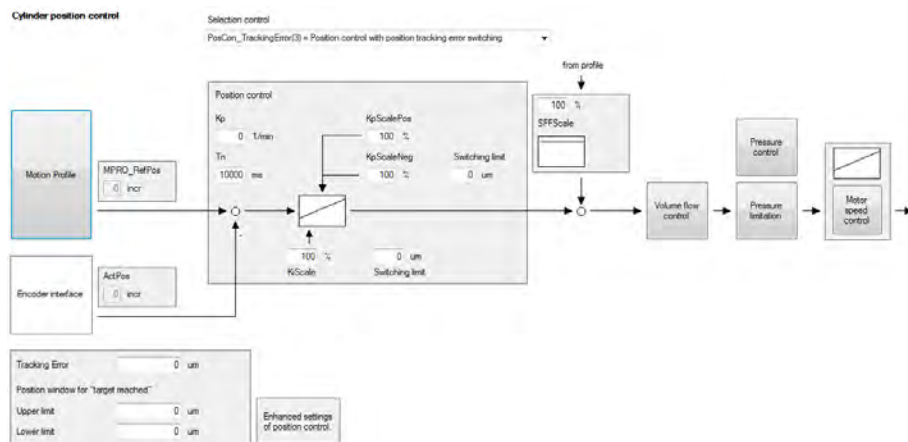


Fig. 7.79: Hydraulic - "position control" PosCon_TrackingError(3)

Position monitoring:

A tracking error can be set to monitor the positioning operation. If this tracking error is exceeded due to an increased load or an error in the system, the controller switches off and reports an error reaction.

Moreover, continuous readjustment of the position can be prevented by defining a position window (P 2870.0 PosWindowLo, P 2870.1 PosWindowUp). When the actual position reaches this window, the motion is stopped and the cylinder is tensioned by switching off the directional valves. In addition, the "InWindow" bit is set in the status word to provide feedback concerning the completion of the positioning operation. It is important to bear in mind that the position window is turned in dependence on the direction of the positioning operation (see Fig. 7.81: Position window and position hysteresis). If no readjustment of the position is desired, it is also possible to define a hysteresis in addition to the position window (P 2870.6

PosHysLo, P 2870.7 PosHysUp). The position controller then positions into the position window but only corrects the position again after a departure from the set hysteresis range.

Tracking Error	0	um
Position window for "target reached"		
Upper limit	0	um
Lower limit	0	um

Fig. 7.80: Position tracking error and position window

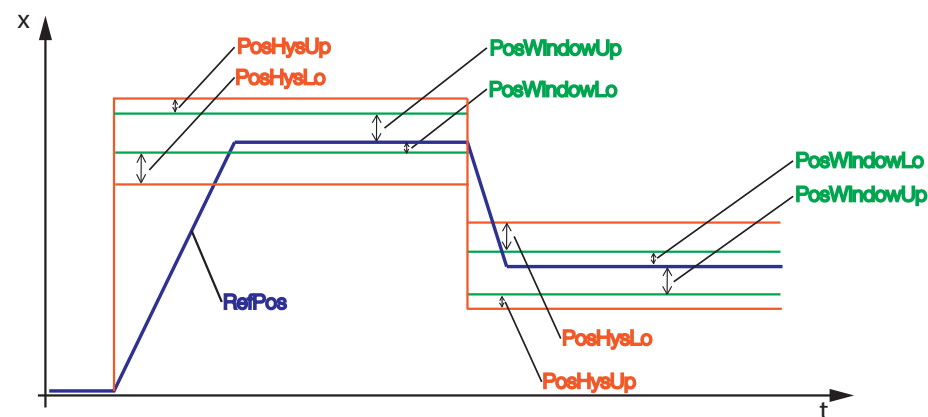


Fig. 7.81: Position window and position hysteresis

ID	Index	Name	Unit	Description
2848		HYD_PosCon		Position Controller Parameters
2848	0	Kp	1/min	Gain of position controller
2848	1	Tn	ms	Position control integration time constant
2848	2	SFF	%	Speed feedforward scaling
2848	3	PosDiffMax	um	Position tracking error monitoring

Table 7.85: "Hydraulic - position control" parameters

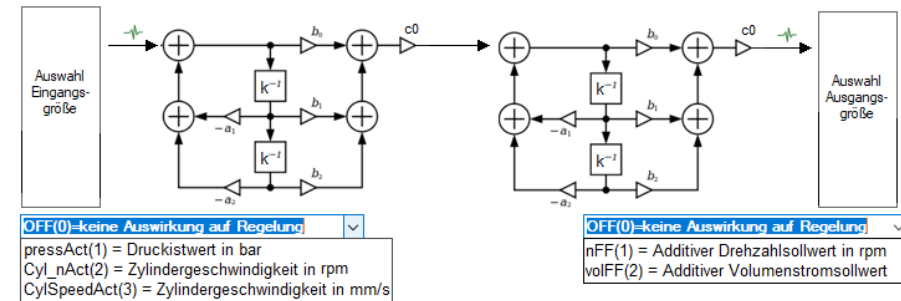
7.11.11 Digital filter Hydraulics

For special applications the hydraulics firmware has two biquad filters connected in series with different input and output variables. For example, acceleration can be fed back to the position controller.

Digitalfilter Hydraulik

Filtertype:

OFF(0)=keine Auswirkung auf Regelung



Koeffizienten Filter 1

a1
a2
b0
b1
b2
c0

Koeffizienten Filter 2

a1
a2
b0
b1
b2
c0

Fig. 7.82: Digital Filter Hydraulics Screen

Via **P 2876 HYD_AdvFilSel** the filter can be activated and the input and output sizes can be selected.

The actual pressure value **P 2843.1 pressAct** in bar or the cylinder speed **P 2843.23 ActSpd** in rpm (Cyl_nAct(2)) or in mm/s (Cyl_ActSpd(3)) are available as input variables.

An additive speed setpoint (nFF(1)) or volume flow rate setpoint (volFF(2)) can be selected at the filter output. The speed reference value is connected to the output of the pressure control and the cylinder speed control. Selecting volFF(2) acts at the

output of the pressure control with volumetric flow rate output and the subordinate volumetric flow rate control of the position controller. Additionally, 6 bits in the **P 2884 HYD_AdvFilCtrl** parameter can be used to switch the filter for individual control modes to active or inactive (filter output is active when corresponding bit = 1).

Bit	Control mode
0	Pressure control
1	Volumetric flow rate control
2	Cylinder speed control
3	Cylinder position control
4	Pump speed control
5	Volumetric flow rate control (without pressure limitation)

Table 7.86: Advanced filter control

The coefficients a1 to b2 can be calculated using a mathematical software tool or a coefficient calculator. The coefficients c0 serve as gain factors at the output of the respective filter. To evaluate the quality of the filter, two scope variables are available for input and output variables (**P 2843.24 AdvFilterOut**, **P 2843.31 AdvFilterIn**).

ID	Index	Name	Unit	Description
2876		HYD_AdvFilSel		Advanced Filter Selection
2876	0	Type		Hydraulic advanced filter: type (0=off), (electronic damping)
2876	1	Source (input filter 1)		Selector of input to filter 1 OFF (0) = no effect on control PressAct (1) = actual pressure value in bar cyl_nACT (2) = cylinder speed in rpm CylSpeedAct (3) = cylinder speed in mm/s
2876	2	Sink (output filter 2)		Selector to output from filter 2 OFF (0) = no effect on control nFF (1) = Additive speed setpoint in rpm VolFF (2) = Additive volumetric flow rate setpoint in rpm

Table 7.87: Parameter P 2876 HYD_AdvFilSel

ID	Index	Name	Unit	Description
2877		HYD_AdvFilCoeff		Advanced Filter Coefficients (electronic damping)
2877	0	BiQuad filter 1: a1		Hydraulic advanced filter coefficient: filter 1, a1
2877	1	BiQuad filter 1: a2		Hydraulic advanced filter coefficient: filter 1, a2
2877	2	BiQuad filter 1: b0		Hydraulic advanced filter coefficient: filter 1, b0
2877	3	BiQuad filter 1: b1		Hydraulic advanced filter coefficient: filter 1, b1
2877	4	BiQuad filter 1: b2		Hydraulic advanced filter coefficient: filter 1, b2
2877	5	BiQuad filter 1: c0		Hydraulic advanced filter coefficient: filter 1, c0
2877	6	BiQuad filter 2: a1		Hydraulic advanced filter coefficient: filter 2, a1
2877	7	BiQuad filter 2: a2		Hydraulic advanced filter coefficient: filter 2, a2
2877	8	BiQuad filter 2: b0		Hydraulic advanced filter coefficient: filter 2, b0
2877	9	BiQuad filter 2: b1		Hydraulic advanced filter coefficient: filter 2, b1
2877	10	BiQuad filter 2: b2		Hydraulic advanced filter coefficient: filter 2, b2
2877	11	BiQuad filter 2: c0		Hydraulic advanced filter coefficient: filter 2, c0

Table 7.88: Parameter P 2877 HYD_AdvFilCoeff

7.11.12 Example: Pressure and pump speed control

This example shows which parameter settings need to be configured in order to operate a servo pump with pressure and pump speed control. Before configuring the parameters for the hydraulic system, the settings for the motor and encoder need to be configured first. After this, “Torque control/Hydraulic control” must be selected as the control mode and the selection of the reference setpoint must be set to “Hydraulic profile” in the hydraulic basic settings.

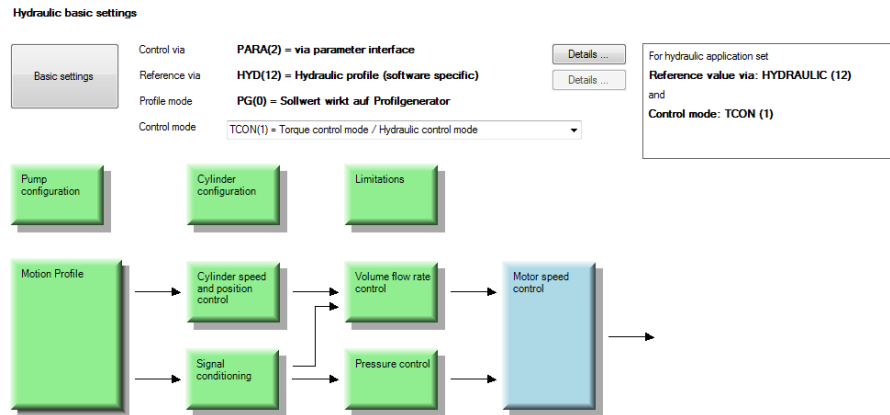


Fig. 7.83: “Hydraulic basic settings” screen

ID	Index	Name	Value	Unit	Description	Type	PDO
300	0	CON_CfgCon	TCON (1)		Select control mode	uint16	x
159	0	MPRO_CTRL_SEL	DS402 (5)		Motion profile: selection	uint16	x
165	0	MPRO_REF_SEL	HYDRAULIC (12)		Motion profile: selection	uint16	x

Table 7.89: Settings for control mode and motion profile

Now the pump specifications – as found on the rating plate or data sheet – need to be entered into **P 2851 - HYD_Pump**. This is also where the minimum and maximum speed limits for the pump and the gear ratio between the motor and the pump are set.

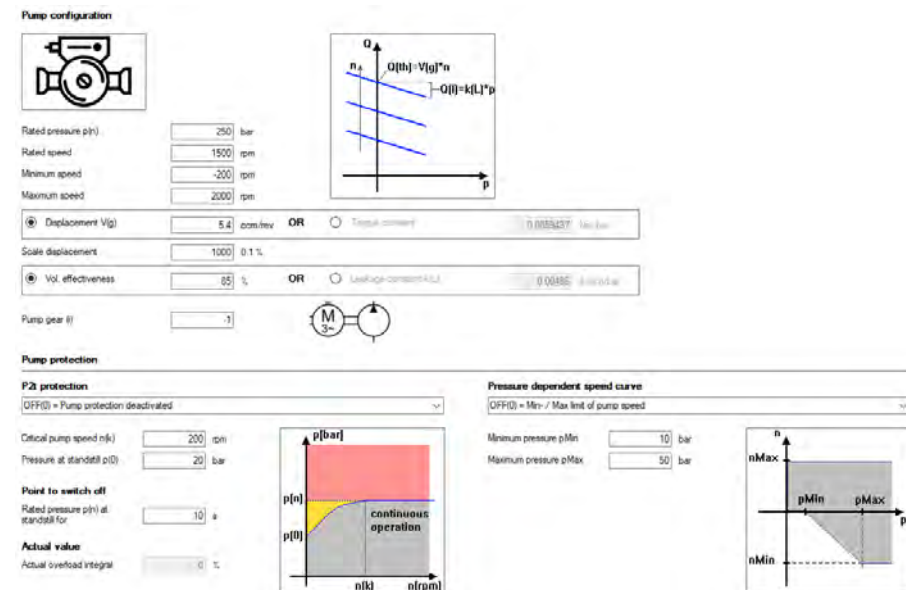


Fig. 7.84: “Pump settings” screen

ID	Index	Name	Value	Unit	Description	Type	PDO
2851		HYD_Pump			Pump parameters		
2851	0	displ_Pump	5.4	ccm/rev	Offset	float32	
2851	1	cTorque	0.0859437	Nm/bar	Torque constant	float32	
2851	2	pNom	250	bar	Nominal pressure	float32	

Table 7.90: Pump data settings

ID	Index	Name	Value	Unit	Description	Type	PDO
2851	3	nNom	1500	rpm	Rated speed	float32	
2851	4	etaVol	80	%	Volumetric efficiency at nominal pressure, rated speed	float32	
2851	5	nMin	0	rpm	Minimum speed	float32	
2851	6	nMax	2000	rpm	Maximum speed	float32	
2851	7	nCritical	200	rpm	Critical speed (@ nominal pressure)	float32	
2851	8	TCritical	10	s	Max. permissible time at low speed and nominal pressure	float32	
2851	9	iGearPump	-1		Gear ratio between pump and motor	float32	
2851	10	p0	20	bar	Max. permissible stationary pressure at a standstill	float32	
2851	11	cLeakage		(l/min)/bar	Leakage constant	float32	
2851	12	stopramp		(1/min)/s	Stop ramp (during valve switching etc.)	float32	
2851	13	tSwValve		ms	Valve switching time	float32	
2851	14	pMin		bar	Minimum pressure (depending on pump protection function)	float32	
2851	15	pMax		bar	Maximum pressure (depending on pump protection function)	float32	

Table 7.90: Pump data settings (continue)

In this example, the actual pressure values will be evaluated using analog inputs ISA00 and ISA01.

Analog standard inputs:

ISA00

Function PACT(-7) = Actual value for pressure control Options...

ISA00 filter time 0 ms

ISA01

Function HYD_P_ACT2(-9) = Hydraulic actual pressure on 2nd ser Options...

ISA01 filter time 1 ms

Fig. 7.85: "Standard analog inputs" screen

ID	Index	Name	Value	Unit	Description	Type	PDO
109	0	MPRO_INPUT_FS_ISA00	PACT (-7)		Function of analogue input ISA00	int16	
110	0	MPRO_INPUT_FS_ISA01	HYD_P_ACT2 (-9)		Function of analogue input ISA01	int16	

Table 7.91: Analog inputs settings

The setpoints will be generated using the hydraulic setpoint profile. This configuration is set up by selecting the function for the analog inputs. **P 2840 - HYD_Cfg** is used to select the location from which the setpoint, actual, and limit values will be evaluated.

Signal setting / Signal scaling

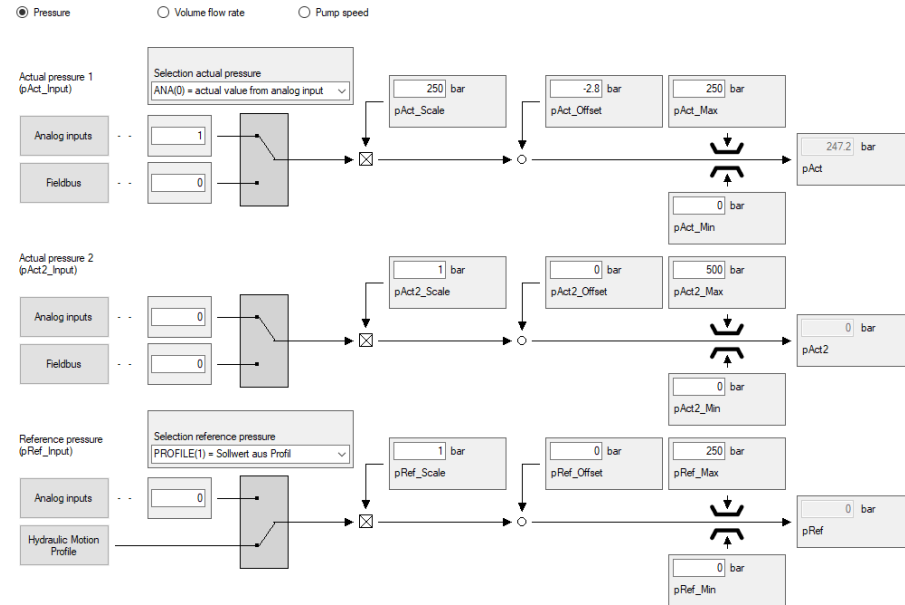


Fig. 7.86: Signal settings screen

ID	Index	Name	Value	Unit	Description	Type	PDO
2840		HYD_Cfg			Configure Hydraulic System Control		
	1	pRefSrc	PROFILE (1)		Hydraulics: Selection of pressure reference source	uint16	
	3	pActCalc	PACTSEL (5)		Hydraulic: Pressure actual value calculation method	uint16	
	4	pMinSrc	PressCon (0)		Minimum pressure source selector	uint16	
	5	pMaxSrc	PressCon (0)		Maximum pressure source selector	uint16	
	6	QMinSrc	PressCon (0)		Minimum flow rate source selector	uint16	
	7	QMaxSrc	PressCon (0)		Maximum flow rate source selector	uint16	

Table 7.92: Selectors settings

ID	Index	Name	Value	Unit	Description	Type	PDO
	8	QActCalc	NONE (0)		Flow rate calculation method	uint16	
	9	QLeakEst	MEAS (0)		Flow rate leakage estimation method	uint16	
	10	nRefSrc	PROFILE (1)		Pump speed reference source selector	uint16	

Table 7.92: Selectors settings (continue)

The control dynamic performance and the pressure and volumetric flow rate limits for the pressure control are configured in **P 2850 - HYD_PressCon**.

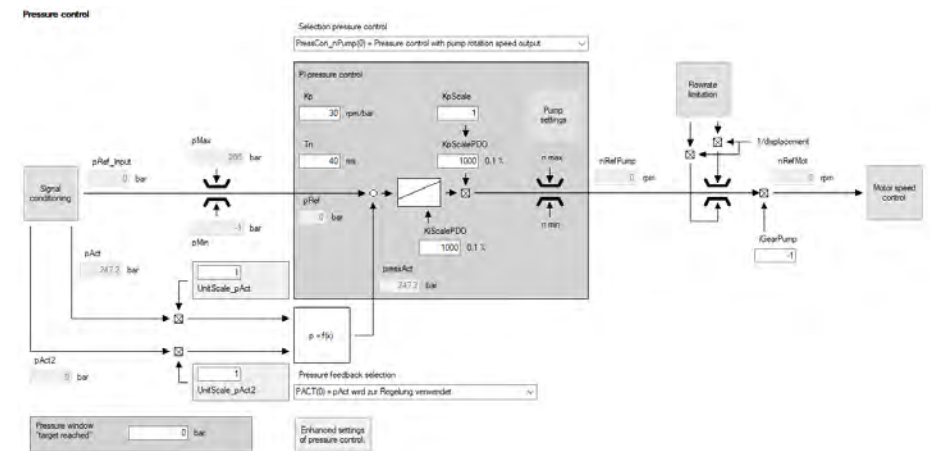


Fig. 7.87: "Pressure control" screen

ID	Index	Name	Value	Unit	Description	Type	PDO
2850		HYD_PressCon			Hydraulics: Pressure regulation parameter		
	0	Kp	5	rpm/bar	Gain	float32	
	2	Tn	3	ms	Integration time constant	float32	

Table 7.93: Dynamism and limitation settings

ID	Index	Name	Value	Unit	Description	Type	PDO
	5	pMin	-50	bar	Minimum permissible pressure	float32	
	6	pMax	50	bar	Maximum permissible pressure	float32	
	7	QMin	-10	l/min	Minimum flow rate	float32	
	8	QMax	10	l/min	Maximum flow rate	float32	

Table 7.93: Dynamism and limitation settings (continue)

The “Signal configuration” area is used to scale and limit the input variables for the hydraulic system from **P 2845 - HYD_Input_Val** again by using **P 2846 - HYD_Input_Adapt**. The results can be seen in **P 2847 - HYD_Val**.

Signal setting / Signal scaling

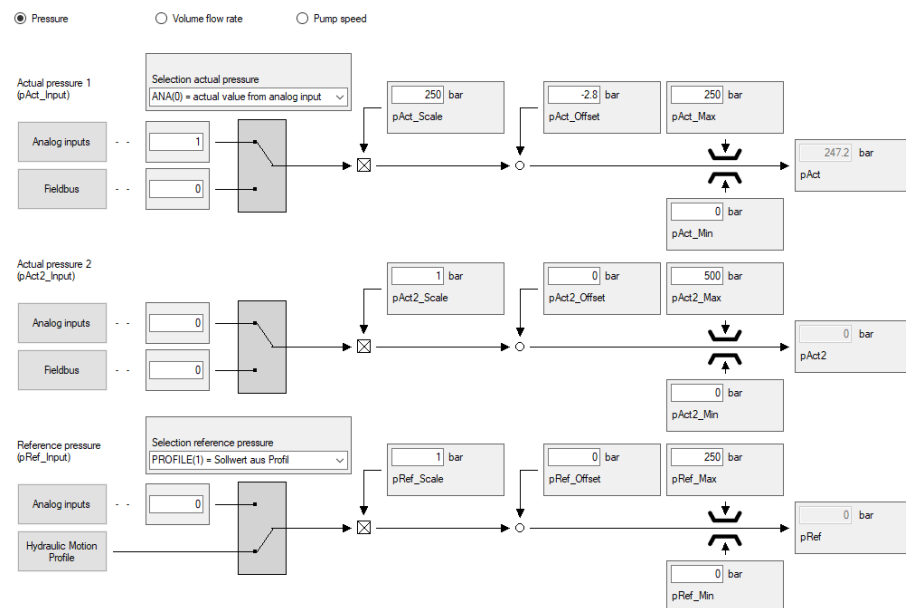


Fig. 7.88: “Signal settings” screen

ID	Index	Name	Value	Unit	Description	Type	PDO
2846		HYD_Input_Adapt			Adaption of input values		
	0	pAct_Scale	1000	bar	Scaling	float32	
	1	pAct_Offset	0	bar	Offset	float32	
	2	pAct_Min	-500	bar	Min	float32	
	3	pAct_Max	500	bar	Max	float32	
	4	pAct2_Scale	1000	bar	Scaling	float32	
	5	pAct2_Offset	-5.9	bar	Offset	float32	
	6	pAct2_Min	0	bar	Min	float32	
	7	pAct2_Max	500	bar	Max	float32	
	8	pRef_Scale	1	bar	Scaling Scaling	float32	
	9	pRef_Offset	0	bar	Offset	float32	
	10	pRef_Min	-100	bar	Min	float32	
	11	pRef_Max	100	bar	Max	float32	
	20	nRef_Scale	1	1/min	Scaling Scaling	float32	
	21	nRef_Offset	0	1/min	Offset	float32	
	22	nRef_Min	-500	1/min	Min	float32	
	23	nRef_Max	500	1/min	Max	float32	

Table 7.94: Scaling settings

The hydraulic motion profile settings are configured using the motion block table. In this example, table index 0 is used for pressure control and table index 1 for pump speed control. The index is changed with the control word. To do this, the table operating mode must be set to CTRL2. “Tab(2) = valve control via motion block table” was selected for the valve control. This means that the valve position must be specified in advance for the respective table motion block.

Hydraulic motion profile:

Operation mode: CTRL2(3) = via control word (Index) ▼

Valve control: Tab(2) = Ventilumschaltung über Fahrsatztable ▼

Settings hydraulic
Setpoint table

Ramp delay for valve switching:

Valve switching time: 200 ms

Hydraulic control word:

HYD_Ctrl

000000000000000b

- ☐ CtrlBit0
- ☐ CtrlBit1
- ☐ CtrlBit2
- ☐ CtrlBit3
- ☐ NewSetPoint
- ☐ use_p_act2
- ☐ SwitchCylOpt
- ☐ Bit7
- ☐ Bit8
- ☐ Bit9
- ☐ Bit10
- ☐ PressLimitOff
- ☐ PressLimitQ10ff
- ☐ PressLimitQ20ff
- ☐ PressLimitQ30ff
- ☐ PressLimitQ40ff

Hydraulic status word:

HYD_State

000000000000000b

- ☒ OpModeBit0
- ☒ OpModeBit1
- ☒ OpModeBit2
- ☒ OpModeBit3
- ☒ NewSetPoint
- ☒ SwitchLeakBypass
- ☒ SwitchCylOpt
- ☒ CtrlLimited
- ☒ RampTargetReached
- ☒ CylValvePos
- ☒ CylValveNeg
- ☒ ValveOpt1
- ☒ ValveOpt2
- ☒ InWindow
- ☒ PressLimitOff
- ☒ Bit15

Fig. 7.89: "Hydraulic Motion profile" screen

ID	Index	Name	Value	Unit	Description	Type	PDO
2862	0	HYD_OpMode	CTRL2		Hydraulics: Operation mode	uint8	

Table 7.95: Operation mode setting

ID	Index	Name	Value	Unit	Description	Type	PDO
2841	0	HYD_Ctrl	0000000000100000b		Hydraulic: system control	uint16	x
2842	0	HYD_State	0000000000000000b		Hydraulic: Status of the control functions	uint16	x

Table 7.96: Control and status Word

Reference values, ramp and valve settings can now be made in the motion block table.

Hydraulic setpoint table:

Set number: 0

Mode: PressCon(0) = Pressure control

Reference value: 120 HYD_UNIT

1. Derivation reference value: 300 HYD_UNIT/s

2. Derivation reference value: 0 HYD_UNIT/s/s

Table control: ☐ PLimit Off ☐ Press Con2 ☐ Active decomp ☐ Pump2 ☐ PinCon Act2 ☐ Output Out1 ☐ Output Out2 ☒ neg ☐ pos ☒ CylHea (A1/A2)

Unit scaling: 100 % G Limit

Delay time automode: 0 ms

Sequence motion Time Off: 0

Sequence motion Event Off: 0

ConType: Value 0 HydValues Subindex (P2843)

Switching condition: Value 0

Compare value: 0

Active setpoint index: 0

Selection setpoint index: 0

1 PumpCon(1) = Pump speed control

Reference value: 500 HYD_UNIT

1. Derivation reference value: 1000 HYD_UNIT/s

2. Derivation reference value: 0 HYD_UNIT/s/s

Table control: ☐ PLimit Off ☐ Press Con2 ☐ Active decomp ☐ Pump2 ☐ PinCon Act2 ☐ Output Out1 ☐ Output Out2 ☒ neg ☐ pos ☒ CylHea (A1/A2)

Unit scaling: 100 % G Limit

Delay time automode: 0 ms

Sequence motion Time Off: 0

Sequence motion Event Off: 0

ConType: Value 0 HydValues Subindex (P2843)

Switching condition: Value 0

Compare value: 0

Active setpoint index: 0

Selection setpoint index: 0

Fig. 7.90: "Motion block table" screen

Motion block 0 is enabled immediately after starting the controller. The various motion blocks can now be selected via bit 0 to bit 4 of the hydraulic control word.

ID	Index	Name	Value	Unit	Description	Type	PDO
2854	0	HYD_PumpRef	0	rpm	Hydraulic pump speed reference	float32	x
2855	0	HYD_PumpAcc	0	rpm/s	Hydraulic: Acceleration of the pump speed	float32	x
2856	0	HYD_PumpDec	0	rpm/s	Hydraulic: Deceleration of the pump speed	float32	x
2857	0	HYD_Ref	15	HYD_UNIT	Hydraulic: Setpoint for volumetric flow rate/pressure/speed/position	float32	x
2858	0	HYD_dRef	15	HYD_UNIT/s	Hydraulic: 1st setpoint derivative	float32	x
2859	0	HYD_d2Ref	0	HYD_UNIT/s/s	Hydraulic: 2nd setpoint derivative	float32	x
2860	0	HYD_ConMode	PRESS		(Hydraulic Control Mode)	uint8	x

Table 7.97: Table index 0 settings

ID	Index	Name	Value	Unit	Description	Type	PDO
2854	1	HYD_PumpRef	0	rpm	Hydraulic pump speed reference	float32	x
2855	1	HYD_PumpAcc	0	rpm/s	Hydraulic: Acceleration of the pump speed	float32	x
2856	1	HYD_PumpDec	0	rpm/s	Hydraulic: Deceleration of the pump speed	float32	x
2857	1	HYD_Ref	15	HYD_UNIT	Hydraulics: Setpoint for volumetric flow rate/pressure/speed/position	float32	x
2858	1	HYD_dRef	15	HYD_UNIT/s	Hydraulic: 1st setpoint derivative	float32	x
2859	1	HYD_d2Ref	0	HYD_UNIT/s/s	Hydraulic: 2nd setpoint derivative	float32	x
2860	1	HYD_ConMode	PUMP_SPEED		(Hydraulic Control Mode)	uint8	x

Table 7.98: Einstellung Tabellenindex 1

7.11.13 Example: Hydraulic position control

This example shows which parameters must be set in order to control the position and speed of a hydraulic cylinder with a linear encoder. The motor and encoder must be parametrised before the hydraulic control settings can be made.

Select "TCON(1) = Torque / hydraulic control" in the hydraulic basic settings and under "Reference via," select "HYD(12) = Hydraulic profile".

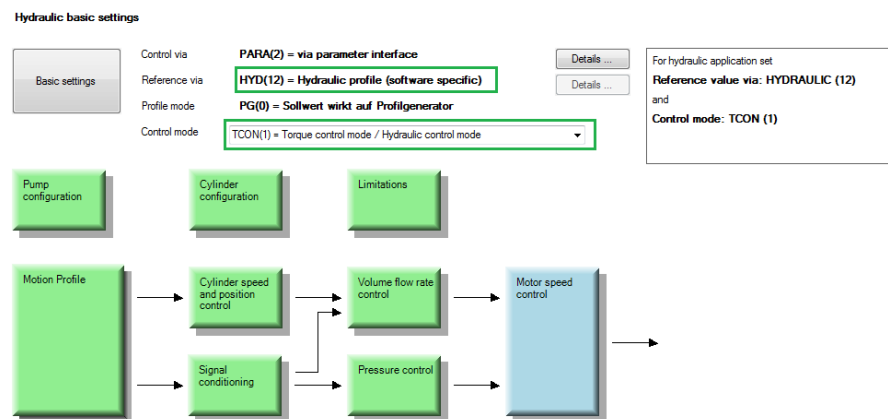


Fig. 7.91: "Hydraulic basic settings" screen

ID	Index	Name	Value	Unit	Description
300	0	CON_CfgCon	TCON (1)		Select control mode
159	0	MPRO_CTRL_SEL	DS402 (5)		Motion profile: Selection Motion control selection
165	0	MPRO_REF_SEL	HYDRAULIC (12)		Selection of motion profile

Table 7.99: Settings for control mode and motion profile

The next step is for the pump specifications – as found on the rating plate or data sheet – to be entered in **P 2851 - HYD_Pump**. This is also where the minimum and maximum speed limits for the pump, the pump displacement volume and the gear ratio between the motor and the pump are set.

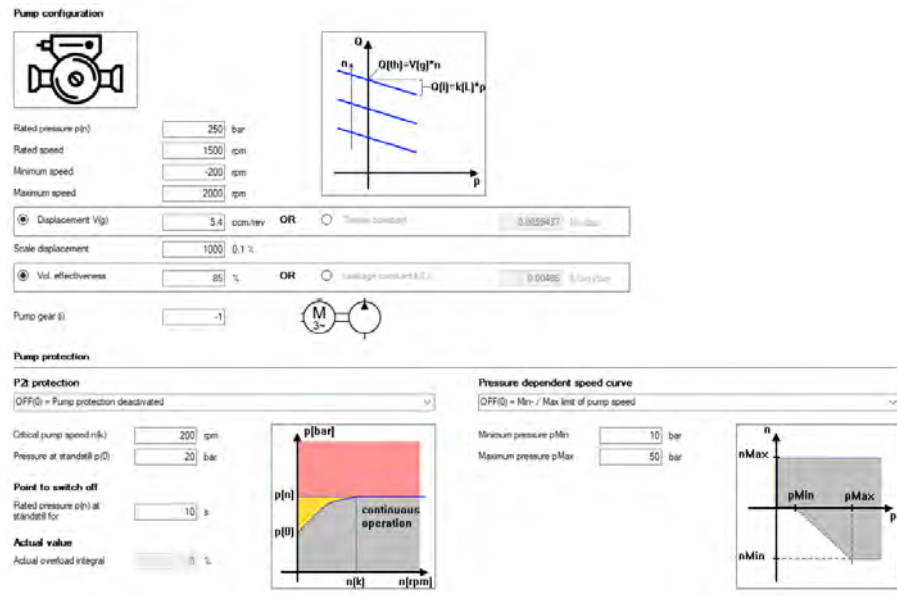


Fig. 7.92: "Pump settings" screen

ID	Index	Name	Value	Unit	Description
2851		HYD_Pump			Pump parameters
2851	0	displ	5.4	ccm/rev	Offset
2851	1	cTorque	0.0859437	Nm/bar	Torque constant
2851	2	pNom	250	bar	Nominal pressure
2851	3	nNom	1500	rpm	Rated speed
2851	4	etaVol	80	%	Volumetric efficiency at nominal pressure, rated speed
2851	5	nMin	0	rpm	Minimum speed
2851	6	nMax	2000	rpm	Maximum speed
2851	7	nCritical	200	rpm	Critical speed (@ nominal pressure)
2851	8	TCritical	10	s	Max. permissible time at low speed and

Table 7.100: Pump data settings

ID	Index	Name	Value	Unit	Description
					nominal pressure
2851	9	iGearPump	-1		Gear ratio between pump and motor
2851	10	p0	20	bar	Max. permissible stationary pressure at a standstill

Table 7.100: Pump data settings (continue)

The position and speed actual values are evaluated via the encoder inputs for position and speed. In this example, an SSI linear encoder is used which must be set to CH1(1) = X7 (e.g. Sin/Cos, channel 1) via the function selector in the encoder screen.

**NOTE**

- The encoder for commutation and torque control as well as speed control are used for the motor.
- The encoder for position control is used for cylinder-position and cylinder-speed control.

Encoder selection

Select from Database

Encoder for commutation and torque control loop:

CH2(2) = X6 (e.g. resolver, channel 2) Options...

Resolver 1-polepair

Encoder offset 0 deg Detect

Encoder for speed control loop:

CH2(2) = X6 (e.g. resolver, channel 2) Options...

Resolver 1-polepair

Encoder for position control loop:

CH1(1) = X7 (e.g. SinCos, channel 1) Options...

HLT2500-L2-S00-S16-0300-G24

Fig. 7.93: "Encoder selection" screen

In addition, the encoder must also be configured under Options. Here, the encoder type can be set under "Cyclic position via" and the absolute value interface of the respective encoder.

Encoder configuration channel 1 (X7)

Encodename HLT2500-L2-S00-S16-0300-G24

Cyclic position via SSI(2) = Digital SSI encoder

Absolute interface SSI(1) = SSI-interface Options...

Gear ratio (if encoder is not fitted at the motor)

Motor 1

Output drive 1

Signal correction (GPOC) OFF(0) = No correction

Fig. 7.94: Encoder configuration channel 1 (X7) screen

The settings for the SSI protocol can be made in the following parameters. The following must be specified here: the SingleTurn and MultiTurn bits, the encoding, and the minimum MultiTurn position.

ID	Index	Name	Value	Unit	Description
543	0	ENC_CH1_MultiT	5		Number of multi-turn bits (absolute encoder)
544	0	ENC_CH1_SingleT	19		Number of single-turn bits (absolute encoder)
545	0	ENC_CH1_Code	GRAY		Selection of the encoding of the SSI absolute encoder
546	0	ENC_CH1_Mode	0001h		Mode selection: SSI absolute encoder
547	0	ENC_CH1_MTBase	- 2147483648		Minimum MultiTurn position (SSI absolute encoder)
548	0	ENC_CH1_MTEEnable	1		Channel 1: Multi-turn as single-turn

Table 7.101: SSI encoder settings

ID	Index	Name	Value	Unit	Description
598	0	ENC_CH1_Position	4909	inc	Channel 1: Position
616	0	ENC_CH1_CycleCount	8		Channel 1: Position encoder sampling cycle (n x 125 µs)
617	0	ENC_CH1_AbsInitMode	DIG		Channel 1: Mode of absolute value initialization

Table 7.101: SSI encoder settings (continue)

The scaling of the units is performed in the motion profile of the standard motor control. A scaling assistant is available for this purpose ("Scaling / Units" button).

Standardisation/units

Position-unit

1

•

•

acceleration-unit

1

•

•

Speed-unit

1

•

•

Torque/force-unit

1

•

•

Basic settings

Control via

PARAM(2) = via parameter interface

Details

Reference via

HYDRAULIC(12) = Hydraulic application

Details

Profile mode

PG(0) = reference acts on profile generator

Fig. 7.95: "Motion profile" screen

Because a volumetric flow rate control underlies the position control, the following settings must be made beforehand.

The parameter **P 2840[8] - QActCalc** can be used to select whether the volumetric flow rate value is to be taken from a sensor (MEAS(0) = From measurement) or, as in this example, determined by means of a calculation using the cylinder speed and the pump displacement volume (CYL(1) = From cylinder speed).

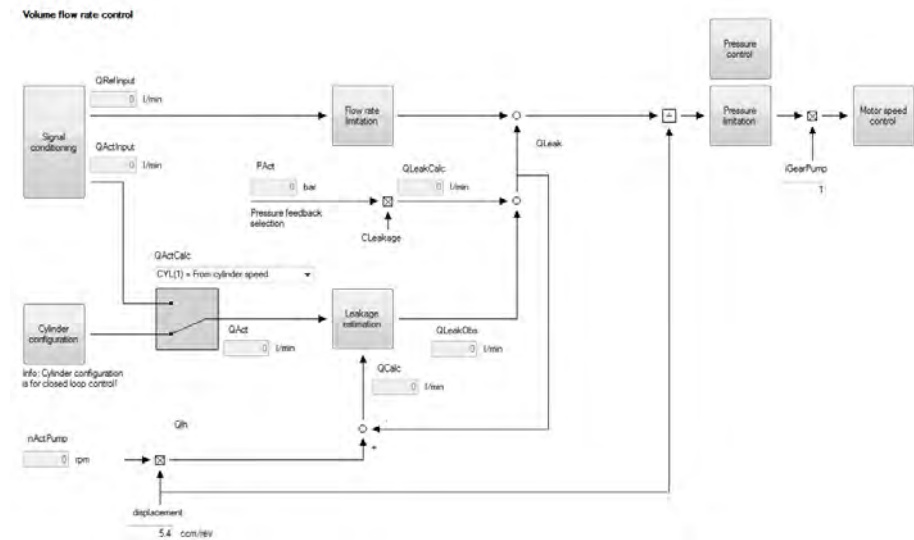


Fig. 7.96: Volumetric flow rate control screen

**NOTE**

- The cylinder geometry must be configured for the CYL(1) mode (see also section "Cylinder configuration" on page 197).

The position controller is a PI controller. The control dynamics can be set using **P 2848 - HYD_PosCon**.

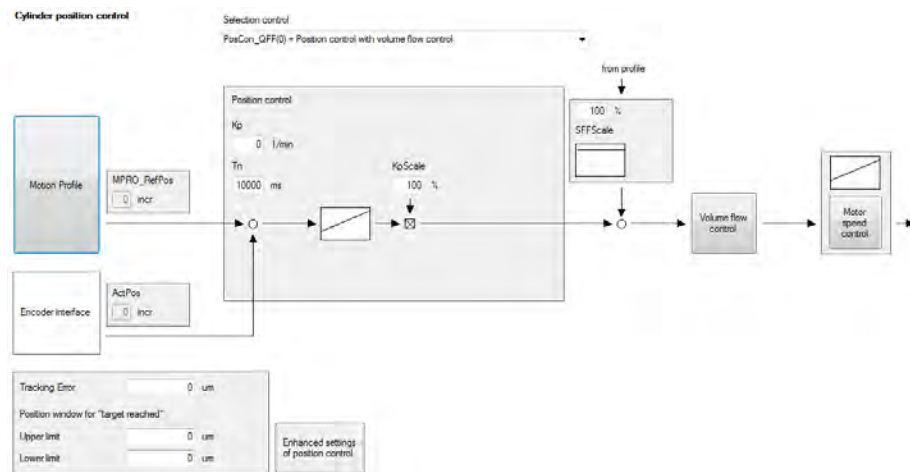


Fig. 7.97: "Position control" screen

ID	Index	Name	Unit	Description
2848		HYD_PosCon		Position Controller Parameters
2848	0	Kp	1/s	Gain of position controller
2848	1	Tn	ms	Position control integration time constant
2848	2	SFF	%	Speed feedforward scaling
2848	3	PosDiffMax	um	Position tracking error monitoring

Table 7.102: "Hydraulic - position control" parameters

The reference values are generated using the hydraulic motion profile. This configuration is set up using the motion block table. In this example, table index 0 is used for position control and table index 1 for speed control. The index is switched by means of the motion block table using a timer. To do so, the table operating mode **P 2862 - HydOpMode** must be set to "Tab(4) = via motion block table". "Tab(2) = valve control via motion block table" was selected for the valve control **P 2840[11] - CylValveSwSel**, meaning that the valve positions must be specified for the respective table index in the motion block table (**P 2863 - Hyd_TabCtrl**).

Hydraulic motion profile:

Operation mode: TAB(4) = via setpoint table

Valve control: Tab(2) = Valve switching via setpoint table

Ramp delay for valve switching:

Valve switching time: 100 ms

Hydraulic control word:

HYD_Ctrl: 000000000000000b

- ☐ CtrlBit0
- ☐ CtrlBit1
- ☐ CtrlBit2
- ☐ CtrlBit3
- ☐ NewSetPoint
- ☐ use p_act2
- ☐ SwitchCylOpt
- ☐ Bit7
- ☐ Bit8
- ☐ Bit9
- ☐ Bit10
- ☐ PressLimitOff
- ☐ PressLimitQ1Off
- ☐ PressLimitQ2Off
- ☐ PressLimitQ3Off
- ☐ PressLimitQ4Off

Hydraulic status word:

HYD_State: 000000000000000b

- ☒ OpModeBit0
- ☒ OpModeBit1
- ☒ OpModeBit2
- ☒ OpModeBit3
- ☒ NewSetPoint
- ☒ SwitchLeakBypass
- ☒ SwitchCylOpt
- ☒ CtrlLimited
- ☒ RampTargetReached
- ☒ CylValvePos
- ☒ CylValveNeg
- ☒ ValveOpt1
- ☒ ValveOpt2
- ☒ InWindow
- ☒ PressLimitOff
- ☒ Bit15

Fig. 7.98: "Hydraulic Motion profile" screen

ID	Index	Name	Value	Unit	Description
2862	0	HYD_OpMode	TAB4		Hydraulics: Operation mode
2840	11	CylValveSwSel	TAB2		Function selector for the valve switchover of the cylinder

Table 7.103: Operation mode setting

Reference values, ramps, valve positions, the respective waiting time of the table index and the subsequent motion block can now be set in the motion block table.

Hydraulic setpoint table:

Fig. 7.99: "Hydraulic motion block table" screen

Selecting the hydraulic control mode:

PressCon(0) = Pressure control

VolConPlim(1) = Volume flow rate control (pressure limited)

SpeedCon(2) = Speed control

PosCon(3) = Position control

NPumpCon(4) = Pump speed control

VolCon(5) = Volume flow rate control (without pressure control)

ID	Index	Name	Unit	Description
2860		HYD_ConMode		
2860	0...15	HYD_ConMode		Hydraulics: Control Mode Hydraulic control mode

Table 7.104: "Hydraulic - Control mode" parameters

Reference value (Pressure, volume, cylinder speed, cylinder position)

ID	Index	Name	Unit	Description
2857		HYD_Ref		
2857	0..15	HYD_Ref		Hydraulic: Setpoint for volumetric flow rate/pressure/speed/position

Table 7.105: "Hydraulic - Reference value" parameters

1st reference value derivative

ID	Index	Name	Unit	Description
2858		HYD_dRef		Hydraulic: 1st setpoint derivative
2858	0..15	HYD_dRef	HYD_UNIT/s	

Table 7.106: "Hydraulic - 1st setpoint derivative" parameters

2nd reference value derivative (jerk limitation or acceleration in the case of a position reference)

ID	Index	Name	Unit	Description
2859		HYD_d2Ref		Hydraulic: 2nd setpoint derivative
2859	0..15	HYD_d2Ref	HYD_UNIT/s/s	

Table 7.107: "Hydraulic - 2nd setpoint derivative" parameters

Hydraulic table control word valve position

ID	Index	Name	Unit	Description
2863		HYD_TabCtrl		
2863	0..15	HYD_TabCtrl		Hydraulic Table control word

Table 7.108: Parameter "Hydraulic table control word"

Hydraulic Wait time in Auto mode

ID	Index	Name	Unit	Description
2864		HYD_TabWaitTime		
2864	0 . 15	HYD_TabWaitTime		Hydraulic table delay time

Table 7.109: Parameter "Hydraulic table delay time"

Hydraulic: Subsequent motion block

ID	Index	Name	Unit	Description
2865		HYD_TabNextIdx		
2865	0 . 15	HYD_TabNextIdx		Hydraulic table next default index

Table 7.110: Parameter "Hydraulic table next default index"

Hydraulic: Alternative motion block

ID	Index	Name	Unit	Description
2866		HYD_TabAltIdx		
2866	0 . 15	HYD_TabAltIdx		Hydraulic table next alternative index

Table 7.111: Parameter "Hydraulic table next alternative index"

Hydraulic: Switching condition

ID	Index	Name	Unit	Description
2867		HYD_TabCondType		
2867	0 . 15	HYD_TabCondType		Hydraulic table state

Table 7.112: Parameter "Hydraulic table state"

Hydraulic: Optional comparison value

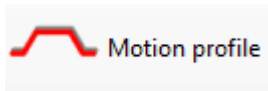
ID	Index	Name	Unit	Description
2868		HYD_TabCondVal		
2868	0 . 15	HYD_TabCondVal		Hydraulic table comparison state

Table 7.113: Parameter "Hydraulic table comparison state"

8 Motion profile

Chapter overview

Pictogram



Navigation ▶ Project tree ▶ Device setup ▶ Motion profile

Brief description This chapter describes the available motion profiles, as well as their basic and special settings.

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8.1 Settings

When it comes to the drive settings for motion profiles, the settings that need to be configured relate to the following: control, units, and commands.

The screenshot shows the 'Motion profile' settings screen. On the left, there is a vertical menu with six categories: 'Standardisation/units' (1), 'Basic settings' (2), 'Stop ramps' (3), 'Homing' (4), 'Jog mode' (5), and 'Synchronized motion' (6). The main area displays the following settings:

- Position-unit:** 1 * mDegree
- Speed-unit:** 1 * rev/min
- acceleration-unit:** 1 * rev/min/s
- Torque/force-unit:** 1 * Nm
- Control via:** OFF(0) = No control selector defined
- Reference via:** OFF(0) = No setpoint
- Profile mode:** PG(0) = reference acts on profile generator
- Method:** Type 35(35) = Actual position = Reference position

There are two 'Details' buttons on the right side of the settings, one next to 'Control via' and one next to 'Reference via', both marked with a circled 7.

Fig. 8.1: Motion profile screen

Scaling profile

- ①
 - Standard/CiA 402
 - SERCOS
 - User defined

Setting of control and reference value channel:

- ②
 - Control/Reference
 - Profile
 - Interpolation
 - Limitation
 - Reference filter
 - Smoothing

Stop ramps / Reaction

- ③
 - to Shutdown
 - to Disable
 - to Halt
 - to Quick-stop
 - to Error

Note: For control via an external PLC, BIT 4 must be set by **P 155 - MPRO_DRVCOM_CFG** if the drive is to adopt the error reaction (such as quick-stop). If this bit is not set, then the controller must assume the job of error handling!

- Setting of quick-stop ramp

Legend for "Motion profile" screen

Selection of homing method	
④	• Homing method
	• Speeds (cam/zero point search)
	• Acceleration
	• Offset
	• Homing maximum distance
Jog speeds	
⑤	• Fast jog
	• Slow jog
Synchronized motion	
⑥	• Master configuration
	• Electronic gearing
	• Electronic cam plate
Details	
⑦	• Additional settings for closed-loop control and reference

Legend for "Motion profile" screen (continue)

8.2 Scaling / Units

As soon as you select "Standardization / units", the Standardization Wizard used to select a standardization profile will appear.

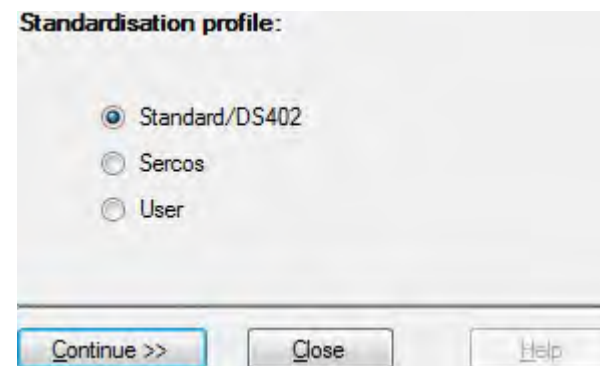


Fig. 8.2: "Standardization profile selection" screen

The wizard helps ensure that the application's physical data will match the Servo Drive's data. If you are using the "Standard / CiA 402" or "SERCOS" profile, the wizard will fully support the scaling definition process. If you use "custom" scaling instead, the wizard will close, as this type of configuration can only be set up directly in the parameter editor.

ID	Index	Name	Unit	Description
283	0	MPRO_FG_Type		Factor group: Type selection DS402(0), Sercos (1), USER(2)

Table 8.1: Parameter ""

8.2.1 Standard/CiA 402



Units:

Position: (0) = X User(0) = User defined position dimens => mDegree

Speed: (0) = X User(0) = User defined speed dimensio => rev/min

Acceleration: (0) = X User/s => rev /min/s

<< Back Continue >> Close Help

Fig. 8.3: "Standardization profile - Standard/CiA 402 - Units" screen



NOTE

- The scaling is entered using exponent syntax.



NOTE

- When using interpolating operation modes (CSV, CSP, CST) via fieldbus, scaling must be performed using the CiA 402 scaling assistant.



Polarity of command values:

Position control modes: ☒ clockwise ☐ anti-clockwise

Speed control modes: ☒ clockwise ☐ anti-clockwise

<< Back Continue >> Close Help

Fig. 8.4: "Standardization profile - Standard/CiA 402 - Direction of rotation" screen

Referred to the motor, the positive direction is clockwise as seen when looking at the motor shaft (A-side bearing plate).

Feed constant:

mDegree

rev of driven shaft

Gear ratio (if available):

Input revolutions (motor shaft) rev

Output revolutions (driving shaft) rev

Position encoder resolution:

incr = 2 (power of two)

rev (motor)

Processing format:

☒ absolute

☐ modulo (rotary table)

Outcoming multiturn resolution

The actual setting of position controller resolution and position standardisation leads to a maximum range from:

rev

mDegree

to:

rev

mDegree

☐ Consider multi-turn overflow

<< Back Done Close Help

Feed constant

The path travelled is proportionate to one motor revolution or, when using a gear unit, to the output-side revolution.

Gear ratio (if available)

Ratio of one motor revolution before the gearing to the number of revolutions on the gear output side. The values for the gear ratio are entered in the screen as integer fractions.

Position controller single-turn resolution

The single-turn resolution of the position controller can be adapted variably to the application. A total of 32 bits are available. In the default setting, 20 of the bits are used for the single-turn position.

Fig. 8.5: "Standardization profile - Standard/CiA 402 - Feed/gearing/resolution/process format" screen

Process format

Processing format:

☐ absolute
☒ modulo (rotary table)

to:

rev
 mDegree

modulo value

mDegree

☐ Consider multi-turn overflow

Position option:

☒ as linear
☐ left direction
☐ right direction
☐ shortest way

Fig. 8.6: “Modulo (rotary table)’ process format” screen

If you select “Modulo (rotary table)”, the indexing table function will be activated. For the circumferential length (= “upper position”), a limit value that defines the point at which a revolution is complete must be entered.

ID	Index	Name	Unit	Description
163	0	MPRO_FG_Config		Factor group configuration
2236	0	MPRO_402_Polarity		607EH DS402 Polarity
2246	0	MPRO_402_PosNotInd		6089H DS402 position notation index
2247	0	MPRO_402_PosDimInd		608AH DS402 position dimension index
2248	0	MPRO_402_VelNotInd		608BH DS402 velocity notation index
2249	0	MPRO_402_VelDimInd		608CH DS402 velocity dimension index
2250	0	MPRO_402_AccNotInd		608DH DS402 acceleration notation index
2251	0	MPRO_402_AccDimInd		608EH DS402 acceleration dimension index

Table 8.2: “Standardization / units - Standard/CiA 402” parameter

ID	Index	Name	Unit	Description
2252		MPRO_402_PosEncRes		608FH DS402 position encoder resolution
2252	0	MPRO_402_PosEncRes	incr	Encoder increments
2252	1	MPRO_402_PosEncRes	rev	Motor revolution
2253		MPRO_402_VelEncRes		6090H DS402 velocity encoder resolution
2253	0	MPRO_402_VelEncRes	incr/s	Encoder increments/s
2253	1	MPRO_402_VelEncRes	rev/s	Motor revolution/s
2254		MPRO_402_GearRatio		6091H DS402 gear ratio
2254	0	MPRO_402_GearRatio	rev	
2254	1	MPRO_402_GearRatio	rev	
2255		MPRO_402_FeedConstant		6092H DS402 feed constant
2255	0	Feed	mDegree	Feed
2255	1	DriveShaftRev	rev	Drive train revolution
2256		MPRO_402_PosFact		6093H DS402 position factor
2256	0	MPRO_402_PosFact	incr	
2256	1	MPRO_402_PosFact	mDegree	
2257		MPRO_402_VelFact		6094H DS402 velocity encoder factor
2257	0	MPRO_402_VelFact	incr/s	
2257	1	MPRO_402_VelFact	rev/min	
2258		MPRO_402_VelFact1		6095H DS402 velocity factor 1
2258	0	MPRO_402_VelFact1		
2258	1	MPRO_402_VelFact1		
2259		MPRO_402_VelFact2		6096H DS402 velocity factor 2
2259	0	MPRO_402_VelFact2		
2259	1	MPRO_402_VelFact2		
2260		MPRO_402_AccFact		6097H DS402 acceleration factor
2260	0	MPRO_402_AccFact	incr/s/s	
2260	1	MPRO_402_AccFact	rev/min/s	

Table 8.2: “Standardization / units - Standard/CiA 402” parameter (continue)

8.2.1.1 “As linear” process option

The circumferential length is set to 360°. On reaching 360° the actual position is set to 0°. It is not necessary to set a negative setpoint for the direction reversal.

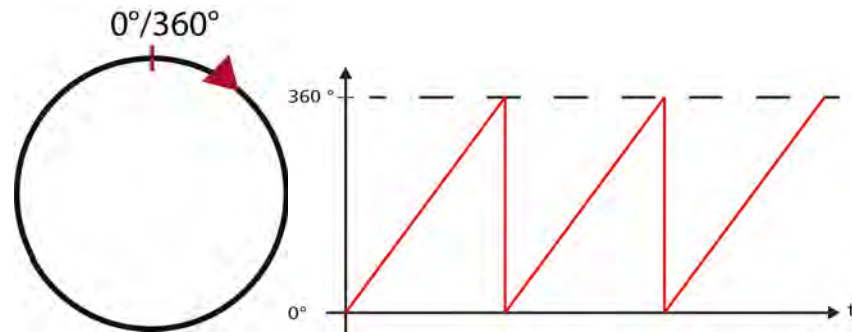


Fig. 8.7: How the “as linear” indexing table function works

8.2.1.2 Process option “Left/right-hand rotation”

Example of a revolution with a circumferential length of 360°, setting “Direction of rotation left/right”:

The circumferential length is set to 360°. In positive direction, after reaching 360° the actual position is set to 0°. The same applies to the negative direction. On reaching 0° the actual position is set to 360°.

Processing format:

☐ absolute

☒ modulo (rotary table)

modulo value: mDegree

☐ Consider multi-turn overflow

Position option:

☐ as linear

☒ left direction

☐ right direction

☐ shortest way

to: rev

mDegree

Fig. 8.8: “‘Anticlockwise rotation’ process option” screen

Processing format:

☐ absolute

☒ modulo (rotary table)

modulo value: mDegree

☐ Consider multi-turn overflow

Position option:

☐ as linear

☐ left direction

☒ right direction

☐ shortest way

to: rev

mDegree

Fig. 8.9: “‘Clockwise rotation’ process option” screen

8.2.1.3 Process option "Path - optimized"

An absolute target position is always approached by the shortest path. Relative movements cannot be carried out with the "path – optimized" mode.

Position range	Example	Effect
Target position < circumference	$120^\circ < 360^\circ$	The drive moves to the target position within 360° .
Target position = circumference	$120^\circ = 120^\circ$	The drive remains in position.
Target position > circumference	$600^\circ - 360^\circ = 240^\circ$	The drive moves to the position within the circumference (target position - (n x circumferential length))

Table 8.3: Path-optimized movement

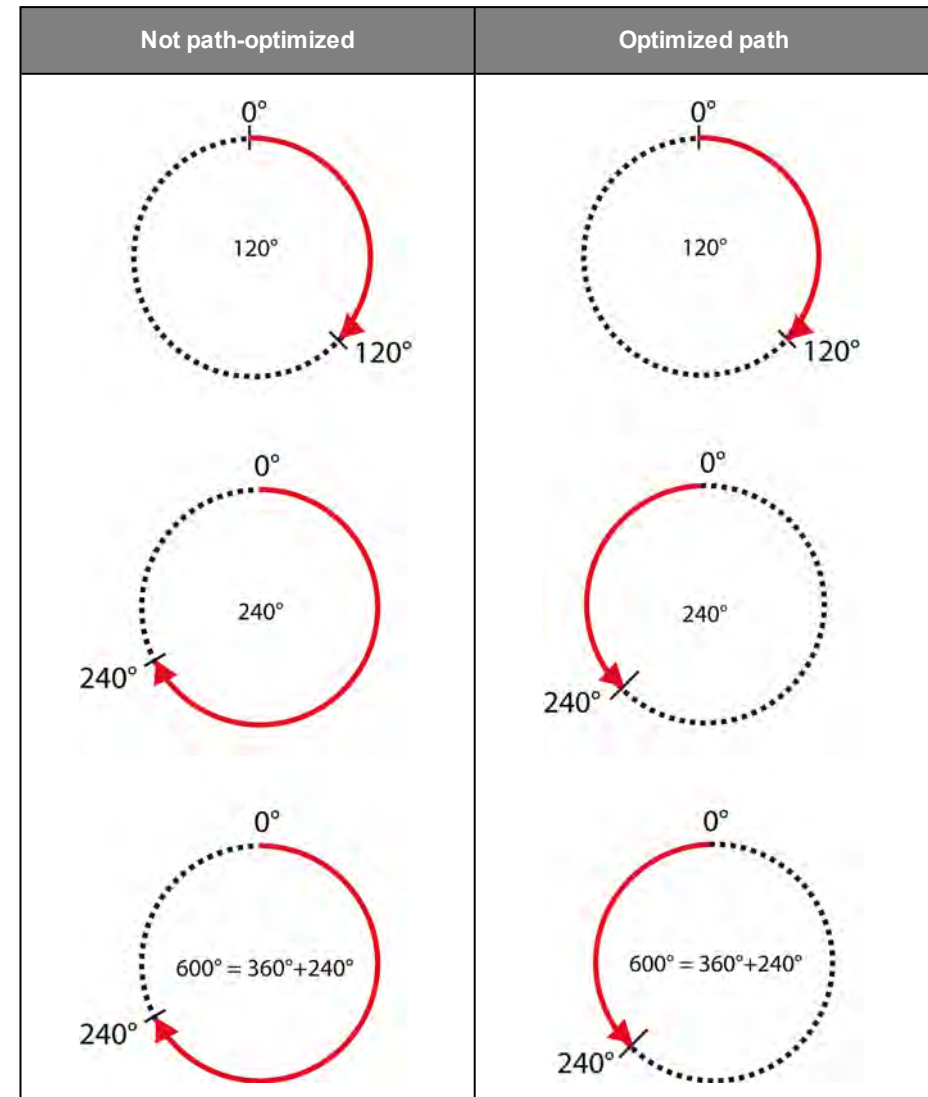


Table 8.4: Path optimization diagram

8.2.1.4 Infinite motion task when using indexing table function

In the case of infinite motion tasks the drive moves at constant speed, regardless of a transmitted target position, until the mode is deactivated or is overwritten by a new motion task. On switching to the next driving set (absolute or relative), the new target position is approached in the current direction of movement. A preset path optimization is ignored when the indexing table is active.

8.2.1.5 Relative motion task when using indexing table function

Relative driving jobs may relate to the current target position or to the actual position. For more information see "Field Buses" user manuals.

In the case of relative driving jobs greater travel distances than the circumferential length are possible.

Example without gear ratio:

- Circumferential length = 360°
- Relative target position = 800°
- Start position = 0°
- Movement:
The drive will complete two motor revolutions (720°) and stop in the 3rd revolution at 80° (800° - 720°).

8.2.2 SERCOS

When using the SERCOS profile, scaling of the units is termed weighting. The weighting describes the physical unit and the exponent with which the numerical values of the parameters exchanged between the master control system and the drives are to be interpreted. The method of weighting is defined by the parameters for position, speed, force/ torque and acceleration weighting.



Units:

Position unit	mDegree
Velocity unit	rev/min
Torque/force unit	cNm
Acceleration unit	rev /min/s

<< Back Continue >> Close Help

Fig. 8.10: Screen for scaling via SERCOS

ID	Index	Name	Unit	Description
163	0	MPRO_FG_Config		Factor group configuration
10043	0	COM_SER_PolaritySpeed		Speed polarity parameter
10044	0	COM_SER_ScaleTypSpeed		Velocity data scaling type
10045	0	COM_SER_ScaleFactorSpeed		Velocity data scaling factor
10046	0	COM_SER_ScaleExpSpeed		Velocity data scaling exponent
10055	0	COM_SER_PolarityPos		Position polarity parameter
10076	0	COM_SER_ScaleTypPos		Position data scaling type
10077	0	COM_SER_ScaleFactorPos		Linear position data scaling factor
10078	0	COM_SER_ScaleExpPos		Linear position data scaling exponent
10085	0	COM_SER_		Torque polarity parameter

Table 8.5: "Standardization / units - SERCOS" parameter

ID	Index	Name	Unit	Description
		PolarityTorque		
10086	0	COM_SER_ScaleTypTorque		Torque/force data scaling type
10093	0	COM_SER_ScaleFactorTorque		Torque/force data scaling factor
10094	0	COM_SER_ScaleExpTorque		Torque/force data scaling exponent
10103	0	COM_SER_ModuloVal	mDegree	Modulo value
10121	0	COM_SER_GearRatioNum		Input revolutions of load gear
10122	0	COM_SER_GearRatioDenom		Output revolutions of load gear
10123	0	COM_SER_FeedConst	um/rev	Feed constant
10160	0	COM_SER_ScaleTypAcc		Acceleration data scaling type
10161	0	COM_SER_ScaleFactorAcc		Acceleration data scaling factor
10162	0	COM_SER_ScaleExpAcc		Acceleration data scaling exponent

Table 8.5: "Standardization / units - SERCOS" parameter (continue)

8.2.2.1 Position unit

Position unit (1)

Position data scaling - 1

Scaling method:

☐ no scaling
☐ linear scaling
☒ rotational scaling

Data reference:

☒ at the motor shaft
☐ at the load

Fig. 8.11: "Standardization profile - SERCOS - Position unit (1)" screen

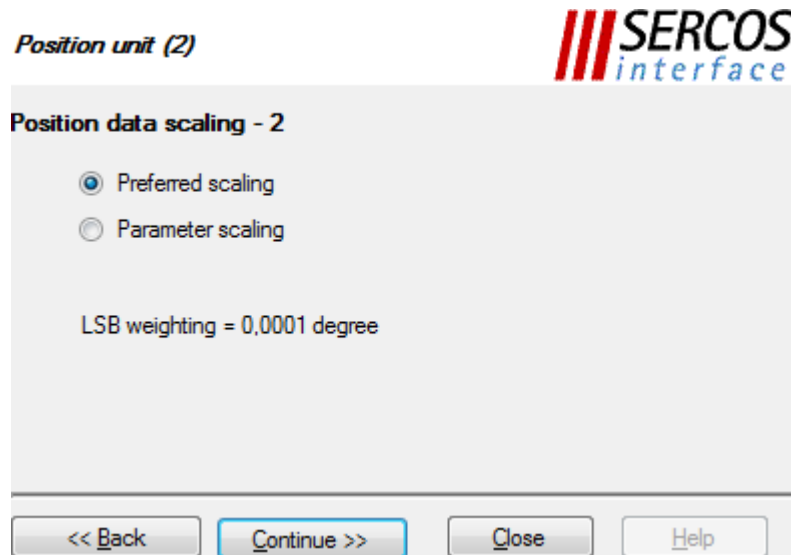


Fig. 8.12: "Standardization profile - SERCOS - Position unit (2)" screen

The "Position weighting method" figure below shows the structure with which the acceleration is scaled using the SERCOS wizard. A distinction must be made between linear (translational) and rotary weighting within this context.

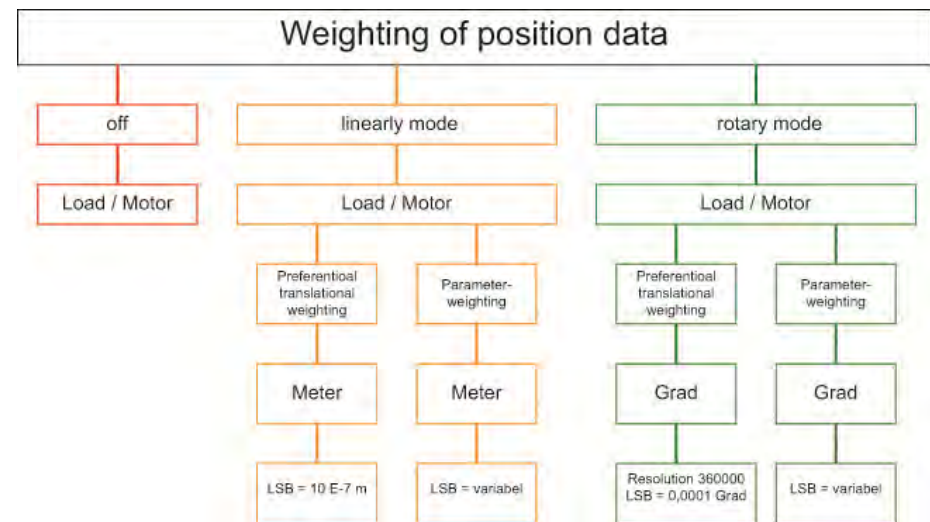


Fig. 8.13: Position data weighting method

Position polarity

The polarity of the position data can be inverted according to the application. An increasing actual position value indicates clockwise rotation (looking at the motor shaft).

Linear weighting

Unit	Weighting factor	Preferential weighting (LSB)
m	1	E ⁻⁷

Table 8.6: Weighting for linear motion (default setting)

Rotary weighting

Unit	Weighting factor	Preferential weighting (LSB)
Degrees	3,600,000	0.0001 µm

Table 8.7: Weighting for rotary motion (default setting)

$$LSB = \text{Einheit} \cdot \frac{1U/min}{\text{rotative Lageauflösung}}$$

$$LSB = \frac{360^\circ}{3600000}$$

8.2.2.2 Speed

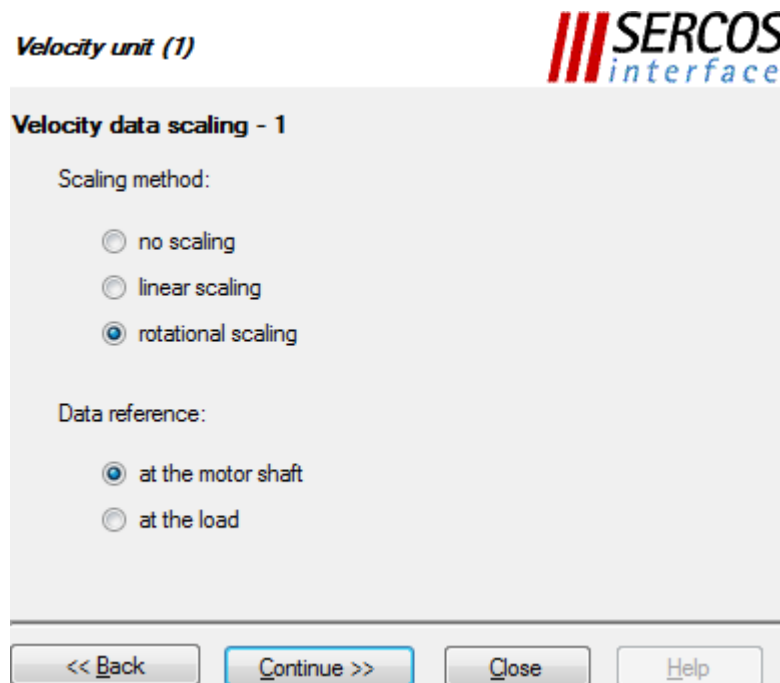


Fig. 8.14: "Standardization profile - SERCOS - Speed (1)" screen

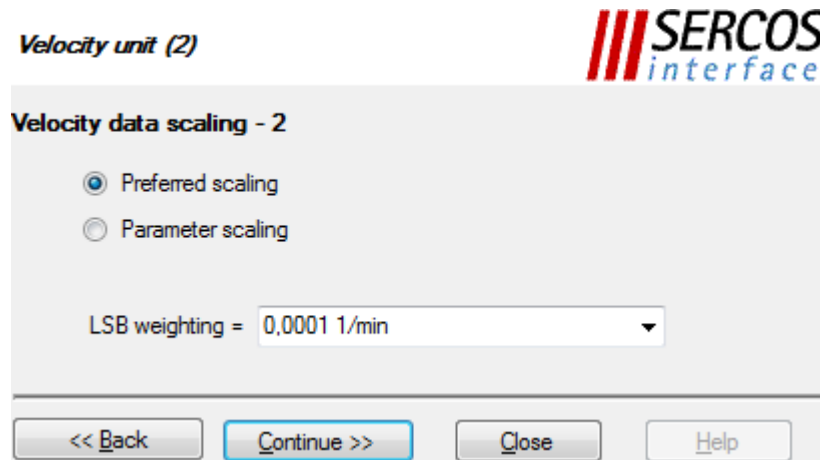


Fig. 8.15: "Standardization profile - SERCOS - Speed (2)" screen

The "Speed data weighting method" figure below shows the structure with which the acceleration is scaled using the SERCOS wizard. A distinction must be made between linear and rotary weighting here.

Speed polarity

The polarity of the speed data can be inverted according to the application. A positive speed reference indicates clockwise rotation (looking at the motor shaft).

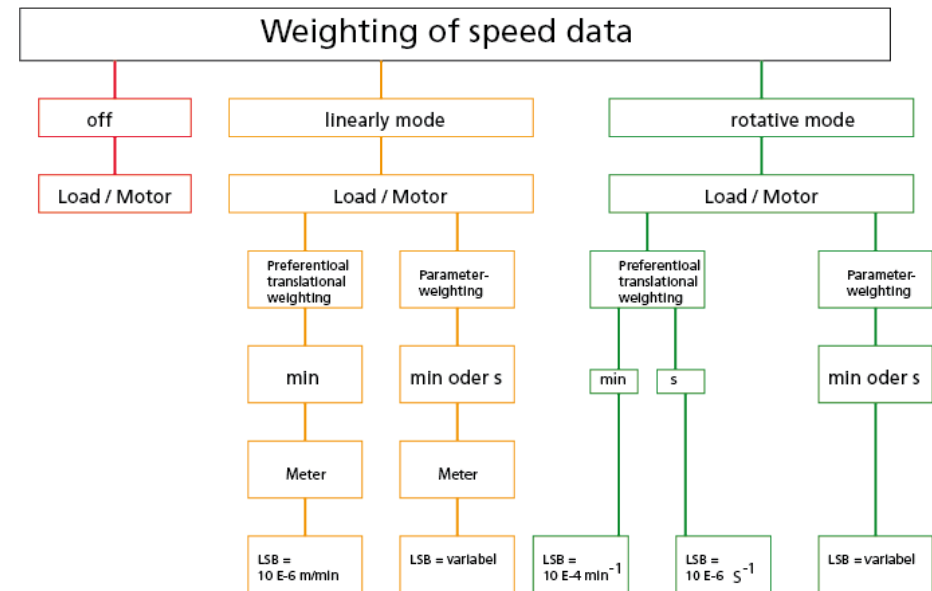


Fig. 8.16: Speed data weighting method

Linear weighting

Unit	Weighting factor	Preferential weighting (LSB)
m/min	1	0.001 m/min

Table 8.8: Weighting for linear motion (default setting)

$$LSB = \text{Einheit} \cdot \text{Exponent} \cdot \frac{\text{Wegeinheit}}{\text{Zeiteinheit}}$$

Rotary weighting

Unit	Weighting factor	Preferential weighting (LSB)
Degrees	3,600,000	0.001 m/min

Table 8.9: Weighting for rotary motion (default setting)

$$LSB = \text{Einheit} \cdot \text{Exponent} \cdot \frac{\text{Umdrehungen}}{\text{min}}$$

8.2.2.3 Unit of torque/power

Torque unit (1)



Torque/Force data scaling - 1

Scaling method:

- ☐ percentage scaling
☐ linear scaling
☒ rotational scaling

Data reference:

- ☒ at the motor shaft
☐ at the load

<< Back Continue >> Close Help

Fig. 8.17: "Standardization profile - SERCOS torque/power(1)" screen

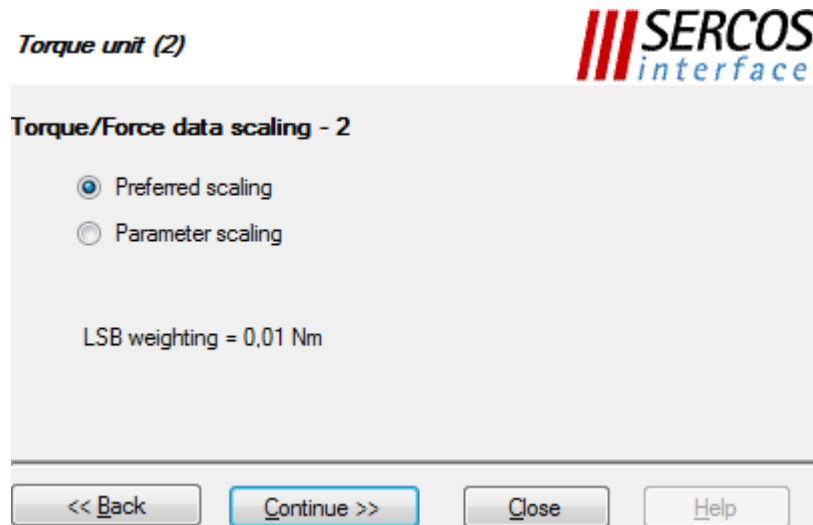


Fig. 8.18: "Standardization profile - SERCOS torque/power(2)" screen

The "Power/torque weighting method" figure below shows the structure with which the acceleration is scaled using the SERCOS wizard. A distinction must be made between linear and rotary weighting here. In percentage weighting the permanently permissible standstill torque of the motor is used as the reference value. All torque/force data is given in [%] with one decimal place.

Torque polarity

The polarity of the torque can be inverted according to the application. A positive torque reference indicates clockwise rotation (looking at the motor shaft).

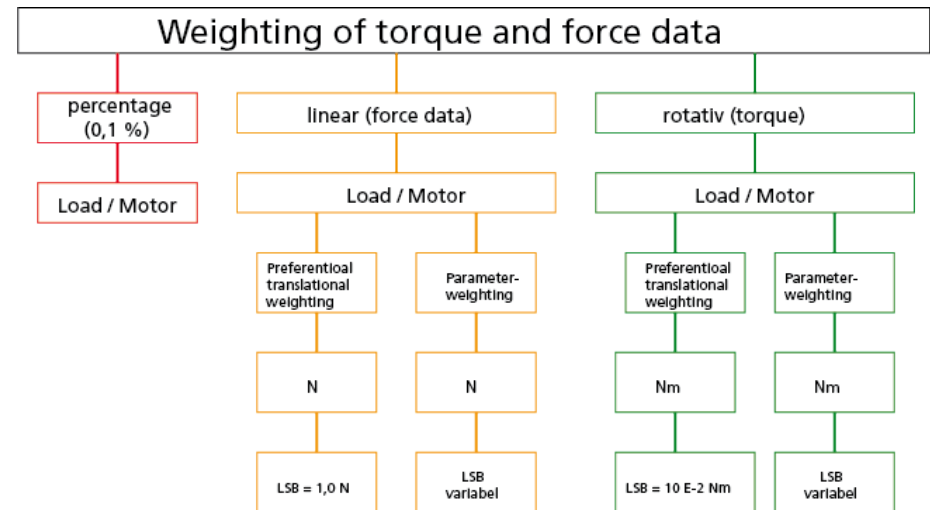


Fig. 8.19: Force/torque weighting method

Linear weighting

Unit	Weighting factor	Parameter weighting (LSB)
Nm	1	LSB = Unit * Exponent

Table 8.10: Weighting for linear motion (default setting)

Rotary weighting

Unit	Weighting factor	Preferential weighting (LSB)	Parameter weighting (LSB)
Nm	1	0.01 Nm	LSB = Unit * Exponent

Table 8.11: Weighting for rotary motion (default setting)

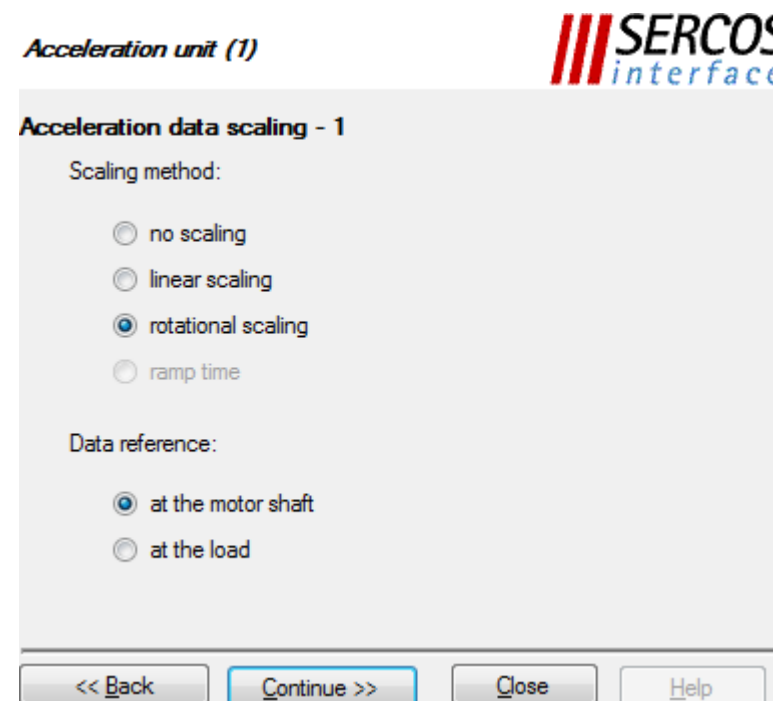
8.2.2.4 Unit of acceleration

Fig. 8.20: "Standardization profile - SERCOS - Acceleration(1)" screen

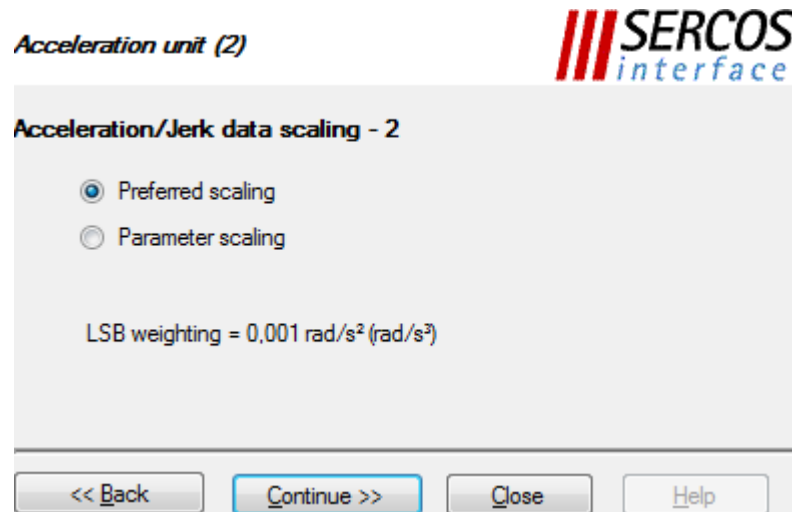


Fig. 8.21: "Standardization profile - SERCOS - Acceleration(2)" screen

The "Acceleration data weighting method" figure below shows the structure with which the acceleration is scaled using the SERCOS wizard. A distinction must be made between linear and rotary weighting here.

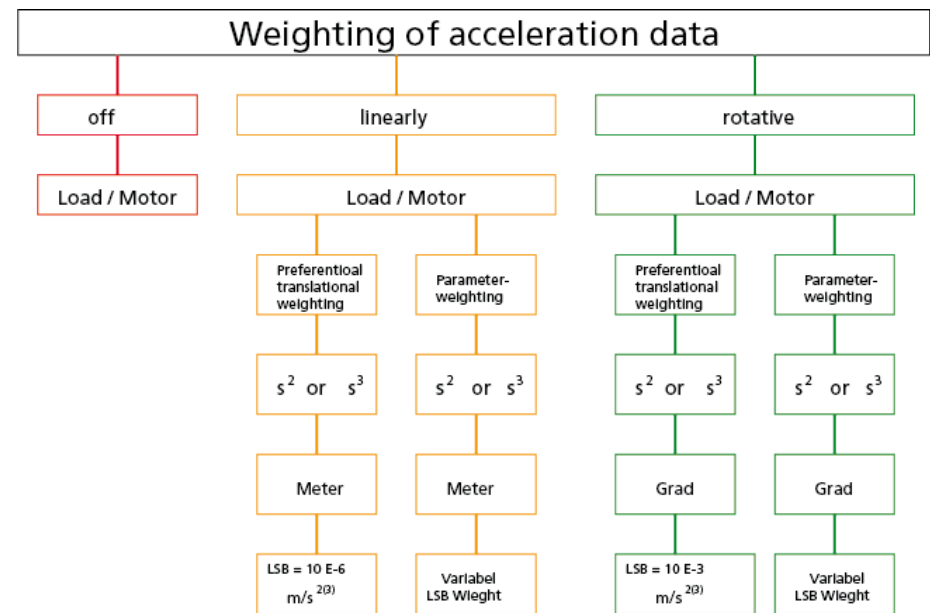


Fig. 8.22: Acceleration weighting

Linear weighting

Unit	Weighting factor	Factory setting (LSB)
m/s ²	1	E ⁻⁶

Table 8.12: Weighting for linear motion (default setting)

$$LSB = \textit{Einheit} \cdot \textit{Exponent} \cdot \frac{\textit{Wegeinheit}}{\textit{Zeiteinheit}}$$

Rotary weighting

Unit	Weighting factor	Factory setting (LSB)
rad/s ²	3,600,000	E ⁻³

Table 8.13: Weighting for rotary motion (default setting)

$$LSB = \text{Einheit} \cdot \text{Exponent} \cdot \frac{\text{Umdrehungen}}{\text{min}}$$

8.2.2.5 Modulo weighting

If Modulo (indexing table application) is to be selected (see Section "As linear" process option" on page 236), the number range of the position data (modulo value) must be entered. When the modulo value is exceeded the actual position is reset to 0.

8.2.3 User defined

No wizard is available for user-defined scaling. The following "Custom scaling diagram" is intended to help with configuring it. Calculation of the factors for position, speed and acceleration is dependent on the selected user unit and the feed constant or gear ratio.

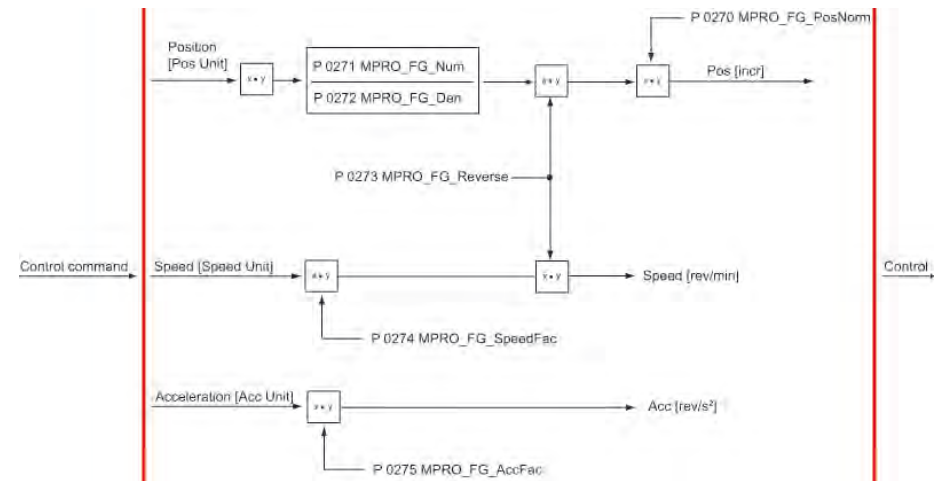


Fig. 8.23: Schematic of user-defined scaling

ID	Index	Name	Unit	Description
163	0	MPRO_FG_Config		Factor group configuration
270	0	MPRO_FG_PosNorm	incr/rev	internal position resolution
271	0	MPRO_FG_Num	rev	Factor group: Numerator (profile independent)
272	0	MPRO_FG_Den	mDegree	Factor group: denominator (profile independent)
273	0	MPRO_FG_Reverse		Factor group: Position and speed reverse (profile independent)
274	0	MPRO_FG_SpeedFac	rev/min/SPEED	Factor group: speed factor (profile independent)
275	0	MPRO_FG_AccFac	rev/s ² /ACC	Factor group: acceleration factor (profile independent)
284	0	MPRO_FG_PosUnit		Unit for position values
285	0	MPRO_FG_PosExp		Factor group: Position unit exponent (profile independent)
286	0	MPRO_FG_		Factor group: Position unit scaling factor

Table 8.14: "Standardization / units - Custom" parameters

ID	Index	Name	Unit	Description
		PosScaleFac		(profile independent)
287	0	MPRO_FG_SpeedUnit		Unit for speed values
288	0	MPRO_FG_SpeedExp		Factor group: Velocity unit exponent (profile independent)
289	0	MPRO_FG_SpeedScaleFac		Factor group: Velocity unit scaling factor (profile independent)
290	0	MPRO_FG_AccUnit		Unit for acceleration and deceleration values
291	0	MPRO_FG_AccExp		Factor group: Acceleration unit exponent (profile independent)
292	0	MPRO_FG_AccScaleFac		Factor group: Acceleration unit scaling factor (profile independent)
293	0	MPRO_FG_TorqueUnit		Unit for torque values
294	0	MPRO_FG_TorqueExp		Factor group: Torque unit exponent (profile independent)
295	0	MPRO_FG_TorqueScaleFac		Factor group: Torque unit scaling factor (profile independent)
298	0	MPRO_FG_UsrActPosDly	ms	Actual position delay (multiple of CON_PConTS)

Table 8.14: "Standardization / units - Custom" parameters (continue)

8.2.3.1 Example of scaling of a rotary motor

Presetting

- 1 motor revolution corresponds to 360° or 1048576 increments
- Speed in [rpm]
- Acceleration in [rpm/s]
- Positioning in [°degrees]

Given

- Position unit **P 0284 MPRO_FG_PosUnit** = [μm]
- Speed unit **P 0287 MPRO_FG_SpeedUnit** = [m/s]

- Acceleration unit **P 0290 MPRO_FG_AccUnit** = [m/s²]
- Feed constant: 0.1 mm = 1 rev
- Gearing: 1 drive revolution = 3 motor revs

Parametrisation

- **P 0284 MPRO_FG_PosUnit** = 1 μm = 1/1000 mm = 10/1000 rev (output) = 30/1000 rev (motor)
- **P 0271 MPRO_FG_Nom** = 3
- **P 0272 MPRO_FG_Den** = 100
- **P 0287 MPRO_FG_SpeedUnit** = 1 m/s = 1000 mm/s = 10 000 rev/s (output) = 30 000 rev/s (motor)*60 (min) = 1 800 000 rev/min
- **P 0275 MPRO_FG_SpeedFac** = 1 800 000
- **P 0290 MPRO_FG_AccUnit** = 1 m/s² = 1000 mm/s = 10 000 rev/s (output) = 30 000 rev/s² (motor)*60 (min) = 1 800 000 rev/min

ID	Name	Function	Standard rotary system
270	MPRO_FG_PosNom	Increments per revolution	1048576 [incr/rev]
271	MPRO_FG_Nom	Numerator	1[rev]
272	MPRO_FG_Den	Denominator	360° [POS]
273	MPRO_FG_Reverse	Reverse direction	False = clockwise
274	MPRO_FG_SpeedFac	Speed factor	1[rpm]
275	MPRO_FG_AccFac	Acceleration factor	1/60 = 0.01667 [rpm/s]

Table 8.15: Parameters for user-defined scaling (rotary system)

ID	Name	Function	Standard rotary system
284	MPRO_FG_PosUnit	Unit for position value	mdegree
287	MPRO_FG_SpeetUnit	Unit for speed value	rev/min
290	MPRO_FG_AccUnit	Unit for acceleration value	rev/min/s

Table 8.15: Parameters for user-defined scaling (rotary system) (continue)

8.2.3.2 Example of scaling of a linear motor

Presetting:

- One revolution corresponds to 32 mm pitch
- Travel in [μm]
- Speed in [mm/sec]
- Acceleration in [mm/s^2]

ID	Name	Function	Standard rotary system
270	MPRO_FG_PosNom	Increments per revolution	1048576 [incr/rev]
271	MPRO_FG_Nom	Numerator	1[rev]
272	MPRO_FG_Den	Denominator	32000 μm

Table 8.16: Parameters for user-defined scaling (linear system)

ID	Name	Function	Standard rotary system
273	MPRO_FG_Reverse	Reverse direction	False = clockwise
274	MPRO_FG_SpeedFac	Speed factor	1.875 rps corresponds to 1 mm/s, $1/32 \text{ mm} = 0.03125 \text{ rps}^2$ $0.03125 \text{ rps}^2 \cdot 60 \text{ s} = 1.875 \text{ rps}$
275	MPRO_FG_AccFac	Acceleration factor	$1/32 \text{ mm} = 0.03125 \text{ rps}^2$ corresponding to 1 mm/s^2

Table 8.16: Parameters for user-defined scaling (linear system) (continue)

8.3 Basic settings

Set control and reference

Control via: OFF(0) = No control selector defined

Reference via: OFF(0) = No setpoint

Motor control start condition: OFF(0) = Switch off drive first in case of power or fault reset

Profile

Profile mode: PG(0) = reference acts on profile generator

Profile type: LinRamp(0) = Linear ramp (trapezoidal profile)

Interpolation

Interpolation type: SplineII(3) = Cubic spline interpolation

Cycle time: 1 ms

Limit

Speed override: 100 %

Reversing lock: OFF(0) = No locking

Reference filter

Filter type: OFF(0) = Function disabled

Fig. 8.24: "Basic settings" screen

Interpolation

See Section "Interpolation" on page 255.



NOTE

- The reference filters are initialized only after the control has been re-enabled or by a device restart.

ID	Index	Name	Unit	Description
144	0	MPRO_DRVCOM_AUTO_START		DriveCom: Auto start of system
159	0	MPRO_CTRL_SEL		Motion profile selection
165	0	MPRO_REF_SEL		Motion profile selection
166	0	MPRO_REF_JTIME	ms	Motion profile jerk time
167	0	MPRO_REF_OVR	%	Motion profile override factor
223	0	MPRO_REF_Config		Motion profile: Config of specific profiling behaviour
301	0	CON_REF_Mode		Mode selection of setpoint profiling
306	0	CON_IpRefTS	ms	Sampling time (for interpolation)
335	0	CON_SCON_DirLock		Direction lock for speed reference value
370	0	CON_IP		Interpolation type
755	0	MPRO_FG_RefPosFilType		Position reference filter type
756		MPRO_FG_RefPosFilData		Reference position filter data
756	0	RefFil_TimeConst	ms	Position reference filter time constant (PT1/PT2/AVG)
756	1	RefFil_DampConst		Position reference filter damping constant
2243	0	MPRO_402_MotionProfType		Profile type

Table 8.17: "Motion profile - Basic settings" parameters

8.3.1 PG mode with speed control

- Select reference source
- Motion profile adaptation: scaling, ramps and smoothing time.
- In reference processing by way of the profile generator the fine interpolator is always in use.

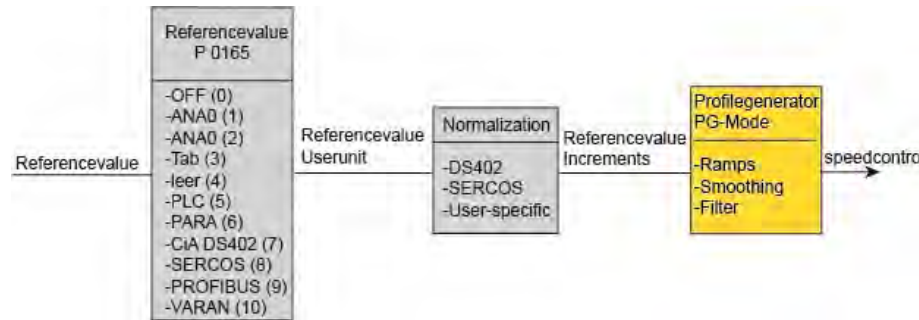


Fig. 8.25: Profile mode speed control

Profile Generator with speed control:

- Control mode **P 300[0] - CON_CfgCon** = speed control
- Under Profile select the profile generator (PG) **P 301[0] - CON_Ref_Mode** = PG(0)
- Selection of reference source/>**P 165[0] - MPRO_REF_SEL**
- Scaling
- Select jerk conditions
- Set stop ramps, smoothing, filter, homing

Set control and reference

Control via: TERM(1) = via terminals

Reference via: TAB(3) = via table

Motor control start condition: OFF(0) = Switch off drive first in case of power or fault reset

Profile

Profile mode: PG(0) = reference acts on profile generator

Profile type: JerkLim(3) = Jerk limited ramp

Interpolation

Interpolation type: SplineII(3) = Cubic spline interpolation

Limit

Speed override: 100 %

Reversing lock: OFF(0) = No locking

Reference filter

Filter type: OFF(0) = Function disabled

Jerk time: 35 ms

Cycle time: 1 ms

The smoothing time will appear on the screen as soon as the profile type is changed from "Linear" to "Jerk limited ramp".

Fig. 8.26: Speed control in PG mode, smoothing

8.3.2 PG mode with position control

Travel commands are transmitted to the internal profile generator (see Section "Basic settings" on page 250). It is composed of the following items:

- Target position
- Maximum travel speed
- Maximum acceleration
- Maximum deceleration
- The profile generator uses the **P 166[0] - MPRO_REF_JTIME** jerk values and a **P 167[0] - MPRO_REF_OVR** override factor for the travel speed in order to generate the trajectory for the position setpoint that will take the least amount of time, taking all limitations into account.
- The position references are then processed with the selected interpolation method.

- The position references are used to generate pre-control values for speed and acceleration. These are scanned at the sampling time of the position controller (normally 125 µs) and switched to the control loops.

8.3.2.1 Motion profile / Basic settings

In this screen the basic settings for the motion profile are made according to the list boxes. If Profile Generator and IP mode are enabled, the reference value is influenced by both functions.

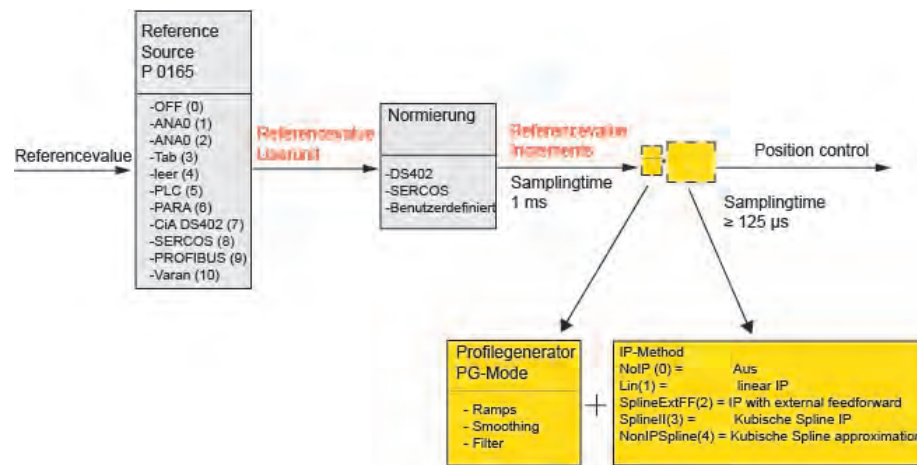


Fig. 8.27: PG mode with position control

8.3.3 IP mode with speed control

In IP (Interpolation) mode the appropriate reference source and correct scaling of units are selected for the speed reference before the reference is passed via the interpolator to the control. Linear interpolation is always applied in this process.

Interpolation (IP) mode

- Reference values are interpolated in linear mode before being switched to the control loops.
- The profile generator is inactive.
- Ramps and smoothing are inactive.
- The reference values are switched directly to the closed-loop control.

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. • Before the “Start” step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.

Speed control in IP mode:

- Control mode **P 300[0] - CON_CfgCon** = speed control or setting via Modes of Operation (CAN, EtherCAT®)
- Selection of reference source **P 165[0] - MPRO_REF_SEL**
- Scaling
- Linear interpolation is always applied in speed control.
- Bus sampling rate: the bus sampling time is custom-set according to the application.

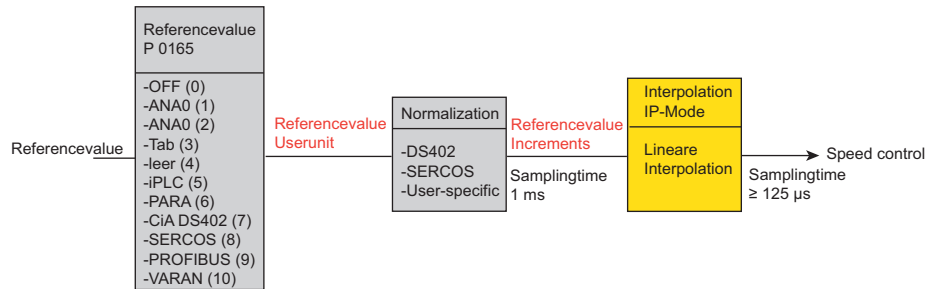


Fig. 8.28: Speed control in IP mode (Motion Profile subject area)



NOTE

- Linear interpolation is always applied in speed-controlled mode. Pre-control is not active.

8.3.4 IP mode with position control

- Position reference values are preset by a higher-level PLC with an appropriate sampling time.
- The cycle time must be balanced between the PLC and controller **P 0306 CON_IpRefTS**.
- The position references are then transferred to the fine interpolator.
- Pre-control values for speed and acceleration are switched to the control loops.
- For more information on the cycle time see the field bus documentation.

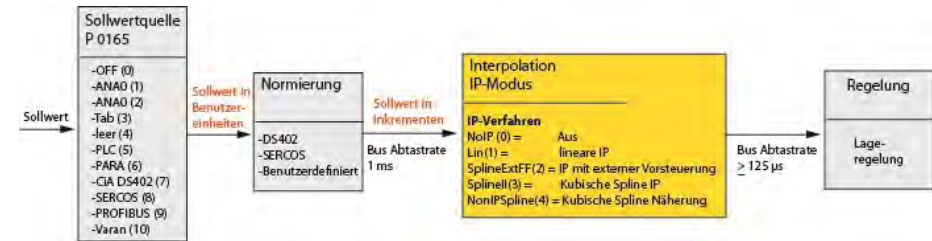


Fig. 8.29: Position control in IP mode (Motion Profile subject area)



NOTE

- In linear interpolation the pre-control is ignored.

8.3.5 Jerk limitation and speed offset

8.3.5.1 Jerk limitation (Profile mode)

The transfer path from the motor to the mechanism may be elastic and so susceptible to oscillation. For that reason, it is advisable to also limit the maximum rate of change of the torque and thus the jerk. Due to the jerk limitation the acceleration and deceleration times rise by the smoothing **P 166[0] - MPRO_REF_JTIME**. The smoothing setting box appears on-screen as soon as the profile type **P 2243[0] - MPRO_402_MotionProf type** is set to JerkLin(3).

8.3.5.2 Speed offset (limitation)

With speed override **P 167[0] - MPRO_REF_OVR** the maximum preset speed reference is scaled in percent.

Set control and reference

Control via: TERM(1) = via terminals

Reference via: TAB(3) = via table

Motor control start condition: OFF(0) = Switch off drive first in case of power or fault reset

Profile

Profile mode: PG(0) = reference acts on profile generator

Profile type: JerkLim(3) = Jerk limited ramp

Interpolation

Interpolation type: SplineII(3) = Cubic spline interpolation

Limit

Speed override: 100 %

Reversing lock: OFF(0) = No locking

Reference filter

Filter type: OFF(0) = Function disabled

Jerk time: 35 ms

Cycle time: 1 ms

The smoothing time will appear on the screen as soon as the profile type is changed from "Linear" to "Jerk limited ramp".

Fig. 8.30: Profile type, smoothing profile type without smoothing

The acceleration and braking ramp = 0, so the jerk is maximum (red curve).

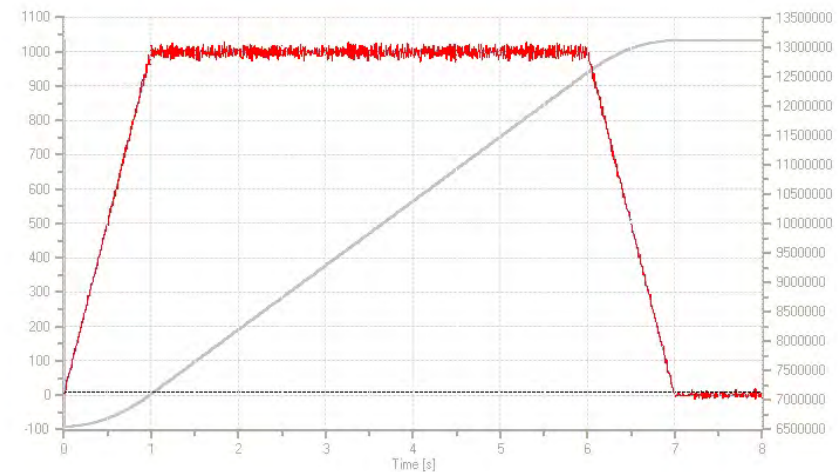


Fig. 8.31: Maximum jerk: Red = actual speed; grey = actual position

The acceleration and braking ramp with preset smoothing time (smoothing time = 2000 ms, red curve)

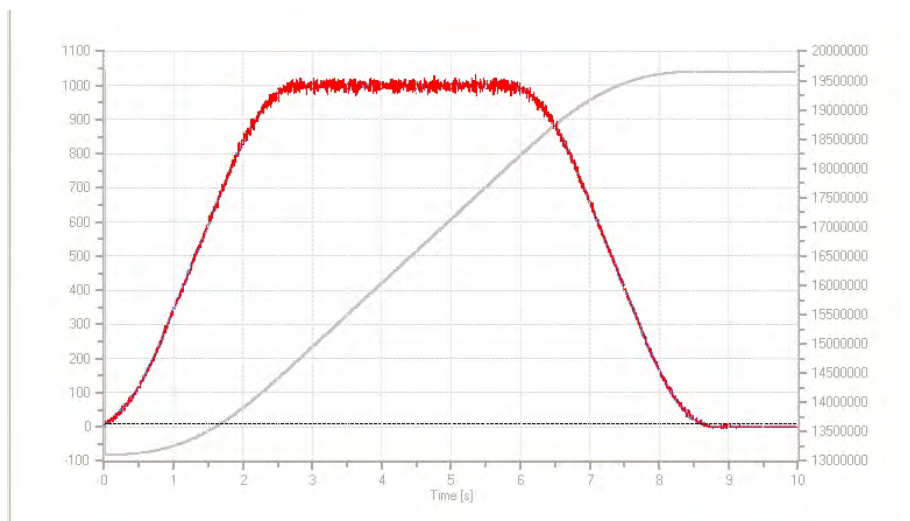


Fig. 8.32: Ramps with smoothing: Red = actual speed; grey = actual position

8.3.6 Interpolation

If there is no analytical description available for a function, and only individual points are known instead, it will not be possible to evaluate the function at just any point.



Fig. 8.33: Known points

By using a suitable interpolation method, the function's values between known points can be estimated. This is termed an interpolation problem. There are a number of solutions to the problem; the user must select the appropriate functions. Depending on the functions chosen, a different interpolant is obtained.

Interpolation is a kind of approximation: the function under analysis is precisely reproduced by the interpolation function at the interpolation points and at the remaining points is at least approximated. The quality of approximation depends on the method chosen. In order to estimate it, additional information above the function f is required. This information is usually obtained naturally even if f is unknown: boundedness, continuity, and differentiability can frequently be assumed.

8.3.6.1 Linear interpolation

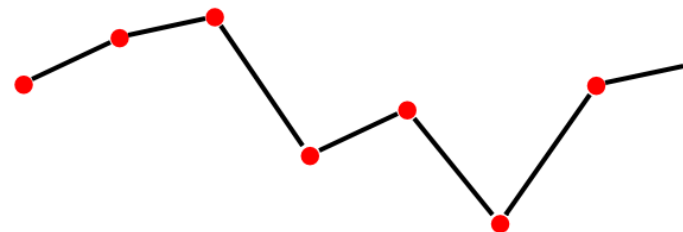


Fig. 8.34: Linear interpolation

Here two given datum points f_0 and f_1 are connected by a line. To $n+1$ differing datum point pairs there is exactly one n -th order interpolation polynomial, which matches at the specified interpolation points.

8.3.6.2 Cubic interpolation

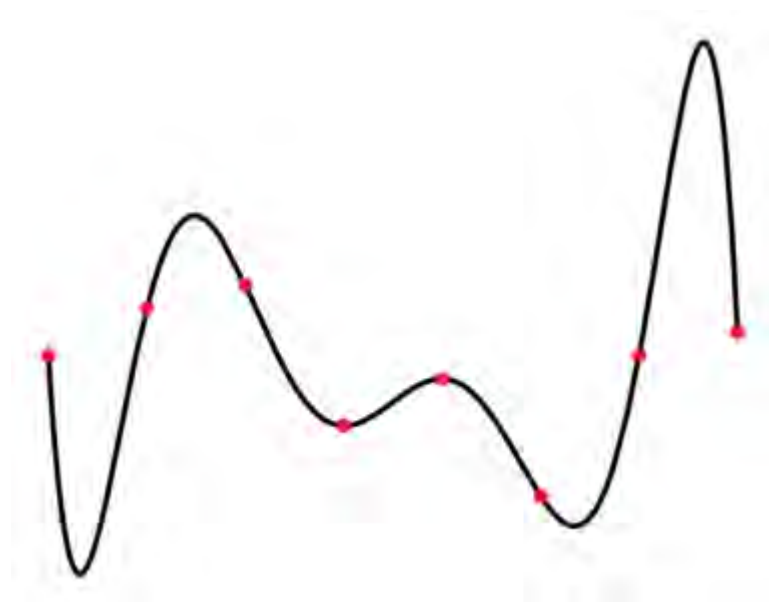


Fig. 8.35: Interpolation polynomial, 7th degree

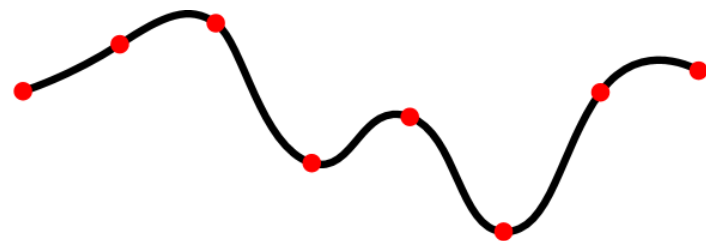


Fig. 8.36: Cubic spline interpolation

As polynomials become more and more unstable as the order of magnitude increases – that is to say, fluctuate widely between the interpolation points – in practice polynomials of an order greater than 5 are rarely applied. Instead, large data sets are interpolated in chunks.

In the case of linear interpolation, that would be a frequency polygon; in the case of 2nd or 3rd order polynomials the usual term used is spline interpolation. In the case of sectionally defined interpolants, the question of consistency and differentiation at the interpolation points is of major importance.

8.3.6.3 MSD Servo Drive interpolation types

P No.	Index	Name / Setting	Unit	Description
370	0	CON_IP		Interpolation type in IP mode
		NoIp(0)		No interpolation: The values are transferred 1:1 to reference processing in 1 ms cycles.
		Lin (1)		Linear interpolation: In the linear interpolation method the acceleration between two points is generally zero. Pre-control of the acceleration values is thus not possible and speed jumps are always caused.
		SplineExtFF(2)		Interpolation with external pre-control: Only on request from Moog.

Table 8.18: Interpolation types MSD Servo Drive

P No.	Index	Name / Setting	Unit	Description
		SplineI(3)		Cubic spline interpolation: Only on request from Moog.
		NonIPSpline(4)		Cubic spline approximation: In this method the interpolation points are approximated by means of B-splines. The trajectory normally does not run exactly through the points specified by the control. The deviation is normally negligibly small. In the interpolation points the transitions are continuous with regard to acceleration, which becomes apparent by minor "noise". In start and target position the interpolation points always match the trajectory. Usage: minimizing noise, smoother motion, restrictions on contouring
		Cos(5)		Cosine interpolation: The interpolation formula corresponds to a Fourier trend of the unknown interpolants.

Table 8.18: Interpolation types MSD Servo Drive (continue)

When using NonIpSpline, superimposed external feed-forward control can be used. The controller must write the feed-forward control values to the corresponding reserved parameters in the relevant bus system. All decelerations should be disabled in the controller.

P 375[0] - CON_IP_SFFScale and **P 376 - CON_IP_TFFScale** must be used to perform the scaling required for the internal units. The result can be viewed in the scope by using scope variables **101 - nref_EXT** and **102 - mref_EXT**. If the scaling appears to be OK, use **P 379 - CON_IP_FFMode** to switch to the external feed-forward control.

8.4 Stop ramps

Stop ramps

Reaction at control off (shutdown)	SDR(1) = Slow down with slow down ramp; disable of the drive function ▼
Reaction at disable reference (disable)	SDR(1) = Slow down with slow down ramp; disable of the drive function ▼
Reaction at halt command	SDR(1) = Slow down on slow down ramp ▼
Reaction at quick stop command	QSR(2) = Slow down on quickstop ramp ▼
Quick stop ramp	3000 rev /min/s
Reaction at fault	QSR(2) = Slow down on quick stop ramp ▼
<button>Error/fault reactions</button>	

Fig. 8.37: "Stop ramps" screen

Each reference source has its own acceleration and braking ramps. There are also the stop ramps (quick-stop ramp), according to the .CiA 402 standard. The ramp functions are only effective in certain system states. The required settings can be selected from the screen. Clicking the "Error/Error reactions" button directly accesses the screen for the error reactions.

Stop ramps in torque control

When in torque control mode (TCON), if one of the following occurs:

- The control is shut down
- The setpoint is disabled
- Stop
- Quick stop
- Error

the set ramps will be performed in rpm.

Reaction to "Control Shutdown"

The "shutdown option code" parameter determines which action is to be executed at the transition from "Operation enable" to "Ready to Switch on" (state machine state 5 to 3).

Reaction to "Disable Operation"

The "disable operation option code" parameter determines which action is to be executed at the transition from "Operation enable" to "Switched on" (state machine state 5 to 4).

Reaction to "Halt"

The "Halt" command interrupts a movement. The drive remains in the "Operation enable" state. When the "Halt" command is cancelled the interrupted movement is completed.

Reaction to "Quickstop"

If the drive needs to be shut down as rapidly as possible due to a malfunction, it must be run down to speed zero on an appropriate ramp. The "Quickstop" function brakes an ongoing movement differently from the normal braking ramp. The servo controller is in the "Quickstop" system state. This state can be quit during or after braking, depending on the status of the quick-stop command and the respective reaction.

ID	Index	Name	Unit	Description
2218	0	MPRO_402_QuickStopOC		605AH DS402 quick-stop option code
2219	0	MPRO_402_ShutdownOC		605BH DS402 reaction to control shutdown
2220	0	MPRO_402_DisableOpOC		605CH DS402 disable operation option code
2221	0	MPRO_402_HaltOC		605DH DS402 halt option code
2222	0	MPRO_402_FaultReactionOC		605EH DS402 fault reaction option code
2242	0	MPRO_402_QuickStopDec	rev/min/s	6085H DS402 quickstop deceleration

Table 8.19: "Motion profile - Stop ramps" parameters

8.5 Homing

Homing serves to establish an absolute position reference (referred to the entire axis), and must usually be performed once after power-up. Homing is necessary when absolute positioning operations are carried out without absolute encoders (e.g. SSI multi-turn encoders). For all other positioning operations (relative, infinite) no homing is required. For zero position adjustment of absolute encoders homing method -5 is available. There are various methods, which can be set according to the application.

The selection of a homing method defines:

- The reference signal (positive limit switch, negative limit switch, reference cam)
- the direction of the drive
- The position of the zero pulse.

8.5.1 Homing screen

The homing movement is dictated by the speed (velocity) V1 and V2, the acceleration and the maximum positioning range.

Homing method **1** Type 35(35) = Actual position = Reference position

Speed during search for switch (V1) **2** 100 rev./min Speed during search for zero (V2) **2** 5 rev./min

Homing acceleration **3** 100 rev./min/s Homing offset **4** 0 mDegree

Homing max. distance **5** 0 mDegree

Scaling of motor torque limit (only active for type 'on block') **6** 100 %

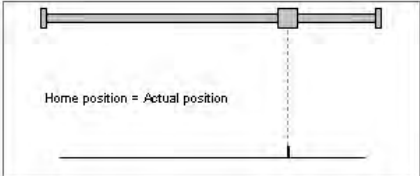


Fig. 8.38: Selection of homing method

① Selection of homing methods (-12) to (35)

② Speed V1: Speed during cam search
Speed V2: Speed during zero point search

③ Acceleration for V1 and V2

The reference point usually has an actual position value defined on the axis side referred to the axis zero.

Ideally, the position value of the drive-side datum point and of the reference

④ point are identical. As the position of the datum point is decisively influenced by the encoder mounting, however, the datum and reference points differ.

To establish a positional reference to the real axis zero, the desired axis-related actual position value of the reference point should be set via the zero offset.

⑤ Limitation of positioning range for homing. On exiting the positioning range, the axis is stopped with the error message "Overrun".

Legend for "Homing method" screen" figure



NOTE

- The reference mark signal can be optionally linked to one of the ISD05 and ISD06 fast digital inputs.

8.5.1.1 Homing to a limit switch:

The digital input must be set to the available selection parameter LCW(5) for a positive limit switch or to LCCW(6) for a negative limit switch.

8.5.1.2 Homing to a cam

Set digital input to HOMSW(10) (P 106 - MPRO_INPUT_FS_ISD06 to P 107- MPRO_INPUT_FS_ISD07).



NOTE

- The homing methods (-1) to (-12) are manufacturer-specific. Homing methods (0) to (35) are defined according to CiA 402.

ID	Index	Name	Unit	Description
169	0	MPRO_REF_HOMING_MaxDistance	mDegree	Homing: Maximum travel (homing to block: block detection)
170	0	MPRO_REF_HOMING_Ctrl		Homing method Controlword
171	0	MPRO_REF_HOMING_BackupPos	mDegree	Homing: backup position
225	0	MPRO_REF_HOMING_TMaxScale	%	Scaling of motor torque limit during homing
2234	0	MPRO_402_HomeOffset	mDegree	607CH DS402 home offset
2261	0	MPRO_402_HomingMethod		6098H DS402 homing method

Table 8.20: "Homing" parameters

ID	Index	Name	Unit	Description
2262		MPRO_402_ HomingSpeeds		6099H DS402 homing speeds
2262	0	SpeedSwitch	rev/min	Cam search speed
2262	1	SpeedZero	rev/min	Zero pulse search speed
2263	0	MPRO_402_ HomingAcc	rev/min/s	609AH DS402 homing acceleration

Table 8.20: "Homing" parameters (continue)

8.5.2 Method (-13): Absolute encoder

Method (-13) works in a similar way to method (-5) (see Section "Method (-5): Absolute encoder" on page 263). However, in this method the home offset is used to define the machine zero point, while in method (-5) it is used to define the offset relative to the encoder's absolute position

The following is the difference between the machine zero points for each method:

- Method (-13): Actual value = Home offset
- Method (-5): Actual value = Absolute encoder position (first needs to be determined with home offset = 0) + new home offset

Method (-13) is significantly easier to use, as it eliminates the need to determine the encoder's absolute position at the machine zero point and back-calculate the actual position.

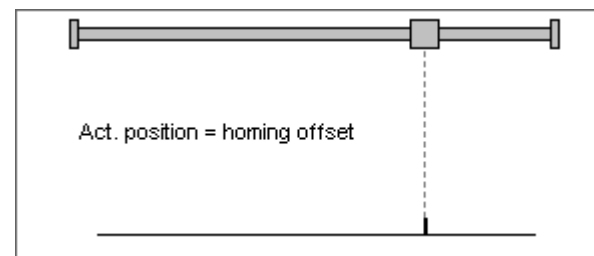


Fig. 8.39: Set the machine homing point

8.5.3 Method (-12): Set absolute position (absolute measuring system)

To set the machine homing point, the rotor or the linear axis is moved to the machine homing point. The desired actual position is written to the parameter "Offset" **P 2234 MPRO_402_Homeoffset**. Afterward, the axis must be referenced once. Every time the axis is started thereafter, the absolute position is calculated automatically. Every time a new homing operation is initiated, the machine homing point is reset to the current position.

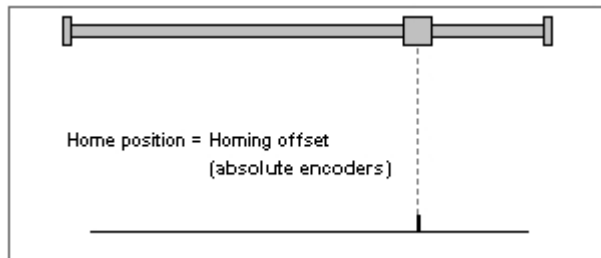


Fig. 8.40: Set the machine homing point

8.5.4 Method (-10) and Method (-11): Move to block with zero pulse

Tracking error monitoring is switched off during the homing procedure.

The maximum permissible torque can be reduced specifically during the homing operation. To do so, parameter **P 0225 MPRO_REF_HOMING_TMaxScale** must be set in the range of 0-100%. Note that this parameter replaces parameter **P 0332 CON_SCON_TMaxScale** during the homing run.

8.5.4.1 Method (-10): Negative direction of travel

With **P 0169 MPRO_REF_HOMING_MaxDistance** the positioning range in which to search for the block is specified. After approaching the block, the drive reverses the direction of rotation until a zero pulse is detected. The first zero pulse after reversing direction corresponds to the zero point. An offset can be programmed in the screen.

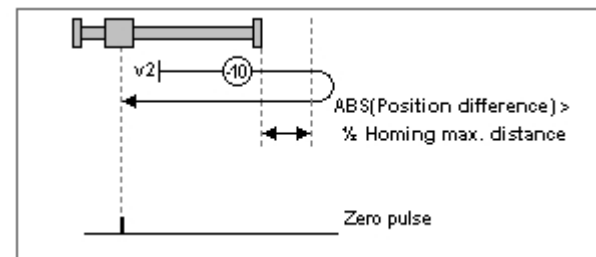


Fig. 8.41: Move to block, negative direction of movement with zero pulse

8.5.4.2 Method (-11): Positive direction of travel

With **P 0169 MPRO_REF_HOMING_MaxDistance** the positioning range in which to search for the block is specified. After approaching the block, the drive reverses the direction of rotation until a zero pulse is detected. The first zero pulse

after reversing direction corresponds to the zero point. An offset can be programmed in the screen.

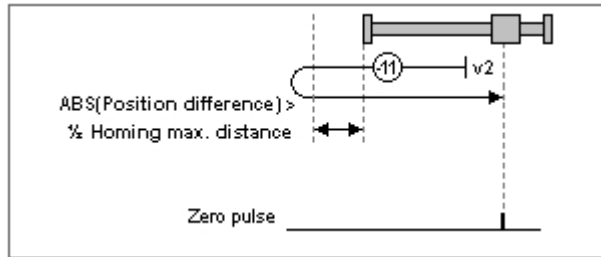


Fig. 8.42: Move to block, positive direction of movement with zero pulse

8.5.5 Method (-8) and (-9): Move to block

Tracking error monitoring is switched off during the homing procedure.

The maximum permissible torque can be reduced specifically during the homing operation. To do so, parameter **P 0225 MPRO_REF_HOMING_TMaxScale** must be set in the range of 0-100%. Note that this parameter replaces parameter **P 0332 CON_SCON_TMaxScale** during the homing run.

8.5.5.1 Method (-8): Negative direction of travel

With **P 0169 MPRO_REF_HOMING_MaxDistance** the tracking error is specified in the positioning range in which the block is detected.

When the block is detected, the system disengages by half the value in parameter **P 0169 MPRO_REF_HOMING_MaxDistance**) and the zero point is defined. An offset can be programmed in the screen.

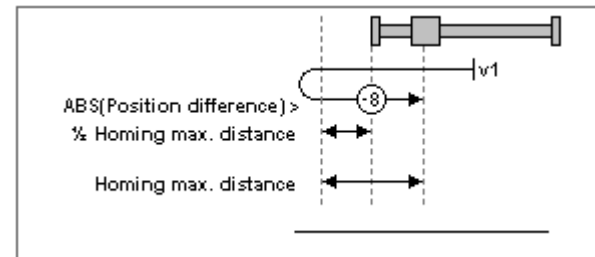


Fig. 8.43: Approach block, negative direction of travel

8.5.5.2 Method (-9): Positive direction of travel

With **P 0169 MPRO_REF_HOMING_MaxDistance** the tracking error is specified in the positioning range in which the block is detected.

When the block is detected, the system disengages by half the value in parameter **P 0169 MPRO_REF_HOMING_MaxDistance**) and the zero point is defined. An offset can be programmed in the screen.

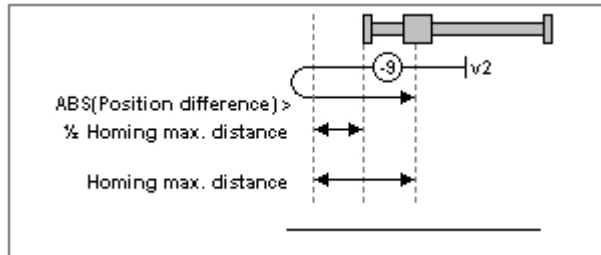


Fig. 8.44: Approach block, positive direction of travel

8.5.6 Method (-7) to (0)

8.5.6.1 Homing method for increment-coded encoders

- Method (-6): Movement in negative direction
- Method (-7): Movement in positive direction

See also Section "Increment-coded reference marks" on page 112.

8.5.6.2 Method (-5): Absolute encoder

These homing methods are suitable for absolute encoders (e.g. SSI multi-turn encoders). Referencing is performed immediately after a mains power up. The reference position is calculated on the basis of the encoder absolute position plus zero offset. In the case of a SSI multi-turn encoder, homing with zero point offset = 0 gives the absolute position of the SSI encoder. Referencing again without changing the setting for the zero point offset does not cause a change of the position. To set the machine reference point homing method (-12) should be used.

8.5.6.3 Method (-4) and method (-3): Not defined

8.5.6.4 Method (-2): No homing

No homing will be performed. The zero point offset is added to the current position. When the power stage is first switched on, "Homing completed" is set as the status. This method is suitable for absolute encoders, provided that no offset compensation is required. For an offset compensation, please select method (-5).

8.5.6.5 Method (-1): Actual position = 0

The actual position corresponds to the zero point; it is set to 0, meaning the controller performs an actual position reset. The zero offset is added.

8.5.7 Method (1) and Method (2): limit switch and zero pulse

8.5.7.1 Method 1: Negative limit switch and zero pulse

- Start movement left; at this time the hardware limit switch is inactive.
- The direction of movement reverses on an active hardware limit switch edge.
- First zero pulse after falling limit switch edge corresponds to zero/reference point.

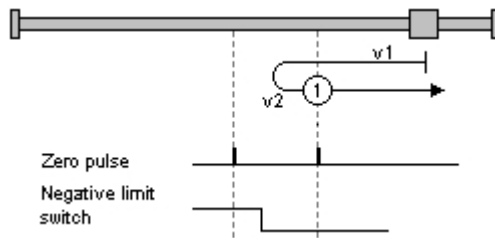


Fig. 8.45: Negative limit switch and zero pulse

8.5.7.2 Method 2: Positive limit switch and zero pulse

- Start movement right; at this time the hardware limit switch is inactive.
- The direction of movement reverses on an active hardware limit switch edge.
- First zero pulse after falling limit switch edge corresponds to zero/reference point.

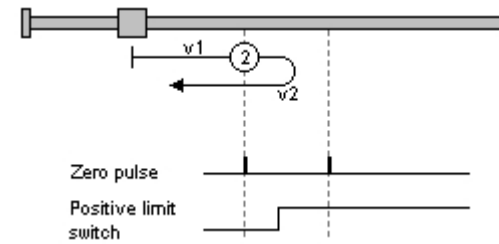


Fig. 8.46: Positive limit switch and zero pulse

8.5.8 Method (3) and (4): Positive reference mark and zero pulse

8.5.8.1 Method (3): Start movement in direction of positive (right) hardware limit switch

- Start movement in direction of positive (right) hardware limit switch; at this time the reference mark is inactive.
- The direction of movement reverses on an active edge from the reference mark.
- The first zero pulse after a falling edge from the reference mark is the zero point/homing point.

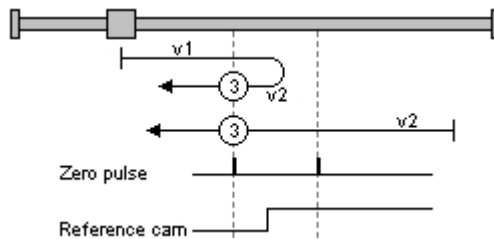


Fig. 8.47: Start condition for positive limit switch

8.5.8.2 Method 4: Start movement in direction of negative (left) hardware limit switch

- Start movement in direction of negative (left) hardware limit switch; at this time the reference mark is inactive.
- The direction of movement reverses on an active edge from the reference mark.
- The first zero pulse after a falling edge from the reference mark is the zero point/homing point.

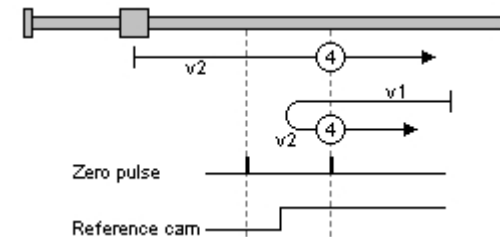


Fig. 8.48: Start condition for negative limit switch

8.5.9 Homing methods 5 and 6: Negative reference mark and zero pulse

8.5.9.1 Method (5): Start movement in direction of positive (right) hardware limit switch with zero pulse

- Start movement in direction of positive (right) hardware limit switch; at this time the reference mark is inactive.
- The first zero pulse after a falling edge from the reference mark is the zero point/homing point.
- The direction of movement reverses on an active edge from the reference mark.
- Start movement in direction of the negative limit switch if the reference mark is inactive.

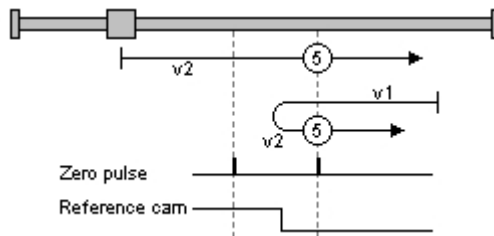


Fig. 8.49: Positive (right) hardware limit switch and zero pulse

8.5.9.2 Method 6: Start movement in direction of negative (left) hardware limit switch with zero pulse

- Start movement in direction of negative (left) hardware limit switch.
- The direction of movement reverses on an inactive edge from the reference mark.

- The first zero pulse after a rising edge from the reference mark is the zero point/homing point.

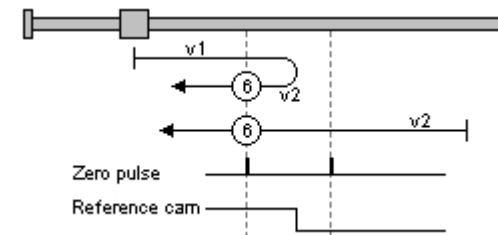


Fig. 8.50: Negative (left) hardware limit switch and zero pulse

8.5.10 Method (7) to (10):

8.5.10.1 Method (7): Reference mark, zero pulse and positive limit switch

- The start movement is in the direction of the positive, right hardware limit switch. Both it and the reference mark are inactive.
- The direction of movement reverses after an active reference mark. The zero point corresponds to the first zero pulse after the falling edge.
- The start movement is in the direction of the negative, left hardware limit switch. The homing point is set at the first zero pulse after a falling edge from the reference mark.
- The first zero pulse after passing the reference mark is the zero point.

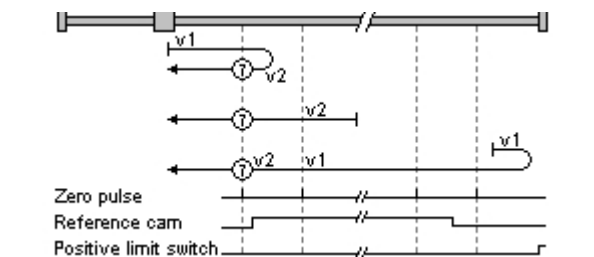


Fig. 8.51: Reference mark, zero pulse and positive limit switch

8.5.10.2 Method (8):

- The zero point is the first zero pulse if the reference mark is active.
- The direction of movement reverses after a falling edge from the reference mark. The zero point corresponds to the first zero pulse after a rising edge from the reference mark.
- The direction of movement reverses when the reference mark has been passed. The zero point corresponds to the first zero pulse after a rising edge.

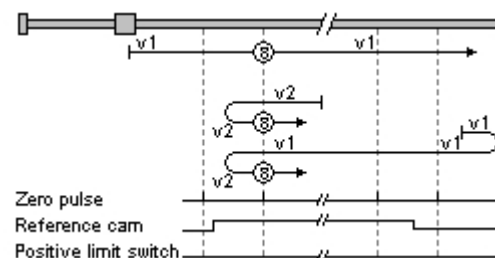


Fig. 8.52: Zero point corresponds to first zero pulse

8.5.10.3 Method (9):

- The direction of movement changes when the reference mark becomes inactive. The zero point corresponds to the first zero pulse after a rising edge.
- The zero point is the first zero pulse if the reference mark is active.

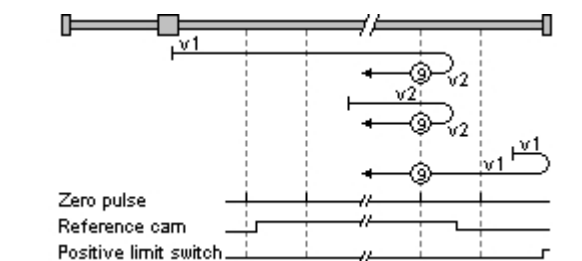


Fig. 8.53: The direction of movement changes when the reference mark becomes inactive.

8.5.10.4 Method (10):

- Once the reference mark has been passed, the first zero pulse after the falling edge is the zero point.

- After a falling edge from the reference mark: The first zero pulse corresponds to the zero point.
- After an active reference mark: The zero point corresponds to the first zero pulse after the falling edge.

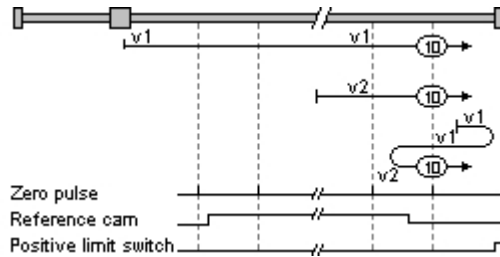


Fig. 8.54: Zero pulse after falling edge corresponds to the zero point.

8.5.11 Method (11) to (14): Reference mark, zero pulse and negative limit switch

8.5.11.1 Method (11)

- Reversal of direction of movement after active reference mark. The zero point corresponds to the first zero pulse after the falling edge.
- Zero point at the first zero pulse after falling edge from the reference mark.
- Movement must have gone beyond the reference mark, then the first zero pulse corresponds to the zero point.

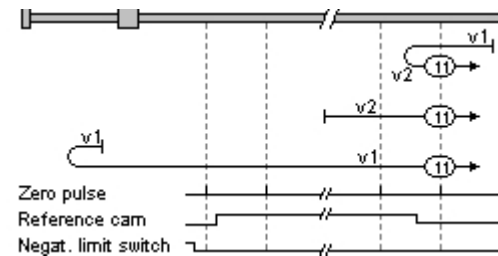


Fig. 8.55: Reversal of direction of movement after active reference mark

8.5.11.2 Method (12)

- Zero point corresponds to the first zero pulse if the reference mark is active.
- Reversal of direction of movement after a falling edge from the reference mark. The zero point corresponds to the first zero pulse after a rising edge from the reference mark.
- Reversal of direction of movement when the reference mark has been passed. The zero point corresponds to the first zero pulse after a rising edge.

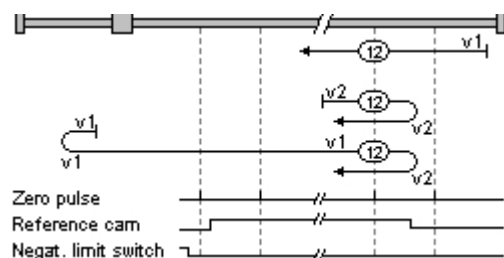


Fig. 8.56: Zero point corresponds to first zero pulse.

8.5.11.3 Method (13)

- Reversal of direction of movement when the reference mark has been passed. The zero point corresponds to the first zero pulse after a rising edge.
- Reversal of direction of movement when the reference mark becomes inactive. The zero point corresponds to the first zero pulse after a rising edge.
- Zero point corresponds to the first zero pulse if the reference mark is active.

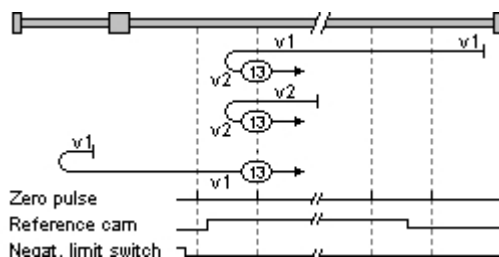


Fig. 8.57: Reversal of direction of movement...

8.5.11.4 Method (14)

- The zero point corresponds to the first zero pulse after crossing the reference mark.

- The zero point corresponds to the first zero pulse after the reference mark's falling edge.
- Reversal of direction of movement after active reference mark. The zero point corresponds to the first zero pulse after the falling edge.

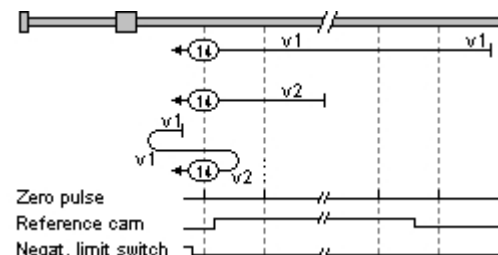


Fig. 8.58: Zero point corresponds to first zero pulse after...

8.5.12 Methods (15) and (16)

These two homing methods are not defined.

8.5.13 Method (17) to (30): Reference mark

8.5.13.1 Method (17) to (30)

Homing methods 17 to 30 are equivalent to methods 1 to 14.

The determination of the homing point is independent of the zero pulse. It only depends on the reference mark or on the limit switches.

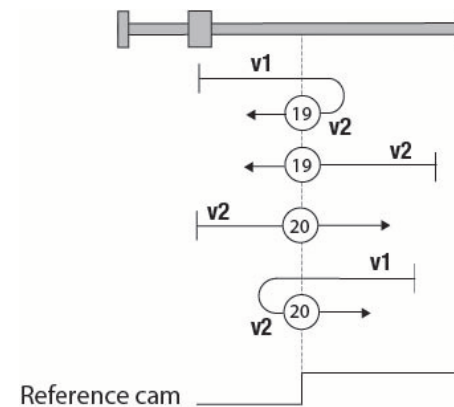


Fig. 8.59: Homing methods 17 to 30 are equivalent to methods 1 to 14

Method 1 corresponds to method 17	The determination of the homing point is independent of the zero pulse. It only depends on the reference mark or on the limit switches.
Method 20 corresponds to method 4	
Method 8 corresponds to method 24	
Method 12 corresponds to method 28	
Method 14 corresponds to method 30	

Table 8.21: Method comparison of the individual homing methods

8.5.14 Methods (31) and (32)

These two homing methods are not defined.

8.5.15 Method (33) and (34): with zero pulse

8.5.15.1 Method (33): Leftward travel direction

The zero pulse corresponds to the first zero pulse to the left.

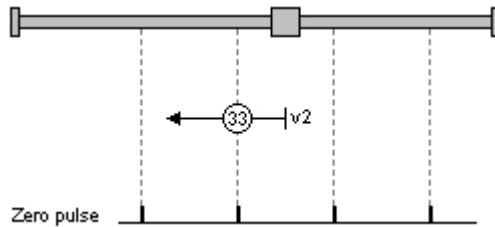


Fig. 8.60: Homing with zero pulse

8.5.15.2 Method (34): Rightward travel direction

The zero pulse corresponds to the first zero pulse to the right.

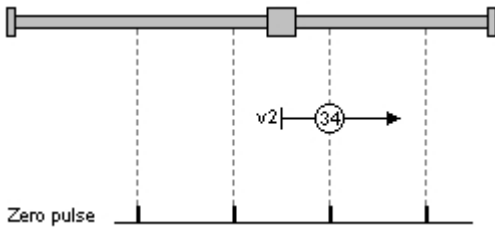


Fig. 8.61: Homing with zero pulse

8.5.16 Method (35)

The actual position corresponds to the reference point.

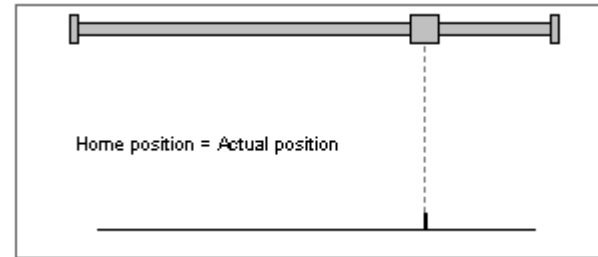


Fig. 8.62: The actual position corresponds to the homing point

8.6 Jog mode

Jog speeds

Slow jog speed rev/min

Quick jog speed rev/min

Fig. 8.63: "Jog speeds" screen

Jog mode (setup mode) is used to record (teach-in) positions, for disengaging in the event of a fault, or for maintenance procedures. A bus system or reference sourcing via terminal can be selected as the reference. The unit corresponds to the selected user unit.

Two speeds are available for both directions. If the drive is to be moved at different speeds, both inputs must be active (relevant bits in bus operation). If the "Jog left" input is activated first and then input two, "Fast jog mode left" is used. If the "Jog right" input is the first activated of the two, "Fast jog mode right" is used.

ID	Index	Name	Unit	Description
168		MPRO_REF_JogSpeeds		Jog mode speeds
168	0	FastJogSpeed	rev/min	Fast jog speed
168	1	SlowJogSpeed	rev/min	Slow jog speed

Table 8.22: "Jog mode" parameters

8.6.1 Configuration

- Jog in positive and negative direction:
Configure two digital inputs
ISD0x = INCH_P (7) = jog +
ISD0x = INCH_N (8) = jog-

- Fast jog**
Both digital inputs must be active (corresponding bits in bus mode)
- Fast jog, leftward direction of travel**
Input "Jog left" and then also enable input two
- Fast jog, rightward direction of travel:**
Input "Jog right" and then also enable input two

8.6.2 Digital Inputs

Digital standard inputs:

ISD00	START(1) = Start motor control
ISD01	HOMST(9) = Start homing
ISD02	TBEN(21) = Enable selected table index
ISD03	TAB0(23) = Binary table index 2 ⁰
ISD04	TAB1(24) = Binary table index 2 ¹
ISD05	JOG_EXT_POS(34) = Jog extended positive direction
ISD06	JOG_EXT_NEG(35) = Jog extended negative direction

Jog in positive direction (34)
Jog in negative direction (35)

Fig. 8.64: "Digital inputs" screen

8.6.3 Manual mode window, "Jog mode" tab

The jog speeds in the Manual mode window are oriented to the values of the "Jog mode speed" screen. The drive is moved using the "Jog -" and "Jog +" buttons.

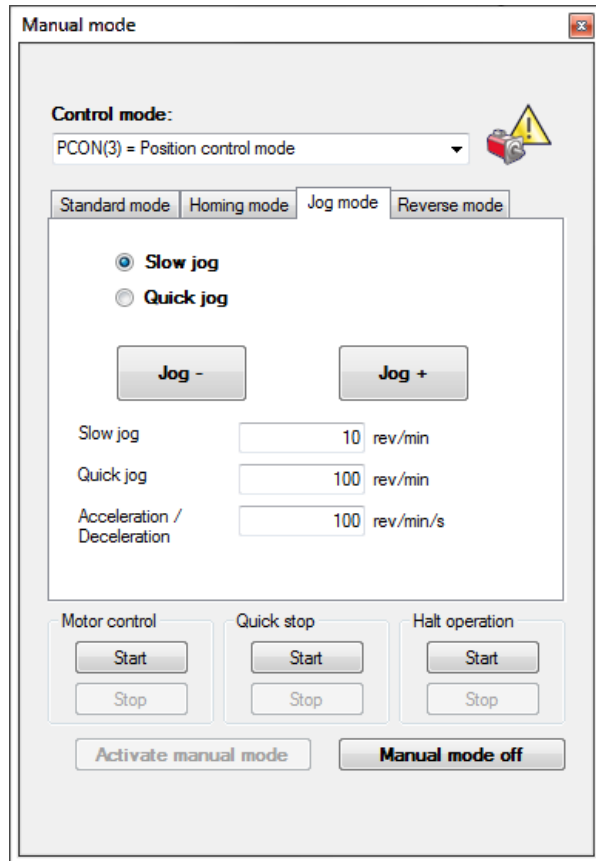


Fig. 8.65: "Jog mode" window

8.7 Reference table

With the reference table up to 16 reference values can be defined. In the process, the drive moves to its targets in conformance to the respective driving sets. Depending on the selected control mode, each reference in the table assigned a speed, acceleration and deceleration value. The table reference values can be used in any control mode.

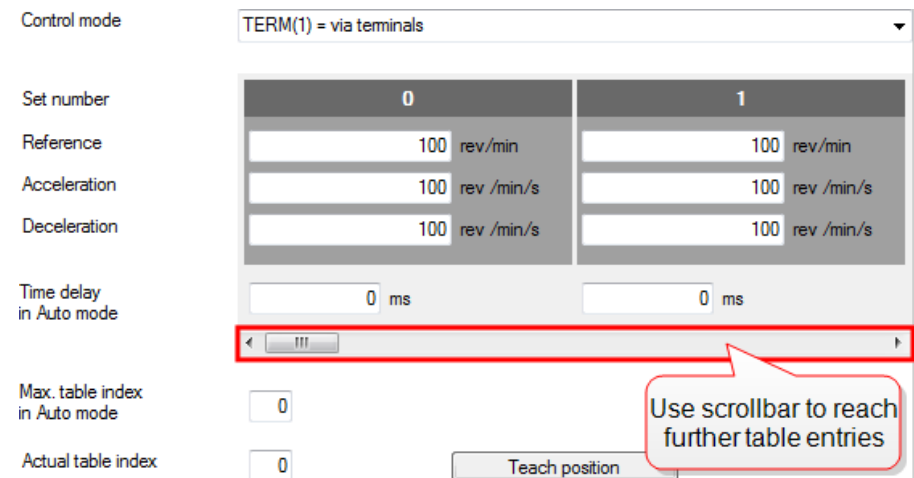


Fig. 8.66: "Reference table" screen

The setpoints need to be provided in the distance units defined by the user (for details on how distance units are defined, see Section "Scaling / Units" on page 232).

Control mode



NOTE

- “Control mode” does **not** refer to the motor control here (see Section "Control" on page 115), but rather to the source that will specify the table index!

P 205[0] - MPRO_TAB_Mode is used to define which source will specify the table index:

- **PARA (0) = via current index (parameter no. 207)**
The value written to **P 207[0] - MPRO_TAB_ActIdx** (via a fieldbus, for example) will immediately be applied as the current table index and the corresponding motion task will be carried out.
- **TERM (1) = via terminals**
A bit pattern that will be applied as the value for the table index will be specified via digital inputs. In order to be able to select all 16 table entries, four digital inputs with **TAB0(23) = Binary table index 2⁰** to **TAB3(26) = Binary table index 2³** need to be configured. For details on configuring the digital inputs, see Section "Digital inputs" on page 299.
- **AUTO (2) = With delay (parameter No. 204)**
Automatic processing of follow-up driving jobs. The number of driving jobs entered in parameter **P 206[0] - MPRO_Tab_MaxIdx** is processed in sequence. This operation is repeated until the drive is stopped or the table is disabled. There will be a wait time of **P 204 - MPRO_TAB_WaitTime** between the individual driving jobs.
- **BUS (3) = via fieldbus**
Selection of a table value via PROFIBUS. No other field bus systems are implemented. For details on PROFIBUS, see Section "PROFIBUS / PROFINET" on page 453.

- **AUTO_COMPLETE (4) = via auto complete mode (parameter no. 204)**
As with "AUTO (2)", as long as the input is set, the table will be executed. After being deactivated, the entire table will be run through to the end once more.

Reference

With ...

- **P 195 - MPRO_TAB_TRef** (for torque control) or
- **P 198 - MPRO_TAB_SRef** (for speed control) or
- **P 202 - MPRO_TAB_PRef** (for position control)

and indexes 0–15, the setpoint for each individual motion task can be defined.

In "Infinite positioning" mode the speed can be specified signed. It is limited by **P 328 [0] - CON_SCON_SMax** (for details, see Section "Speed- / velocity limits" on page 322).

Mode

If the Servo Drive is run with motor control mode "PCON(3) = Position control mode" (for information on the setting, see Section "Basic settings" on page 117), the "Mode" and "Speed" lines will be added to the "Setpoint table" screen.

Control mode: TERM(1) = via terminals

	0	1
Set number	0	0
Reference	mDegree	mDegree
Mode	ABS(0) = Absolute	ABS(0) = Absolute
Speed	100 rev/min	100 rev/min
Acceleration	100 rev/min/s	100 rev/min/s
Deceleration	100 rev/min/s	100 rev/min/s
Time delay in Auto mode	0 ms	
Max. table index in Auto mode	0	
Actual table index	0	

Use scrollbar to reach further table entries.

Teach position

Fig. 8.67: "Setpoint table" screen when using the "PCON(3) = Position control mode" control mode

P 203 - MPRO_TAB_PMode is used to define the type of positioning used:

- **ABS(0) = Absolute**
Absolute positioning
- **REL(1) = Relative (after "target reached")**
Relative positioning after target position reached.
- **REL at once(2) = Relative (at once)**
Aborts a current motion task and moves, as of the current position, to the new reference.
- **SPEED(3) = Endless (speed controlled)**
If a table value is set to SPEED, an infinite motion task is transmitted. If a table value with the setting ABS or REL is additionally selected, the infinite job is quit and the newly selected table value is approached from the current position.

Speed

If the Servo Drive is run with motor control mode "PCON(3) = Position control mode" (for information on the setting, see Section "Basic settings" on page 117), the "Mode" and "Speed" lines will be added to the "Setpoint table" screen.

P 201 - MPRO_TAB_PSpd is used to define the speed for a motion task.

Acceleration

With ...

- **P 193 - MPRO_TAB_TAcc** (for torque control) or
- **P 196 - MPRO_TAB_SAcc** (for speed control) or
- **P 199 - MPRO_TAB_PAcc** (for position control)

and indexes 0–15, the accelerations for moving to the setpoint for each individual motion task can be defined. The input must not be zero.

Deceleration

With ...

- **P 194 - MPRO_TAB_TDec** (for torque control) or
- **P 197 - MPRO_TAB_SDec** (for speed control) or
- **P 200 - MPRO_TAB_PDec** (for position control)

and indexes 0–15, the deceleration for each individual motion task can be defined. The input must not be zero.

Wait time in Auto mode

P 204 - MPRO_TAB_WaitTime is used to define the wait time before the next motion task is carried out.

Maximum table index in Auto mode

P 206[0] - MPRO_Tab_MaxIdx is used to define the table index up to which driving jobs will be carried out in one of the auto modes.

Current table index

P 207[0] - MPRO_Tab_ActIdx will show the index for the motion task that is currently active. If parameter **P 205 MPRO_TAB_Mode** is set to "Para(0)", a driving set can be entered and approached directly.

Activation of reference table

The following procedures can be used in order to activate the setpoint table for operation.

Activation	Setting	Function
Actuation via digital inputs	Input ISDxx = TBEN	Enable a selected driving set. The selection of a new motion task always interrupts an ongoing positioning and the follow-up job logic.
Actuation via digital inputs	Input ISDxx = TAB0 to TAB3	The binary significance (2^0 , 2^1 , 2^2 , 2^3) results from the TABx assignment. The setting TAB0 has the lowest significance (2^0) and TAB3 the highest (2^3). A high level on the digital input activates the corresponding driving set.
Triggering via field bus system	Enable "Execute motion task" bit.	Enable a selected driving set. The selection of a new motion task always interrupts an ongoing positioning and the follow-up job logic.
Triggering via field bus system	"Activate follow-up job" bit	The binary significance (2^0 , 2^1 , 2^2 , 2^3) results from the TABx assignment of the control word. The setting TAB0 has the lowest significance (2^0) and TAB3 the highest (2^3).

Table 8.23: Activation of table references

ID	Index	Name	Unit	Description
193		MPRO_TAB_TAcc		TAB: Torque mode acceleration
193	0	MPRO_TAB_TAcc	Nm/ms	
193	1 - 15	MPRO_TAB_TAcc	Nm/ms	
194		MPRO_TAB_TDec		TAB: Torque mode deceleration
194	0	MPRO_TAB_TDec	Nm/ms	
194	1 - 15	MPRO_TAB_TDec	Nm/ms	

Table 8.24: "Setpoint table settings" parameters

ID	Index	Name	Unit	Description
195		MPRO_TAB_TRef		TAB: Torque mode reference value
195	0	MPRO_TAB_TRef	Nm	
195	1 - 15	MPRO_TAB_TRef	Nm	
196		MPRO_TAB_SAcc		TAB: Speed mode acceleration
196	0	MPRO_TAB_SAcc	rev/min/s	
196	1 - 15	MPRO_TAB_SAcc	rev/min/s	
197		MPRO_TAB_SDec		TAB: Speed mode deceleration
197	0	MPRO_TAB_SDec	rev/min/s	
197	1 - 15	MPRO_TAB_SDec	rev/min/s	
198		MPRO_TAB_SRef		TAB: Speed mode reference value
198	0	MPRO_TAB_SRef	rev/min	
198	1 - 15	MPRO_TAB_SRef	rev/min	
199		MPRO_TAB_PAcc		TAB: Position control mode acceleration
199	0	MPRO_TAB_PAcc	rev/min/s	
199	1 - 15	MPRO_TAB_PAcc	rev/min/s	
200		MPRO_TAB_PDec		TAB: Position control mode Acceleration
200	0	MPRO_TAB_PDec	rev/min/s	
200	1 - 15	MPRO_TAB_PDec	rev/min/s	
201		MPRO_TAB_PSpd		TAB: Position control mode speed
201	0	MPRO_TAB_PSpd	rev/min	
201	1 - 15	MPRO_TAB_PSpd	rev/min	
202		MPRO_TAB_PPos		TAB: Position control mode reference value
202	0	MPRO_TAB_PPos	mDegree	
202	1 - 15	MPRO_TAB_PPos	mDegree	
203		MPRO_TAB_PMode		Position control table: Mode
203	0	MPRO_TAB_PMode		
203	1 - 15	MPRO_TAB_PMode		
204		MPRO_TAB_WaitTime		TAB: Wait time
204	0	MPRO_TAB_WaitTime	ms	
204	1 - 15	MPRO_TAB_WaitTime	ms	
205	0	MPRO_TAB_Mode		TAB mode
206	0	MPRO_Tab_MaxIdx		TAB: Max index in AUTO mode
207	0	MPRO_TAB_ActIdx		TAB: Actual index
208		MPRO_TAB_OutputNo		OSD TAB: actual table index and target

Table 8.24: "Setpoint table settings" parameters (continue)

ID	Index	Name	Unit	Description
				reached
208	0	MPRO_TAB_OutputNo		
208	1 - 15	MPRO_TAB_OutputNo		
269	0	MPRO_TAB_Ctrl		TAB: control word

Table 8.24: "Setpoint table settings" parameters (continue)

8.8 Analog channel (ISA00 und ISA01)

Scaling

10 V correspond to rev/min

Offset (O) rev/min

Backlash (B) rev/min

Motion profile

Acceleration ramp rev/min/s

Deceleration ramp rev/min/s

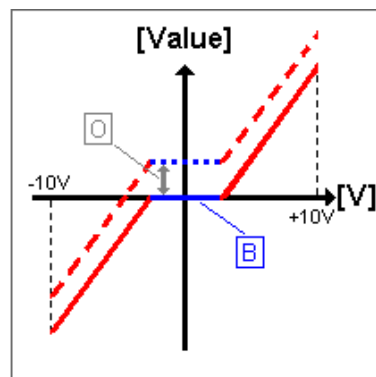


Fig. 8.68: "Analog channel" screen

Two standard analog inputs (ISA00, ISA01) are available. These inputs can be configured...

- with negative values for analog setpoint settings
- with positive values for digital setpoint processing

(P 109[0] - MPRO_INPUT_FS_ISA00 and P 110[0] - MPRO_INPUT_FS_ISA01).

see also section "Analog Inputs" on page 312. By using the "REV(-2) = analog setpoint" setting, an analog input voltage of ± 10 V can be processed as a setpoint.

10 V correspond to

This parameter (P 173 - MPRO_ANA0_Scale for ISA00, P 183 - MPRO_ANA1_Scale for ISA01) is used to define which speed / which torque / which position corresponds to the maximum analog value. Depending on the control mode being used (see Section "Basic settings" on page 117), the value will be stored in parameter index [0] (torque control), [1] (speed control) or [2] (position control).

Offset (O)

This parameter (P 174 - MPRO_ANA0_SOffset for ISA00, P 184 - MPRO_ANA1_SOffset for ISA01) compensates for component variations and is used for offset compensation purposes. Depending on the control mode being used (see Section "Basic settings" on page 117), the value will be stored in parameter index [0] (torque control), [1] (speed control) or [2] (position control).

Backlash (B)

This parameter (P 175 - MPRO_ANA0_SThreshold for ISA00, P 185 - MPRO_ANA1_SThreshold for ISA01) can suppress axis motion close to the standstill (stop) position. Depending on the control mode being used (see Section "Basic settings" on page 117), the value will be stored in parameter index [0] (torque control), [1] (speed control) or [2] (position control).

Acceleration ramp

This parameter serves as an acceleration ramp for torque control (P 176[0] - MPRO_ANA0_TRamp for ISA00, P 186[0] - MPRO_ANA1_TRamp for ISA01) or speed control (P 177[0] - MPRO_ANA0_SRamp for ISA00, P 187[0] - MPRO_ANA1_SRamp for ISA01). Depending on the control mode being used (see Section "Basic settings" on page 117), the value will be stored in parameter index [0] (torque control), [1] (speed control) or [2] (position control).

Deceleration ramp

This parameter serves as a deceleration ramp for torque control (P 176[1] - MPRO_ANA0_TRamp for ISA00, P 186[1] - MPRO_ANA1_TRamp for ISA01) or speed control (P 177[1] - MPRO_ANA0_SRamp for ISA00, P 187[1] - MPRO_ANA1_SRamp for ISA01). Depending on the control mode being used (see Section "Basic settings" on page 117), the value will be stored in parameter index [0] (torque control), [1] (speed control) or [2] (position control).

8.8.1 Special characteristics of position control mode analog

A threshold value can also be specified which generates a run-on range around the last reference value. A ramp function calculates a motion profile for the position reference from pre-defined acceleration and speed limits.

The position references on the analog channel are not applied immediately, but dependent on a digital input. Accordingly, one of the ISD00 to ISD06 digital inputs must be set to a value of "REFANAEN(28) = Enable analog reference value" (see Section "Digital inputs" on page 299). The position setpoint being received will only be applied if the corresponding digital input is active. The acceleration is entered using **P 173[0] - MPRO_ANA0_TScale** or **P 183[0] - MPRO_ANA1_TScale**.

8.8.2 Wire Break Monitoring

P 399 - CON_ANAWireBrk_Th can be used to configure wire break monitoring for the analog inputs. For details see Section "Wire Break Monitoring" on page 315.

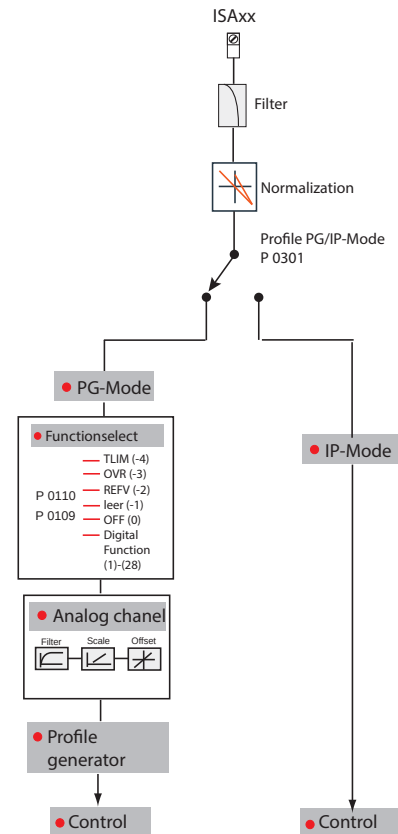


Fig. 8.69: Reference processing structure

ID	Index	Name	Unit	Description
395		CON_ANA_Isaf_Scaled		"analog inputs: Values (filt, norm, comp, scaled)"
395	0	ISA00		"Scaled, compensated, filtered, normalized value"
395	1	ISA01		"Scaled, compensated, filtered, normalized value"
396		CON_ANA_Scale_ThUpper		analog inputs: Upper scaling limits
396	0	ISA00	%	Upper scaling (@ 10 V) threshold
396	1	ISA01	%	Upper scaling (@ 10 V) threshold
397		CON_ANA_Scale_ThZero		analog inputs: Zero scaling thresholds
397	0	ISA00	V	Zero scaling threshold (+/-)
397	1	ISA01	V	Zero scaling threshold (+/-)
398		CON_ANA_Scale_ThLower		analog inputs: Lower scaling limits
398	0	ISA00	%	Lower scaling (@ zero threshold) threshold
398	1	ISA01	%	Lower scaling (@ zero threshold) threshold
399		CON_ANA_WireBrk_Th		analog inputs: Wire break thresholds
399	0	ISA00	V	Wire break detection threshold
399	1	ISA01	V	Wire break detection threshold
405	0	CON_ANA_Filt0	ms	analog input ISA00: Filter time constant (PT 1)
408		CON_ANA_Isaf_Norm		"analog inputs: Values (filt, norm)"
408	0	ISA00		"Filtered, normalized value"
408	1	ISA01		"Filtered, normalized value"

Table 8.25: "analog channel" parameters

ID	Index	Name	Unit	Description
173		MPRO_ANA0_Scale		ANA0: scale factors
173	0	MPRO_ANA0_TScale	Nm	ANA0: scale factor torque reference
173	1	MPRO_ANA0_SScale	rev/min	ANA0: scale factor speed reference
173	2	MPRO_ANA0_PScale	mDegree	ANA0: scale factor position reference
174		MPRO_ANA0_Offset		ANA0: offsets
174	0	MPRO_ANA0_TOffset	Nm	ANA0: offsets for torque reference

Table 8.26: "analog channel ISA00" parameters

ID	Index	Name	Unit	Description
174	1	MPRO_ANA0_SOffset	rev/min	ANA0: offsets for speed reference
174	2	MPRO_ANA0_POffset	mDegree	ANA0: offsets for position reference
175		MPRO_ANA0_Threshold		ANA0: thresholds
175	0	MPRO_ANA0_TThreshold	Nm	ANA0: threshold for torque reference
175	1	MPRO_ANA0_SThreshold	rev/min	ANA0: threshold for speed reference
175	2	MPRO_ANA0_PThreshold	mDegree	ANA0: threshold for position reference
176		MPRO_ANA0_TRamp		ANA0: Torque mode acceleration [0] and deceleration [1]
176	0	MPRO_ANA0_TRamp	Nm/s	
176	1	MPRO_ANA0_TRamp	Nm/s	
177		MPRO_ANA0_SRamp		ANA0: Speed mode acceleration [0] and deceleration [1]
177	0	MPRO_ANA0_SRamp	SPEED/s	
177	1	MPRO_ANA0_SRamp	SPEED/s	

Table 8.26: "analog channel ISA00" parameters (continue)

ID	Index	Name	Unit	Description
183		MPRO_ANA1_Scale		ANA1: scale factors
183	0	MPRO_ANA1_TScale	Nm	ANA0: scale factor torque reference
183	1	MPRO_ANA1_SScale	rev/min	ANA0: scale factor speed reference
183	2	MPRO_ANA1_PScale	mDegree	ANA0: scale factor position reference
184		MPRO_ANA1_Offset		ANA1: offsets
184	0	MPRO_ANA1_TOffset	Nm	ANA1: offsets for torque reference
184	1	MPRO_ANA1_SOffset	rev/min	ANA1: offsets for speed reference
184	2	MPRO_ANA1_POffset	mDegree	ANA1: offsets for position reference
185		MPRO_ANA1_Threshold		ANA1: thresholds
185	0	MPRO_ANA1_TThreshold	Nm	ANA1: threshold for torque reference
185	1	MPRO_ANA1_SThreshold	rev/min	ANA1: threshold for speed reference
185	2	MPRO_ANA1_PThreshold	mDegree	ANA1: threshold for position reference

Table 8.27: "analog channel ISA01" parameters

ID	Index	Name	Unit	Description
		PThreshold		
186		MPRO_ANA1_TRamp		ANA1: Torque mode acceleration [0] and deceleration[1]
186	0	MPRO_ANA1_TRamp	Nm/s	
186	1	MPRO_ANA1_TRamp	Nm/s	
187		MPRO_ANA1_SRamp		ANA1: Speed mode acceleration [0] and deceleration [1]
187	0	MPRO_ANA1_SRamp	SPEED/s	
187	1	MPRO_ANA1_SRamp	SPEED/s	

Table 8.27: "analog channel ISA01" parameters (continue)

8.9 State machine

The system state of the drive is basically managed by the central state machine according to CiA 402. However, the transitions and states which the state machine passes through are dependent on the drive profile setting and the bus system used. During operation, a distinction is made between drive standstill, operation and the error states.

Display	System state
	Initialization on device startup
	Not ready (DC link voltage possibly too low)
	Start inhibit (DC link voltage present, power stage off)
	Starting lockout
	Ready for start
	Control initialization: Auto commutation, flux build-up etc.

Table 8.28: Central state machine according to CiA 402 device display

Display	System state
	Control enabled
	Quick stop active
	Error reaction active
	Error state (in this state the error is indicated directly on the display.)
	Device is reset (display flashes)
• Number [5.] flashes when "STO" (Safe Torque Off) input is active. Display goes out when STO inactive. • The dot on the display flashes when the power stage is active.	

Table 8.28: Central state machine according to CiA 402 device display (continue)

**NOTE**

- The system states indicated on the display may differ from the states in the table depending on the drive profile setting.

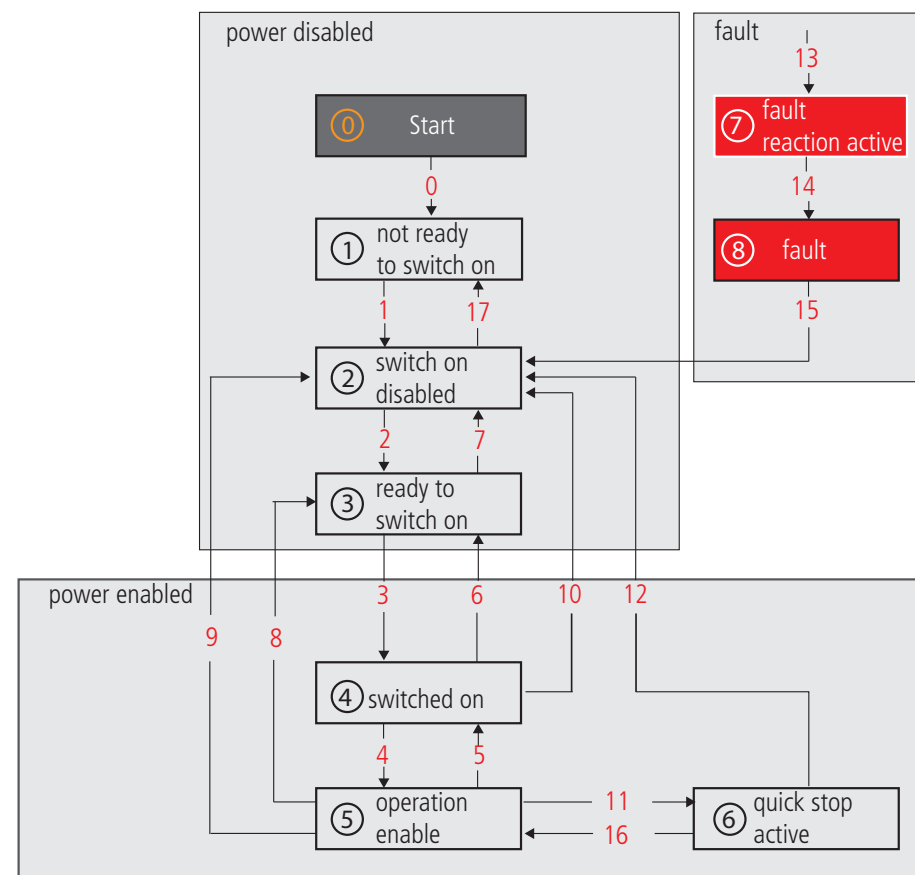


Fig. 8.70: State machine diagram based on CANopen communications

① to ① State number

1 to 17 State transition (No. 17: DC link voltage switched off)

Legend for "State machine diagram based on CANopen communications" figure

8.10 Touch probe

Using the touch probe inputs, touch probe functions can be performed. In order to be able to do this, **P 106[0] - MPRO_INPUT_FS_ISD05** and **P 107[0] - MPRO_INPUT_FS_ISD06** must be used to set digital inputs ISD05 and ISD06 to "PROBE(15) = Touch probe (only ISD05/06)" (see Section "Digital inputs" on page 299). HTL encoders can be evaluated or pulse counters implemented using the MSD PLC .

The touch probe can be triggered with **P 240 - MPRO_TP_Ctrl**. This enables triggering on a positive or negative edge, or on both edges, of the signal detected on the touch probe inputs. After the measurement, the parameter jumps back to the value "NONE (0)" and the latch position is mapped in the corresponding subindex of parameter **P 241 - MPRO_TP_Position**. A continuous touch probe mode is not possible at present, so the touch probe has to be reactivated after the measurement.

P 1402 - MPRO_TP_Channel can be used to select various positions as actual value sources of the latch position for the touch probe functionality.

The following table provides an overview of the available settings. The counters are accessed via the MSD PLC or a bus system.

ID	Index	Name / Setting	Unit	Description
240		MPRO_TP_Ctrl		Touch probe: Control
The following settings apply to indexes 0–2	0			NONE (0) = No function
	1			POS (1) = Positive edge
	2			NEG (2) = Negative edge
	3			BOTH (3) = Both edges
240	0	MPRO_TP_Ctrl		
240	1	MPRO_TP_Ctrl		
240	2	MPRO_TP_Ctrl		
241		MPRO_TP_Position		Probe: Pos. high/low edge of TP0/1, encoder zero pulse

Table 8.29: "Touch probe" parameters

ID	Index	Name / Setting	Unit	Description
241	0	MPRO_TP_Position	mDegree	
241	1	MPRO_TP_Position	mDegree	
241	2	MPRO_TP_Position	mDegree	
241	3	MPRO_TP_Position	mDegree	
241	4	MPRO_TP_Position	mDegree	
1400	0	MPRO_TP_Config		Touch probe: Configuration
		TP_TP (0)		TP0, TP1 touch probe
		AB (1)		TP0, TP1 as encoder, A/B as quadrature counting
		PD_UP (2)		TP0, TP1 as encoder, pulse (TP0) / direction (TP1), count up on direction high
		PD_DOWN (3)		TP0, TP1 as encoder, pulse (TP0) / direction (TP1), count down on direction high
		PC_PC (4)		TP0 pulse counter, TP1 pulse counter
		PC_TP (5)		TP0 pulse counter, TP1 touch probe
		TP_PC (6)		TP1 touch probe, TP0 pulse counter
		ENC_ENC (7)		TP0 encoder counter, TP1 encoder counter
		ENC_TP (8)		TP0 encoder counter, TP1 touch probe
		TP_ENC (9)		TP0 touch probe, TP1 encoder counter
1402		MPRO_TP_Channel		Touch probe: Channel
The following settings apply to indexes 0–2	0			ACTPOS (0) = Actual position in user units
	1			ACTPOSINC (1) = Actual position in increments
	2			MASTERPOS (2) = Master position in increments
	3			ENCPOS_CH1 (3) = Encoder position Channel 1
	4			ENCPOS_CH1_INC (4) = Encoder position Channel 1 in increments
	5			ENCPOS_CH2 (5) = Encoder position Channel 2
	6			ENCPOS_CH2_INC (6) = Encoder position Channel 2 in increments

ID	Index	Name / Setting	Unit	Description
		7		ENCPOS_CH3 (7) = Encoder position Channel 3
		8		ENCPOS_CH3_INC (8) = Encoder position Channel 3 in increments
		9		ENCPOS_CH4 (9) = Encoder position Channel 4
		10		ENCPOS_CH4_INC (10) = Encoder position Channel 4 in increments
		11		ACTPOS2 (11) = Actual position of redundant encoder in user units
		12		Sercos (12) = Referred to Sercos profile parameters S-x-0426, S-x-0427
		13		UserRefPos(13)= Reference position in user units
		14		MasterPosST(14) = Master position (ECAM, EGEAR) singleturn, always steps
		15		CommonMasterPos(15) = Master position (ECAM, EGEAR) singleturn, always steps
		16		CommonMasterPosST(15) = Master position (ECAM, EGEAR) singleturn, always steps
1402	0	MPRO_TP_Channel		
1402	1	MPRO_TP_Channel		
1402	2	MPRO_TP_Channel		
1404		MPRO_TP_Lines		Touch probe: Lines @ pulse counter on channel x
1404	0	MPRO_TP_Lines		
1404	1	MPRO_TP_Lines		

Table 8.29: "Touch probe" parameters (continue)

NOTE

- For more information refer to the bus system user manuals or the description of the MSD PLC .

8.11 Synchronized motion

The Synchronized Movement function enables synchronous running of the drive in relation to a real or virtual master axis.

Digital control signals are used to provide positionally precise disengagement from the guide value (e.g. with standstill at cycle end) and positionally precise engagement to the current guide value.

An encoder system, the virtual master or the parameter interface is selected as the master encoder in the master configuration. By setting the parameter interface to a bus system (Basic setting Control and Reference) control is programmed via a bus system.

Synchronized motion:

Mode of synchronized motion

OFF(0) = Synchronized motion off

Master konfiguration

Electronic gear

Electronic camming

Fig. 8.71: "Synchronized motion" screen

There are various modes available in the "synchronization mode" drop-down menu (P 242[0] - MPRO_ECAM_SyncModMode):

- Off(0) = Synchronized motion off
- ECAM_iPlc(1) = Electr. Cam plate via MSD PLC
- EGEAR_iPlc(2) = Electr. Gearing via MSD PLC
- ECAM_PARA(3) = Electr. Cam plate via parameter
- EGEAR_PARA(4) = Electr. Gearing via parameter

The other parameters are configured in separate screens that can be accessed with the corresponding buttons.

- Master configuration (see Section "Master configuration" on page 289)
- Electr. Gearing (see Section "Electronic gearing" on page 292)
- Electr. Cam plate (see Section "Electronic cam plate" on page 286)

P 1318[0] - MPRO_ECAM_ControlWord is the control word for "synchronized motion" (see Section "Control word for synchronized motion" on page 288).

P 1326[0] - MPRO_ECAM_StatusWord is the status word for "synchronized motion" (see Section "Status word for synchronized motion" on page 288).

ID	Index	Name	Unit	Description
242	0	MPRO_ECAM_SyncModMode		ECAM / EGEAR: Mode of synchronized motion
265	0	MPRO_ECAM_CamSlave_SpeedFactor		ECAM / EGEAR: Slave speed factor (1 = 100%).
266	0	MPRO_ECAM_CamSlave_TorqueFactor		ECAM / EGEAR: Slave torque factor (1 = 100%).
268	0	MPRO_ECAM_AsyncMode		ECAM / EGEAR: Mode of switching off sync. motion
1318	0	MPRO_ECAM_ControlWord		ECAM / EGEAR: Control word
1326	0	MPRO_ECAM_StatusWord		ECAM / EGEAR: Status word

Table 8.30: "Synchronized motion" parameters

8.11.1 Electronic cam plate

8.11.1.1 Table selection

ID	Index	Name	Unit	Description
1300	0	MPRO_ECAM_CTS_MasterRef		ECAM: CamTableSelect - Master reference
1301	0	MPRO_ECAM_CTS_SlaveRef		ECAM: CamTableSelect - Slave reference
1305	0	MPRO_ECAM_CTS_ChangeMethod		ECAM: CamTableSelect - Method for changing the camtable
1306	0	MPRO_ECAM_CTS_ChangeMode		ECAM: CamTableSelect - Mode for changing the camtable
1307	0	MPRO_ECAM_CTS_ChangeDistance	incr	ECAM: CamTableSelect - Distance for changing the camtable

Table 8.31: "Electronic camming - Table selection" parameters

8.11.1.2 Synchronization

ID	Index	Name	Unit	Description
1342	0	MPRO_ECAM_CI_SyncPosMT	incr	ECAM: CamIn - Synchronization position (multiturn part)
1343	0	MPRO_ECAM_CO_BreakingPosMT	incr	ECAM: CamOut - Decoupling pos. (multiturn part)
1303	0	MPRO_ECAM_CI_MasterOffset	incr	ECAM: CamIn - Master offset
1308	0	MPRO_ECAM_CI_MasterRef		ECAM: CamIn - Master reference
1309	0	MPRO_ECAM_CI_SlaveRef		ECAM: CamIn - Slave reference
1310	0	MPRO_ECAM_CI_CouplingMode		ECAM: CamIn - Coupling mode
1311	0	MPRO_ECAM_CI_CouplingDist	incr	ECAM: CamIn - Coupling distance
1312	0	MPRO_ECAM_CI_SyncPosMT	incr	ECAM: CamIn - Synchronization position

Table 8.32: "Electronic camming - Synchronization" parameters

ID	Index	Name	Unit	Description
		SyncPosST		(singleturn part)
1313	0	MPRO_ECAM_CO_SlaveRef		ECAM: CamOut - Slave reference
1314	0	MPRO_ECAM_CO_DecouplingMode		ECAM: CamOut - Decoupling mode
1315	0	MPRO_ECAM_CO_BreakingPosST	incr	ECAM: CamOut - Decoupling position (singleturn part)
1316	0	MPRO_ECAM_CO_DecouplingDist	incr	ECAM: CamOut - Decoupling distance
1317	0	MPRO_ECAM_CO_StandstillPos	mDegree	ECAM: CamOut - Slave standstill position

Table 8.32: "Electronic camming - Synchronization" parameters (continue)

8.11.1.3 Table segments

ID	Index	Name	Unit	Description
1329	0 to 63	MPRO_ECAM_SegData_IndexNext		ECAM: Index of the following segment
1330	0 to 63	MPRO_ECAM_SegData_IndexPrev		ECAM: Index of the previous segment
1331	0 to 63	MPRO_ECAM_SegData_ProfileMode		ECAM: Profile mode of the current segment
1332	0 to 63	MPRO_ECAM_SegData_DistMaster		ECAM: Length of the master section of the current segment
1333	0 to 63	MPRO_ECAM_SegData_DistSlave		ECAM: Length of the slave section of the current segment
1334	0 to 63	MPRO_ECAM_SegData_Lambda		ECAM: Lambda value of the current segment
1335	0 to 63	MPRO_ECAM_SegData_StatusWord		ECAM: Status word of the current segment
1336	0 to 63	MPRO_ECAM_SegData_ControlWord		ECAM: Control word of the current segment

Table 8.33: "Electronic camming - Table segments" parameters

ID	Index	Name	Unit	Description
1337	0 to 63	MPRO_ECAM_SegData_SegmentMode		ECAM: Segment mode of the current segment
1338	0 to 63	MPRO_ECAM_SegData_ConstPool		ECAM: Indicator for pool of constants, current segment
1339	0 to 63	MPRO_ECAM_SegData_Constants		ECAM: First constant of the current segment

Table 8.33: "Electronic camming - Table segments" parameters (continue)

8.11.1.4 CAM setpoint segments

ID	Index	Name	Unit	Description
1346		MPRO_ECAM_SP_Table		ECAM: Setpoint table interface
1346	0	Index		Index of setpoint table
1346	1	Value		Value at index of setpoint table
1347	0 to 31	MPRO_ECAM_SP_Index		ECAM: Setpoint segments start index
1348	0 to 31	MPRO_ECAM_SP_Length		ECAM: Setpoint segments length
1349	0 to 31	MPRO_ECAM_SP_MaDist		ECAM: Setpoint segments master distance
1350	0	MPRO_ECAM_SP_IpoType		ECAM: Setpoint segments interpolation type
1351	0	MPRO_ECAM_SP_Checksum		ECAM: Setpoint table checksum
1352	0 to 31	MPRO_ECAM_SP_GainNum		ECAM: Setpoint segments gain numerator
1353	0 to 31	MPRO_ECAM_SP_GainDen		ECAM: Setpoint segments gain denominator

Table 8.34: "Electronic camming - CAM setpoint segments" parameters

8.11.2 Control word for synchronized motion

Bit	Function	PLC function
0-7	Start segment (8-bit value)	-
8-15	Reserved	-
16	Absolute (true) / relative (false) master relationship	-
17	Absolute (true) / relative (false) master (CAM) relationship at cam in	-
18	Absolute (true) / relative (false) slave (CAM) relationship at cam in	-
19-23	Reserved	-
24	Change gear ratio of the electronic gear online	MCB_GearRatioChange
25	Disable master calculation	MCB_Cam_MasterEnable
26	Enable master calculation	MCB_Cam_MasterEnable
27	Select CAM table	MCB_CamTableSelect
28	Start Ecam	MCB_CamIn
29	Stop Ecam	MCB_CamOut
30	Start Egear	MCB_GearIn
31	Stop Egear	MCB_GearOut

Table 8.35: Control word ECAM (P 1318[0] - MPRO_ECAM_ControlWord)

8.11.3 Status word for synchronized motion

Bit number	Description
0-7	Actual segment (8-bit value)
8-11	Actual ECAM / EGEAR state machine state (4 Bit value) • 0: ECAM / EGEAR asynchronous • 1: ECAM / EGEAR synchronous • 2: ECAM / EGEAR synchronizing • 3: ECAM / EGEAR desynchronizing • 4: ECAM / EGEAR active and waiting for going asynchronous • 5: ECAM / EGEAR inactive and waiting for going synchronous
12-26	Reserved
27	ECAM / EGEAR is active
28	Valid segments chosen
29	Master data are valid
30	Master is initialized
31	Master calculation is active

Table 8.36: ECAM status word (P 1326[0] - MPRO_ECAM_StatusWord)

8.11.4 Master configuration

Master configuration:

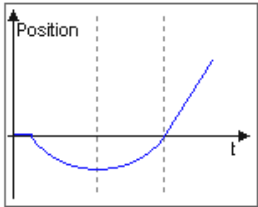
Channel selection (master encoder) PARA(2) = Parameter interface master Options...

Anti reverse mode INACTIVE(0) = Reverse lock inactive

Filter type PT1(1) = PT1 filter

Filter time 1 ms

Speed factor 1
0 ... 1 => 0 ... 100%



Parameter interface master:

Position resolution master Inc/U 2^16 incr(16) =

Fig. 8.72: "Master configuration" screen

Channel selection (master encoder)

P 1319[0] - MPRO_ECAM_CamMaster_AxisType is used to define the master encoder.

- *NO AXIS (0) = No axis*
- *VIRTUAL MASTER (1) = Virtual master*
If you select this function, you will be able to configure additional settings by clicking on the enabled "Options..." button (see Section "Virtual Master" on page 295).
- *PARA (2) = Master parameter interface*
If you select this function because a higher-level controller is being used as

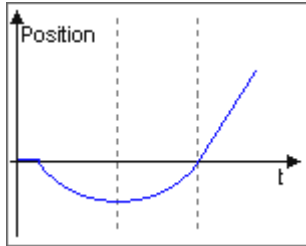
the master encoder, you will need to set the resolution relative to a single motor revolution in **P 250 - MPRO_ECAM_PARAMaster_Amplitude** (see below).

- *ENC CH1 (3) = Encoder channel 1 X7 (Sin/Cos)*
- *ENC CH2 (4) = Encoder channel 2 X6 (Resolver)*
- *ENC CH3 (5) = Encoder channel 3 X8 (optional)*
This function is only available if an external interface X8 (option module) is present.
- *TP0 (6) = Pulse counter on probe channel 0 (TP0)*
- *TP1 (7) = Pulse counter on probe channel 1 (TP1)*
- *ENC_CH4 (8) = Encoder channel 4 (p. e. fieldbus)*
- *TWIN_POS (9) = TWIN remote reference position (P-2607)*

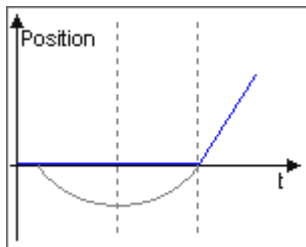
Anti-reverse mode

P 1320[0] - MPRO_ECAM_CamMaster_RevLockMode is used to define the reverse lock mode, which can be used either with or without path compensation. The dashed lines in the following diagrams indicate what the engagement distance is:

- **INACTIVE (0) = Reverse lock inactive**
The slave follows the master directly and in every direction.



- **ACTIVE WAY COMP (1) = Reverse lock active - with way compensation**
While the slave accelerates to the speed of the master during engagement, the master and slave do not move synchronously. This function needs to be selected in order to quickly catch up to the master that is running ahead.



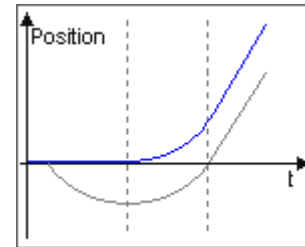
- Master (black line) rotates in the blocked direction
- The slave (blue line) will remain stopped
- Master rotates in the unblocked direction

- Slave only starts moving along with it again as soon as the master reaches the zero position.

Example:

If the master, which has moved two motor revolutions in the direction blocked for the slave, then moves in the unblocked direction again, the slave only moves off when the master has traversed the zero point.

- **ACTIVE (2) = Reverse lock enabled - without path optimization**



- Master (black line) rotates in the blocked direction
- The slave (blue line) remains stopped
- Master rotates in the unblocked direction again
- The slave follows the master directly in the unblocked direction

Example:

Assume the master has moved two motor revolutions in the direction for which the slave lock is enabled. If the master now moves in the direction for which there is no lock, the slave will immediately start running in that direction.

Filter type

When using a real master encoder, encoder signals may be subject to noise. **P 1340 [0] - MPRO_ECAM_CamMaster_SpeedFilTyp** can be used to select a filter type in order to smooth the signals.

- OFF (0) = No filter
- PT1 (1) = PT1 filter
- AVG (2) = Average filter

Filter time

If **P 1340[0]** is used to enable a filter, **P 1327[0] - MPRO_ECAM_CamMaster_SpeedTFil** can be used to define the corresponding filter time.

Speed factor

The master encoder can be assigned an additional speed factor **P 1328[0] - MPRO_ECAM_CamMaster_SpeedFactor**.

Incl/rev master encoder position resolution

If you are using a higher-level controller (**P 1319[0] = PARA (2)**), you will need to set the number of increments per motor revolution in **P 250[0] - MPRO_ECAM_ParaMaster_Amplitude**.

ID	Index	Name	Unit	Description
247	0	MPRO_ECAM_ParaMaster_ActPos	incr	ECAM / EGEAR: Parameter interface master position
248	0	MPRO_ECAM_ParaMaster_ActSpeed	rpm	ECAM / EGEAR: Parameter interface master speed
249	0	MPRO_ECAM_ParaMaster_ActAcc	rpm / s	ECAM / EGEAR: Parameter interface master acceleration
250	0	MPRO_ECAM_ParaMaster_Amplitude		ECAM / EGEAR: Parameter interface master amplitude

Table 8.37: "Synchronized motion - Master configuration" parameters

ID	Index	Name	Unit	Description
1319	0	MPRO_ECAM_CamMaster_AxisType		ECAM / EGEAR: Channel selection of internal master input
1320	0	MPRO_ECAM_CamMaster_RevLockMode		ECAM / EGEAR: Reverse lock mode of master drive
1321	0	MPRO_ECAM_CamMaster_Amplitude	incr	ECAM / EGEAR: Amplitude of the internal master
1322	0	MPRO_ECAM_CamMaster_GearNum		ECAM / EGEAR: Gear numerator of the master drive
1323	0	MPRO_ECAM_CamMaster_GearDen		ECAM / EGEAR: Denominator of the master drive
1327	0	MPRO_ECAM_CamMaster_SpeedTFil	ms	ECAM / EGEAR: Filter time constant of master speed
1328	0	MPRO_ECAM_CamMaster_SpeedFactor		ECAM / EGEAR: Speed factor of the internal master
1340	0	MPRO_ECAM_CamMaster_SpeedFilTyp		ECAM / EGEAR: Filter type of master speed
1341	0	MPRO_ECAM_CamMaster_Offset	incr	ECAM / EGEAR: Master drive offset

Table 8.37: "Synchronized motion - Master configuration" parameters (continue)

8.11.5 Electronic gearing

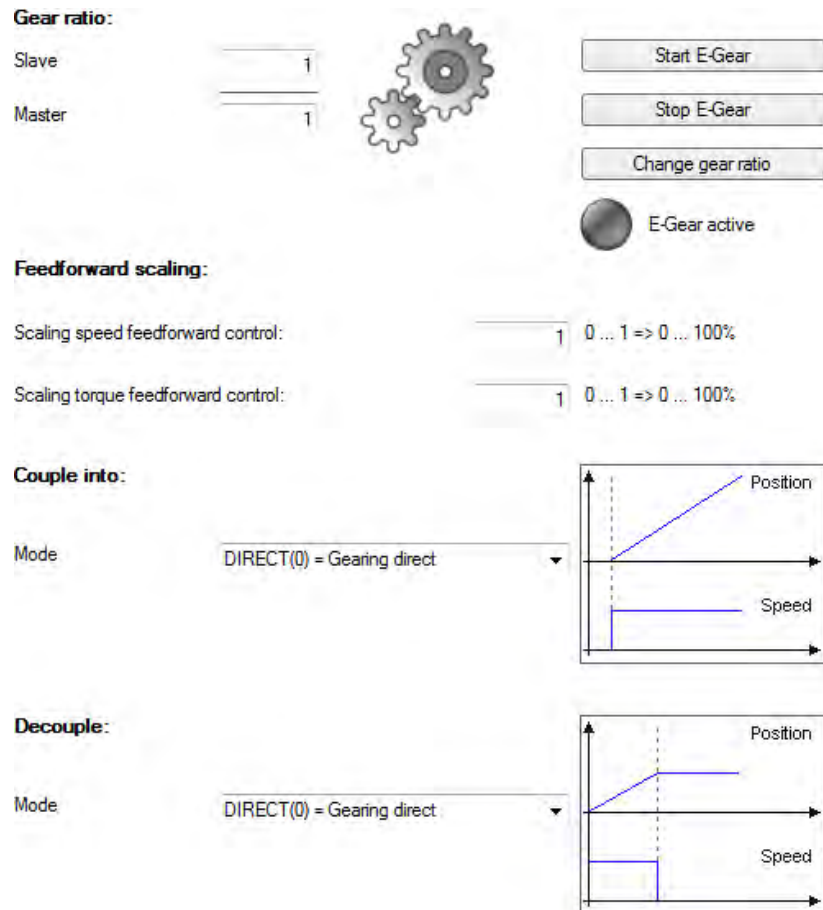


Fig. 8.73: "Electronic gearing" screen

Gear ratio

The gear ratio is specified as a fraction. This ensures that the position references can be translated to the motor shaft with no rounding error.

- "Slave" (P 252[0] - MPRO_ECAM_Egear_GearNum) is the numerator
- "Master" (P 251[0] - MPRO_ECAM_Egear_GearDen) is the denominator

Scaling of speed pre-control

Defined with P 265[0] - MPRO_ECAM_CamSlave_SpeedFactor .

Scaling of torque pre-control

Defined with P 266[0] - MPRO_ECAM_CamSlave_TorqueFactor.

Engagement

See Section "Engagement" on page 293.

Disengagement

See Section "Disengagement" on page 294.

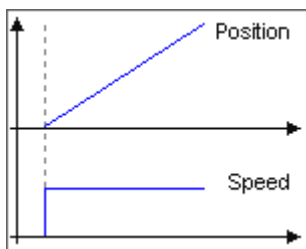
ID	Index	Name	Unit	Description
251	0	MPRO_ECAM_Egear_GearDen		EGEAR: Gear denominator
252	0	MPRO_ECAM_Egear_GearNum		EGEAR: Numerator of gear ratio
1344	0	MPRO_ECAM_Egear_LimRefAcc	rpm/s	EGEAR: Acceleration limit for reference
1345	0	MPRO_ECAM_Egear_LimRefJerk	rpm/s^2	EGEAR: Jerk limit for reference

Table 8.38: "Synchronized motion - Electronic gearing" parameters

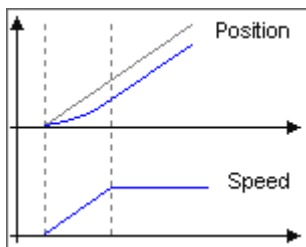
8.11.6 Engagement

P 253[0] - **MPRO_ECAM_Egear_GearInMode** is used to define the mode for engagement.

- **DIRECT (0) = Direct**
Direct engagement: Angular synchronous; with jerking (no ramps).

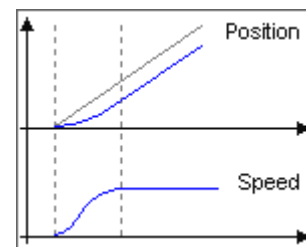


- **RAMP (1) = Linear speed ramp**
Engagement with linear acceleration: Not angular synchronous; with jerking.
P 255[0] (see below) can be used to define the acceleration.

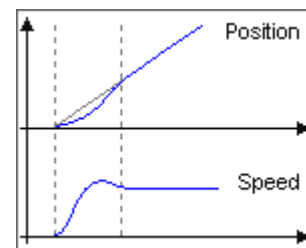


- **FADE (2) = Engagement fade-out**
Engagement with fade-in function (5th degree polynomial): Not angular synchronous; jerk-limited. The position is ignored. There always remains a variation between reference and actual position. **P 257[0]** (see below) is

used to define the engagement distance (between the dashed lines).



- **CROSSFADE (3) = Crossfading**
Engagement with crossfading function (5th degree polynomial): Angular synchronous; jerk-limited; speed will overshoot during engagement.



P 255[0] - **MPRO_ECAM_Egear_GearInAcc** is used to define the acceleration for the "RAMP (1)" mode.

P 257[0] - **MPRO_ECAM_Egear_GearInDist** is used to define the engagement distance. The actual engagement occurs within this range (between the dashed lines).

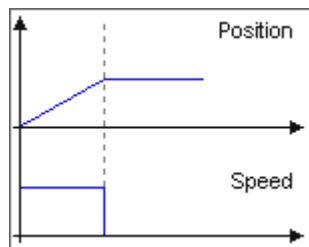
ID	Index	Name	Unit	Description
253	0	MPRO_ECAM_Egear_GearInMode		EGEAR: GearIn - engagement mode
255	0	MPRO_ECAM_Egear_GearInAcc	rev/min/s	EGEAR: GearIn - acceleration ramp for engagement
257	0	MPRO_ECAM_Egear_GearInDist	incr	EGEAR: GearIn - engagement distance
263	0	MPRO_ECAM_Egear_GearInJerk	rpm/s^2	EGEAR: GearIn - acceleration ramp jerk for engagement

Table 8.39: "Synchronized motion - Electronic gearing - Engagement" parameters

8.11.7 Disengagement

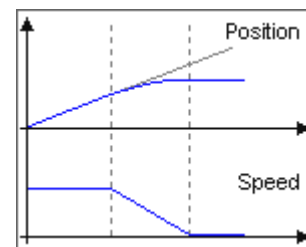
P 254[0] - **MPRO_ECAM_Egear_GearOutMode** is used to define the mode for disengagement.

- **DIRECT (0) = Direct**
Direct disengagement: With jerking (no ramps).

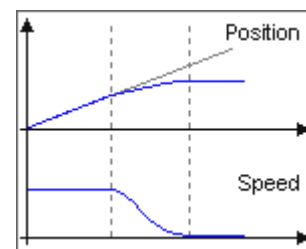


- **RAMP (1) = Linear speed ramp**
Disengagement with linear deceleration: With jerking. **P 256[0]** (see below)

can be used to define the deceleration.



- **FADE (2) = Engagement fade-out**
Disengagement with fade-out function (5th order polynomial): jerk limited. The position is ignored. There always remains a variation between reference and actual position. **P 258[0]** (see below) is used to define the disengagement distance (between the dashed lines).



P 256[0] - **MPRO_ECAM_Egear_GearOutAcc** is used to define the deceleration for the "RAMP (1)" mode.

P 258[0] - **MPRO_ECAM_Egear_GearOutDist** is used to define the disengagement distance. The actual disengagement occurs within this range (between the dashed lines).

ID	Index	Name	Unit	Description
254	0	MPRO_ECAM_Egear_GearOutMode		EGEAR: GearOut - disengagement mode
256	0	MPRO_ECAM_Egear_GearOutDec	rev/min/s	EGEAR: GearOut - deceleration ramp for disengagement
258	0	MPRO_ECAM_Egear_GearOutDist	incr	EGEAR: GearOut - disengagement distance
264	0	MPRO_ECAM_Egear_GearOutJerk	rpm/s^2	EGEAR: GearOut - acceleration ramp jerk for disengagement

Table 8.40: "Synchronized motion - Electronic gearing - Disengagement" parameters

8.12 Virtual Master

Virtual Master:

Speed rpm

Amplitude incr/rev

Acceleration rpm/s

Deceleration rpm/s

Jerk rpm/s^2

Status: READY

Actual speed: 0 rpm

Actual position: 0 incr

Fig. 8.74: "Virtual master" screen

Click "Start" to start the engagement and click "Stop" and "Halt" correspondingly to stop it.



NOTE

- The virtual master must be activated by clicking the "Start" button, and remains active for operation of a synchronized movement.

ID	Index	Name	Unit	Description
244	0	MPRO_ECAM_VM_Speed	rpm	Virtual master reference speed
245	0	MPRO_ECAM_VM_Amplitude	incr/rev	Virtual master amplitude
246	0	MPRO_ECAM_VM_PosAct	incr	Virtual master actual position
259	0	MPRO_ECAM_VM_Acc	rpm/s	Virtual master acceleration
260	0	MPRO_ECAM_VM_Dec	rpm/s	Virtual master deceleration
261	0	MPRO_ECAM_VM_Jerk	rpm/s ²	Virtual master jerk
262	0	MPRO_ECAM_VM_SpeedAct	rpm	Virtual master actual speed
267	0	MPRO_ECAM_VM_Ctrl		Virtual master control word

Table 8.41: "Virtual master" parameters

8.13 Common master

ID	Index	Name	Unit	Description
1407	0	MPRO_CMST_ControlWord		Common master: Control word
1408	0	MPRO_CMST_StatusWord		Common master: Status word
1409		MPRO_CMST_Para		Data of common master
1409	0	Source		Source of value processing
1409	1	Destination		Destination of value processing
1409	2	RevLockMode		Reverse lock mode
1409	3	Amplitude	incr	Amplitude
1409	4	GearNum		Gear numerator
1409	5	GearDen		Gear denominator
1409	6	SpeedFilType		Speed filter: Filter type
1409	7	SpeedFilTs	ms	Speed filter: Filter time
1409	8	SpeedFactor		Speed filter: Factor
1409	9	Offset	incr	Position offset
1410		MPRO_CMST_ParaPhasing		Data of common master phasing
1410	0	Position	incr	Position phasing difference
1410	1	Velocity	rpm	Position phasing velocity
1410	2	Acceleration	rpm/s	Position phasing acceleration
1411		MPRO_CMST_ActVal		Actual values of common master
1411	0	PosST	incr	Position singleturn part
1411	1	PosMT	r	Position multiturn part
1411	2	Vel	rpm	Velocity

Table 8.42: "Common master" parameters

8.14 Cam group (CAM switch)

The function is not available as standard. It must be specially requested. Please contact Moog.

8.15 Data handling

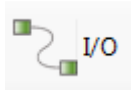
ID	Index	Name	Unit	Description
2920	0	MPRO_DATA_Ctrl		Extended data control word
2921	0	MPRO_DATA_Stat		Extended data status word
2922	0	MPRO_DATA_Act		Actual signal value
2923	0	MPRO_DATA_Upper		Reference upper limit value
2924	0	MPRO_DATA_Lower		Reference lower limit value
2925	0	MPRO_DATA_Ref		Reference value
2926	0	MPRO_DATA_Signal		Signal selection
2927	0	MPRO_DATA_ActIdx		Actual index of value
2928		MPRO_DATA_Info		Extended data information
2928	0	MPRO_DATA_MaxIdx		Maximum stored values
2928	1	MPRO_DATA_Crc		CRC of stored values
2929		MPRO_DATA_Value		Feed-forward calculation mode
2929	0	MPRO_DATA_UpperLimit		Upper limit offset
2929	1	MPRO_DATA_LowerLimit		Lower limit offset
2930	0	MPRO_DATA_DataName		Name of data set

Table 8.43: "Data handling" parameters

9 Inputs/Outputs settings

Chapter overview

Pictogram



Navigation ► Project tree ► Device setup ► Input/Output settings

Brief description This chapter describes how the digital inputs and outputs, the analog inputs and outputs, and the motor brake output on the MSD Servo Drive and MSD Single-Axis Servo Drive Compact work and are configured.

Contents	9.1 Inputs/Outputs settings	298
	9.2 Digital inputs	299
	9.3 Digital Outputs	307
	9.4 Analog Inputs	312
	9.5 Analog outputs (option only for MSD Servo Drive)	316
	9.6 Motor brake output	317

9.1 Inputs/Outputs settings

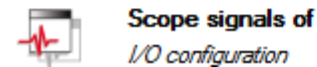
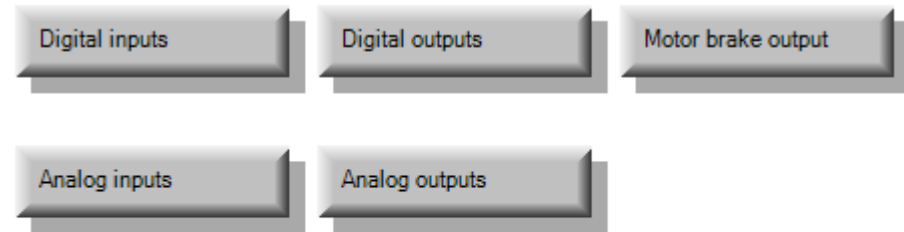


Fig. 9.1: "Inputs/Outputs settings" screen

The buttons on this screen can be used to access and configure the individual input and output types.

Inputs

- Before using the digital inputs, they are normally associated with a special device functionality for **digital** inputs with the use of function selectors.
- Likewise, before using the analog inputs, these are normally associated with a special device functionality for **analog** inputs. The corresponding function selectors also make it possible to select a special digital functionality instead.
- Two of the digital standard inputs on the device are what are referred to as "touch probe inputs". These inputs are faster than the other inputs.

Outputs

- While function selectors can be used to assign **digital** outputs a wide range of special device functionalities for digital outputs, the special device functionality for analog outputs is considerably more limited and does not overlap with the digital outputs' functionality. Moreover, analog outputs are only available when using X8 option modules!
- The motor brake output is a digital output with special hardware for driving a motor brake, which is normally found inside the motor casing.

9.2 Digital inputs

Digital standard inputs:		Low active	Digital Filter	
ISD00	START(1) = Start motor control	☐	0 ms	Options...
ISD01	HOMST(9) = Start homing	☐	0 ms	Options...
ISD02	TBEN(21) = Enable selected table index	☐	0 ms	Options...
ISD03	TAB0(23) = Binary table index 2 ⁰	☐	0 ms	Options...
ISD04	TAB1(24) = Binary table index 2 ¹	☐	0 ms	Options...
ISD05	JOG_EXT_POS(34) = Jog extended positive direction	☐	0 ms	Options...
ISD06	JOG_EXT_NEG(35) = Jog extended negative direction	☐	0 ms	Options...

Enable power stage (hardware):				
ENPO	OFF(0) = Hardware enable powerstage		0 ms	Options...

Digital virtual inputs:		On / Off	
ISV00	OFF(0) = No function	☐	Options...
ISV01	OFF(0) = No function	☐	Options...

[Show status of digital inputs](#)

Fig. 9.2: "Function selectors of the digital inputs" screen

Digital inputs can be:

- **ISD0x**
Digital standard inputs on the outside of the device with a functionality that can be freely configured to the greatest extent possible ("S" standard inputs)
- **ENPO**
A digital input (EnablePower) on the outside of the device that is used to enable/lock the power stage with hardware and that has a functionality that can be configured, albeit with very strict limitations
- **ISDSH**
A digital input (Safe Stop) on the outside of the device that is used for an enable/lock signal by the safety stop circuit and that has a functionality that cannot be changed
- **ISV0x**
"Virtual inputs" on the inside of the device with a freely configurable functionality much like that available for the ISD0x inputs
- **IED0x**
In addition, there can be additional digital inputs if the X8 option is used ("E" expansion inputs)

Status of the digital inputs

Clicking on the "Status of digital inputs" field on the input screen for the digital inputs will open a visualization showing the digital inputs' states (see Section "Status of the digital inputs" on page 303).

9.2.1 Digital standard inputs

There is a selector that can be used to assign a function to each digital standard input. Certain functions will only be available for certain inputs or with specific function packages. Depending on the configured function, the "Options..." button may become enabled. If so, it can be used to switch directly to a different subject area to there define the function's exact behaviour.

- The touch probe function is only available at ISD05 (**P 106[0] - MPRO_INPUT_FS_ISD05**) and ISD06 (**P 107[0] - MPRO_INPUT_FS_ISD06**).
- All inputs can be switched from "active-high" to "active-low" (individual bits in **P 120 - MPRO_INPUT_INV**).
- All inputs can be smoothed with a freely configurable filter time (**P 118 - MPRO_INPUT_FILTER**).

ID	Index	Name	Unit	Description
101	0	MPRO_INPUT_FS_ISD00		Function of digital input ISD00
102	0	MPRO_INPUT_FS_ISD01		Function of digital input ISD01
103	0	MPRO_INPUT_FS_ISD02		Function of digital input ISD02
104	0	MPRO_INPUT_FS_ISD03		Function of digital input ISD03
105	0	MPRO_INPUT_FS_ISD04		Function of digital input ISD04
106	0	MPRO_INPUT_FS_ISD05		Function of digital input ISD05
107	0	MPRO_INPUT_FS_ISD06		Function of digital input ISD06
108	0	MPRO_INPUT_FS_ISDSH		Function of digital input ISDSH
113		MPRO_INPUT_FS_IEDxx		Inputs extended digital: Function of digital inputs
113	0	IED00		Function of digital input IED00
113	1	IED01		Function of digital input IED01
113	2	IED02		Function of digital input IED02
113	3	IED03		Function of digital input IED03
118		MPRO_INPUT_FILTER		Digital inputs: Filter time
118	0	MPRO_INPUT_FILTER	ms	for ENPO
118	1	MPRO_INPUT_FILTER	ms	for ISD00
118	2	MPRO_INPUT_FILTER	ms	for ISD01
118	3	MPRO_INPUT_FILTER	ms	for ISD02
118	4	MPRO_INPUT_FILTER	ms	for ISD03
118	5	MPRO_INPUT_FILTER	ms	for ISD04
118	6	MPRO_INPUT_FILTER	ms	for ISD05
118	7	MPRO_INPUT_FILTER	ms	for ISD06
118	8	MPRO_INPUT_FILTER	ms	for ISA00
118	9	MPRO_INPUT_FILTER	ms	for ISA01
118	10	MPRO_INPUT_FILTER	ms	for ISDSH
118	11	MPRO_INPUT_FILTER	ms	for IED00
118	12	MPRO_INPUT_FILTER	ms	for IED01
118	13	MPRO_INPUT_FILTER	ms	for IED02

Table 9.1: "Digital standard inputs" parameters

ID	Index	Name	Unit	Description
118	14	MPRO_INPUT_FILTER	ms	for IED03
119	0	MPRO_INPUT_STATE_FIL		States of filtered and inverted digital inputs
120	0	MPRO_INPUT_INV		Dig. Input inversion (ENPO=0, ISD00-05=1-6, SH=7, ISD06=16)

Table 9.1: "Digital standard inputs" parameters (continue)

9.2.2 Function selectors

ID	Index	Name / Setting	Unit	Description
101 - 107	0	MPRO_INPUT_FS_ISDxx		Function selectors for the digital inputs
		Off (0)		Input without function
		START (1)		Start of control: Motor is energized. The direction of rotation depends on the reference.
		INV (2)		Inverse reference value
		STOP (3)		Carries out a quick stop as per the quick stop response (active-low)
		HALT (4)		Disable feed: The ongoing axis movement is interrupted and resumed as per the "HALT" reaction following resetting.
		LCW (5)		Limit switch positive direction: Limit switch evaluation without overrun protection, positive direction. The reaction to limit switch overrun and to interchanged limit switches can be preset.
		LCCW (6)		Limit switch negative direction: Limit switch evaluation without overrun protection, negative direction. The reaction to limit switch overrun and to interchanged limit switches can be preset.
		INCH_P (7)		Jog in positive direction
		INCH_N (8)		Jog in negative direction

Table 9.2: Function selectors "Digital inputs"

ID	Index	Name / Setting	Unit	Description
		HOMST (9)		Start homing according to the homing method parameterized in P 02261 MPRO_402_Homing Method
		HOMSW (10)		Homing switch to determine the zero for positioning
		E_EXT (11)		External error: Error messages from external devices cause an error message with the reaction determined in parameter P 30[11] - Reac_External
		WARN (12)		External collective warning
		RSERR (13)		Reset alarm: Error messages are reset with a rising edge if the error is no longer present. In some special case it is necessary to restart the device in order to reset an error. Note the settings in the "Error reactions" subject area (see Section "Error reactions" on page 336).
		MAN (14)		Switch control location selector: When using fieldbus operation, a digital switch can be used to switch the setpoint source P 165[0] - MPRO_REF_SEL and the control location P 159[0] - MPRO_CTRL_SEL to "Term".
		PROBE (15)		ISD00 to ISD04: Not defined ISD05 and ISD06: The function can only be executed via the fast inputs ISD05 and ISD06 in conjunction with PLC or CANopen/EtherCAT.
		PLC (16)		Input can be evaluated by PLC program
		PLC_IR (17)		Interruption of the PLC program
		MP_UP (18)		Motor potentiometer: Increase reference value
		MP_DOWN (19)		Motor potentiometer: Decrease reference value
		HALT_PC (20)		Disable feed with following position control (from V1.35-06)
		TBEN (21)		Import and execution of selected table driving set
		TBTEA (22)		Write actual position into selected table index: Teach-in for position references. The current position is stored in the specified table index on a rising edge. The index can be defined via the inputs in binary format (setting 23-26) or set via P 207[0] - MPRO_TAB_ActIdx . The teach-in

ID	Index	Name / Setting	Unit	Description
				function can also be activated by parameter P 269[0] - MPRO_TAB_Ctrl bit 0.
		TAB0 (23)		Binary table index 2^0
		TAB1 (24)		Binary table index 2^1
		TAB2 (25)		Binary table index 2^2
		TAB3 (26)		Binary table index 2^3
		EGEAR (27)		Start/Stop electronic gearing
		REFANAEN (28)		Enable analogue reference. This only applies if the drive is in position control mode.
		ENC (29)		Use of ISD05 / ISD06 as encoder input (pulse count, pulse/direction).
		JOG_EXT_POS (34)		Jog Positive (extended mode)
		JOG_EXT_NEG (35)		Jog Negative (extended mode)
		FAST_DISC (36)		Fast discharge of DC link (using a braking resistor)
		LIM_OFF (37)		Limits off (torque and speed): Torque scaling (P 332[0] - CON_SCON_TmaxScale) and speed limiting (P 337[0] - CON_SCON_SmaxScale) will be disabled (ISDxx = "high"). If the function is not parameterized to an input (ISDxx = "low") the limits are always active.
		LOCK_POS (38)		Lock positive direction: Reversing lock, positive direction (access also via MSD PLC).
		LOCK_NEG (39)		Lock negative direction: Reversing lock, negative direction (access also via MSD PLC).
		BRAKE_ON (40)		Switch off motor break at once
		PWR_REL_DIRECT (41)		Used to manually switch the precharge relay (with 1000 ms delay) Use only after consultation with Moog.
		SPINDLECLAMP_S1 (42)		Switch 1 input
		SPINDLECLAMP_S2 (43)		Switch 2 input
		SPINDLECLAMP_S3 (44)		Switch 3 input
		SPINDLECLAMP_P (45)		Clamping Pressurized input
		SlaveBC (46)		Brake chopper synchronization only on ISD05 and ISD06
		USER2 (47)		Test case 47
		START_PRC (48)		Start process controller

Table 9.2: Function selectors "Digital inputs" (continue)

9.2.3 Hardware enable – power stage

MSD Servo Drive Single-Axis System, MSD Servo Drive Multi-Axis System and MSD Single-Axis Servo Drive Compact support the "STO" (Safe Torque Off) safety function in accordance with the requirements of EN ISO 13849-1 and EN 61800-5-2 / IEC/EN 62061 / IEC/EN 61508.



NOTE

- For basic information, as well as mandatory planning, wiring, commissioning and testing requirements for the STO function, see the "STO safety function description" for the MSD Servo Drive Single-Axis System, MSD Servo Drive Multi-Axis System and MSD Single-Axis Servo Drive Compact (ID No.: CB19388).

The digital input "ENPO" is reserved for the hardware enable. At the setting **P 100[0] - MPRO_INPUT_FS_ENPO** = "OFF(0)" the digital input signal is used merely for safe shutdown of the drive and as protection against switching on.

With the setting **P 100[0] - MPRO_INPUT_FS_ENPO** = "START (1)" in combination with **P 144[0] - MPRO_DRVCOM_AUTO_START** = "ON" autostart mode is activated (only in MSD Servo Drive). With "STO active" activating the "ENPO" is sufficient to start control of the drive. When the "ENPO" is cancelled the drive runs down uncontrolled. If the switch-on delay is active, the power stage starts when the preset timer has elapsed.

ID	Index	Name / Setting	Unit	Description
100	0	MPRO_INPUT_FS_ENPO		Function of digital input ENPO
		Off (0)		Hardware enable power stage
		START (1)		Hardware enable power stage & start motor control

Table 9.3: "Enable power stage (hardware)" parameters

9.2.4 Digital virtual inputs

Virtual inputs are digital software inputs actuated via MSD PLC or field bus. The virtual inputs **P 111[0] - MPRO_INPUT_FS_ISV00** and **P 112[0] - MPRO_INPUT_FS_ISV0** can use all digital functions which are also available to the real digital inputs.

ID	Index	Name	Unit	Description
111	0	MPRO_INPUT_FS_ISV00		Function selector ISV00
112	0	MPRO_INPUT_FS_ISV01		Function selector ISV01
120	0	MPRO_INPUT_INV		Dig. Input inversion (ENPO=0, ISD00–05=1-6, SH=7, ISD06=16)

Table 9.4: "Digital virtual inputs" parameters

9.2.5 Status of the digital inputs

Clicking on the "Status of digital inputs" field on the input screen for the digital inputs will open a visualization showing the digital inputs' states.

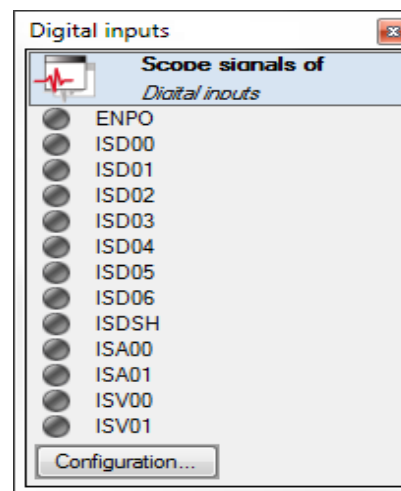


Fig. 9.3: "Status of digital inputs" screen

ID	Index	Name	Unit	Description
121	0	MPRO_INPUT_STATE		Dig. Inputs: Status

Table 9.5: "Status of digital inputs" parameters

9.2.6 Control selector switching

The function selector (MPRO_INPUT_FS_ISDxx) assigns the digital inputs their functionality.

Using the setting "MAN(14)=Switch control location selector" here will make it possible to switch the control location via a terminal to the setpoint source selected in **P 164[0] - MPRO_REF_SEL_MAN**. This enables fast switching to manual control for setup or emergency running mode, for example.

When a digital input set to "MAN(14)" is activated, the control location **P 159[0] - MPRO_REF_SEL = "TERM"** switches (switch to "TERM" is not displayed in the Moog DRIVEADMINISTRATOR 5). In parallel, the reference source is set to the

reference selected via parameter **P 164[0] - MPRO_REF_SEL_MAN**. The start signal must be connected to a digital input (ISD0x = Start). The control mode **P 300[0] - CON_CfgCon** cannot be switched. The "MAN(14)" mode is displayed in the field bus control word.

It is *not* possible to switch to "MAN" mode

- when the power stage is active
- when the drive in the Moog DRIVEADMINISTRATOR 5 is operated via the manual mode window.

A level-triggered START **P 144[0] - MPRO_DRVCOM_AUTO_START=LEVEL (1)** is ignored in "MAN" mode. After activation of "MAN" mode, the START input must be reset. When "MAN" mode is ended the motor control also stops.

P No.	Index	P Name / Setting	Unit	Function
164	0	MPRO_REF_Sel_MAN		Selection of motion profile
		OFF (0)		No profile selected
		ANA0(1)		Reference value of analogue input ISA0
		ANA1(2)		Reference value of analogue input ISA1
		TAB(3)		Reference from table
		PLC_BASIC(4)		Profile via PLC definition
		PLC(5)		Reference from PLC
		PARA(6)		Reference via parameter
		DS402(7)		Reference via CiA 402 IEC1131
		Sercos(8)		Reference via SERCOS
		PROFI(9)		Reference via PROFIBUS
		VARAN(10)		Reference via VARAN
		TWIN(11)		Reference via external option "TWINsync"
		HYD(12)		Hydraulic profile (software-specific)
		ANA2(13)		Profile via analogue channel 2 (Technology option)
		ANA2(14)		Profile via analogue channel 3 (Technology option)

Table 9.6: "Control selector switching" parameters

P No.	Index	P Name / Setting	Unit	Function
		ANA2(15)		Profile via analogue channel 4 (Technology option)
		ANA2(16)		Profile via analogue channel 5 (Technology option)
		TCAM(17)		Table camming (software specific)

Table 9.6: "Control selector switching" parameters (continue)

9.2.7 Power-up sequence

The power-up sequence must be maintained when the drive starts, regardless of the control mode. If the power-up sequence is followed, the drive starts with a rising edge of the digital input parameterized to "START" or when the corresponding "Start" bit is set via a bus system. The reference polarity determines the direction of rotation.

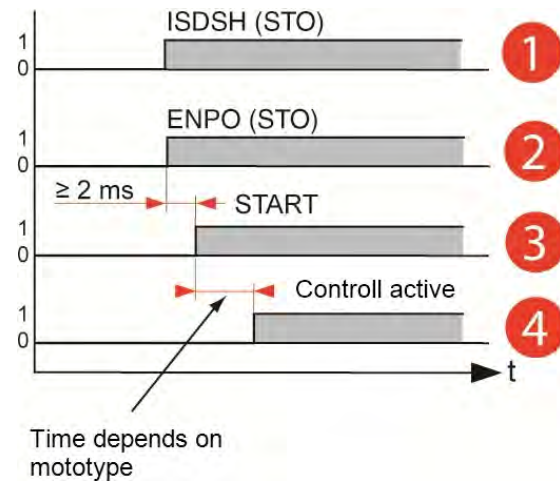


Fig. 9.4: Time diagram of sequences

Command	System state
① Starting lockout	ISDSH Safe Standstill (STO)
② Ready for start	ENPO EnablePower
③ On	Bit (0) = START(1)
④ Active control	Active control

Legend for Time diagram of sequences

9.2.8 Pulse direction

Pulse direction can be realized using the MSD PLC or EGEAR (electrical gearing). With EGEAR, control is carried out in the control mode "Term (1) via terminals" as follows.

Setting the control mode

Setting of the manner in which the control is to be carried out.

Invoke Motion profile -> Basic setting.

Set "Term (1) = set via terminals" under "Control via." The setting for the reference under "Reference via" is irrelevant.

Parameter setting for speed/direction

Set parameter **P 1400** (MPRO_TP_config) to "PC_PC(4)" (= TP0, pulse counter, TP1, pulse counter). The speed, but not the direction, can be changed.

Setting **P 1400** (MPRO_TP_config) to "PD_UP(2)" (TP0, TP1 as encoder; pulse (TP0) / direction (TP1), count up on direction high) means both the speed and the direction can be changed. To find out which setting is possible, see the description of the parameter. Parameter **P 1404** (MPRO_TP_Lines) is used to set the resolution (pulses/revolution).

Setting the digital standard inputs ISD05 and ISD06

The setting can be made in the screen I/O configuration -> Dig. Inputs.

Set ISD05 and ISD06 to ENC(29) = Encoder (pulse count / pulse direction on ISD05, ISD06 only).



NOTE

- The electrical connection is made via terminals X4/20 (ISD05) and X4/21 (ISD06).

Digital standard inputs:		Low active	Digital Filter	
ISD00	OFF(0) = No function	☐	0 ms	Options...
ISD01	OFF(0) = No function	☐	0 ms	Options...
ISD02	OFF(0) = No function	☐	0 ms	Options...
ISD03	OFF(0) = No function	☐	0 ms	Options...
ISD04	OFF(0) = No function	☐	0 ms	Options...
ISD05	ENC(29) = Encoder (pulse count / pulse direction on I	☐	0 ms	Options...
ISD06	ENC(29) = Encoder (pulse count / pulse direction on I	☐	0 ms	Options...

Fig. 9.5: Digital inputs pulse direction

Setting the electrical gearing (EGEAR)

Invoke Motion profile -> Synchronized motion.

Set the electrical gearing (EGEAR) according to the following figures.



NOTE

- If **P 1404** (MPRO_TP_Lines) is not set [factory setting is 1 pulse = 1 revolution], then the gear ratio is important for the speed of the rotor.

Set the synchronisation mode to “EGEAR_PARA(4) = Electronic gearing via parameters.”

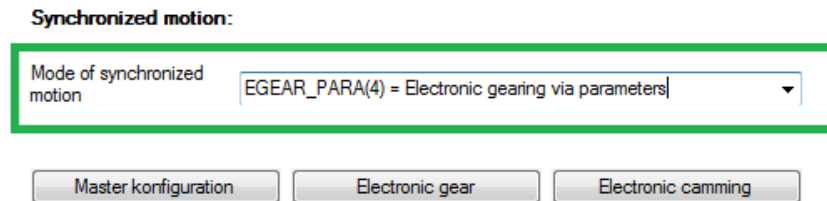


Fig. 9.6: Set the EGEAR pulse direction

Select “Master configuration” in the screen.

Set the channel selection and anti-reverse mode.

Selection options:

TP0(6) = Pulse counter on probe channel 1 (TP0)

TP1(7) = Pulse counter on probe channel 1 (TP1)

Master configuration:

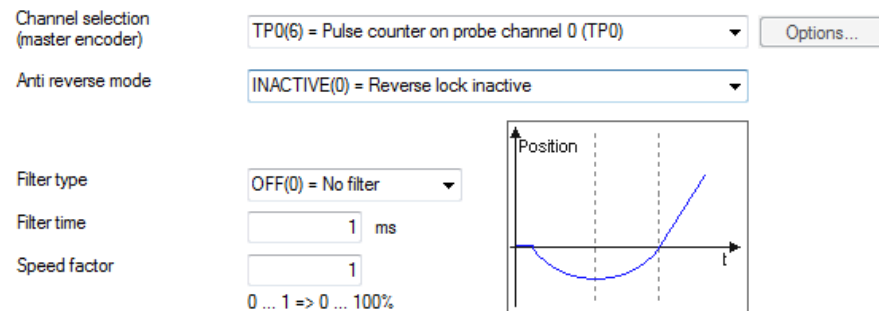


Fig. 9.7: Pulse direction master configuration

In the screen, select “Electric gearing.”

Set the gear ratio.

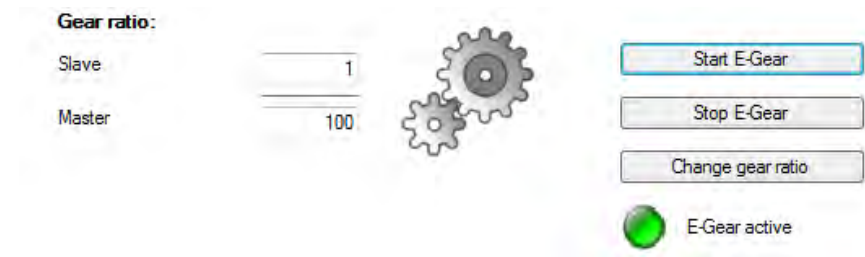


Fig. 9.8: Selecting the electric gearing pulse direction

Enable the function with “Start E-Gear.”



NOTE

- The signals ISD06 and ISD05 are HTL signals, which is why the voltage level must be greater than 20 V. The frequency must not be higher than 300 kHz.

9.3 Digital Outputs

Digital standard outputs: Low active ☐

OSD00 ☐

OSD01 ☐

OSD02 ☐

Relay outputs:

RELOUT1 ☐

[Show status of digital outputs](#)

Fig. 9.9: "Function selector of the digital inputs" screen

9.3.1 Standard digital outputs

- There is a selector that can be used to assign a function to each digital standard output.
- Certain functions will only be available with specific function packages.
- Depending on the configured function, the "Options..." button may become enabled. If so, it can be used to switch directly to a different subject area to there define the function's exact behaviour.
- All standard outputs can be switched from "active-high" to "active-low" (bits 1 to 3 in **P 142[0] - MPRO_OUTPUT_INV**).

Digital input states

Clicking on the "Status of digital outputs" field on the input screen for the digital outputs will open a visualization showing the digital outputs' states (see Section "Digital input states" on page 309).

ID	Index	Name	Unit	Description
122	0	MPRO_OUTPUT_FS_OSD00		Function of digital output OSD00
123	0	MPRO_OUTPUT_FS_OSD01		Function of digital output OSD01
124	0	MPRO_OUTPUT_FS_OSD02		Function of digital output OSD02
142	0	MPRO_OUTPUT_INV		Output inv. OSD0-2(0-2),MBRK(6),REL 1/2 (7/15),OED0-7(16-23)

Table 9.7: "Digital standard outputs" parameters

9.3.2 Function selectors

ID	Index	Name / Setting	Unit	Description
122-124	0	MPRO_OUTPUT_FS_OSDxx		Function selectors for digital outputs
		Off (0)		No function
		ERR (1)		Collective error message
		BRAKE (2)		Motor brake: Output activated according to holding brake function
		ACTIV (3)		Power stage and control active
		S_RDY (4)		Device initialized: Output is activated when the device is initialized after power-on.
		C_RDY (5)		Control initialized: Output is activated when the device is "Ready to switch on" based on setting of the "ENPO" signal and no error message has occurred. Device ready - ReadyToSwitchOn flag in DriveCom status word set (in states 3, 4, 5, 6, 7)
		REF (6)		Target reached / Reference reached: The preset reference has been reached (dependent on control mode)
		HOMATD (7)		Homing point reached
		E_FLW (8)		Tracking error
		ROT_R (9)		Motor in standstill window when running right
		ROT_L (10)		Motor in standstill window when running left
		ROT_0 (11)		Motor in standstill window, depending on actual value
		STOP (12)		Drive in quickstop state

Table 9.8: "Digital outputs" function selectors

ID	Index	Name / Setting	Unit	Description
		HALT (13)		The drive is in the HALT state: activated via CiA 402 profile, input or PROFIBUS IntermediateStop, SERCOS. Reaction according to HALT option code (P 2221[0] - MPRO_402_HaltOC).
		LIMIT (14)		Output is set when a reference value reaches its limit.
		T_GT_TX (15)		Torque greater than P 741[0]
		N_GT_NX (16)		Speed greater than P 740[0]
		P_LIM_ACTIV (17)		Position reference limited (e.g. with parameterized software limit switches)
		N_LIM_ACTIV (18)		Speed reference limited
		T_LIM_ACTIV (19)		Torque reference limited
		(20)		Not defined
		ENMO (21)		Motor contactor output (if the motor is wired through a contactor)
		PLC (22)		PLC sets output
		WARN (23)		Warning (Collective warning message)
		WUV (24)		Warning: undervoltage in DC link
		WOV (25)		Warning: voltage overload in DC link
		WIIT (26)		Warning I2t power stage
		WOTM (27)		Motor overtemperature warning (only with KTY84-130, NTC, PT100 and PT1000)
		WOTI (28)		Servo Drive heat sink temperature warning
		WOTD (29)		Servo Drive internal temperature warning
		WLIS (30)		Warning: current threshold reached
		WLS (31)		Warning: speed threshold reached
		WIT (32)		Warning I2t motor protection
		WLTQ (33)		Warning torque/force threshold reached
		TBACT (34)		Table positioning in "AUTO" and activated state
		TAB0 (35)		Actual table index 2^0
		TAB1 (36)		Actual table index 2^1
		TAB2 (37)		Actual table index 2^2
		TAB3 (38)		Actual table index 2^2
		COM_1MS (39)		Set output via field bus in 1 ms cycle

Table 9.8: "Digital outputs" function selectors (continue)

ID	Index	Name / Setting	Unit	Description
		COM_NC (40)		Set output via field bus in NC cycle
		USER (41)		Firmware-specific function
		TBREF (42)		Selected table index executed (target reached)
		DS-TRIGGER (43)		Digital Oscilloscope Trigger Event
		SM_REF (44)		Target reached at synchronized motion
		CAM_LINE_A (45)		Cam switch track A
		CAM_LINE_B (46)		Cam switch track B
		(47)		Not defined
		(48)		Not defined
		(49)		Not defined
		(50)		Not defined
		(51)		Not defined
		(52)		Not defined
		(53)		Not defined
		BC_State (54)		Brake chopper active state
		SH_S (55)		Safe torque off (STO) active
		BC_FAIL (56)		Brake chopper error; triggered with negative edge
		ESYNC (57)		Synchronous function of electronic gearing or cam active
		IDLENESS (58)		Logic link of "motor standstill" and "Not Ready to Switch on" state
		PRDY (59)		Ready to switch on
		(60)		Not defined
		(61)		Not defined
		(62)		Not defined
		(63)		Not defined
		(64)		Not defined
		(65)		Not defined
		(66)		Not defined
		(67)		Not defined
		(68)		Not defined
		(69)		Not defined
		(70)		Not defined

ID	Index	Name / Setting	Unit	Description
		(71)		Not defined
		(72)		Not defined
		(73)		Not defined
		HYD_VAL_OPT1 (74)		Hydraulic control option 1 (software specific)
		HYD_VAL_OPT2 (75)		Hydraulic control option 2 (software specific)
		HYD_CYL_POS (76)		Drive signal, extend hydraulic valve cylinder
		HYD_CYL_NEG (77)		Drive signal, retract hydraulic valve cylinder
		HYD_LEAK_BYP (78)		Drive signal, hydraulic valve bypass
		HYD_VALVE_CD (79)		Drive signal, hydraulic valve direction switchover
		DIS_ACT (80)		Fast discharge active
		WBRC (81)		Warning brake chopper overload
		FR_ACT (82)		Status "Fault reaction active"
		F_ACT (83)		Error active
		ISD00 (84)		Status of ISD00
		ISD01 (85)		Status of ISD01
		ISD02 (86)		Status of ISD02
		ISD03 (87)		Status of ISD03
		ISD04 (88)		Status of ISD04
		ISD05 (89)		Status of ISD05
		ISD06 (90)		Status of ISD06
		ISA00 (91)		Status of ISA00 (digital)
		ISA01 (92)		Status of ISA01 (digital)

Table 9.8: "Digital outputs" function selectors (continue)

9.3.3 Relay outputs

- Relay output RELOUT1 is freely available, while the function of the second relay output, RELOUT2, is set and cannot be changed.
- There is a selector that can be used to assign a function to the relay output.
- Certain functions will only be available with specific function packages.

- Depending on the configured function, the "Options..." button may become enabled. If so, it can be used to switch directly to a different subject area to there define the function's exact behaviour.
- The relay output can be switched from "active-high" to "active-low" (bit 8 in **P 142[0] - MPRO_OUTPUT_INV**).



NOTE

- Relay output RELOUT2 (**P 127[0] - MPRO_OUTPUT_FS_RELOUT2**) outputs the status of the STO function. Accordingly, it is set to "SH_S" and cannot be changed. Because of this, this output will not be shown on the screen.
- For basic information, as well as mandatory planning, wiring, commissioning and testing requirements for the STO function, see the "STO safety function description" for the MSD Servo Drive Single-Axis System, MSD Servo Drive Multi-Axis System and MSD Single-Axis Servo Drive Compact (ID No.: CB19388).

ID	Index	Name	Unit	Description
126	0	MPRO_OUTPUT_FS_RELOUT1		Function of digital output RELOUT1
127	0	MPRO_OUTPUT_FS_RELOUT2		Function of dig. output RELOUT2 is fixed on 'Safety Hold'
142	0	MPRO_OUTPUT_INV		Output inv. OSD0-2(0-2), MBRK(6), REL1/2 (7/15), OED0-7(16-23)

Table 9.9: "Relay outputs" parameters

9.3.4 Digital input states

Clicking on the "Status of digital outputs" field on the input screen for the digital outputs will open a visualization showing the digital outputs' states.

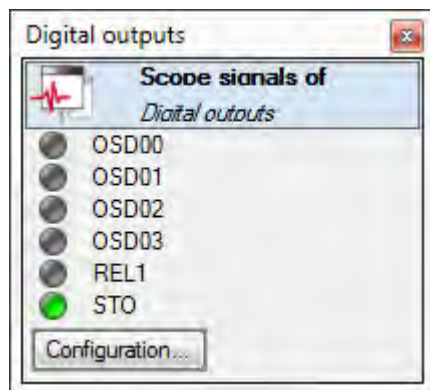


Fig. 9.10: "Status of digital outputs" screen

ID	Index	Name	Unit	Description
143	0	MPRO_OUTPUT_STATE		Dig. Outputs: Status

Table 9.10: "Status of digital outputs" parameters

9.3.5 Reference reached REF(6)

If a digital output is set to "REF(6) = Target reached / Reference reached" for torque and speed control as well as positioning, a range can be defined in which the actual value may deviate from the reference without the "Reference reached REF(6)" message becoming inactive. Reference value fluctuations caused by reference input are thus taken into account.

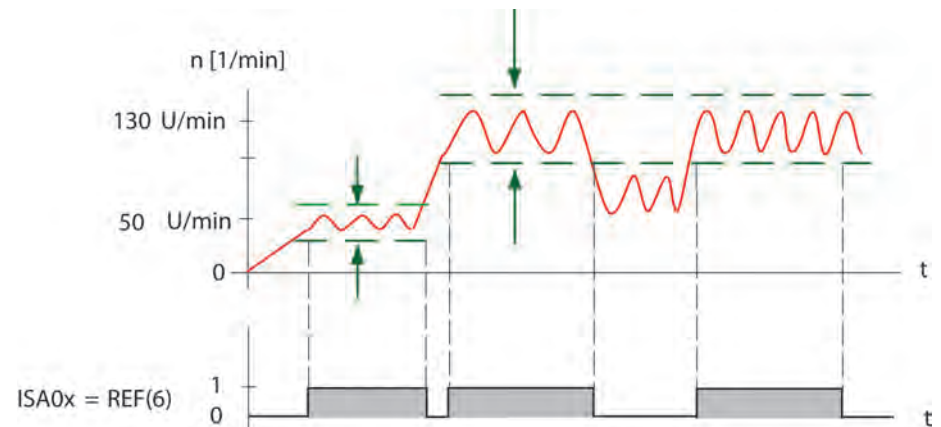


Fig. 9.11: Threshold definition

9.3.6 Reference limitation LIMIT(14)

The "LIMIT(14)" function for a digital output signals when a setpoint has reached its limit. In this case the output is set. The limit values for maximum torque and maximum speed depend on the preset control system.

Torque control

Limit value monitoring becomes active when the torque reference exceeds the maximum torque (see Section "Limitations / Thresholds" on page 320).

Speed control

Limit value monitoring becomes active when the speed reference value exceeds the maximum speed (see Section "Limitations / Thresholds" on page 320).

Positioning

Limit value monitoring becomes active when the speed reference exceeds the maximum speed or the torque reference exceeds the maximum torque (see Section "Limitations / Thresholds" on page 320).

Infinite positioning/speed mode

Monitoring is activated in infinite positioning (speed mode) when the speed reference has been reached. If an ongoing positioning operation is interrupted with "HALT", the "Reference reached" message is not sent in this phase. The message only appears after the actual target position has been reached.

9.3.7 Switching with motor contactor

Switching in the power cable should only be carried out in a de-energized state. Failure to follow this requirement may result in problems and damage (e.g. overvoltage or overcurrent shutdowns, pitted contacts). To ensure currentless switching, the contacts of the motor contactor must be closed before enabling the power stage. In the opposite case the contacts must remain closed until the power stage has been switched off. Corresponding safety time periods for the motor contactor switching must be implemented in the control sequence of the machine or else the special "ENMO" software function of the servo controller must be employed.

A power contactor in the motor supply line can be directly controlled by the servo controller via parameter **P 125[0] - MPRO_OUTPUT_FS_MOTOR_BRAKE** = ENMO (21). The timer **P 148[0] - MPRO_DRVCOM_ENMO_Time** defines the on-and-off delay of the power contactor. Based on the time delay, the reference value is applied after the power contactor is active. If the power stage is switched off, the power contactor isolates the motor from the controller.



NOTE

- Additional times for the typical contact chatter on a contactor must be taken into account when specifying the time for timer **P 148[0] - MPRO_DRVCOM_ENMO_Time**. They may be several hundred ms, depending on contactor.

9.4 Analog Inputs

Analog standard inputs:

ISA00

Function

ISA00 filter time ms

ISA01

Function

ISA01 filter time ms

Fig. 9.12: "Function selector of the analog inputs" screen

9.4.1 Standard analog inputs

- There is a selector that can be used to assign a function to each analog standard input (**P 109[0] - MPRO_INPUT_FS_ISA00** and **P 110[0] - MPRO_INPUT_FS_ISA01**).
- Certain functions will only be available with specific function packages.
- Depending on the configured function, the "Options..." button may become enabled. If so, it can be used to switch directly to a different subject area to there define the function's exact behaviour.
- Every analog input can be smoothed with a freely configurable filter time (**P 405[0] - CON_ANA_Filt0** and **P 406[0] - CON_ANA_Filt1**).
- **P 427[0] - CON_ANA_CalibZero** can be used to trigger a zero correction routine for both analog inputs. If you use this routine, there must not be any voltage at the inputs.

- **P 428[0] - ISA00** and **P 428[1] - ISA01** can be used to assign an offset to each analog input separately. For more details on how to use offsets, see Section "Analog input scaling" on page 314.
- **P 429[0] - ISA00_gain** and **P 429[1] - ISA01_gain** can be used to assign a gain factor to each analog input separately. For more details on how to use gain factors, see Section "Analog input scaling" on page 314.
- **P 429[2] - ISA00_limMin** and **P 429[3] - ISA01_limMin** can be used to assign a lower limit to each analog input separately.
- **P 429[4] - ISA00_limMax** and **P 429[5] - ISA01_limMax** can be used to assign an upper limit to each analog input separately.
- The analog inputs' compensated, filtered, and normalized values will be available in **P 407 - CON_ANA_Isaf**.
- **P 665[0] - DV_CAL_IsaType** can be used to configure the analog inputs as voltage or current inputs. This setting will apply to both inputs.



NOTE

- The parameters are reinitialized only after the control has been re-enabled or by a device restart.

ID	Index	Name	Unit	Description
109	0	MPRO_INPUT_FS_ISA00		Function of analogue input ISA00
110	0	MPRO_INPUT_FS_ISA01		Function of analogue input ISA01
405	0	CON_ANA_Filt0	ms	Analogue input ISA00: Filter time constant
406	0	CON_ANA_Filt1	ms	Analogue input ISA01: Filter time constant
407		CON_ANA_Isaf		Analogue inputs: Values (filt, norm, comp)
407	0	ISA00		Compensated, filtered, normalized value
407	1	ISA01		Compensated, filtered, normalized value
427	0	CON_ANA_CalibZero		Analogue inputs: Calibration of analogue channel offset @zero input
428		CON_ANA_Offset		Analogue inputs: Offset
428	0	ISA00	V	Voltage offset for input ISA00
428	1	ISA01	V	Voltage offset for input ISA01
429		CON_ANA_Gain		Analogue inputs: Gain scaling

Table 9.11: "Analog inputs" parameters

ID	Index	Name	Unit	Description
429	0	ISA00_gain		Gain scaling for input ISA00
429	1	ISA01_gain		Gain scaling for input ISA01
429	2	ISA00_limMin		Minimum value for input ISA00
429	3	ISA01_limMin		Minimum value for input ISA01
429	4	ISA00_limMax		Maximum value for input ISA00
429	5	ISA01_limMax		Maximum value for input ISA01
665	0	DV_CAL_IsaType		Analogue inputs: Switch between current/voltage input

Table 9.11: "Analog inputs" parameters (continue)

9.4.2 Function selectors

Before using the analog inputs, they are normally associated with a special device functionality for **analog** inputs. The corresponding function selectors also make it possible to select a special digital functionality instead.

ID	Index	Name / Setting	Unit	Description
109-110	0	MPRO_INPUT_FS_ISA0x		"Analogue inputs" "function selectors"
		PRC_REF (-14)		Process controller reference value
		PRC_ACT (-13)		Process controller actual value
		ENC_ANA (-12)		Analogue encoder (on channel 4)
		TWIN_SCALE (-11)		TWIN position scaling
		HYD_Q_ACT (-10)		Hydraulic actual flow (software specific)
		HYD_P_ACT2 (-9)		Hydraulic actual pressure on 2nd sensor (software specific)
		HYD_Q_REF (-8)		Hydraulic reference flow (software specific)
		HYD_P_ACT (-7)		Hydraulic actual pressure (software specific)
		HYD_P_REF (-6)		Hydraulic reference pressure (software specific)
		VFC_REF_SCALE (-5)		VFC reference scaling 0-100% (software specific)
		TLIM (-4)		Analogue torque limit 0-100%
		OVN (-3)		Speed override 0-100% at positioning

Table 9.12: "Analog inputs" function selectors

ID	Index	Name / Setting	Unit	Description
		REFV (-2)		Analogue reference
		(-1)		Not defined
		Off (0)		No function
		START (1)		Start motor control
		INV (2)		Inverse reference value
		STOP (3)		Execute quickstop
		HALT (4)		Disable feed
		LCW (5)		Limit switch positive direction
		LCCW (6)		Limit switch negative direction
		INCH_P (7)		Jog Positive
		INCH_N (8)		Jog Negative
		HOMST (9)		Start homing
		HOMSW (10)		Reference switch
		E_EXT (11)		External error
		WARN (12)		External warning
		RSERR (13)		Reset alarm
		MAN (14)		Switch control location selector
		(15)		Not defined
		PLC (16)		Used in PLC
		PLC_IR (17)		PLC interrupt
		MP_UP (18)		Motor potentiometer Negative
		MP_DOWN (19)		Motor potentiometer Positive
		(20) - (20)		Not defined
		TBEN (21)		Enable selected table index
		TBTEA (22)		Write actual position into selected table index
		TAB0 (23)		Binary table index 2^0
		TAB1 (24)		Binary table index 2^1
		TAB2 (25)		Binary table index 2^2
		TAB3 (26)		Binary table index 2^3
		EGEAR (27)		Start / stop Egear
		REFANAEN (28)		Enable analogue reference
		(29)		Not defined
		(30)		Not defined

ID	Index	Name / Setting	Unit	Description
		(31)		Not defined
		(32)		Not defined
		(33)		Not defined
		JOG_EXT_POS (34)		Jog Positive (extended mode)
		JOG_EXT_NEG (35)		Jog Negative (extended mode)
		FAST_DISC (36)		Fast discharge
		LIM_OFF (37)		Limits (torque and velocity) off
		LOCK_POS (38)		Lock positive direction
		LOCK_NEG (39)		Lock negative direction
		BRAKE_ON (40)		Switch off motor break at once
		PWR_REL_DIRECT (41)		Direct activation of power relay (with 1000ms delay)
		(42)		Undocumented value
		(43)		Undocumented value
		(44)		Undocumented value
		(45)		Undocumented value
		(46)		Undocumented value
		(47)		Undocumented value
		(48)		Undocumented value

Table 9.12: "Analog inputs" function selectors (continue)

9.4.3 Analog input scaling

Analog input scaling makes it possible to convert the analog input value to the process variable by using a gain factor, offset and backlash. The illustration shows how the scaling function works. Entering the desired voltage ranges will yield the values for the offset (**P 428 - CON_ANA_Offset**) and gain (**P 429 - CON_ANA_Gain**).

Depending on the function selected for the ISAx analog input with the function selector, it will be possible to use the "Options..." button to configure additional process variables such as "the backlash in rev/min" (when using an analog setpoint, REFV).

Usage examples

- Change to input voltage range of analog torque scaling
- Change to input voltage range of speed override function
- Change to switching threshold of a digital input function

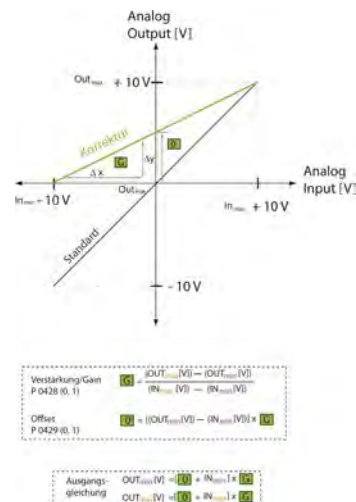


Fig. 9.13: Scaling of an analog channel

Example: Analog torque scaling:

The standard setting for the controller is an input voltage range of 0 V to +10 V, corresponding to 0% to 100%. With this setting, any value between -10 V and 0 V corresponds to 0%.

- Say that you want an input voltage range of -10 V to +10 V, in which case -10 V would correspond to 0% of the torque and +10 V to 100% of the torque.
 - $IN_{min} = -10 \text{ V}$, $OUT_{min} = 0 \text{ V}$
 - $IN_{max} = +10 \text{ V}$, $OUT_{max} = +10 \text{ V}$

- Calculations are $G = \frac{(+10V)-(0V)}{(+10V)-(-10V)} = \frac{+10V}{+20V} = \frac{1}{2}$ and $O = [0V - (-10V)] \times \frac{1}{2} = +10V \times \frac{1}{2} = 5V$
- Resulting in a gain of $G = 0.5$ and an offset of $O = 5V$

9.4.4 Profile mode and analog inputs

Parameter **P 301[0] - CON_REF_Mode** determines whether the reference values are processed via the profile generator (setting "PG(0)") or directly (setting "IP(1)"). If direct input via IP mode is selected, only the input filters are active. The analog values are scanned and filtered in the torque control cycle and then directly transferred as references for the speed or torque control.

CAUTION!	Your system/motor may be damaged if put into operation in an uncontrolled or inappropriate manner.
	Improper conduct can cause damage to your system / machine. • Before the "Start" step, make absolutely sure that a valid setpoint has been entered, as the configured setpoint will be immediately transmitted to the motor after the motor control function starts, which may result in the motor accelerating unexpectedly.



NOTE

- If the analog inputs are used as feedback for control circuits, they will be sampled every 125 µs.
- If functions are assigned to the analog inputs using **P 109 [0]/P 110[0]**, the inputs will be sampled every 1 ms.
- By switching parameter **P 301[0] - CON_REF_Mode** from PG(0) to IP(1) mode, an analog input can be used as a "fast input" (e.g. Touch probe). The sampling time set in **P 306[0] - CON_IpRefTS** for the interpolation takes effect.

9.4.5 Wire Break Monitoring

P 399 - CON_ANA_WireBrk_Th is used to define the wire break monitoring threshold (in V) (parameter index [0] for ISA00, parameter index [1] for ISA01). If the voltage falls below this limit an error message is generated. The error response can be configured using **P 30[52] - Reac_Ana** (see Section "Error reactions" on page 336).

ID	Index	Name	Unit	Description
399		CON_ANA_WireBrk_Th		Analogue inputs: Cable break detection limits
399	0	ISA00	V	Cable break detection limit for analogue input ISA00
399	1	ISA01	V	Cable break detection limit for analogue input ISA01

Table 9.13: "Wire break monitoring" parameters

9.5 Analog outputs (option only for MSD Servo Drive)

Analog outputs (Option):

OEA00 (CAN options card)

Function:

Scale factor: V/DIM

Offset (O): V

Filter time: ms

OEA01 (CAN options card)

Function:

Scale factor: V/DIM

Offset (O): V

Filter time: ms

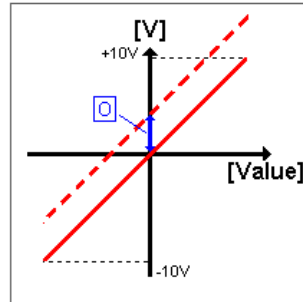


Fig. 9.14: "Function selection of optional analog outputs (option)" screen

If your MSD Servo Drive features the "CANopen + 2AO" technology option, you will have two analog outputs available, enabling you to output values from the controller using analog signals. The function selector offers nine variables for selection for each output. These variables can be filtered, scaled, and assigned an offset.

9.5.1 Function selectors

ID	Index	Name / Setting	Unit	Description
129, 130	0	MPRO_OUTPUT_FS_OEAxx		Function selectors for analog outputs
		OFF (0)		No function
		NACT(1)		Actual speed
		TACT(2)		Actual torque/force
		IRMS(3)		Effective current
		PARA (4)		Value of parameter 134[0]
		ACTPOS(5)		Position actual value
		VDC(6)		DC link voltage
		ACTPOS_MODULO(7)		Actual modulo position
		ACT_POWER(8)		Power
		APP_POWER(9)		Apparent power

Table 9.14: "analog outputs" function selectors



NOTE

- For a full description of the analog outputs in the "CANopen+2AO" communication option (technical data, connections, configuration), see the "CANopen + 2 analog outputs Specification" (ID No.: CA79904-001).
- The technology option "CANopen + 2AO" is not available for MSD Single-Axis Servo Drive Compact.
- To determine whether your MSD Servo Drive comes with the "CANopen + 2AO" technology option, you can check the electronic rating plate (see Section "Electronic rating plate" on page 464).

9.6 Motor brake output

Motor brake

Motor brake output X13/X20

Cable break detection

Fig. 9.15: "Motor brake settings" screen



NOTE

- On the MSD Single-Axis Servo Drive Compact, the motor brake output for frame sizes 2 to 5 will be found on connector X13.
- On the MSD Servo Drive (Single-Axis System and Multi-Axis System), the motor brake output...
 - For frame sizes 1 to 4 will be found on connector X13
 - For frame sizes 5 to 6a will be found on connector X20
 - For frame size 7 will be found on connector X44

An optional holding brake built-in to motor provides protection against unwanted motion when the power is cut and in case of error. If the brake is mounted on the axis mechanism and not directly on the shaft, note that undesirably severe torsional forces may occur on sudden engagement of the brake.

The **P 125[0] - MPRO_OUTPUT_FS_MOTOR_BRAKE** function selector can be used to select any function (similar to those for the digital outputs) for the motor brake output. However, the special motor brake control section hardware will be used for the selected function.

However, when using a motor brake with **P 125[0] - MPRO_OUTPUT_FS_MOTOR_BRAKE = BRAKE(2)**, the criteria for braking need to be defined. This criteria can consist of a variety of states, limits, threshold values, input signals, and fieldbus commands.

P 748[0] - MON_MotorBrkGuard can be used to activate a monitoring mechanism at the motor brake output that will monitor both wire breaks and current. The brake function can also be used in the other digital outputs, though without current and wire break monitoring.

If the output is set to BRAKE(2), the brake can be configured with the "Options..." button (see Section "Motor brake details" on page 318).

ID	Index	Name	Unit	Description
125	0	MPRO_OUTPUT_FS_MOTOR_BRAKE		Function of motor brake (X13)
748	0	MON_MotorBrkGuard		Motor brake guarding

Table 9.15: "Motor brake output" parameters

9.6.1 Motor brake details

Motor brake details

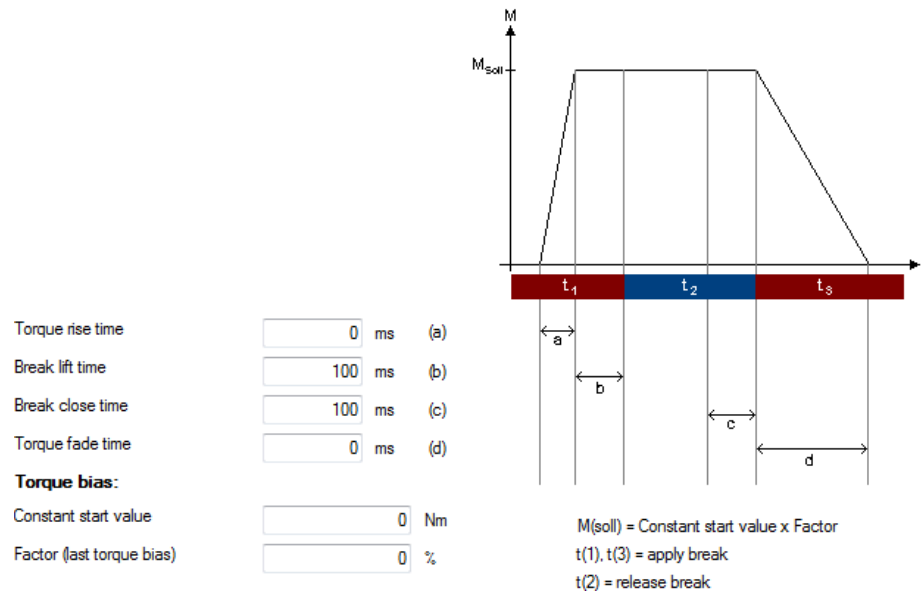


Fig. 9.16: "Motor brake details" screen

The brake response can be adapted to the requirements of the application. This function can be used in both speed as well as position controlled operation.

ID	Index	Name	Unit	Description
213	0	MPRO_BRK_LiftTime	ms	Motor brake lift time
214	0	MPRO_BRK_CloseTime	ms	Motor brake close time
215	0	MPRO_BRK_RiseTime	ms	Motor brake: torque rise time
216	0	MPRO_BRK_FadeTime	ms	Motor brake: Torque fade time

Table 9.16: "Motor brake details" parameters

ID	Index	Name	Unit	Description
217	0	MPRO_BRK_LastTorqFact	%	Motor brake: Stored load factor for Torque
218	0	MPRO_BRK_StartTorq	Nm	Motor brake: initial torque (constant)
219	0	MPRO_BRK_LastTorq	Nm	Motor brake: saved Torque
220	0	MPRO_BRK_Lock		lock brake

Table 9.16: "Motor brake details" parameters (continue)



NOTE

- Please check the settings of the stop ramps if use of a holding brake is specified (see Section "Stop ramps" on page 257).

9.6.1.1 Check motor brake state

The scope IDs **4022 Brake State** and **4023 Brake timer** allow you to record and carry out diagnostics for the motor brake state.

Scope ID 4022: Brake state

The scope ID **4022** shows the motor brake state. Possible motor brake states are:

Phase	State
0	Power off: Brake closed
1	Rise: Torque rise up time (time: a)
2	Lift: Brake open time (time: b)
3	Open
4	Close: Brake close time (time: c)
5	Fade: Torque rise down time (time: d)
6	—
7	—

Table 9.17: Scope ID 4022 Brake state

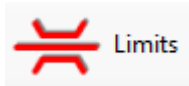
Scope ID 4023 Brake timer

The scope ID **4023** shows the running timer for the times a, b, c and d.
See Fig. 9.16: “Motor brake details” screen

10 Limitations / Thresholds

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Limits / thresholds

Brief description

This chapter describes the available limits and threshold values for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact.

Contents

10.1 Settings	320
10.2 Torque- / force limits	322
10.3 Speed- / velocity limits	322
10.4 Position limitation	323
10.5 Power stage	324

10.1 Settings

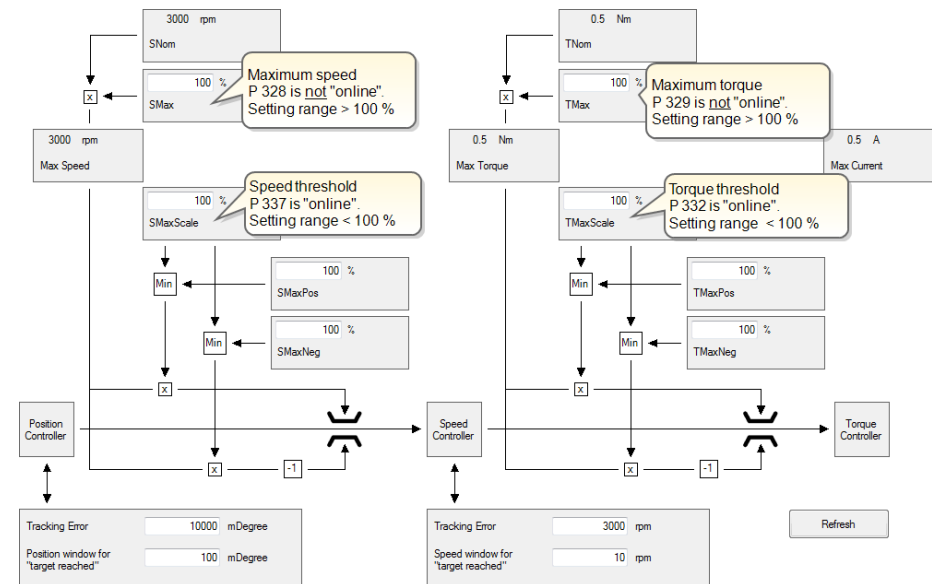


Fig. 10.1: "Limitations and thresholds" screen

To protect the device, the motor and the complete plant it is necessary to limit the variables torque, speed and position. These limits act independently of other limitations within the motion profile.

The limits are specified as percentages of the rated quantities (current, torque, speed,...), so that following calculation logical default settings are available. The defaults relate to 100% of the ratings. The parameters must therefore be adapted to application and motor. The motor quantity limits can be read out in **P 338[0] - CON_SCON_ActMax**.

Limitations in closed-loop controlled mode

- Torque- / force limits
- Speed- / velocity limits
- Position limitation
- Power stage (see Section "Power stage" on page 324)

P 745 - MON_RefWindow and **P 746[0] - MON_UsrPosWindow** indicate the status of the configured limits and are incorporated into the general **P 151[0] - MPRO_DRVCOM_STAT_DWord** status word.

P 737[0] - MON_MNCTL and **P 737[1] - MON_MNSTAT** can be used to monitor and output the status of the mains connection and the motor phases.

ID	Index	Name	Unit	Description
338		CON_SCON_ActMax		Motor control limits
338	0	Max_Speed_Motor	rpm	Maximum motor speed
338	1	Max_Current_Motor	A	Maximum motor current
338	2	Max_Torque_Motor	Nm	Maximum motor torque
338	3	Max_UsrSpeed_Motor	rev/min	Maximum motor speed in user units
338	4	MaxCurrent_Inverter	A	Maximum current @ actual voltage level and switching freq.
338	5	Reserved	-	Reserved
338	6	Reserved	-	Reserved
338	7	MaxCurrent_Limit	A	Maximum current limit (motor or inverter)
737		MON_MNCTL		Monitoring control and status word
737	0	MON_MNCTL		Monitoring control word
737	1	MON_MNSTAT		Monitoring status word
745		MON_RefWindow		Speed Setpoint reached window
745	0	TargetReached	rpm	Window for speed control target reached
745	1	Standstill	rpm	Window for motor standstill
745	2	TorqueTargetReached	Nm	Window for torque target reached
745	3	Hyst. TargetReached	rpm	Hysteresis window for speed control target reached
745	4	Hyst. Standstill	rpm	Hysteresis window for speed control standstill
746	0	MON_UsrPosWindow	mDegree	Setpoint reached pos. window

Table 10.1: "Limits / thresholds" parameters

Motor phase failure detection

Setting **P 737-MON_MNCTL[0]**, Bit 0 = 1 (01h) activates motor phase failure detection. This monitors the motor phase current between 25 Hz and 3000 Hz electrical rotating field frequency.

The error message 53-1 is generated if at least one of each of the three quadratic mean current values deviates by 15%. If the current is smaller than $(0.1A)^2$, no error is triggered.

If monitoring from 5 Hz is required, **P 737 MON_MNCTL[0]**, Bit 5 = 1 (21h) can also be set.

Single-phase power failure detection

Setting **P 737-MON_MNCTL[0]**, Bit 3 = 1 (08h) activates power failure detection. This is implemented by calculating the quadratic ripple (variance) of the DC link voltage.

For the actual value, see **P 701-MON_ActValues[28]**, VDC_Variance.

The parameters for this function can be found in **P 760**. The threshold value is specified in **P 760-MON_VDC_Guard[2]**, Max_var and a time in **P 760-MON_VDC_Guard[3]**, Max_time. If the variance exceeds the threshold value for the specified time, a single-phase error 54-1 is detected.

If **P 737-MON_MNCTL**, Bit 4 = 1 is set, the error 34-0 PowerFail is initiated.

10.2 Torque- / force limits

- The torque is limited to a maximum by **P 329[0] - CON_SCON_TMax**. In the default setting the torque limit corresponds to the rated torque of the motor. The possible setting range is 0-1000 %. The parameter can be changed during operation.
- In addition, **P 329[0] - CON_SCON_TMax** can be used to determine what the maximum current is. To do this, multiply **P 329[0] - CON_SCON_TMax** by the rated current.
- **P 332[0] - CON_SCON_TMaxScale** enables the torque limit set in **P 329[0]** to be scaled online – that is, during operation.
- It is additionally possible via **P 330[0] - CON_SCON_TMaxNeg** and **P 331[0] - CON_SCON_TMaxPos** to change the torque limit for different directions of rotation during operation.

ID	Index	Name	Unit	Description
329	0	CON_SCON_TMax	%	Speed control maximum torque
330	0	CON_SCON_TMaxNeg	%	Scaling of negative motor torque limit
331	0	CON_SCON_TMaxPos	%	Scaling of positive motor torque limit
332	0	CON_SCON_TMaxScale	%	Scaling of motor torque limit
741	0	MON_TorqueThresh	Nm	Monitoring torque / force threshold

Table 10.2: “Limits / thresholds - Torque / force limits” parameters



NOTE

- When using homing methods -8, -9, -10, and -11, **P 332[0] - CON_SCON_TMaxScale** is replaced by **P 225[0] - MPRO_REF_HOMING_TMaxScale**.
- To protect against overspeed if a requested torque is not reached, **P 337[0] - CON_SCON_SMaxScale** is used to limit the speed controller to a percentage of the rated speed.

10.3 Speed- / velocity limits

- **P 328[0] - CON_SCON_SMax** can be used to set the maximum speed limit. In the default setting the speed limit is the same as the rated speed of the motor. The possible setting range is 0-2000%. The parameter cannot be changed during operation. A change is only effective after restarting the control.
- **P 337[0] - CON_SCON_SMaxScale** enables the torque limit set in **P 328[0]** to be scaled online – that is, during operation.
- It is additionally possible via **P 333[0] - CON_SCON_TMaxNeg** and **P 334[0] - CON_SCON_TMaxPos** to change the torque limit for different directions of rotation during operation.
- **P 744[0] - MON_SDiffMax** is used to specify the permissible difference between the setpoint speed and the actual speed (tracking error) in revolutions.
- **P 745[0] - MON_RefWindow** is used to define the point at which the setpoint is considered to have been reached.

ID	Index	Name	Unit	Description
167	0	MPRO_REF_OVR	%	Motion profile override factor
328	0	CON_SCON_SMax	%	Speed control maximum speed
333	0	CON_SCON_SMaxNeg	%	Scaling of negative motor speed limit
334	0	CON_SCON_SMaxPos	%	Scaling of positive motor speed limit
335	0	CON_SCON_DirLock		Direction lock for speed reference value
337	0	CON_SCON_SMaxScale	%	Scaling of motor speed limit
740	0	MON_SpeedThresh	rpm	Monitoring speed threshold
744	0	MON_SDiffMax	rpm	Speed tracking error

Table 10.3: “Limits / thresholds - Speed limits” parameters

10.4 Position limitation

- Position limiting is only applicable in positioning mode and will be enabled only once homing is successfully completed (see Section "Homing" on page 258).
- P 2235[0] - MPRO_402_SoftwarePosLimit** is used to define the lower position limit. **P 2235[1] - MPRO_402_SoftwarePosLimit** is used to define the upper position limit. This function is also referred to as "software limit switches".
- In addition, **P 743[0] - MON_UsrPosDiffMax** can be used to define the maximum tracking error.
- P 746[0] - MON_UsrPosWindow** can be used to define the zero speed window (position setpoint reached).

Positioning mode	Function
Absolute	Before enabling an absolute motion task, a check is made whether the target is in the valid range – that is, within the software limit switches. If the target is outside, no motion task is signalled and the programmed error reaction as per P 30 Error Reactions is executed.
Endless	This mode can only be used when using speed-controlled operation. The drive travels until a software limit switch is detected. Then the programmed error reaction is executed.

Table 10.4: Positioning mode

ID	Index	Name	Unit	Description
224	0	MPRO_REF_TargetReachedOpC		Target reached option code
743	0	MON_UsrPosDiffMax	mDegree	Position difference threshold
2235		MPRO_402_SoftwarePosLimit		607DH DS402 software position limit (SW limit switch)
2235	0	MPRO_402_SoftwarePosLimit	mDegree	Minimum position limit (negative software limit switch)
2235	1	MPRO_402_SoftwarePosLimit	mDegree	Maximum position limit (positive software limit switch)
746	0	MON_UsrPosWindow	mDegree	"Reference reached" window

Table 10.5: "Limits / thresholds - Position limits" parameters



NOTE

- The response when a position limit is reached (**P 2235 - MPRO_402_SoftwarePosLimit**) will depend on the error response that has been configured (see Section "Error reactions" on page 336).

10.5 Power stage

- If the value for the DC link voltage exceeds the value set in parameter **P 747 [0] - MON_PF_OnLimit**, error ERR-34 "Power failure detected" is reported and the parameterized error reaction is triggered (see Section "Error reactions" on page 336).
- By setting a quickstop as the error reaction in the parameters using an adequately steep deceleration ramp, the DC link voltage can be maintained above the undervoltage threshold (see Section "Power failure bridging" on page 29). This reaction lasts until the drive has been braked to a lower speed.

ID	Index	Name	Unit	Description
747	0	MON_PF_ONLimit	V	Voltage limit for power failure
749	0	MON_DevOverVoltage	V	Overvoltage DC-link
750		MON_CurrToGround		Fault current
750	0	Current to ground	A	Maximum fault current to ground
750	1	Current in power-off	A	Maximum fault current in power-off
757	0	MON_PwrActVal_Tf	ms	Filter time constant for actual power values

Table 10.6: "Limits / thresholds - Power stage" parameters

11 Alarms & warnings

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Alarms & warnings

Brief description

This chapter describes the possible alarm and warning events, thresholds for triggering and resetting, and error reactions.

Contents

11.1 Warning status	325
11.2 Alarms and warnings (Details)	327
11.3 Warning thresholds	334
11.4 Error display	335
11.5 Error reactions	336
11.6 Error list	339

11.1 Warning status

- The status for the most important warnings can be checked with...
 - The “Warnings” pictogram on the quick launch toolbar or via
 - ► Project tree ► Device setup ► Alarms & warnings ► Warning status.

A visual representation of the most important bits in status word **P 34[0]** - **ERR_WRN_State** will appear.

- As soon as there is a warning, the corresponding bit will be set in status word **P 34[0]** and the visual representation will display it in the form of an LED with a solid light. The bits can also be displayed and recorded over time in the form of an oscilloscope signal.
- The individual trigger thresholds for setting and resetting a warning are defined in **P 730 - MON_WarningLevel** (see Section “Warning thresholds” on page 334).

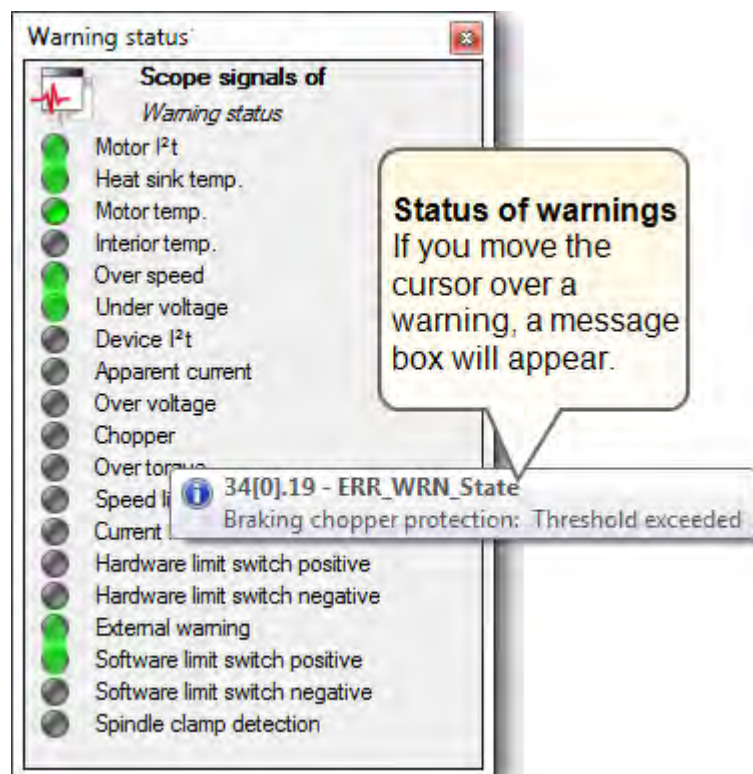


Fig. 11.1: Warning status window

ID	Index	Name	Unit	Description
34	0	ERR_WRN_State		Device warning status word

Table 11.1: "Warning status" parameters

The following table shows what all the bits in status word **P 34[0]** mean:

P 34 Bit-No.	Meaning
(0)	I ² t integrator (motor) warning threshold exceeded
(1)	Heat sink temperature
(2)	Motor temperature
(3)	Interior temperature
(4)	Reserved for SERCOS
(5)	Excessive speed
(6)	Reserved for SERCOS
(7)	Reserved for SERCOS
(8)	Reserved for SERCOS
(9)	Undervoltage
(10)	Reserved for SERCOS
(11)	Reserved for SERCOS
(12)	Reserved for SERCOS
(13)	Reserved for SERCOS
(14)	Reserved for SERCOS
(15)	Reserved for SERCOS
(16)	I ² t integrator (device) exceeded
(17)	Monitoring of apparent current
(18)	Overvoltage

Table 11.2: Device warning status word

P 34 Bit-No.	Meaning
(19)	Protection of brake chopper, warning threshold exceeded
(20)	Overtorque
(21)	Spindle monitoring
(22)	Reserved
(23)	Reserved
(24)	Speed reference limitation active
(25)	Current reference limitation
(26)	Right limit switch active
(27)	Left limit switch active
(28)	External warning via input
(29)	Software limit switches positive
(30)	Software limit switches negative
(31)	Reserved

Table 11.2: Device warning status word (continue)

To view the entire **P 34[0]** status word at once, double-click on the list.

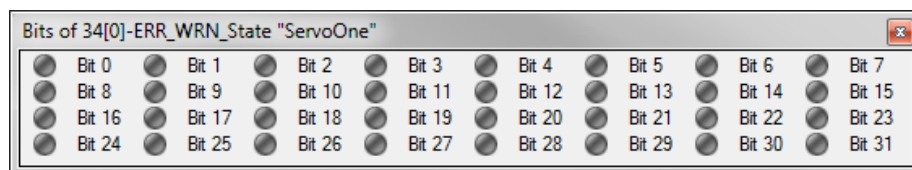


Fig. 11.2: Status word **P 34[0]** visual representation

11.2 Alarms and warnings (Details)

	Actual error	1	2
Counter	-	-	-
Label	-	-	-
Cause	-	-	-
Remedy	-	-	-
Operating hours [hh:mm:ss]	-	-	-
Info	-	-	-
Source	-	-	-
DriveCom state	-	-	-
Operating hours (power stage) [hh:mm:ss]	-	-	-
Actual Current [A]	-	-	-
Actual voltage [V]	-	-	-
Actual speed [1/min]	-	-	-
Temp. KK [deg C]	-	-	-
Temp. int. [deg C]	-	-	-

Error counter:

Over voltage	1	I2t power amplifier	7
Over current	10	reserved	0
Overtemp. heat sink	0	reserved	0
Overtemp. device interior	0	reserved	0

Fig. 11.3: "Alarms and warnings (Details)" screen

To open an overview of the current error and a history containing the most recent 20 errors, go to ►Project tree ►Device setup ►Alarms & warnings ►Alarms & warnings (Details). The screen will also show a counter for the most common errors.

- **P 33 - ActualError** will describe the current error in detail, including a timestamp, the probable cause, potential fixes, etc.
- **P 39[0] - ERR_ErrorID** will contain the error code, which provides information regarding the error location and error type of the current error.
- **P 71 - ActualErrorExt** will contain information on the state of the Servo Drive at the time the current error occurred, e.g. current, voltage, speed, temperatures.

- **P 31 - ErrorStack** and **P 70 - ErrorStackExt** will contain the history with the most recent 20 errors along with the contents from **P 33** and **P 71**. **P 31 - ErrorStack** and **P 70 - ErrorStackExt** can also be displayed as tables (see).
- **P 72 - ErrorAbsCount** is a counter for various pre-defined error events.

ID	Index	Name	Unit	Description
31		ErrorStack		Error history of device
31	0	Cause		Error cause
31	1	Remedy		Error remedy
31	2	ID		Error id
31	3	Location		Error location
31	4	Time		Time stamp
31	5	CommentId		Additional comment (id)
31	6	CommentText		Additional comment (text)
31	7	Line		Line of error occurrence
31	8	File		Source / File
31	9	Cause		Error cause
31	10	Remedy		Error remedy
31	11	ID		Error id
31	12	Location		Error location
31	13	Time		Time stamp
31	14	CommentId		Additional comment (id)
31	15	CommentText		Additional comment (text)
31	16	Line		Line of error occurrence
31	17	File		Source / File
31	18	Cause		Error cause
31	19	Remedy		Error remedy
31	20	ID		Error id
31	21	Location		Error location
31	22	Time		Time stamp
31	23	CommentId		Additional comment (id)
31	24	CommentText		Additional comment (text)
31	25	Line		Line of error occurrence

Table 11.3: "Alarms & warnings (Details)" parameters

ID	Index	Name	Unit	Description
31	26	File		Source / File
31	27	Cause		Error cause
31	28	Remedy		Error remedy
31	29	ID		Error id
31	30	Location		Error location
31	31	Time		Time stamp
31	32	CommentId		Additional comment (id)
31	33	CommentText		Additional comment (text)
31	34	Line		Line of error occurrence
31	35	File		Source / File
31	36	Cause		Error cause
31	37	Remedy		Error remedy
31	38	ID		Error id
31	39	Location		Error location
31	40	Time		Time stamp
31	41	CommentId		Additional comment (id)
31	42	CommentText		Additional comment (text)
31	43	Line		Line of error occurrence
31	44	File		Source / File
31	45	Cause		Error cause
31	46	Remedy		Error remedy
31	47	ID		Error id
31	48	Location		Error location
31	49	Time		Time stamp
31	50	CommentId		Additional comment (id)
31	51	CommentText		Additional comment (text)
31	52	Line		Line of error occurrence
31	53	File		Source / File
31	54	Cause		Error cause
31	55	Remedy		Error remedy
31	56	ID		Error id
31	57	Location		Error location
31	58	Time		Time stamp

ID	Index	Name	Unit	Description
31	59	CommentId		Additional comment (id)
31	60	CommentText		Additional comment (text)
31	61	Line		Line of error occurrence
31	62	File		Source / File
31	63	Cause		Error cause
31	64	Remedy		Error remedy
31	65	ID		Error id
31	66	Location		Error location
31	67	Time		Time stamp
31	68	CommentId		Additional comment (id)
31	69	CommentText		Additional comment (text)
31	70	Line		Line of error occurrence
31	71	File		Source / File
31	72	Cause		Error cause
31	73	Remedy		Error remedy
31	74	ID		Error id
31	75	Location		Error location
31	76	Time		Time stamp
31	77	CommentId		Additional comment (id)
31	78	CommentText		Additional comment (text)
31	79	Line		Line of error occurrence
31	80	File		Source / File
31	81	Cause		Error cause
31	82	Remedy		Error remedy
31	83	ID		Error id
31	84	Location		Error location
31	85	Time		Time stamp
31	86	CommentId		Additional comment (id)
31	87	CommentText		Additional comment (text)
31	88	Line		Line of error occurrence
31	89	File		Source / File
31	90	Cause		Error cause
31	91	Remedy		Error remedy

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

ID	Index	Name	Unit	Description
31	92	ID		Error id
31	93	Location		Error location
31	94	Time		Time stamp
31	95	CommentId		Additional comment (id)
31	96	CommentText		Additional comment (text)
31	97	Line		Line of error occurrence
31	98	File		Source / File
31	99	Cause		Error cause
31	100	Remedy		Error remedy
31	101	ID		Error id
31	102	Location		Error location
31	103	Time		Time stamp
31	104	CommentId		Additional comment (id)
31	105	CommentText		Additional comment (text)
31	106	Line		Line of error occurrence
31	107	File		Source / File
31	108	Cause		Error cause
31	109	Remedy		Error remedy
31	110	ID		Error id
31	111	Location		Error location
31	112	Time		Time stamp
31	113	CommentId		Additional comment (id)
31	114	CommentText		Additional comment (text)
31	115	Line		Line of error occurrence
31	116	File		Source / File
31	117	Cause		Error cause
31	118	Remedy		Error remedy
31	119	ID		Error id
31	120	Location		Error location
31	121	Time		Time stamp
31	122	CommentId		Additional comment (id)
31	123	CommentText		Additional comment (text)
31	124	Line		Line of error occurrence

ID	Index	Name	Unit	Description
31	125	File		Source / File
31	126	Cause		Error cause
31	127	Remedy		Error remedy
31	128	ID		Error id
31	129	Location		Error location
31	130	Time		Time stamp
31	131	CommentId		Additional comment (id)
31	132	CommentText		Additional comment (text)
31	133	Line		Line of error occurrence
31	134	File		Source / File
31	135	Cause		Error cause
31	136	Remedy		Error remedy
31	137	ID		Error id
31	138	Location		Error location
31	139	Time		Time stamp
31	140	CommentId		Additional comment (id)
31	141	CommentText		Additional comment (text)
31	142	Line		Line of error occurrence
31	143	File		Source / File
31	144	Cause		Error cause
31	145	Remedy		Error remedy
31	146	ID		Error id
31	147	Location		Error location
31	148	Time		Time stamp
31	149	CommentId		Additional comment (id)
31	150	CommentText		Additional comment (text)
31	151	Line		Line of error occurrence
31	152	File		Source / File
31	153	Cause		Error cause
31	154	Remedy		Error remedy
31	155	ID		Error id
31	156	Location		Error location
31	157	Time		Time stamp

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

ID	Index	Name	Unit	Description
31	158	CommentId		Additional comment (id)
31	159	CommentText		Additional comment (text)
31	160	Line		Line of error occurrence
31	161	File		Source / File
31	162	Cause		Error cause
31	163	Remedy		Error remedy
31	164	ID		Error id
31	165	Location		Error location
31	166	Time		Time stamp
31	167	CommentId		Additional comment (id)
31	168	CommentText		Additional comment (text)
31	169	Line		Line of error occurrence
31	170	File		Source / File
31	171	Cause		Error cause
31	172	Remedy		Error remedy
31	173	ID		Error id
31	174	Location		Error location
31	175	Time		Time stamp
31	176	CommentId		Additional comment (id)
31	177	CommentText		Additional comment (text)
31	178	Line		Line of error occurrence
31	179	File		Source / File
33		ActualError		Actual device error
33	0	Cause		Error cause
33	1	Remedy		Error remedy
33	2	ID		Error identification
33	3	Location		Error Location
33	4	Time	s	Time stamp
33	5	CommentId		Additional error comment (id)
33	6	CommentText		Additional error comment (text)
33	7	Line		Line of error occurrence
33	8	Source file of error occurrence		Additional error comment (text)
39	0	ERR_ErrorID		Device Error ID (low word) and Error

ID	Index	Name	Unit	Description
				Location (high word)
70		ErrorStackExt		Extended error history of device
70	0	Count		"Counter, if same error occurs again"
70	1	DriveComState		Actual DriveComState
70	2	TimePowerStage		Power stage time stamp of error event
70	3	Current	A	Actual current
70	4	Voltage	V	Actual DC voltage
70	5	ActSpeed	1/min	Actual speed
70	6	Temp_KK	deg C	Absolute temperature of cooling block
70	7	Temp_Int	deg C	Absolute temperature of interior
70	8	Count		"Counter, if same error occurs again"
70	9	DriveComState		Actual DriveComState
70	10	TimePowerStage		Power stage time stamp of error event
70	11	Current	A	Actual current
70	12	Voltage	V	Actual DC voltage
70	13	ActSpeed	1/min	Actual speed
70	14	Temp_KK	deg C	Absolute temperature of cooling block
70	15	Temp_Int	deg C	Absolute temperature of interior
70	16	Count		"Counter, if same error occurs again"
70	17	DriveComState		Actual DriveComState
70	18	TimePowerStage		Power stage time stamp of error event
70	19	Current	A	Actual current
70	20	Voltage	V	Actual DC voltage
70	21	ActSpeed	1/min	Actual speed
70	22	Temp_KK	deg C	Absolute temperature of cooling block
70	23	Temp_Int	deg C	Absolute temperature of interior
70	24	Count		"Counter, if same error occurs again"
70	25	DriveComState		Actual DriveComState

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

ID	Index	Name	Unit	Description
70	26	TimePowerStage		Power stage time stamp of error event
70	27	Current	A	Actual current
70	28	Voltage	V	Actual DC voltage
70	29	ActSpeed	1/min	Actual speed
70	30	Temp_KK	deg C	Absolute temperature of cooling block
70	31	Temp_Int	deg C	Absolute temperature of interior
70	32	Count		"Counter, if same error occurs again"
70	33	DriveComState		Actual DriveComState
70	34	TimePowerStage		Power stage time stamp of error event
70	35	Current	A	Actual current
70	36	Voltage	V	Actual DC voltage
70	37	ActSpeed	1/min	Actual speed
70	38	Temp_KK	deg C	Absolute temperature of cooling block
70	39	Temp_Int	deg C	Absolute temperature of interior
70	40	Count		"Counter, if same error occurs again"
70	41	DriveComState		Actual DriveComState
70	42	TimePowerStage		Power stage time stamp of error event
70	43	Current	A	Actual current
70	44	Voltage	V	Actual DC voltage
70	45	ActSpeed	1/min	Actual speed
70	46	Temp_KK	deg C	Absolute temperature of cooling block
70	47	Temp_Int	deg C	Absolute temperature of interior
70	48	Count		"Counter, if same error occurs again"
70	49	DriveComState		Actual DriveComState
70	50	TimePowerStage		Power stage time stamp of error event
70	51	Current	A	Actual current
70	52	Voltage	V	Actual DC voltage
70	53	ActSpeed	1/min	Actual speed
70	54	Temp_KK	deg	Absolute temperature of cooling block

ID	Index	Name	Unit	Description
			C	
70	55	Temp_Int	deg C	Absolute temperature of interior
70	56	Count		"Counter, if same error occurs again"
70	57	DriveComState		Actual DriveComState
70	58	TimePowerStage		Power stage time stamp of error event
70	59	Current	A	Actual current
70	60	Voltage	V	Actual DC voltage
70	61	ActSpeed	1/min	Actual speed
70	62	Temp_KK	deg C	Absolute temperature of cooling block
70	63	Temp_Int	deg C	Absolute temperature of interior
70	64	Count		"Counter, if same error occurs again"
70	65	DriveComState		Actual DriveComState
70	66	TimePowerStage		Power stage time stamp of error event
70	67	Current	A	Actual current
70	68	Voltage	V	Actual DC voltage
70	69	ActSpeed	1/min	Actual speed
70	70	Temp_KK	deg C	Absolute temperature of cooling block
70	71	Temp_Int	deg C	Absolute temperature of interior
70	72	Count		"Counter, if same error occurs again"
70	73	DriveComState		Actual DriveComState
70	74	TimePowerStage		Power stage time stamp of error event
70	75	Current	A	Actual current
70	76	Voltage	V	Actual DC voltage
70	77	ActSpeed	1/min	Actual speed
70	78	Temp_KK	deg C	Absolute temperature of cooling block
70	79	Temp_Int	deg C	Absolute temperature of interior
70	80	Count		"Counter, if same error occurs again"
70	81	DriveComState		Actual DriveComState

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

ID	Index	Name	Unit	Description
70	82	TimePowerStage		Power stage time stamp of error event
70	83	Current	A	Actual current
70	84	Voltage	V	Actual DC voltage
70	85	ActSpeed	1/min	Actual speed
70	86	Temp_KK	deg C	Absolute temperature of cooling block
70	87	Temp_Int	deg C	Absolute temperature of interior
70	88	Count		"Counter, if same error occurs again"
70	89	DriveComState		Actual DriveComState
70	90	TimePowerStage		Power stage time stamp of error event
70	91	Current	A	Actual current
70	92	Voltage	V	Actual DC voltage
70	93	ActSpeed	1/min	Actual speed
70	94	Temp_KK	deg C	Absolute temperature of cooling block
70	95	Temp_Int	deg C	Absolute temperature of interior
70	96	Count		"Counter, if same error occurs again"
70	97	DriveComState		Actual DriveComState
70	98	TimePowerStage		Power stage time stamp of error event
70	99	Current	A	Actual current
70	100	Voltage	V	Actual DC voltage
70	101	ActSpeed	1/min	Actual speed
70	102	Temp_KK	deg C	Absolute temperature of cooling block
70	103	Temp_Int	deg C	Absolute temperature of interior
70	104	Count		"Counter, if same error occurs again"
70	105	DriveComState		Actual DriveComState
70	106	TimePowerStage		Power stage time stamp of error event
70	107	Current	A	Actual current
70	108	Voltage	V	Actual DC voltage
70	109	ActSpeed	1/min	Actual speed
70	110	Temp_KK	deg	Absolute temperature of cooling block

ID	Index	Name	Unit	Description
			C	
70	111	Temp_Int	deg C	Absolute temperature of interior
70	112	Count		"Counter, if same error occurs again"
70	113	DriveComState		Actual DriveComState
70	114	TimePowerStage		Power stage time stamp of error event
70	115	Current	A	Actual current
70	116	Voltage	V	Actual DC voltage
70	117	ActSpeed	1/min	Actual speed
70	118	Temp_KK	deg C	Absolute temperature of cooling block
70	119	Temp_Int	deg C	Absolute temperature of interior
70	120	Count		"Counter, if same error occurs again"
70	121	DriveComState		Actual DriveComState
70	122	TimePowerStage		Power stage time stamp of error event
70	123	Current	A	Actual current
70	124	Voltage	V	Actual DC voltage
70	125	ActSpeed	1/min	Actual speed
70	126	Temp_KK	deg C	Absolute temperature of cooling block
70	127	Temp_Int	deg C	Absolute temperature of interior
70	128	Count		"Counter, if same error occurs again"
70	129	DriveComState		Actual DriveComState
70	130	TimePowerStage		Power stage time stamp of error event
70	131	Current	A	Actual current
70	132	Voltage	V	Actual DC voltage
70	133	ActSpeed	1/min	Actual speed
70	134	Temp_KK	deg C	Absolute temperature of cooling block
70	135	Temp_Int	deg C	Absolute temperature of interior
70	136	Count		"Counter, if same error occurs again"
70	137	DriveComState		Actual DriveComState

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

ID	Index	Name	Unit	Description
70	138	TimePowerStage		Power stage time stamp of error event
70	139	Current	A	Actual current
70	140	Voltage	V	Actual DC voltage
70	141	ActSpeed	1/min	Actual speed
70	142	Temp_KK	deg C	Absolute temperature of cooling block
70	143	Temp_Int	deg C	Absolute temperature of interior
70	144	Count		"Counter, if same error occurs again"
70	145	DriveComState		Actual DriveComState
70	146	TimePowerStage		Power stage time stamp of error event
70	147	Current	A	Actual current
70	148	Voltage	V	Actual DC voltage
70	149	ActSpeed	1/min	Actual speed
70	150	Temp_KK	deg C	Absolute temperature of cooling block
70	151	Temp_Int	deg C	Absolute temperature of interior
70	152	Count		"Counter, if same error occurs again"
70	153	DriveComState		Actual DriveComState
70	154	TimePowerStage		Power stage time stamp of error event
70	155	Current	A	Actual current
70	156	Voltage	V	Actual DC voltage
70	157	ActSpeed	1/min	Actual speed
70	158	Temp_KK	deg C	Absolute temperature of cooling block
70	159	Temp_Int	deg C	Absolute temperature of interior
71		ActualErrorExt		Extended actual device error
71	0	DriveComState		Actual DriveComState
71	1	ActualTimePowerStageValue		Power stage time stamp of error event
71	2	Current	A	Actual current
71	3	Voltage	V	Actual DC voltage
71	4	ActSpeed	1/min	Actual speed
71	5	Temp_KK	deg	Absolute temperature of cooling block

ID	Index	Name	Unit	Description
			C	
71	6	Temp_Int	deg C	Absolute temperature of interior
72		ErrorAbsCount		Absolute error counters
72	0	Over voltage		Overvoltage
72	1	Over current		Overcurrent
72	2	Over temp. inverter		Overheating
72	3	Over temp. device		Overheating
72	4	I2t power amplifier		I2t power amplifier or chopper absolute errors
72	5	-		Reserved
72	6	-		Reserved
72	7	-		Reserved

Table 11.3: "Alarms & warnings (Details)" parameters (continue)

11.3 Warning thresholds

- **P 730 - MON_WarningLevel** can be used to define warning thresholds in order to prevent Servo Drive nuisance tripping. Each warning is assigned on and off thresholds. This enables parameterization of a hysteresis that meets the requirement of the application. Warnings can also be programmed onto digital outputs.

ID	Index	Name	Unit	Description
730		MON_WarningLevel		Warning levels
730	0	UnderVoltage_ON	V	DC link undervoltage
730	1	UnderVoltage_OFF	V	DC link undervoltage
730	2	OverVoltage_ON	V	DC link Overvoltage
730	3	OverVoltage_OFF	V	DC link Overvoltage
730	4	I_ON	A	Motor current
730	5	I_OFF	A	Motor current
730	6	DeviceI2t_ON	%	I ² t device protection
730	7	DeviceI2t_OFF	%	I ² t device protection
730	8	MotorI2t_ON	%	I ² t motor protection
730	9	MotorI2t_OFF	%	I ² t motor protection
730	10	Torque_ON	Nm	Torque limit reached
730	11	Torque_OFF	Nm	Torque limit reached
730	12	Speed_ON	rpm	Speed limit reached
730	13	Speed_OFF	rpm	Speed limit reached
730	14	TC_ON	degC	Maximum heat sink temperature reached
730	15	TC_OFF	degC	Maximum heat sink temperature reached
730	16	Tint_ON	degC	Maximum interior temperature reached
730	17	Tint_OFF	degC	Maximum interior temperature reached
730	18	MotorTemp_ON X5	degC	Maximum motor temperature reached (temperature sensor on X5)
730	19	MotorTemp_OFF X5	degC	Maximum motor temperature reached (temperature sensor on X5)
730	20	MotorTemp_ON X6	degC	Maximum motor temperature reached (temperature sensor on X6)
730	21	MotorTemp_OFF X6	degC	Maximum motor temperature reached (temperature sensor on X6)

Table 11.4: "Warning thresholds" parameters

11.4 Error display

There are a number of ways of displaying an error message. An error message is indicated on the display of the servo controller (display D1/D2) or via the Moog DRIVEADMINISTRATOR 5. It provides a user-friendly readout in the "Device status" window.

11.4.1 Servo Drive display

The display on the Servo Drive shows the various device states and possible error messages. Two 7-segment displays are available for this purpose. To display an error number and an error, "ER" for Error flashes, then the error number, and then the number of the error location.

Example: ER ▶16 ▶01

Display readout	Function
	Attention – error message
	Errors marked with a dot on the display (D1/D2) can only be reset when the cause of the fault has been eliminated.
	Maximum speed exceeded

Table 11.5: Servo Drive error display

Display readout	Function
	Speed tracking error above threshold value

Table 11.5: Servo Drive error display (continue)

11.4.2 Display in the Moog DRIVEADMINISTRATOR 5

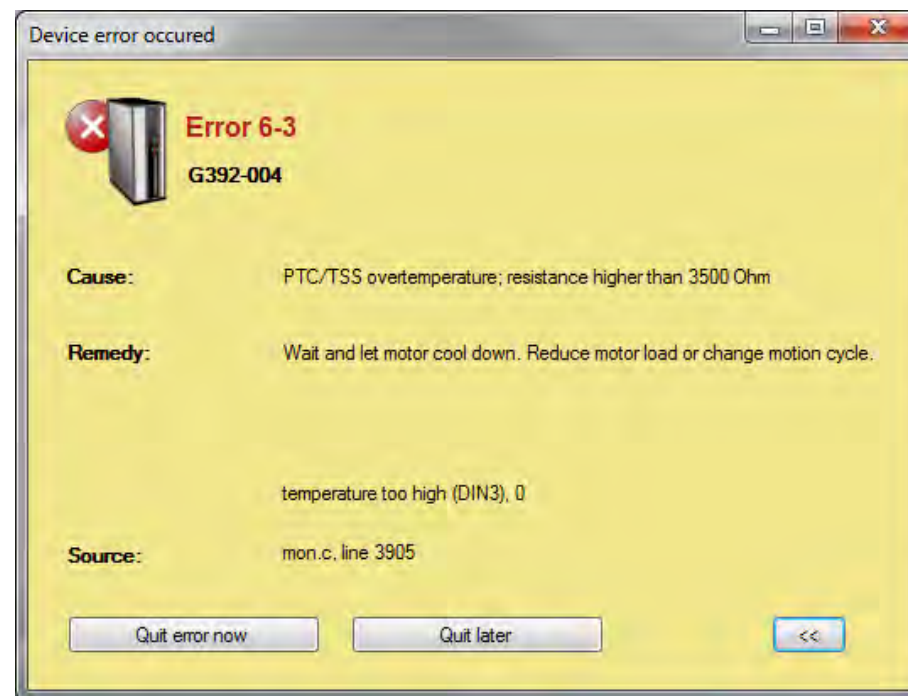


Fig. 11.4: Error display in the Moog DRIVEADMINISTRATOR 5

Immediately after an error occurs, it will be shown in a window. After closing the window by clicking on "Quit error" or "Later," you can view the current error and the 20 most recent errors (see Section "Alarms and warnings (Details)" on page 327).

11.5 Error reactions

- **P 30 - ErrorReactions** is used to define how the Servo Drive will respond in the event of an error. These responses are defined individually for 62 different error scenarios. A selection of up to nine different responses will be available (see Section "Error reactions" on page 336).
- **P 38[0] - ERR_Specific2OptCode** can be used to define an additional error response if the Servo Drive features an optional function package.

Error reaction	Function
Ignore (0)	Ignore error Exception: For the HW limit switch, in which case a warning will be generated (P 34 bit 29 or bit 30)
Specific1 (1)	The error will be reported; the response will be carried out by the integrated PLC (V2.0 and higher) Exception: For the HW limit switch, in which case a warning will be generated (P 34 bit 29 or bit 30) and there will be a STOP request (deceleration with ramp depending on the STOP option code, without any change to the DRIVECOM system state). At standstill the relevant direction is blocked as long as the limit switch is active.
Specific2 (2)	The error will be reported; the response will be carried out by an external controller

Table 11.6: Error reactions

Error reaction	Function
FaultReactionOptionCode (3)	The error will be reported; the response will depend on the "fault reaction code" Response as per P 38[0] • Disable 0: Inhibit power stage, motor coasts down • EXT_TO_ROT_0 -1: External reaction, power stage inhibited on timeout or standstill (P 154) • EXT_TO -2: External reaction, power stage inhibited on timeout (P 154) • PLC_TO -3: MSD PLC reaction, drive disabled by timeout (P 154) • PLC -4: MSD PLC reaction
ServoStop (4)	Notify error, execute quick stop and wait for restart of control
ServoStopAndLock (5)	Notify error, execute quick stop, disable power stage, protect against restart
ServoHalt (6)	Notify error, disable power stage
ServoHaltAndLock (7)	Notify error, disable power stage, protect against restart
WaitERSAndReset (8)	Notify error, disable power stage, reset error (only by 24 V control voltage Off/On)

Table 11.6: Error reactions (continue)

ID	Index	Name	Unit	Description
30		ErrorReactions		Error reactions
30	0	Reac_NoError		Error reaction on "no error"
30	1	Reac_RunTimeError		Error reaction on "runtime error"
30	2	Reac_ParaList		Error reaction on "parameter list error"
30	3	Reac_Off		Error reaction on "undervoltage" in DC link
30	4	Reac_OverVoltage		Error reaction on "overvoltage" in DC link
30	5	Reac_OverCurrent		Error reaction on "overcurrent"
30	6	Reac_OvertempMotor		Error reaction on "over temperature motor"
30	7	Reac_OvertempInverter		Error response: Power stage overtemperature
30	8	Reac_OvertempDevice		Error response: Internal overtemperature
30	9	Reac_I2tMotor		Error reaction: I2T error, motor
30	10	Reac_I2tPowerAmplifier		Error response: Power stage I2T error
30	11	Reac_External		Error response: External error
30	12	Reac_ComOptCan		Error response: CAN communication option
30	13	Reac_ComOptSercos		Error response: Sercos communication option
30	14	Reac_ComOptEtherCAT		Error response: EtherCAT® communication option
30	15	Reac_Parameter		Error response: Parameter error
30	16	Reac_SpeedDiff		Error response: Speed tracking error
30	17	Reac_PositionDiff		Error response: Position tracking error
30	18	Reac_MotionControl		Error response: Control error
30	19	Reac_FatalError		Error response: Fatal device error
30	20	Reac_HardwareLimitSwitch		Error response: Hardware limit switch
30	21	Reac_Init		Error response: Encoder initialization
30	22	Reac_EncCH1Init		Error response: Channel 1 initialization encoder error
30	23	Reac_EncCH2Init		Error response: Channel 2 initialization encoder error
30	24	Reac_EncCH3Init		Error response: Channel 3 initialization encoder error
30	25	Reac_EncoderCycl		Error reaction: Cycl. encoder operation
30	26	Reac_EncCH1Cycl		Error reaction: Encoder error, cycl. operation, channel 1

Table 11.7: Parameters "Error reactions"

11 Alarms & warnings

ID	Index	Name	Unit	Description
30	27	Reac_EncCH2Cycl		Error reaction: Encoder error, cycl. operation, channel 2
30	28	Reac_EncCH3Cycl		Error reaction: Encoder error, cycl. operation, channel 3
30	29	Reac_TC		Error response: Hardware error
30	30	Reac_InitCon		Error response: Control initialization
30	31	Reac_PLC		Error reaction: Ext. PLC program
30	32	Reac_ComOptDp		Error response: PROFIBUS DP communication option
30	33	Reac_Timing		Error reaction: Int. Runtime error
30	34	Reac_PowerFail		Error response: Power failure
30	35	Reac_EncObs		Error response: Encoder monitoring
30	36	Reac_ComOptVARAN		Error response: VARAN communication option
30	37	Reac_SynCtrl		Error response: Synchronization controller
30	38	Reac_OverCurrent_BC		Error response: Braking chopper
30	39	Reac_TWIN		Error response: TWINSYNC
30	40	Reac_TWIN_TOPT		Error response: TWINSYNC technology option
30	41	Reac_FastDischargeTimeOut		Error response: DC link fast discharge timeout
30	42	Reac_EtcMaster		Error response: EtherCAT® master
30	43	Reac_Ethernet		Error response: Ethernet configuration
30	44	Reac_WireBreak		Error response: Wire break
30	45	Reac_LockViolate		Error response: Setpoint exceeded
30	46	Reac_PositionLimit		Error response: Software limit switch
30	47	Reac_FSAFE_NonSafetySystem		"Reaction on ""FSAFE - error in non-safety-system"""
30	48	Reac_NmtStateChanged		Error response: NMT state change
30	49	Reac_FSAFE_SafetySystem		"Reaction on ""FSAFE - alarm or error in safety-system"""
30	50	Reac_TimeOut		"Reaction on ""TimeOut: Allowed duration of negative speed in pressure control exceeded"""
30	51	Reac_EncStatus		"Reaction on ""EncStatus: Warning or Errorbit set by Encoder"""
30	52	Reac_Ana		"Reaction on ""error on analogue input"""
30	53	Reac_MotorFailure		"Reaction on ""motor failure"""

Table 11.7: Parameters "Error reactions" (continue)

ID	Index	Name	Unit	Description
30	54	Reac_GridFailure		"Reaction on ""power grid failure (by detection circuit)"""
30	55	Reac_SpeedGuard		"Reaction on ""speed guarding error"""
30	56	Reac_MagBearing		"Reaction on ""magnetic bearing error"""
30	58	Reac_Hydraulic		"Reaction on ""error from Hydraulic system"""
30	59	Reac_FPGAMod		"Reaction on ""error from FPGA Modulator control"""
30	60	Reac_ClampMonitoring		"Reaction on ""error from Spindle Clamp Monitoring"""
30	61	Reserved		Reserved
30	62	Reac_EncMultiturnLost		"Reaction on ""error from Encoder-Multiturn-is-lost"""
38	0	ERR_Specific2OptCode		Error reaction specific option code

Table 11.7: Parameters "Error reactions" (continue)

11.6 Error list

11.6.1 Error 0: Unknown error

No Error.	An error message with the error number 0 usually does not occur.(inverse error number)
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11.6.2 Error 1: Runtime error

11.6.2.1 Error 1-0 (emergency code 6010h)

Cause: Unknown runtime error

Suggested steps:

See exception message

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	--

11.6.2.2 Error 1-1 (emergency code 6010h)

Cause: Error while installing a dynamic module

Suggested steps:

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	--

11.6.2.3 Error 1-2 (emergency code 6010h)

Cause: Error while flash initialisation / flash access

Suggested steps:

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	--

11.6.2.4 Error 1-3 (emergency code 6010h)

Cause: Error while PLC initialisation / PLC execution

Suggested steps:

Check PLC program

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	--

11.6.2.5 Error 1-4 (emergency code 6010h)

Cause: Run time error, not enough CPU performance, PLC scheduling stopped

Suggested steps:

Check PLC program

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	--

11.6.2.6 Error 1-5 (emergency code 6010h)

Cause: Unknown EXCEPTION in TC-safety

Suggested steps:

Acknowledge error! - If the error occurs again, reset device!

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.3 Error 2: Parameter list error

11.6.3.1 Error 2-1 (emergency code 6320h)

Cause: Parameter initialisation failed

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.3.2 Error 2-2 (emergency code 6320h)

Cause: Parameter virgin initialisation failed

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.3.3 Error 2-3 (emergency code 5530h)

Cause: Error in parameter saving routine

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
An unexpected error in the file system has occurred.	• Please report this error to your service partner. • Please check with your service partner how to generate an image file of the drive. • Please provide the Moog DRIVEADMINISTRATOR 5 message log.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.3.4 Error 2-4 (emergency code 6320h)

Cause: Error in paralist while adding a new parameter

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
------------------------------------	---

11.6.3.5 Error 2-5 (emergency code 5530h)

Cause: Parameter check failed

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.3.6 Error 2-6 (emergency code 6320h)

Cause: Parameter ID is multiply defined

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.3.7 Error 2-7 (emergency code 5400h)

Cause: The selected switching frequency is not supported

Suggested steps:

Choose different voltage level and/ or switching frequency

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.3.8 Error 2-8 (emergency code 6320h)

Cause: Error in power stage initialization; selected device voltage not supported

Suggested steps:

Choose different voltage level and/ or switching frequency

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.3.9 Error 2-9 (emergency code 6320h)

Cause: Overvoltage value greater than the maximum permitted value of the output stage.

Suggested steps:

Please check parameter (749) MON_DevOverVoltage.

11.6.4 Error 3: Undervoltage error

11.6.4.1 Error 3-1 (emergency code 3120h)

Cause: Undervoltage in DC link

Suggested steps:

Re-start process when power is available. Please check grid conditions.

An under-voltage occurred on the drive while this axis was switched on.	• Power supply was possibly switched off. • Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Verify that the grid is stable under load condition.
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11.6.4.2 Error 3-2 (emergency code 3120h)

Cause: Undervoltage: Power fail function has reached minimum speed

Suggested steps:

Re-start process when power is available. Please check grid conditions and power fail levels.

An under-voltage occurred on the drive while this axis was switched on.	• Power supply was possibly switched off. • Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Verify that the grid is stable under load condition.
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11.6.5 Error 4: Overvoltage error

11.6.5.1 Error 4-1 (emergency code 3110h)

Cause: Overvoltage detected

Suggested steps:

An over-voltage occurred.	• Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Over-voltage may be caused by a decelerating axis, possibly with high inertia. Reduce deceleration ramp. • Consider using a braking resistor with higher power. If the supply unit has an internal braking resistor, please contact your service partner.
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11.6.5.2 Error 4-2 (emergency code 3110h)

Cause: Maximum DC-link mean potential deviation detected.

Suggested steps:

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
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11.6.6 Error 5: Overcurrent error

11.6.6.1 Error 5-1 (emergency code 2250h)

Cause: Overcurrent shut-off by hardware

Suggested steps:

Please check power wiring and control settings

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.2 Error 5-2 (emergency code 2350h)

Cause: Overcurrent shut-off (fast) by software

Suggested steps:

Please check power wiring and control settings

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.3 Error 5-3 (emergency code 2350h)

Cause: Measuring range of AD converter exceeded

Suggested steps:

Please check power wiring and control settings

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.4 Error 5-4 (emergency code 2250h)

Cause: Short-circuit test on initialization

Suggested steps:

Please check power wiring for short-circuit

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.5 Error 5-5 (emergency code 2350h)

Cause: (Fast) Overcurrent shut-off "below 5 Hz"

Suggested steps:

Please check torque limits, speed profile and control settings

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.6 Error 5-6 (emergency code 2350h)

Cause: Total current monitoring

Suggested steps:

Please check ground connection or power wiring of motor and device, check current values

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.7 Error 5-7 (emergency code 2350h)

Cause: Fast I²t at high overload

Suggested steps:

Please check control and motion profile settings or reduce load

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.6.8 Error 5-8 (emergency code 2350h)

Cause: Maximum fault current (= absolut sum current) in power-off detected

Suggested steps:

Please check ground connection or power wiring of motor and device, check current values

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.7 Error 6: Motor temperature error

11.6.7.1 Error 6-1 (emergency code 4310h)

Cause: Motor temperature above threshold value

Suggested steps:

Wait and let motor cool down. Reduce motor load or change motion cycle.

The motor temperature is too high.	• Please let the motor cool down • Please check motor temperature and motor temperature resistance (PTC sensors do not report the motor temperature). If the values are not plausible, check cables and sensor type. • If you are not using a system motor, please check with the motor manufacturer if the motor can stand a higher temperature
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11.6.7.2 Error 6-2 (emergency code 4310h)

Cause: PTC short circuit detected (DIN2)

Suggested steps:

Please check PTC cable and sensor

The motor temperature is too high.	• Please let the motor cool down • Please check motor temperature and motor temperature resistance (PTC sensors do not report the motor temperature). If the values are not plausible, check cables and sensor type. • If you are not using a system motor, please check with the motor manufacturer if the motor can stand a higher temperature
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11.6.7.4 Error 6-4 (emergency code 4310h)

Cause: PTC/TSS error, resistance still higher than 1650 Ohm after overtemperature

Suggested steps:

Wait and let motor cool down. Reduce motor load or change motion cycle.

The motor temperature is too high.	• Please let the motor cool down • Please check motor temperature and motor temperature resistance (PTC sensors do not report the motor temperature). If the values are not plausible, check cables and sensor type. • If you are not using a system motor, please check with the motor manufacturer if the motor can stand a higher temperature
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11.6.7.3 Error 6-3 (emergency code 4310h)

Cause: PTC/TSS overtemperature, resistance higher than 3500 Ohm

Suggested steps:

Wait and let motor cool down. Reduce motor load or change motion cycle.

The motor temperature is too high.	• Please let the motor cool down • Please check motor temperature and motor temperature resistance (PTC sensors do not report the motor temperature). If the values are not plausible, check cables and sensor type. • If you are not using a system motor, please check with the motor manufacturer if the motor can stand a higher temperature
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11.6.7.5 Error 6-5 (emergency code 4310h)

Cause: Motor protection method not supported

Suggested steps:

Try to use different sensor connection, or contact your service provider

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.8 Error 7: Device heatsink temperature error

11.6.8.1 Error 7-1 (emergency code 4210h)

Cause: Heat sink temperature too high

Suggested steps:

reduce the load and check the conditions of the drive

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.9 Error 8: Device inside temperature error

11.6.9.1 Error 8-1 (emergency code 4210h)

Cause: Interior temperature monitor

Suggested steps:

check the conditions of the drive

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.10 Error 9: I²t motor error

11.6.10.1 Error 9-1 (emergency code 2350h)

Cause: I²t motor protection limit value exceeded

Suggested steps:

Reduce load on motor or check load cycle

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
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11.6.11 Error 10: I2t power amplifier error

11.6.11.1 Error 10-1 (emergency code 2350h)

Cause: I²t power stage protection limit value exceeded

Suggested steps:

Reduce load on motor or check load cycle

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
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11.6.11.2 Error 10-2 (emergency code 2350h)

Cause: Internal brake resistor was overloaded

Suggested steps:

Use slower deceleration ramp, check for external accelerating torque, or use unit with external brake resistor

An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.
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11.6.12 Error 11: External digital input error

11.6.12.1 Error 11-1 (emergency code FF00h)

Cause: External error at digital input detected

Suggested steps:

There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.13 Error 12: CAN error

11.6.13.1 Error 12-1 (emergency code 8140h)

Cause: CAN option: BusOff error

Suggested steps:

Please check cable and terminal resistant

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.13.2 Error 12-2 (emergency code 8130h)

Cause: CAN option: Guarding error

Suggested steps:

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.13.3 Error 12-3 (emergency code 8100h)

Cause: CAN option: Message transmit failed

Suggested steps:

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.13.4 Error 12-4 (emergency code 8130h)

Cause: CAN option: Heartbeat error

Suggested steps:

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.13.5 Error 12-5 (emergency code 8100h)

Cause: CAN option: Illegal address

Suggested steps:

Please check the configuration of the CAN address (software and hardware settings). The parameter 2005[0] indicates the set CAN software address, The parameter 2058[0] indicates the set CAN address of the DIP switches.

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.13.6 Error 12-6 (emergency code 8200h)

Cause: CAN option: mapping error

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.13.7 Error 12-7 (emergency code 8130h)

Cause: CAN option: Sync / RxPDO timeout error

Suggested steps:

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.13.8 Error 12-8 (emergency code FF00h)

Cause: CAN option: Error while parameter initialisation

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.14 Error 13: SERCOS error

11.6.14.1 Error 13-1 (emergency code FF00h)

Cause: Sercos option: Error while hardware initialisation

Suggested steps:

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
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11.6.14.2 Error 13-2 (emergency code FF00h)

Cause: Sercos option: Illegal communication phase

Suggested steps:

Error during phase switching or invalid phase switching. Please check the settings in the master!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.14.3 Error 13-3 (emergency code FF00h)

Cause: Sercos option: Optical fiber break

Suggested steps:

Please check the function of the optical fibres and the correct wiring.

11.6.14.4 Error 13-4 (emergency code FF00h)

Cause: Sercos option: Receive data disturbed

Suggested steps:

Disturbed receive data due to distortion. Lightwave power does not match to the cable length. Please check the cable length!

11.6.14.5 Error 13-5 (emergency code FF00h)

Cause: Sercos option: MST failure

Suggested steps:

Missing master sync telegram. Please check the wiring!

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.14.6 Error 13-6 (emergency code FF00h)

Cause: Sercos option: MDT failure

Suggested steps:

Missing master data telegram. Please check the wiring!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.14.7 Error 13-7 (emergency code FF00h)

Cause: Sercos option: 2 drives with same address in the ring

Suggested steps:

Please check the configured SERCOS address (parameter 3000 for SERCOS II / parameter 11040 for SERCOS III)

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.14.8 Error 13-8 (emergency code FF00h)

Cause: Sercos option: Phase upshift failure

Suggested steps:

Error during phase switching (up-shift) by master. Please check the settings in the master!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.14.9 Error 13-9 (emergency code FF00h)

Cause: Sercos option: Phase downshift failure

Suggested steps:

Error during phase switching (down-shift) by master. Please check the settings in the master!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.14.10 Error 13-10 (emergency code FF00h)

Cause: Sercos option: Phase switching without ready acknowledge

Suggested steps:

Error during phase switching. Switchover without or with incorrect command execution. Please check the settings in the master!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.14.11 Error 13-11 (emergency code FF00h)

Cause: Sercos option: Error while parameter initialisation

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.14.12 Error 13-12 (emergency code FF00h)

Cause: Sercos option: Run time error

Suggested steps:

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.14.13 Error 13-13 (emergency code FF00h)

Cause: Sercos option: Watchdog failure

Suggested steps:

SERCOS controller hardware watchdog. Please check the settings in the master!

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.14.14 Error 13-14 (emergency code FF00h)

Cause: Sercos option: Error in parameter data

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.14.15 Error 13-15 (emergency code FF00h)

Cause: Sercos option: Communication error

Suggested steps:

Error in the topology detection. Topology not stable or not detected. Please check the wiring!

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
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11.6.15 Error 14: EtherCAT error

11.6.15.1 Error 14-1 (emergency code 8130h)

Cause: ECAT watchdog timeout, Sync manager 0/1 watchdog error

Suggested steps:

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.15.2 Error 14-2 (emergency code 8130h)

Cause: EtherCAT®: Parameter error, parameter data implausible

Suggested steps:

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
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11.6.15.3 Error 14-3 (emergency code 8130h)

Cause: Internal ram error

Suggested steps:

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
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11.6.15.4 Error 14-4 (emergency code 8130h)

Cause: Invalid Configuration, Ethercat communication controller does not support requested Sync Manager

Suggested steps:

Check the configuration of the SyncManager in the EtherCAT master and in the parameters 2029-2032.

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.15.5 Error 14-5 (emergency code 8130h)

Cause: Missing Ethercat receive process data on Sync Manager 2

Suggested steps:

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.15.6 Error 14-6 (emergency code 8130h)

Cause: Local Error, Slave has changed the EtherCAT state autonomously

Suggested steps:

The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.
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11.6.16 Error 15: Parameter error

11.6.16.1 Error 15-1 (emergency code 2350h)

Cause: Error while init current monitoring

Suggested steps:

Check the device setting! (If possible, try a different switching frequency.)

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.2 Error 15-2 (emergency code 2350h)

Cause: Error while init I2t monitoring

Suggested steps:

Please check the parameter of the motor protection

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.3 Error 15-3 (emergency code FF00h)

Cause: Error: Timeout during auto commutation

Suggested steps:

Please check auto commutation parameters

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.4 Error 15-4 (emergency code FF00h)

Cause: Error in motor model initialization

Suggested steps:

Please check motor parameters and motor type

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.5 Error 15-5 (emergency code FF00h)

Cause: Error while initializing control

Suggested steps:

Please check switching frequency, voltage level, and device type

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.6 Error 15-6 (emergency code 6320h)

Cause: Error while inializing the standardization parameters

Suggested steps:

Please check the standardization parameter settings

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.7 Error 15-7 (emergency code 6320h)

Cause: Encoder gear ratio vs. line count out of range

Suggested steps:

Please check encoder parameters

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.8 Error 15-8 (emergency code 8400h)

Cause: Unknown speed calculation method selected

Suggested steps:

Please check the parameters of the speed observer (P350)

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.9 Error 15-9 (emergency code FF00h)

Cause: Error in observer or filter initialization.

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.10 Error 15-10 (emergency code 8300h)

Cause: Error initializing current control

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
An overcurrent was detected.	• Please check current control settings and step response. • Check the motor's saturation settings (parameter MOT_LSigDiff). If the error occurred in high-current range, lower saturation values manually. • If possible, reduce the needed current, especially in low-frequency range. • If possible, lower the switching frequency or enable automatic frequency selection. • Check if the encoder offset is set properly. • Consider using an axis module with higher current rating.

11.6.16.11 Error 15-12 (emergency code FF00h)

Cause: Plant inertia / mass is invalid

Suggested steps:

Please specify motor inertia or try to identify plant inertia

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.12 Error 15-13 (emergency code FF00h)

Cause: Drive commissioning: Watchdog failure via service tool access

Suggested steps:

Check your network connection

11.6.16.13 Error 15-14 (emergency code FF00h)

Cause: Drive initialization: Unexpected error during drive initialization

Suggested steps:

Check the drives parameter settings

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.14 Error 15-15 (emergency code FF00h)

Cause: Parameter: Auto save to MMC failed

Suggested steps:

Check MMC or disable function

11.6.16.15 Error 15-16 (emergency code FF00h)

Cause: Selected switch frequency is not possible

Suggested steps:

Change switch frequency or disable PWM-frequency switching

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.16 Error 15-17 (emergency code FF00h)

Cause: Autotuning mode not supported (in this configuration)

Suggested steps:

Please use other autotuning mode or tune by hand

11.6.16.17 Error 15-18 (emergency code FF00h)

Cause: Error in power fail initialization

Suggested steps:

Check power fail parameters or disable function

11.6.16.18 Error 15-19 (emergency code FF00h)

Cause: Error in camming or electronic gearing initialization

Suggested steps:

Check parameter or IEC configuration

11.6.16.19 Error 15-20 (emergency code FF00h)

Cause: Error in configuration of CAM module

Suggested steps:

Check for even number of configured cam edges. All configured cam edges have to be in ascending order.

11.6.16.20 Error 15-21 (emergency code FF00h)

Cause: Dataset to be loaded is not valid

Suggested steps:

Check Parameter PRam_PARA_DataSetLdVal

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.16.21 Error 15-22 (emergency code FF00h)

Cause: Invalid production data detected

Suggested steps:

Please contact your service provider

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.16.22 Error 15-23 (emergency code FF00h)

Cause: Parameter settings requires a valid software key

Suggested steps:

Please contact your service provider

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.17 Error 16: Speed difference error

11.6.17.1 Error 16-1 (emergency code 8400h)

Cause: Speed tracking error too large

Suggested steps:

Check your parameter P744

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.17.2 Error 16-2 (emergency code 8400h)

Cause: Current speed above maximum speed of motor > 120%

Suggested steps:

Check your parameter data set

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.18 Error 17: Position difference error

11.6.18.1 Error 17-1 (emergency code 8611h)

Cause: Position tracking error too large

Suggested steps:

Check your parameter P743

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.19 Error 18: Motion control error

11.6.19.1 Error 18-1 (emergency code 8612h)

Cause: Homing: Limit switches interchanged

Suggested steps:

Check limit switches

There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.19.2 Error 18-2 (emergency code 8612h)

Cause: Homing: Limit switch tripped unexpectedly

Suggested steps:

Check home switch

There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.19.3 Error 18-3 (emergency code 8612h)

Cause: Homing: Limit switch error

Suggested steps:

Please check the limit switches.

There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.

11.6.19.4 Error 18-4 (emergency code FF00h)

Cause: Homing: Wrong homing method, homing method not available

Suggested steps:

- Please restart the application (24V reset).
- If the error is still reported after the restart please contact your service partner.

An error occurred at the homing method.	• Please acknowledge the error. • Please start the homing method again.
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11.6.19.5 Error 18-5 (emergency code FF00h)

Cause: Homing: Homing method available but not defined

Suggested steps:

Homing is not available with this motion profile. Please select another homing method.

11.6.19.6 Error 18-6 (emergency code FF00h)

Cause:

Homing: Drive not ready for homing: Error is triggered when the motor is not stopped , or the standstill bit is not set (Standstill window).

Suggested steps:

Please stop the motor. Check the position window parameter 746 [0] (subject area limits).

11.6.19.7 Error 18-7 (emergency code FF00h)

Cause: Homing: Drive not ready for jog mode

Suggested steps:

Please stop the motor. Check the position window parameter 746 [0] (subject area limits).

11.6.19.8 Error 18-8 (emergency code FF00h)

Cause: Homing: Control mode does not match homing method

Suggested steps:

Homing is only possible in position control mode.

11.6.19.9 Error 18-9 (emergency code FF00h)

Cause: Homing: Encoder initialization error

Suggested steps:

The homing during device start-up was not performed due to an internal error.
Please restart the application (24V reset).

An error occurred at the homing method.	• Please acknowledge the error. • Please start the homing method again.
---	---

11.6.19.10 Error 18-10 (emergency code FF00h)

Cause: Homing: Homing travel exceeded

Suggested steps:

- The zero pulse has not been reached within the permissible distance. Please check the zero pulse of the encoder and the parameter 169[0] for the maximum distance.
- Please check whether the encoder is working correctly.

11.6.19.11 Error 18-11 (emergency code FF00h)

Cause: Max. permissible tracking error on "Start control" exceeded

Suggested steps:

Reset error and start again

An error occurred at the homing method.	• Please acknowledge the error. • Please start the homing method again.
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11.6.19.12 Error 18-12 (emergency code FF00h)

Cause: Memory overflow for table values

Suggested steps:

Reset error and start again

An error occurred at the homing method.	• Please acknowledge the error. • Please start the homing method again.
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11.6.19.13 Error 18-13 (emergency code FF00h)

Cause: Error initializing last actual position after restart.

Suggested steps:

Reset error and start again

An error occurred at the homing method.	• Please acknowledge the error. • Please start the homing method again.
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11.6.20 Error 19: Fatal error

11.6.20.1 Error 19-1 (emergency code 5400h)

Cause: PST: Data index too large

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.2 Error 19-2 (emergency code 5400h)

Cause: PST: Error in switching frequency-dependent data

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.3 Error 19-3 (emergency code 5400h)

Cause: PST: Invalid EEPROM data

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.4 Error 19-4 (emergency code 5400h)

Cause: PST: CRC error

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.5 Error 19-5 (emergency code 5400h)

Cause: PST: Error reading power stage data

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.6 Error 19-6 (emergency code 5400h)

Cause: PST: Error writing power stage data

Suggested steps:

Call your service provider.

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.7 Error 19-7 (emergency code 5420h)

Cause: Current in braking resistor even though transistor switched off

Suggested steps:

Call your service provider.

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
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11.6.20.8 Error 19-8 (emergency code 5300h)

Cause: Hardware identification failed

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.9 Error 19-9 (emergency code 5300h)

Cause: Flash memory failure

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.10 Error 19-10 (emergency code 5300h)

Cause: Initialisation of runtime system failed

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.11 Error 19-11 (emergency code 5300h)

Cause: Software licence key or level is invalid

Suggested steps:

Please contact your service provider

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.12 Error 19-12 (emergency code 5300h)

Cause: No ram memory for communication option available

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.13 Error 19-13 (emergency code 5300h)

Cause: Error while FPGA programming

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.14 Error 19-14 (emergency code 5300h)

Cause: Error while loading a dynamic software module

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

11.6.20.15 Error 19-15 (emergency code 5300h)

Cause: Error in initialization of protected memory

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.20.16 Error 19-16 (emergency code 5300h)

Cause: File access on device not complete

Suggested steps:

File transfer interrupted, file maybe corrupt, login and try again!

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.20.17 Error 19-17 (emergency code 5300h)

Cause: Safety-system run-up with illegal firmware!

Suggested steps:

Process firmware-update and process power on (24V) reset!

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.20.18 Error 19-18 (emergency code 5300h)

Cause: Firmware-update of safety-system failed!

Suggested steps:

Process power on (24V) reset!

11.6.20.19 Error 19-19 (emergency code 5300h)

Cause: System run-up with illegal FPGA firmware!

Suggested steps:

Update the FPGA with the correct firmware!

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.20.20 Error 19-20 (emergency code 5300h)

Cause: Safety production data invalid (no data or CRC failure)

Suggested steps:

Update of safety production data required, contact your service provider

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
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11.6.20.21 Error 19-21 (emergency code 5300h)

Cause: Failure in code data area (ROM) detected

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

11.6.20.22 Error 19-22 (emergency code 5300h)

Cause: Functionality or hardware not supported in this software version

Suggested steps:

Please contact your service provider

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.20.23 Error 19-23 (emergency code 6100h)

Cause: Fatal error on safety controller SR1 detected

Suggested steps:

Read additional information, check safety system and switch off/on device to acknowledge error

11.6.20.24 Error 19-24 (emergency code 6100h)

Cause: Fatal error on safety controller SR2 detected

Suggested steps:

Read additional information, check safety system and switch off/on device to acknowledge error

11.6.21 Error 20: Hardware limit switch error

11.6.21.1 Error 20-1 (emergency code 8612h)

Cause: Hardware limit switches interchanged

Suggested steps:

Check your hardware

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.21.2 Error 20-2 (emergency code 8612h)

Cause: Positive hardware limit switch (LSW_P) detected

Suggested steps:

Check your hardware

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.21.3 Error 20-3 (emergency code 8612h)

Cause: Negative hardware limit switch (LSW_N) detected

Suggested steps:

Check your hardware

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.22 Error 21: Initialization, common error

Group error initialization	• This is a common error number used for several initialization errors, which have no own error number
----------------------------	--

11.6.22.1 Error 21-2 (emergency code 7305h)

Cause: Electronic nameplate, interface, group error: no further information available.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.2 Error 21-3 (emergency code 7305h)

Cause: Electronic nameplate, parameterization: ENP operation is switched off.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.3 Error 21-4 (emergency code 7305h)

Cause: Electronic nameplate, parameterization: ENP operation is not supported by firmware.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.4 Error 21-5 (emergency code 7305h)

Cause: Electronic nameplate, OEM data: no OEM memory defined in the encoder.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.5 Error 21-6 (emergency code 7305h)

Cause: Electronic nameplate, OEM data: no ENP defined in the OEM memory of the encoder.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.6 Error 21-7 (emergency code 7305h)

Cause: Electronic nameplate, parameterization: no order for ENP operation.

Suggested steps:

Define an order for ENP operation. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.7 Error 21-10 (emergency code 7305h)

Cause: Electronic nameplate, OEM data error, FindBlock: block with number BN not found.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.8 Error 21-11 (emergency code 7305h)

Cause: Electronic nameplate, OEM data: data CRC check failed (DCRC).

Suggested steps:

Function "Electronic nameplate" only partially available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.9 Error 21-12 (emergency code 7305h)

Cause: Electronic nameplate, process block error: group error from schort frame check of the block being read.

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.10 Error 21-13 (emergency code 7305h)

Cause: Electronic nameplate, process block error: parameter write access error (group error from return of internal parameter acces).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.11 Error 21-21 (emergency code 7305h)

Cause: Electronic nameplate, process block error: SpecialBlock (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.12 Error 21-22 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 2 ECOFF (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.13 Error 21-23 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 3 MotIdent (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.14 Error 21-24 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 4 MotDat PMSM (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.15 Error 21-25 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 5 EncFeedback (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.16 Error 21-26 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 6 MotProtection (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.17 Error 21-27 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 7 MotBreak (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.18 Error 21-28 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 8 Actuator (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.19 Error 21-29 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 9 MotComp (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.20 Error 21-30 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 10 MotDatASM (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.21 Error 21-31 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 11 MotDatLin (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.22 Error 21-32 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 12 DevSpecDatDS2110 (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.22.23 Error 21-33 (emergency code 7305h)

Cause: Electronic nameplate, process block error: block 13 DevSpecDatServo1 (no further information available).

Suggested steps:

Function "Electronic nameplate" not available. Please contact your service provider.

ENP	• The "Electronic Nameplate" (ENP) is located in the OEM memory of the motor encoder and contains primarily motor related data. • In the simplest case, the ENP contains only the commutation angle (ECOFF) between motor phases and encoder mounting.
-----	--

11.6.23 Error 22: Encoder channel 1, initialization error

11.6.23.1 Error 22-1 (emergency code 7305h)

Cause: Channel 1 Initialization, SinCos: Line count with SinCos absolute encoder must be 2^n

Suggested steps:

Please enter a line count of 2^n (number of tracks).

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.2 Error 22-2 (emergency code 7305h)

Cause: Channel 1 Initialization, SinCos: timeout error, getting AB-SquareSum

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.3 Error 22-3 (emergency code 7305h)

Cause: Channel 1 Initialization, SinCos: error, encoder monitoring

Suggested steps:

Please connect the encoder correctly.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.4 Error 22-4 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: error, no EnDat 2.1 encoder (May be, it's an SSI encoder!?)

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5 . • The most common cause of error is the wiring to the encoder.
----------------------------------	---

11.6.23.5 Error 22-5 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: error, 'Lines' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.6 Error 22-6 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: error, 'MultiTurn' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5 . The most common cause of error is the wiring to the encoder.
----------------------------------	---

11.6.23.7 Error 22-7 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: error, 'SingleTurn' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.8 Error 22-8 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: CRC error, position data from encoder

Suggested steps:

The transmission is probably disturbed. Please check the wiring to the encoder.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.9 Error 22-9 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: CRC error, parameter data from encoder

Suggested steps:

The transmission is probably disturbed. Please check the wiring to the encoder.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.10 Error 22-10 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: not allowed write operation to write protected cells or protection cells of the encoder

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably a software problem! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.11 Error 22-15 (emergency code 7305h)

Cause: Channel 1 Initialization, SSI: 'MultiTurn' from parameter (543) ENC_CH1_MultiT

Suggested steps:

Change the input of the multiturn bits of the parameter.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	--

11.6.23.12 Error 22-16 (emergency code 7305h)

Cause: Channel 1 Initialization, SSI: 'SingleTurn' from parameter (544) ENC_CH1_SingleT

Suggested steps:

Change the input of the singleturn bits of the parameter.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	--

11.6.23.13 Error 22-17 (emergency code 7305h)

Cause: Channel 1 Initialization, SSI: parity error, position data from encoder

Suggested steps:

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.14 Error 22-20 (emergency code 7305h)

Cause: Channel 1 Initialization, SSI: encoder monitoring

Suggested steps:

Check whether the encoder is correctly connected

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.15 Error 22-22 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: common error

Suggested steps:

Group error --> look at message window of the Moog DriveAdministrator.

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.16 Error 22-23 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: timeout error

Suggested steps:

Please check the wiring of the encoder

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.17 Error 22-24 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: impossible COMMAND in response from encoder

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.18 Error 22-25 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: CRC error in error status response from encoder (communication error)

Suggested steps:

Please check the wiring of the encoder

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.19 Error 22-26 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE, error status response: encoder communication error

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.20 Error 22-27 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE, error status response: technical or process error (inside encoder)

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.21 Error 22-28 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: error status response from encoder with no error (error code 0)

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.23.22 Error 22-29 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: CRC error in response from encoder (communication error)

Suggested steps:

Please check the wiring of the encoder

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.23 Error 22-30 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE, response with error bit, status: encoder communication error

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.24 Error 22-31 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE, response with error bit, status: technical or process error (inside encoder)

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.25 Error 22-32 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE, response with error bit, status: no error from encoder

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.26 Error 22-33 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: encoder status error, encoder signals communication error

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.27 Error 22-34 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: encoder status error, encoder signals technical or process error

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.28 Error 22-35 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: type key error, encoder returned an unknown type key code

Suggested steps:

Please look at parameter (552) ENC_CH1_AbsEncStatus

Initialization encoder channel	• This is probably a software problem! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.29 Error 22-36 (emergency code 7305h)

Cause: Channel 1 Initialization, HIPERFACE: not allowed write operation to write protected cells or protection cells of the encoder

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably a software problem! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.30 Error 22-37 (emergency code 7305h)

Cause: Channel 1 Initialization, TTL: the processor board inside the servo drive is incompatible with this function.

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably a hardware problem! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.31 Error 22-38 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat 2.1: error, 'PositionBits' read from encoder

Suggested steps:

Number of clocks to transmit the position from the encoder. No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	---

11.6.23.32 Error 22-40 (emergency code 7305h)

Cause: Channel 1 Initialization, Np: error from review of parameters 'Lines' and 'NominalIncrement'

Suggested steps:

Please check this parameters.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
--------------------------------	--

11.6.23.33 Error 22-41 (emergency code 7300h)

Cause: Channel 1/3 Initialization, EndDat: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel	• Error during the initialization routines of encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
--------------------------------	--

11.6.23.34 Error 22-42 (emergency code 7305h)

Cause: Channel 1 Initialization, SSI: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.35 Error 22-43 (emergency code 7305h)

Cause: Channel 1 Initialization, SinCos: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.36 Error 22-44 (emergency code 7305h)

Cause: Channel 1 Initialization, LinMot: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.23.37 Error 22-45 (emergency code 7305h)

Cause: Channel 1 Initialization: the internal multiturn resolution is too low to process ENC_CH1_MTBBase correctly.

Suggested steps:

Please reduce the internal position resolution to free bits for the internal multi-turn information.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.23.38 Error 22-46 reserved

11.6.23.39 Error 22-47 (emergency code 7305h)

Cause: Channel 1 Initialization, EndDat22: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 1	• Error during the initialization routines of encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
----------------------------------	--

11.6.24 Error 23: Encoder channel 2, initialization error

11.6.24.1 Error 23-1 (emergency code 7304h)

Cause: Channel 2 Initialization, Resolver: error 'Lines' from parameter (560) ENC_CH2_Lines

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 2	• Error during the initialization routines of encoder channel 2. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.24.2 Error 23-2 (emergency code 7304h)

Cause: Channel 2 Initialization, Resolver: timeout error, getting AB-SquareSum

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel 2	• Error during the initialization routines of encoder channel 2. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.24.3 Error 23-3 (emergency code 7304h)

Cause: Channel 2 Initialization, Resolver: error, encoder monitoring

Suggested steps:

Please connect the encoder correctly.

Initialization encoder channel 2	• Error during the initialization routines of encoder channel 2. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.24.4 Error 23-4 (emergency code 7306h)

Cause: Channel 2 Initialization, SinCos: error, hardware

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 2	• Error during the initialization routines of encoder channel 2. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25 Error 24: Encoder channel 3, initialization error

11.6.25.1 Error 24-1 (emergency code 7307h)

Cause: Channel 3 Initialization: error, module identification failed

Suggested steps:

Please look up, if there's placed the right hardware module in the slot of X8

Identification of the X8 module	• This is probably a hardware problem of the X8 module! • Please check if the correct X8 module is installed. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • If the error occurs again (after 24V reset), please contact your service provider.
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11.6.25.2 Error 24-2 (emergency code 7307h)

Cause: Channel 3 Initialization: common error from encoder option module

Suggested steps:

Please look at Log entry window for error code information

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.3 Error 24-3 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: error, encoder monitoring

Suggested steps:

Please connect the encoder correctly.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.4 Error 24-4 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: error, no EnDat 2.1 encoder (May be, it's an SSI encoder!?)

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.5 Error 24-5 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: error, 'Lines' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.6 Error 24-6 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: error, 'MultiTurn' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.7 Error 24-7 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: error, 'SingleTurn' read from encoder

Suggested steps:

Please note additional Information in the message window of the Moog DRIVEADMINISTRATOR 5.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.8 Error 24-8 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: CRC error, position data from encoder

Suggested steps:

The transmission is probably disturbed. Please check the wiring to the encoder.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.9 Error 24-9 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: CRC error, parameter data from encoder

Suggested steps:

The transmission is probably disturbed. Please check the wiring to the encoder.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.10 Error 24-10 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: not allowed write operation to write protected cells or protection cells of the encoder

Suggested steps:

No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably a software problem! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.11 Error 24-15 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: 'MultiTurn' from parameter (573) ENC_CH1_MultiT

Suggested steps:

Change the input of the multiturn bits of the parameter.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.12 Error 24-16 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: 'SingleTurn' from parameter (574) ENC_CH1_SingleT

Suggested steps:

Change the input of the singleturn bits of the parameter.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.13 Error 24-17 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: parity error, position data from encoder

Suggested steps:

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.14 Error 24-20 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: encoder monitoring

Suggested steps:

Check whether the encoder is correctly connected

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.15 Error 24-38 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat 2.1: error, 'PositionBits' read from encoder

Suggested steps:

Number of clocks to transmit the position from the encoder. No further information available. Please contact your service provider.

Initialization encoder channel	• This is probably an internal problem of the encoder! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.16 Error 24-40 (emergency code 7307h)

Cause: Channel 3 Initialization, Np: error from review of parameters 'Lines' and 'NominalIncrement'

Suggested steps:

Please check this parameters.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.17 Error 24-41 (emergency code 7307h)

Cause: Channel 1/3 Initialization, EndDat: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel	• Error during the initialization routines of encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.18 Error 24-42 (emergency code 7307h)

Cause: Channel 3 Initialization, SSI: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.19 Error 24-43 (emergency code 7307h)

Cause: Channel 3 Initialization, SinCos: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.20 Error 24-44 (emergency code 7307h)

Cause: Channel 3 Initialization, LinMot: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.21 Error 24-45 (emergency code 7307h)

Cause: Channel 3 Initialization, SinCos: error, encoder monitoring

Suggested steps:

Please connect the encoder correctly.

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.22 Error 24-46 (emergency code 7307h)

Cause: Channel 3 Initialization: the internal multiturn resolution is too low to process ENC_CH3_MTBBase correctly.

Suggested steps:

Please reduce the internal position resolution to free bits for the internal multi-turn information.

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.25.23 Error 24-47 (emergency code 7307h)

Cause: Channel 3 Initialization, EndDat22: common error

Suggested steps:

Please note the extended information of the error message

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.24 Error 24-50 (emergency code 7300h)

Cause: Channel 3 Initialization, TOPT: Used FPGA version does not match TechOpt card functionality.

Suggested steps:

Please update the FPGA to the right version or replace the TechOpt card.

X8 option module: Firmware- or FPGA version will not work	• This is probably a firmware problem! • Please check if the correct firmware is on the servo drive. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • If the error occurs again (after 24V reset), please contact your service provider.
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11.6.25.25 Error 24-51 (emergency code 7300h)

Cause: Channel 3 Initialization, HDSL: common error

Suggested steps:

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.25.26 Error 24-52 (emergency code 7300h)

Cause: Channel 3 Initialization, HDSL: error reading the initial position

Suggested steps:

Initialization encoder channel 3	• Error during the initialization routines of encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
Initialization HIPERFACE-DSL	• Error during the initialization of HIPERFACE-DSL (HDSL). • Probably there is a problem due to insufficient mounting of the encoder. Make sure that the encoder has been mounted correctly. • The problem could also have been caused by mechanical vibration during initialization.

11.6.26 Error 25: Encoder cyclic process, common error

11.6.26.1 Error 25-1 (emergency code FF00h)

Cause: Encoder cyclic, Getting commutation: position difference too high

Suggested steps:

Check the Parameter of autocommutation!

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.26.2 Error 25-2 (emergency code FF00h)

Cause: Encoder cyclic, Getting commutation: offset difference outside tolerance (> 30 grad)

Suggested steps:

Check the Parameter of autocommutation!

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.26.3 Error 25-3 (emergency code FF00h)

Cause: Encoder cyclic, Getting commutation: redundant encoder, maximum tracking error exceeded

Suggested steps:

Check parameters P524 and P597!

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.26.4 Error 25-4 (emergency code FF00h)

Cause: Encoder cyclic, Getting commutation: error with hall encoder

Suggested steps:

Check the Parameter of Hall-Encoder / Commutation!

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.26.5 Error 25-5 (emergency code FF00h)

Cause: Encoder cyclic, ENC_PCon: missing encoder configuration for PCON mode

Suggested steps:

Please configure encoder channel for position control (P522).

Initialization encoder channel	• This is probably a problem of the parameterization! • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
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11.6.26.6 Error 25-6 (emergency code FF00h)

Cause: Encoder cyclic, Getting commutation: zero marker not found (hall encoder)

Suggested steps:

Please check time and frequency (Hall-Encoder). Please check the encoder wiring!

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.27 Error 26: Encoder channel 1, cyclic process error

11.6.27.1 Error 26-1 (emergency code 7305h)

Cause: Channel 1 cyclic, Np (distance coded): error, measured 'counter distance' is out of range

Suggested steps:

Please check the wiring of the encoder

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.27.2 Error 26-2 (emergency code 7305h)

Cause: Channel 1 cyclic, Np (distance coded): error, delta correction failed

Suggested steps:

Please check the wiring of the encoder, perhaps reduce the speed.

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.27.3 Error 26-3 (emergency code 7305h)

Cause: Channel 1 cyclic, Np (distance coded): error, calculated 'delta' is out of range

Suggested steps:

Please check the wiring of the encoder

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 1. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.28 Error 28: Encoder channel 3, cyclic process error

11.6.28.1 Error 28-1 (emergency code 7307h)

Cause: Channel 3 cyclic, Np (distance coded): error, measured 'counter distance' is out of range

Suggested steps:

Please check the wiring of the encoder

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.28.2 Error 28-2 (emergency code 7307h)

Cause: Channel 3 cyclic, Np (distance coded): error, delta correction failed

Suggested steps:

Please check the wiring of the encoder, perhaps reduce the speed.

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.28.3 Error 28-3 (emergency code 7307h)

Cause: Channel 3 cyclic, Np (distance coded): error, calculated 'delta' is out of range

Suggested steps:

Please check the wiring of the encoder

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
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11.6.29 Error 30: Control initialization error

11.6.29.1 Error 30-1 (emergency code 5300h)

Cause: Initialization error analog input

Suggested steps:

Check calibration of analog inputs

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.29.2 Error 30-2 (emergency code 5300h)

Cause: Initialization error calculating motor torque constant

Suggested steps:

Check motor parameters

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.29.3 Error 30-3 (emergency code 5300h)

Cause: Error while calculating flux model of asynchr. motor

Suggested steps:

Check motor parameters (Rrot, Lsig, Lmag) and magn.current Imag

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.29.4 Error 30-4 (emergency code 5300h)

Cause: Error by setting up Imag Table

Suggested steps:

Check Imag, Slim and table entries of module CON_FM

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.29.5 Error 30-5 (emergency code 5300h)

Cause: Error in U/f-control initialization

Suggested steps:

Check VFC parameters

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.29.6 Error 30-6 reserved

11.6.29.7 Error 30-7 (emergency code 5300h)

Cause: Error at lookup table (bigtab) calculation

Suggested steps:

Check settings of table configuration

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.30 Error 31: PLC error

11.6.30.1 Error 31-0 (emergency code FF00h)

Cause: User defined Error detected.

Suggested steps:

Error was triggered by iPLC application (Function: MCB_CTR_SetError). Further information is available from the programmer of the application!

11.6.31 Error 32: PROFIBUS/PROFINET of error

11.6.31.1 Error 32-1 (emergency code 8100h)

Cause: Profibus/Profinet option: process data timeout

Suggested steps:

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.31.2 Error 32-2 (emergency code 8100h)

Cause: Profinet IRT: No firmware on Profinet option available!

Suggested steps:

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.31.3 Error 32-3 (emergency code 8100h)

Cause: Profinet IRT: sign of life fault!

Suggested steps:

This is possibly an EMC issue. This is very likely if the problem occurs when switching on motor control and/ or when connecting DC link power supply.	• Please check the device cabling for proper connection. • Please check device grounding, i. e. the connection to a metal backplane and cabinet connection to earth. • Check motor grounding and motor cable length.
The device was probably disconnected from the master controller, or the master is overloaded.	• Please check the bus system connection. Try to replace the cables. • Please try to reduce computational load on the master. • Try to increase the master cycle time.

11.6.32 Error 33: Internal timing error

11.6.32.1 Error 33-0 (emergency code 5300h)

Cause: ADC task automatically interrupted

Suggested steps:

Please restart device.

Computational load in time-critical task of axis module is too high.	• Please reduce computational load by removing parameters from mapping. • De-activate features of control system or motion control.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.32.2 Error 33-1 (emergency code 5300h)

Cause: Control task exceeded scan time

Suggested steps:

Please restart device.

Computational load in time-critical task of axis module is too high.	• Please reduce computational load by removing parameters from mapping. • De-activate features of control system or motion control.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.32.3 Error 33-2 (emergency code 5300h)

Cause: Internal timing error

Suggested steps:

Please restart device.

Computational load in time-critical task of axis module is too high.	• Please reduce computational load by removing parameters from mapping. • De-activate features of control system or motion control.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.32.5 Error 33-4 (emergency code 5300h)

Cause: Internal timing error

Suggested steps:

Run time error, not enough CPU performance, check PLC program

Computational load in time-critical task of axis module is too high.	• Please reduce computational load by removing parameters from mapping. • De-activate features of control system or motion control.
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.32.4 Error 33-3 (emergency code 5300h)

Cause: Unknown EXCEPTION in TC-safety

Suggested steps:

Reset device!

11.6.33 Error 34: Powerfail funktion error

11.6.33.1 Error 34-0 (emergency code 3220h)

Cause: Power fail detected and reaction active

Suggested steps:

Check net connection of servo

An under-voltage occurred on the drive while this axis was switched on.	• Power supply was possibly switched off. • Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Verify that the grid is stable under load condition.
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11.6.33.2 Error 34-1 (emergency code 3220h)

Cause: Returning DC-link voltage detected

Suggested steps:

Restart Device

An under-voltage occurred on the drive while this axis was switched on.	• Power supply was possibly switched off. • Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Verify that the grid is stable under load condition.
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11.6.33.3 Error 34-2 (emergency code 3220h)

Cause: Power fail initialization failed

Suggested steps:

Check power fail parameter settings

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.34 Error 35: Encoder monitoring error

11.6.34.1 Error 35-0 (emergency code 7300h)

Cause: Unknown encoder monitoring error

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.2 Error 35-1 (emergency code 7305h)

Cause: ENC CH1 SinCos: error, encoder monitoring

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.3 Error 35-2 (emergency code 7304h)

Cause: ENC CH2 Resolver: error, encoder monitoring

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.4 Error 35-3 (emergency code 7307h)

Cause: ENC CH3 SinCos: error, encoder monitoring

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.5 Error 35-4 (emergency code 7305h)

Cause: ENC CH1 SSI: error, encoder monitoring

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.6 Error 35-5 (emergency code 7305h)

Cause: ENC CH1 SSI: error, parity error

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.7 Error 35-6 (emergency code 7307h)

Cause: ENC CH3 SSI: error, encoder monitoring

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.8 Error 35-7 (emergency code 7307h)

Cause: ENC CH3 SSI: error, parity error

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.9 Error 35-8 (emergency code 7305h)

Cause: ENC CH1: wire break on digital encoder

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.10 Error 35-9 (emergency code 7307h)

Cause: ENC CH3: wire break on digital encoder

Suggested steps:

Check encoder cables, voltage supply, and selection. Make sure unused channels are switched off.

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.34.11 Error 35-10 (emergency code 7305h)

Cause: ENC CH1 ENDAT: error, diagnosis

Suggested steps:

endat encoder cyclic diagnosis monitoring error, check encoder

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
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11.6.34.12 Error 35-11 (emergency code 7307h)

Cause: ENC CH3 ENDAT: error, diagnosis

Suggested steps:

endat encoder cyclic diagnosis monitoring error, check encoder

The encoder is not connected or not working properly.	• If this is encoder has analog signals, please check the signal amplitude vs. parameter EncObsMin • Check cabling. If available, please try another encoder and cable. • See detailed error information (>>) for a more detailed description.
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11.6.34.13 Error 35-12 (emergency code 7307h)

Cause: Channel 3 cyclic, HDSL: status error --> position invalid

Suggested steps:

'Please check the encoder and wiring.

Encoder channel, cyclic evaluation	• Error during the cyclic evaluation of an encoder channel 3. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5. • The most common cause of error is the wiring to the encoder.
HIPERFACE-DSL, cyclic processing	• Error during the cyclic execution of HIPERFACE-DSL (HDSL). • The problem could have been caused by mechanical shock. • If short-time failures are tolerable, use parameter ENC_CH3_ErrorTol to tolerate a given number of failures. Scope the error counter ENC_CH3_ErrorCount to monitor the behaviour. In case of an error, position is estimated from previous data.

11.6.35 Error 37: Synchronization controller error

11.6.35.1 Error 37-1 (emergency code 6100h)

Cause: Wrong ratio between interpolation-, synchronization- or velocity control time

Suggested steps:

Check the set cycle times in parameter 306, as well as according to the used bus system 2015 or 2266. Please pay attention to the different units!

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.36 Error 38: Braking chopper error

11.6.36.1 Error 38-1 (emergency code 4210h)

Cause: P*t-integrator value exceeds maximum

Suggested steps:

Check/reduce the load of the chopper

11.6.37 Error 39: TWIN monitoring error

11.6.37.1 Error 39-0 (emergency code 7300h)

Cause: TWIN-Monitoring: speed difference between master and slave is too large

Suggested steps:

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.37.2 Error 39-1 (emergency code 7300h)

Cause: TWIN-Monitoring: torque difference between master and slave is too large

Suggested steps:

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.37.3 Error 39-2 (emergency code 7300h)

Cause: Tech-Option remote error

Suggested steps:

TwinSync: Error on slave

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.37.4 Error 39-3 (emergency code 2350h)

Cause: Maximum phase difference detected

Suggested steps:

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.37.5 Error 39-4 (emergency code 2350h)

Cause: TWIN-Monitoring: position difference between master and slave is too large

Suggested steps:

The control system failed to track the reference value	• Please check if the axis is blocked. • Try to reduce acceleration or deceleration. • If reference speed is higher than the motor rated speed, please check field weakening settings. In field-weakening range, the available torque per current is reduced.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.37.6 Error 39-5 (emergency code 2350h)

Cause: TWIN-Monitoring: Power fail on remote device

Suggested steps:

-

11.6.38 Error 40: Tech option error

11.6.38.1 Error 40-0 (emergency code 7300h)

Cause: Tech-Option communication error

Suggested steps:

TWIN communication lost, check wiring or framing errors of TWIN option

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.2 Error 40-1 (emergency code 7300h)

Cause: Tech-Option communication error

Suggested steps:

Tech-Option switching-frequency discrepancy

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.3 Error 40-2 (emergency code 7300h)

Cause: Tech-Option mode conflict

Suggested steps:

Tech-Option both master / both slave

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.4 Error 40-3 (emergency code 7300h)

Cause: Tech-Option remote error

Suggested steps:

Error pending on remote servo

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.5 Error 40-4 (emergency code 7300h)

Cause: Tech-Option communication error

Suggested steps:

DriveCom-States are not the same

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.6 Error 40-5 (emergency code 7300h)

Cause: Tech-Option communication error

Suggested steps:

dSPACE control mode discrepancy

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.7 Error 40-6 (emergency code 7300h)

Cause: Tech-Option initialisation error

Suggested steps:

Error while loading dynamic software module

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.9 Error 40-8 (emergency code 7300h)

Cause: Tech-Option initialisation error

Suggested steps:

Error in TwinSync mapping configuration

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.38.8 Error 40-7 reserved

11.6.39 Error 41: Fast discharge monitoring error (dc-link)

11.6.39.1 Error 41-0 (emergency code 7300h)

Cause: Maximum period for fast discharge exceeded (35 s)

Suggested steps:

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.40 Error 43: Ethernet error

11.6.40.1 Error 43-0 (emergency code 6100h)

Cause: Unknown error in Ethernet interface

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.40.2 Error 43-1 (emergency code 6100h)

Cause: Plausibility error between IP adress and subnetmask, subnetmask was corrected!

Suggested steps:

Check the settings of the IP address and the subnetmask of the Ethernet interface (X3/X9) in the parameters 671 and 688.

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
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11.6.41 Error 44: Wire break, common error

11.6.41.1 Error 44-1 (emergency code 6100h)

Cause: Motor brake not connected on X13

Suggested steps:

Check motor brake or other device connected on X13, or disable guarding

11.6.42 Error 45: Lock violation error

11.6.42.1 Error 45-0 (emergency code 8612h)

Cause: Unknown lock violate error

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

The reference value violates a lock, a limit switch or the setpoint limitation.	• Please check reference values. If this axis is working in cyclic synchronous mode, make a scope record. • Check factor group settings. • Check the limitation settings. • Check mode of operation.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.42.2 Error 45-1 (emergency code 8612h)

Cause:

Movement requested which was limited by reversing lock, limit switch or reference value limitation.

Suggested steps:

Quit error and change reference value

The reference value violates a lock, a limit switch or the setpoint limitation.	• Please check reference values. If this axis is working in cyclic synchronous mode, make a scope record. • Check factor group settings. • Check the limitation settings. • Check mode of operation.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.42.3 Error 45-2 (emergency code FF00h)

Cause:

Movement requested which was limited by reversing lock, limit switch or reference value limitation. Lock active in both directions

Suggested steps:

Check plausibility of limit switches and/or software limits

The reference value violates a lock, a limit switch or the setpoint limitation.	• Please check reference values. If this axis is working in cyclic synchronous mode, make a scope record. • Check factor group settings. • Check the limitation settings. • Check mode of operation.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.42.4 Error 45-3 (emergency code 8612h)

Cause: Software limit switch overtravel detected, traversing task rejected

Suggested steps:

Quit error and change reference value

The reference value violates a lock, a limit switch or the setpoint limitation.	• Please check reference values. If this axis is working in cyclic synchronous mode, make a scope record. • Check factor group settings. • Check the limitation settings. • Check mode of operation.
This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.

11.6.43 Error 46: Position limit error

11.6.43.1 Error 46-0 (emergency code 8612h)

Cause: Unknown position limit error

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.43.2 Error 46-1 (emergency code 8612h)

Cause: Negative software limit switch is exceeded (negative position limit)

Suggested steps:

Quit error and change reference value

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.43.3 Error 46-2 (emergency code 8612h)

Cause: Positive software limit switch is exceeded (positive position limit)

Suggested steps:

Quit error and change reference value

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.43.4 Error 46-3 (emergency code 8612h)

Cause: Software limit switch overtravel detected

Suggested steps:

Quit error and change reference value

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.43.5 Error 46-4 (emergency code 8612h)

Cause: Position reference value out of range

Suggested steps:

Quit error and change reference value

Position was limited internally.	• Please check factor group setting and position command • Take a scope record to determine if the position control overshoots.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.44 Error 47: Functional safety, common error

11.6.44.1 Error 47-0 (emergency code 6100h)

Cause: Unknown error in functional safety interface detected

Suggested steps:

Acknowledge error, if the error occurs again, reset device

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.44.2 Error 47-1 (emergency code 6100h)

Cause: Communication error to safety system detected

Suggested steps:

Acknowledge error, if the error occurs again, reset device

An error occurred in the communication to the safety system.	• Please acknowledge the error. • If the error occurs again please restart the application (24V reset).
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.44.3 Error 47-2 (emergency code 6100h)

Cause: Error while requesting data from safety system

Suggested steps:

Acknowledge error, if the error occurs again, reset device

An error occurred in the communication to the safety system.	• Please acknowledge the error. • If the error occurs again please restart the application (24V reset).
This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.

11.6.44.4 Error 47-3 (emergency code 6100h)

Cause: Download of safe PLC application file failed

Suggested steps:

Acknowledge error and try download again

An error occurred at the up- or download of the safety program.	• Please check the security program. • Please check the connection settings of your safety system in SafePLC S. • Please reload or download the safety program again.
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11.6.44.5 Error 47-4 (emergency code 6100h)

Cause: Upload of safe PLC application file failed

Suggested steps:

Acknowledge error and try upload again

An error occurred at the up- or download of the safety program.	• Please check the security program. • Please check the connection settings of your safety system in SafePLC S. • Please reload or download the safety program again.
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11.6.44.6 Error 47-5 (emergency code 6100h)

Cause: Safety firmware invalid (no firmware or CRC failure)

Suggested steps:

Update of safety firmware required, contact your service provider

Invalid safety firmware.	• An update of the required safety firmware is necessary. • Please report this error to your service partner.
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11.6.45 Error 49: Safety system error

11.6.45.1 Error 49-0 (emergency code 6100h)

Cause: Unknown fatal error in functional safety interface

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

This is probably a software issue.	• Please try to switch to a different version of device firmware. • Save your dataset and reset the axis module to factory setting. See if the error persists, or if it comes with activating a certain feature.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.45.2 Error 49-1 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of master or local device detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.3 Error 49-2 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of master or local device detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.4 Error 49-3 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of Slave 1 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.5 Error 49-4 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of Slave 1 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.6 Error 49-5 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of Slave 2 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.7 Error 49-6 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of Slave 2 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.8 Error 49-7 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of Slave 3 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.9 Error 49-8 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of Slave 3 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.10 Error 49-9 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of Slave 4 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.11 Error 49-10 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of Slave 4 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.12 Error 49-11 (emergency code 6100h)

Cause: Alarm on safety controller SR1 of Slave 5 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.13 Error 49-12 (emergency code 6100h)

Cause: Alarm on safety controller SR2 of Slave 5 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An alarm occurred at the safety controller.	• Please check the safety program and the wiring of the safety system. • Please acknowledge the alarm at the safety master. The safety master acknowledges all slave alarms and resets the network status to "RUN".

11.6.45.14 Error 49-13 (emergency code 6100h)

Cause: Error on safety controller SR1 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An error occurred at the safety controller.	• Please check the safety program and the wiring of the security system. • Please acknowledge the error on the affected device. Subsequently the alarm must be acknowledged at the safety master to reset the network status to "RUN". • Please restart the application (24V reset).

11.6.45.15 Error 49-14 (emergency code 6100h)

Cause: Error on safety controller SR2 detected

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	• Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An error occurred at the safety controller.	• Please check the safety program and the wiring of the security system. • Please acknowledge the error on the affected device. Subsequently the alarm must be acknowledged at the safety master to reset the network status to "RUN". • Please restart the application (24V reset).

11.6.45.16 Error 49-15 (emergency code 6100h)

Cause: Safety network alarm, initiated by safety master

Suggested steps:

Read additional information, check safety system or wiring and acknowledge alarm/error

Extended diagnosis of safety errors/alarms.	Further information on the error/alarm code can be found in the "MSD Servo Drive Software with Safety PLC Function Error Description".
An error occurred at the safety controller.	- Please check the safety program and the wiring of the security system. - Please acknowledge the error on the affected device. Subsequently the alarm must be acknowledged at the safety master to reset the network status to "RUN". - Please restart the application (24V reset).

11.6.46 Error 51: Encoder status, common error

11.6.46.1 Error 51-1 (emergency code 7305h)

Cause: Channel 1, Status from encoder: warning or error bit set by encoder

Suggested steps:

Please check encoder manual for further information.

Encoder channel, internal status from digital encoder	- Error during reading from a digital encoder. - Warning information or error status information reported by the encoder. - In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
---	--

11.6.46.2 Error 51-2 (emergency code 7307h)

Cause: Channel 3, Status from encoder: warning or error bit set by encoder

Suggested steps:

Please check encoder manual for further information.

Encoder channel, internal status from digital encoder	- Error during reading from a digital encoder. - Warning information or error status information reported by the encoder. - In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
---	--

11.6.47 Error 52: Analog inputs error

11.6.47.1 Error 52-1 (emergency code FF00h)

Cause: analog input: Wire break detected

Suggested steps:

Check analog input configuration

There is a problem with the digital/analog inputs	• Please check the 24V I/O wiring, function assignment and inversion parameters. • Please check connected switches for chattering. Consider using the input filter.
This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.

11.6.48 Error 53: Motor failure error

11.6.48.1 Error 53-1 (emergency code 6100h)

Cause: At least one motor phase missing

Suggested steps:

Check motor wiring

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
-----------------------------------	--

11.6.49 Error 54: Power grid failure error

11.6.49.1 Error 54-1 (emergency code 6100h)

Cause: At least one grid phase missing

Suggested steps:

Check grid wiring

An under-voltage occurred on the drive while this axis was switched on.	• Power supply was possibly switched off. • Please check if the actual grid voltage matches the supply setting (parameter PST_VoltageSupply) • Verify that the grid is stable under load condition.
---	---

11.6.50 Error 55: Speed guarding error

11.6.50.1 Error 55-1 (emergency code 6100h)

Cause: Speed guarding digital input

Suggested steps:

Check digital inputs

This issue is probably caused by an unsuitable parameter setting.	• Save your parameter set for a later restore. • See 'history of parameter changes' and undo the latest changes. • Please check your parameter set for implausible settings. • Please set device to factory setting, restart, and see if the error occurs again. • When reporting this error to your service partner, please include your device's parameter setting.
The speed control might run away, most likely due to a wrong encoder offset.	• Please check that the encoder offset is set properly. • If auto commutation is used, re-view the auto commutation setting and test under all possible conditions. • If torque mode is used, reduce torque, ensure external speed limitation, or increase speed control gain for stronger limitation.

11.6.51 Error 57: reserved

11.6.52 Error 58: HYDRAULIK, common error

11.6.52.1 Error 58-1 (emergency code 6100h)

Cause: Hydraulics, p2t: overload of hydraulic pump

Suggested steps:

Please reduce the load.

Hydraulics, cyclic processing	• Error during the cyclic execution of the hydraulics. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
-------------------------------	--

11.6.52.2 Error 58-2 (emergency code 6100h)

Cause: Hydraulics, tracking error monitoring: maximum tracking error exceeded

Suggested steps:

Please check the parameterization.

Hydraulics, cyclic processing	• Error during the cyclic execution of the hydraulics. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
-------------------------------	--

11.6.53 Error 60: Spindle clamping system monitoring error

11.6.53.1 Error 60-1 (emergency code 6100h)

Cause: Tool not clamped correctly while in operation

Suggested steps:

Do not switch on drive while tool is not clamped correctly

11.6.53.2 Error 60-2 (emergency code 6100h)

Cause: Unknown combination of input signals

Suggested steps:

Check input wiring and settings

11.6.53.3 Error 60-3 (emergency code 6100h)

Cause: Clamping pressure was not applied properly

Suggested steps:

Check clamping pressure generation

11.6.54 Error 61: End damping error

11.6.54.1 Error 61-1 (emergency code 6100h)

Cause: End damping speed limitation error

Suggested steps:

Switch off/on device. Please contact your service provider if this error occurs again

11.6.55 Error 62: Battery buffered encoder

11.6.55.1 Error 62-1 (emergency code 7305h)

Cause: Encoder channel 1: Endat22, Error 'M-ALL-Power-Down' (BAT)

Suggested steps:

Multiturn position is lost! Please perform a new homing of the drive. Please reset the encoder internal warnings and errors with parameters (642) and (644).

M-ALL-Power-Down' (BAT)	• A sensor with implementation of the multi-turn part via battery buffer is connected. • The error occurs when both voltages, on the one hand the normal encoder supply voltage and on the other hand the auxiliary battery voltage, had failed at the same time at the encoder. • In this case, the multiturn part of the position is lost.
-------------------------	--

11.6.55.2 Error 62-3 (emergency code 7307h)

Cause: Encoder channel 3: Endat22, Error 'M-ALL-Power-Down' (BAT)

Suggested steps:

Multiturn position is lost! Please perform a new homing of the drive. Please reset the encoder internal warnings and errors with parameters (642) and (644).

M-ALL-Power-Down' (BAT)	• A sensor with implementation of the multi-turn part via battery buffer is connected. • The error occurs when both voltages, on the one hand the normal encoder supply voltage and on the other hand the auxiliary battery voltage, had failed at the same time at the encoder. • In this case, the multiturn part of the position is lost.
-------------------------	--

11.6.56 Error 63: Error brake monitoring

11.6.56.1 Error 63-1 (emergency code 6100h)

Cause: Brake monitoring error, cannot reach target torque, brake remains closed

Suggested steps:

Check torque or system limits, control settings or motor data set

This is possibly a hardware issue	If other measures fail to solve the problem, please replace the servo drive.
-----------------------------------	--

11.6.57 Error 68: SSI encoder, Error bit failure

11.6.57.1 Error 68-1 (emergency code FF00h)

Cause: ENC CH1 SSI: error, from special error bit from encoder

Suggested steps:

Please check the documentation of the SSI encoder, to find out the cause of the set of the encoder internal error (or warning).

Encoder channel, internal status from digital encoder	• Error during reading from a digital encoder. • Warning information or error status information reported by the encoder. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
---	--

11.6.58 Error 69: SSI encoder, Warning bit failure

11.6.58.1 Error 69-1 (emergency code FF00h)

Cause: ENC CH1 SSI: failure, because of special warning bit from encoder

Suggested steps:

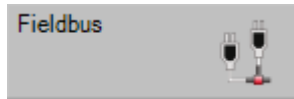
Please check the documentation of the SSI encoder, to find out the cause of the set of the encoder internal error (or warning).

Encoder channel, internal status from digital encoder	• Error during reading from a digital encoder. • Warning information or error status information reported by the encoder. • In any case look at init outputs in the message window of the Moog DRIVEADMINISTRATOR 5.
---	--

12 Fieldbus

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Fieldbus

Brief description

This chapter describes the configuration options for various fieldbuses and makes reference to the corresponding User manuals where appropriate.

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12.2 SERCOS	453
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12.4 Synchronization / Configuration	454
12.5 EDS file generator	454

12.1 CANopen / EtherCAT®



NOTE

- For a full description of the CANopen / EtherCAT® fieldbus option for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact (operation, system requirements, connection, operating modes, configuration, commissioning), see the CANopen / EtherCAT® User manual (ID No.: CA65647-001).
- CANopen is standardized in EN 50325-4.
- For general information on CANopen, please visit www.canopen.org
- EtherCAT® is defined in IEC/EN 61158 and IEC 61784.
- For general information on EtherCAT®, please visit www.ethercat.org
- EtherCAT® is a registered trademark and patented technology licensed by Beckhoff Automation GmbH, Germany.

EtherCAT®

12.2 SERCOS



NOTE

- For a full description of the SERCOS fieldbus option for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact (operation, system requirements, connection, operating modes, configuration, commissioning), see the User manual SERCOS II and III (ID No.: CA65648-001 and CA97557-001, available in EN only).
- SERCOS is defined in IEC 61784, IEC/EN 61158 and IEC/EN 61800-7.
- Refer to www.sercos.org for general information about SERCOS

12.3 PROFIBUS / PROFINET



NOTE

- For a full description of the PROFIBUS and PROFINET fieldbus options for the MSD Servo Drive and MSD Single-Axis Servo Drive Compact (operation, system requirements, connection, operating modes, configuration, commissioning), see the PROFIBUS and PROFINET User manual (ID No.: CA65645-001).
- PROFIBUS and PROFINET are defined in IEC/EN 61158 and IEC 61784.
- For general information on PROFIBUS and PROFINET, please visit www.profibus.com

12.4 Synchronization / Configuration

This function is used to synchronize the internal controller clock with an external sync signal (e.g. from a fieldbus). When applications are experiencing a lot of jitter, this function makes it possible to eliminate it to the greatest extent possible.



NOTE

- If you are under the impression that your application requires the use of this special function, please contact your project engineer.

ID	Index	Name	Unit	Description
2008		COM_SYNC_CTRL		Set-up of fieldbus synchronization control
2008	0	COM_SYNC_CTRL_Ref	15ns	Reference time for incoming sync telegrams relative to AD start
2008	1	COM_SYNC_CTRL_Wnd	15ns	Window for detecting axis synchronization
2008	2	COM_SYNC_CTRL_kp		DC link controller: Gain
2008	3	COM_SYNC_CTRL_ki	ms	integration
2008	4	COM_SYNC_CTRL_max	us	Maximum control output value
2008	5	COM_SYNC_CTRL_min	us	min control output
2008	6	COM_SYNC_CTRL_Tfil	ms	synchronization filter time
2008	7	COM_SYNC_CTRL		-
155	0	MPRO_DRVCOM_CFG		DriveCom: Device configuration (requires restart)
2009	0	COM_CFG_File		Generates fieldbus specific config file

Table 12.1: Synchronization / Configuration parameters

12.5 EDS file generator

Device EDS file generator:

Select file...

C:\Users*.EDS

Start generator

Fig. 12.1: EDS file generator screen

To be able to integrate a MSD Servo Drive or MSD Single-Axis Servo Drive Compact into a CANopen fieldbus network, you will need an EDS file.

This EDS file can

- a. Be generated with the help of the EDS file generator for the current firmware on the device
- b. Be downloaded from our website, <http://www.moogsoftwaredownload.com/msd.html>.



NOTE

- The CANopen fieldbus system is one of the options available for the MSD Single-Axis Servo Drive Compact, MSD Servo Drive Single-Axis System and Multi-Axis System series. It is only available if installed at the factory, and cannot be retrofitted.

12.5.1 Create an EDS file

Proceed as follows to create an EDS (Electronic Data Sheet) file:

1. Start Moog DRIVEADMINISTRATOR 5.
2. Connect a MSD Servo Drive to the Moog DRIVEADMINISTRATOR 5 and provide the appropriate firmware.

**NOTE**

- The IDs (e.g. vendor ID, product code etc.) on the selected MSD Servo Drive are taken into account when creating the file.
- Reset the device to factory settings before creating the EDS file.
- Back up the device configuration beforehand!

3. Open the EDS file generator.
Device setting -> Fieldbus -> EDS generator.

Device EDS-file generator:

4. Press the “Select file” button to choose the storage location for the MSD Servo Drive EDS file. The preset name for the EDS file is composed of the name of the “device”, the “firmware version” of the active device and the file extension “EDS”.

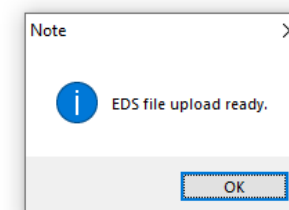
Device
G392-004-L_V174.30-60-00000.EDS
Firmware version

5. Select the desired storage location.
6. Press the “Start creation” button.
Creation of the EDS file begins. The progress, the path and the file name are entered in the window.
Press the “Stop creation” button to cancel the process.

Device EDS-file generator:

7. The following message appears when creation of the EDS file is complete.

Device EDS-file generator:



8. Press the “OK” button.

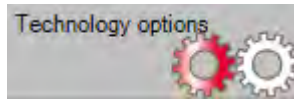
**NOTE**

- Please note that this process can take several hours!

13 Technology options (X8)

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Technology options (X8)

Brief description

This chapter provides information on the technology options available for connector X8.

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13.3 Sin/Cos encoder	457
13.4 TTL with encoder simulation	458
13.5 SSI encoder simulation	458
13.6 TwinSync	459

13.1 Selection of modules

Technology Options X8

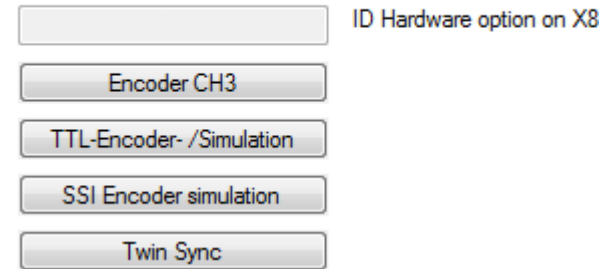


Fig. 13.1: "Technology options (X8) settings" screen

Option X8 (available only from the factory; cannot be retrofitted) supports the following options:

- Sin/Cosmodule (see Section "Channel 3: Interface X8 (optional)" on page 82)
- TTL encoder/simulation (see Section "TTL with encoder simulation" on page 458)
- TTL encoder with commutation signals
- SSI module (see Section "SSI encoder simulation" on page 458)
- TWINsync module (see Section "TwinSync" on page 459)

For the encoder types that can be evaluated, see Section "Channel 3: Interface X8 (optional)" on page 82.

13.2 Second Sin/Cos encoder

**NOTE**

- For a full description of the “Second Sin/Cos encoder” technology option (technical data, connections, configuration), see the “Specification Option 2 - Technology, second Sin/Cos encoder” (ID No.: CA79903-001).

13.3 Sin/Cos encoder

**NOTE**

- For a full description of the “Sin/Cos encoder” technology option (technical data, connections, configuration), see the “Specification Option 2 - Technology, Sin/Cos encoder” (ID No.: CB13516-001).

13.4 TTL with encoder simulation



NOTE

For a full description of the “TTL with encoder simulation” technology option (technical data, connections, configuration), see ...

- For the MSD Servo Drive **with hardware version up to .1** and **firmware version V2.15 or higher**: The “Option 2 - Technology, TTL encoder / TTL encoder simulation Specification” (ID No.: CB08758-001)
- For the MSD Servo Drive **with hardware version .2 or higher** and **any firmware version**, as well as the MSD Single-Axis Servo Drive Compact with **hardware version .1 or higher** and **firmware version V1.10 or higher**: The “Option 2 - Technology, TTL encoder simulation / TTL master encoder Specification” (ID No.: CB32164-001).

13.5 SSI encoder simulation



NOTE

- For a full description of the “SSI encoder option” technology option (technical data, connections, configuration), see the “Option 2 - Technology, SSI encoder simulation Specification” (ID No.: CB08760-001).

13.5.1 Parameters

SSI encoder simulation is enabled by setting **P 2800[0] - TOPT_SSI_Mode** to 1.

ID	Index	Name	Unit	Description
2800	0	TOPT_SSI_Mode		Operation mode of SSI option
2801	0	TOPT_SSI_MultiT	bit	Number of multiturn bits
2802	0	TOPT_SSI_SingleT	bit	Number of singleturn bits
2803	0	TOPT_SSI_Polarity		SSI polarity
2804	0	TOPT_SSI_Phase		SSI phase
2805	0	TOPT_SSI_ParityEnable		SSI parity enable
2806	0	TOPT_SSI_ParityType		SSI type of parity bit
2807	0	TOPT_SSI_SyncOffset	us	SSI synchronization offset
2808	0	TOPT_SSI_SyncUse		Synchronize to SSI cycle
2809	0	TOPT_SSI_InSync		SSI synchronization status
2810	0	TOPT_SSI_EncobsUse		Transmit encoder observation bit
2811	0	TOPT_InOut_EncSim_Source		Encoder simulation, signal source
2820	0	TOPT_SSI_GrayCode		Use Gray coding
2821	0	TOPT_SSI_Baudrate		SSI Baud rate
2822	0	TOPT_SSI_MultiturnVal		actual SSI multiturn value
2823	0	TOPT_SSI_SingleturnVal		actual SSI singleturn value

Table 13.1: SSI encoder simulation parameters

13.6 TwinSync



NOTE

- For a full description of the “TWINsync” technology option (technical data, connections, configuration), see the “Option 2 - Technology, TWINsync option Specification” (ID No.: CB08759-001).
-

14 Device status

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Device status

Brief description

This chapter describes the options available for viewing the device status.

Contents

14.1 Device status	460
14.2 Status bits	461
14.3 Load factor	461

14.1 Device status

To select various status and control signals for viewing in the oscilloscope or as trigger signals, click on the "Scope signals of *Device status*" (at the very top of the window).

Comprehensive error information can be accessed using the "Error History" button (see Section "Alarms and warnings (Details)" on page 327.)

If an error is currently present, it can be confirmed by clicking on the "Quit error" button.

ID	Index	Name	Unit	Description
150	0	Numerical status		Current numerical device status
152	0	Textual status		Current device status
153	0	Fault reset		Fault reset command

Table 14.1: "Device status" parameters



NOTE

- On the device, the device statuses are shown on the 7-segment display. See Operation Manuals MSD Servo Drive and MSD Single-Axis Servo Drive Compact.

14.2 Status bits

To select the DriveCom status word (**P 151[0]**) for viewing in the oscilloscope, click on the “Scope signals of *Status bits*” (at the very top of the window).

ID	Index	Name	Unit	Description
151	0	MPRO_DRVCOM_STAT_DWord		DriveCom status word (32Bit)

Table 14.2: “Device status - Status bits” parameters

14.3 Load factor

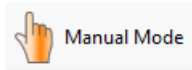
ID	Index	Name	Unit	Description
1651		LU_Timing_Max		SW Timing: Maximum times
1651	0	LU_Timing	ms	Control ISR
1651	1	LU_Timing	ms	Asynchronous 1ms Task
1651	2	LU_Timing	ms	Initialization Task
1651	3	LU_Timing	ms	Control COM Handler
1651	4	LU_Timing	ms	Service COM Handler
1651	5	LU_Timing	ms	CoDeSys RTS Task
1651	6	LU_Timing	ms	Motion 1ms Task
1652		LU_Timing_Avg		SW Timing: Average times
1652	0	LU_Timing	ms	Control ISR
1652	1	LU_Timing	ms	Asynchronous 1ms Task
1652	2	LU_Timing	ms	Initialization Task
1652	3	LU_Timing	ms	Control COM Handler
1652	4	LU_Timing	ms	Service COM Handler
1652	5	LU_Timing	ms	CoDeSys RTS Task
1652	6	LU_Timing	ms	Motion 1ms Task
1653	0	LU_Timing_Reset		Reset maximal and average timing values
1654	0	LU_Timing_Total	%	Total computer load
1661		LU_MemoryLoad		SW Memory: Memory Load
1661	0	LU_Memory	%	Context Save Area
1661	1	LU_Memory	%	Dynamic program memory total
1661	2	LU_Memory	%	Dynamic program memory ICODE
1661	3	LU_Memory	%	Dynamic program memory SCODE

Table 14.3: “Device status - Load” parameters

15 Manual mode

Chapter overview

Pictogram



Navigation

► Project tree ► Device setup ► Manual mode

Brief description

This chapter describes the configuration and control options for the “Manual mode” window.

Contents

15.1 Manual mode window	462
15.2 Manual mode control status	463

15.1 Manual mode window



NOTE

- Read, comply with, and confirm the safety prompt!
- As soon as the “Manual mode” window opens, all unrelated device settings will be disabled. These device settings will be re-enabled after the “Manual mode” window is closed.

The manual mode window will appear, but be disabled at first. Once you click on the “Activate manual mode” button, a safety prompt that needs to be confirmed will appear.



Fig. 15.1: Safety information

Once the safety prompt is confirmed, the “Manual mode” window will be enabled, after which you can select a control mode and configure it for manual operation. Depending on the control mode you selected, one to four configuration tabs will appear:

- A table with the parameters that are specific to the relevant control mode but that will only apply when using manual mode (e.g. acceleration, deceleration, setpoint, speed, etc.)
- Homing (see Section "Homing" on page 258)
- Jog mode, which can be used to move the motor step-by-step in a positive or negative direction with two different speeds.
- Reversing operation, in which the motor can be moved back and forth with adjustable accelerations and speeds.

ID	Index	Name	Unit	Description
229	0	MPRO_PARA_CTRL		Drive commissioning: Control word
230	0	MPRO_PARA_PRef	mDegree	Drive commissioning: Position reference value / amplitude
231	0	MPRO_PARA_SRef	rev/min	Drive commissioning: Speed reference value / amplitude
232	0	MPRO_PARA_Acc	rev/min/s	Drive commissioning: Acceleration
233	0	MPRO_PARA_Dec	rev/min/s	Drive commissioning: Deceleration
234	0	MPRO_PARA_TRef	Nm	Drive commissioning: Torque reference value
235	0	MPRO_PARA_Frequency	Hz	Drive commissioning: Frequency of test signal in IP mode
236	0	MPRO_PARA_SignalType		Drive commissioning: Type of test signal in IP mode
237	0	MPRO_PARA_WatchDog	ms	Drive commissioning: Watchdog tick
238	0	MPRO_PARA_Time	ms	Drive commissioning: Reverse control timer
297	0	MPRO_FG_ActualSpeedFac		Factor group: actual speed factor (1/min to user speed)

Table 15.1: “Manual mode” parameters

15.2 Manual mode control status

Double-clicking on “Manual mode control status” will open a window that will show the status word for the MSD Servo Drive in hexadecimal format.

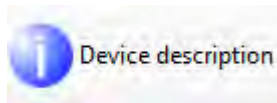
ID	Index	Name	Unit	Description
229	0	MPRO_PARA_CTRL		Drive commissioning: Control word

Table 15.2: “Manual mode control status” parameters

16 Drive description

Chapter overview

Pictogram



Navigation ► Project tree ► Device setup ► Drive description

Brief description This chapter describes the MSD Servo Drive characteristics and information available in parameters.

Contents 16.1 Electronic rating plate 464

16.1 Electronic rating plate

The electronic rating plate provides a variety of information concerning the MSD Servo Drive, including the device model, serial number, communication and technology options, hardware and software versions, and operating time. This information is also available in the form of parameters.

ID	Index	Name	Unit	Description
1	0	DV_DeviceId		Device family/series ID
2	0	DV_DeviceName		Device name / product name
3	0	DV_DeviceAliasName		Application-specific device name alias
4	0	DV_SwVersion		Firmware version of the device in plain text. Total software version of device (plain text)
5	0	DV_DeviceFamilyName		Device family name
6	0	DV_SwVersionId		Firmware version of the device
7		DV_SwModulVersion		Version numbers of supported software modules which have a parameter interface
7	0	DV_SwModulVersion		
7	1	DV_SwModulVersion		
7	2	DV_SwModulVersion		
7	3	DV_SwModulVersion		
8	0	DV_VendorName		Manufacturer name
49	0	DV_SwStatus		Bit-Darstellung mehrerer Softwarefunktionen Flag representation of several software functions
59	0	DV_SwOptionX11Ver		Software version option on X11
63	0	DV_BuildDate		Erstelldatum und Firmwareinformationen Build date and firmware info
79	0	DV_LoadedParamDataSet		Name of the currently loaded parameter data set
662	0	DV_CAL_ChopperGuard		Aktivierung der internen Bremschopperüberwachung Internal chopper guarding enable
672	0	DV_CAL_SerialNumServo		Produktinformation: Seriennummer Production information: serial number of device

Table 16.1: "Drive description" parameters

ID	Index	Name	Unit	Description
679	0	DV_CAL_CB_ArticleNumber		Controller board article number
697	0	DV_CAL_SafeFirmDataCrc		Safety firmware data CRC
707	0	MON_OpTime_Raw		Operation time
708	0	MON_OpEnTime_Raw		Operation enabled time

Table 16.1: "Drive description" parameters (continue)

ID	Index	Name	Unit	Description
9	0	DV_SwVersionVar		Software version variant of device (plain text)
24		USB_IO_Statistic		Statistic data of USB-IO Infineon driver
24	0	uReset		Reset statistics data
24	1	uIntEp0		
24	2	uIntEp1		Aufrufzähler des Endpunkt 1 ACK-Interrupts Calling count of handler for end point 1 ACK interrupts
24	3	uIntEp2		Aufrufzähler des Endpunkt 2 Interrupts Calling count of handler for end point 2 interrupts
24	4	uSetup		Aufrufzähler der SUI-Konfigurationsroutine Calling count of SUI setup handler
24	5	uConfiguration		Aufrufzähler der CFI-Konfigurationsroutine Calling count of CFI configuration handler
24	6	uRxMsgCnt		Anzahl empfangener Datenpakete Number of received data packets
24	7	uRxMsgBytes		Anzahl empfangener Datenbytes Number of received data bytes
24	8	uTxMsgCnt		Anzahl gesendeter Datenpakete Number of transmitted data packets
24	9	uTxMsgBytes		Anzahl gesendeter Datenbytes Number of transmitted data bytes
24	10	uRxAck		Aufrufzähler des Empfangs-acknowledge-Interrupts Calling count of receive acknowledge interrupt
24	11	uTxAck		Aufrufzähler des Sende-acknowledge-Interrupts Calling count of transmit acknowledge interrupt

Table 16.2: "Drive description - Software details" parameters

ID	Index	Name	Unit	Description
24	12	uIntTmtEp0		Aufrufzähler des Endpunkt 0 Sendeinterrupts Calling count of endpoint 0 transmit interrupt
24	13	uIntWrn		Aufrufzähler des Warnungsebeneninterrupts Calling count of warning level interrupt
24	14	iRetryCount		Anzahl zweiter Versuche ein Datenpaket zu übertragen Number of second attempts to transmit a data packet
24	15	ResetCount		Anzahl empfangener Rücksetzbefehlsssequenzen Number of received reset command sequences
24	16	CriticalErrorCount		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical basic USB driver errors
24	17	CriticalErrorCount1		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical basic USB driver errors
24	18	CriticalErrorCount2		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical basic USB driver errors
24	19	CriticalErrorCount3		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical basic USB driver errors
24	20	CriticalErrorCount4		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical basic USB driver errors
24	21	AppliErrorCount		Anzahl kritischer Fehler des Basis USB-Treibers Number of critical errors in application layer
24	22	RxFifoHandlerCnt		Aufrufzähler der Empfangsroutine Calling count of receive handler
24	23	USBdriveMode		ID des USB-Treibermodus (0=kein, 1=alt, 2=sicher) ID of USB driver mode (0 = none, 1 = old, 2 = secure)
24	24	BlockChecksumError		Anzahl fehlgeschlagener 64Byte Blöcke Number of failed 64 byte blocks
60	0	DV_SwOptionX12ID		ID software option on X12
64	0	DV_SwBaseVersion		Software base version
65	0	DV_SwCompatibilityLevel		Software compatibility level
80		DV_SwBootInfo		Bootloader information, version and checksum
80	0	DV_SwBootVersion		Bootloader information, version
80	1	DV_SwBootChecksum		Bootloader information, checksum
81	0	DV_SwChecksum		Checksum of firmware in flash

Table 16.2: "Drive description - Software details" parameters (continue)

ID	Index	Name	Unit	Description
50	0	DV_HwPrintID		ID hardware print
51	0	DV_HwPrintSubID		Hardwareprint Sub-ID
52	0	DV_HwOptionX11ID		ID hardware option on X11
53	0	DV_HwOptionX12ID		ID hardware option on X12
54	0	DV_HwCpldID		Hardware CPLD / ASIC: ID
55	0	DV_ChipID		Chip and redesign tracing identification
75	0	TOPT_Sel		TechOption: Select

Table 16.3: Parameter "Drive description - Hardware version"

ID	Index	Name	Unit	Description
15		PARAM_DSC_Para		Detailed description of a parameter
15	0	Index		Index (consecutive numbering) of parameter in actual parameter listing
15	1	ID		Parameter identification number
15	2	SubParameterCount		Number of sub parameters
15	3	Name		Parameter name
15	4	Introduction		Short parameter introduction
15	5	ReadLevel		Essential level for parameter read access
15	6	WriteLevel		Essential level for parameter write access
15	7	Attributes		Manufacturer dependent attributes
15	8	DisplayAttributes		Harmonized attributes for parameter representation
15	9	IsComplex		True if parameter consists of individually different sub parameters
15	10	IsInteractive		True if parameter access triggers an interactive command
15	11	GroupId		Identification number of parameter group to which this parameter belongs to
15	12	SaveGroups		Flag representation of device save group to which this parameter belongs
16		PARAM_DSC_SubPara		Description of a single sub parameter
16	0	ParaId		Parameter no.
16	1	SubParaId		Sub parameters no.

Table 16.4: Parameter "Drive description - Interface"

ID	Index	Name	Unit	Description
16	2	Name		Sub parameters name
16	3	Unit		Sub parameters unit
16	4	Introduction		Sub parameters short introduction
16	5	DataType		Sub parameters data type identification
16	6	DataTypeName		Sub parameters data type name
16	7	Attributes		Sub parameter attributes
16	8	Minimum		Sub parameter minimum value as float32
16	9	Maximum		Sub parameter maximum value as float32
16	10	Default		Sub parameter default value as float32
16	11	StringMinimum		Minimum value as text
16	12	StringMaximum		Maximum value as text
16	13	StringDefault		Manufacture-specific default value as text
16	14	NativeMinimum		Native sub parameter minimum value as 4-byte data stream
16	15	NativeMaximum		Native sub parameter maximum value as 4-byte data stream
16	16	NativeDefault		Native sub parameter default value as 4-byte data stream
17		PARAM_DSC_Groups		List of names of parameter groups
17	0	PARAM_DSC_Groups		
17	...	PARAM_DSC_Groups		
17	21	PARAM_DSC_Groups		
18		PARAM_DSC_SaveGroups		List of names of parameter save groups
18	0	PARAM_DSC_SaveGroup		
18	...	PARAM_DSC_SaveGroup		
18	12	PARAM_DSC_SaveGroup		
19		PARAM_DSC_Device		Device description concerning parameter list
19	0	ParaCount		Number of registered parameters
19	1	GroupCount		Number of parameter groups
19	2	SaveGroupCount		Number of parameter save groups
20		PARAM_DSC_Para2		Detailed description of a parameter
20	0	Index		Index (consecutive numbering) of parameter in actual parameter listing
20	1	ID		Parameter identification number

ID	Index	Name	Unit	Description
20	2	SubParameterCount		Number of sub parameters
20	3	Name		Parameter name
20	4	Introduction		Short parameter introduction
20	5	ReadLevel		Essential level for parameter read access
20	6	WriteLevel		Essential level for parameter write access
20	7	Attributes		Manufacturer dependent attributes
20	8	DisplayAttributes		Harmonized attributes for parameter representation
20	9	IsComplex		True if parameter consists of individually different sub parameters
20	10	IsInteractive		True if parameter access triggers an interactive command
20	11	GroupId		Identification number of parameter group to which this parameter belongs to
20	12	SaveGroups		Flag representation of device save group to which this parameter belongs
21		PARAM_DSC_SubPara2		Short description of a single sub parameter
21	0	ParamId		Parameter no.
21	1	SubParamId		Sub parameters no.
21	2	Name		Sub parameters name
21	3	Unit		Sub parameters unit
21	4	Introduction		Sub parameters short introduction
21	5	DataType		Sub parameters data type identification
21	6	DataTypeName		Sub parameters data type name
21	7	Attributes		Sub parameter's attributes
21	8	Minimum		Sub parameters minimum value as float32
21	9	Maximum		Sub parameters maximum value as float32
21	10	Default		Sub parameters default value as float32
21	11	StringDefault		Manufacture-specific default value as text
21	12	NativeMinimum		Native sub parameter minimum value as 4-byte data stream
21	13	NativeMaximum		Native sub parameter maximum value as 4-byte data stream
21	14	NativeDefault		Native sub parameter default value as 4-byte data stream

Table 16.4: Parameter "Drive description - Interface" (continue)

ID	Index	Name	Unit	Description
22		PARAM_DSC_Groups2		List of names of parameter groups
22	0	PARAM_DSC_Groups		
22	...	PARAM_DSC_Groups		
22	21	PARAM_DSC_Groups		
48		PARAM_DSC_SaveGroups2		List of names of parameter save groups
48	0	PARAM_DSC_SaveGroup		
48	...	PARAM_DSC_SaveGroup		
48	12	PARAM_DSC_SaveGroup		

Table 16.4: Parameter "Drive description - Interface" (continue)

17 Enhanced/additional functions

Chapter overview

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Navigation

Brief description This chapter describes "Reloading individual parameters" and "Uploading and downloading parameter data sets".

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17.1 Reloading individual parameters

The parameters **P 97 - PARA_DataSetLdCfg**, **P 98 - PARA_DataSetLdID** and **P 99 - PARA_DataSetLdVal** allow you to adapt individual parameter values as needed.

The parameters and values to be loaded can be defined by means of special character strings and assigned to an associated data set ID. Determination of the data set ID can be accomplished by means of digital inputs or a parameter, for example. One possible application would be storing two motor data sets in one device which can be switched over in dependence on a certain event.

17.1.1 Parameters used

P 97 - PARA_DataSetLdCfg

The parameter **P 97 - PARA_DataSetLdCfg** is used to activate the function and to make the general settings for the generation of the data set ID.

P 98 - PARA_DataSetLdID

The desired data set IDs are entered in **P 98 - PARA_DataSetLdID**. Up to 100 entries can be made (subindex 099). The parameter ID entered here makes reference to the subindex in **PARA_DataSetLdVal** via the associated subindex of **PARA_DataSetLdID**.

P 99 - PARA_DataSetLdVal

The character strings associated with the respective data set IDs (linked via the subindex with **P 98**) which define the parameters and values to be loaded are entered in **P 99 - PARA_DataSetLdVal**.

17.1.2 Parameter list

ID	Index	Name/Setting	Unit	Description
97		PARA_DataSetLdCfg		DataSet Loader Configuration
	0	Opt		Configuration options
		OFF (0)		Function not active
		ON(1)		Activate function
	1	FS:		Function selector
		0 = OFF		No data set ID is determined.
		1 = TERM		Determination via digital inputs (MPRO_INPUT_STATE & PARA_DataSetLdCfg[1])
		2 = PARA		The data set ID is determined from a selectable parameter. The value of the parameter (Para_ID/ParaSubID) is used to generate the data set ID.
	2	Mask		Bitmask
	3	ActID		Currently selected data set ID
	4	Para_ID		Parameter index for generating the data set ID (if FS=PARA)
	5	Para_SubID		Parameter subindex for generating the data set ID (if FS=PARA)
	6	Para_Scale		The parameter value is scaled (multiplication) for the generation of the data set ID using the value indicated.
	7	Para_Offset		Parameter offset for generating the data set ID
98		PARA_DataSetLdID		
	0 -99	PARA_DataSetLdID		List of the possible data set IDs
99		PARA_DataSetLdVal		
	0 -99	PARA_DataSetLdVal		Associated character strings which describe parameters and values which are to be changed

Table 16.5: Parameter "Reloading individual parameters"

Activation

The function is activated by the setting of the parameter **P 97 - PARA_DataSetLdCfg [0] Opt = 1**.

Determining the data set ID

The parameter **P 97 - PARA_DataSetLdCfg[1] FS** is the function selector and specifies which source is used for determining the data set ID.

The parameter **P 97 - PARA_DataSetLdCfg[2]** (= PARA_DataSetLd_Mask) functions in this case as the bitmask for selecting (e.g. the desired digital inputs).

- off (0) Manual switchover via ActID
- 1 Switchover via digital inputs
- 2 Switchover via separate parameter

The currently determined data set ID is displayed in parameter **P 97 - PARA_DataSetLdCfg[3]** (= ActID).

Manual allocation of the data set ID

If parameter **P 97 - PARA_DataSetLd_FS = OFF(0)**, then the data set ID can be allocated "manually."

Every imaginable data set ID should be entered in parameter **P 98 - PARA_DataSetLdID[x]** at least once under any subindex desired.

Automatic data set ID determination

Parameter **P 97 = Para(2)** allows switching between the data set IDs via any parameter desired (for example, a fieldbus parameter). To do so, the parameter must be entered in **P 97.4** and the associated subindex in **P 97.5**.

The value of the parameter entered is overwritten in **P 97.3**.

Using parameter **P 97 - PARA_DataSetLd_FS = PARA(2)**, the data set ID is determined automatically from the current value of the parameter specified by **P 97 - PARA_DataSetLdCfg[4]** and **P 97 - PARA_DataSetLdCfg[5]** and is entered in **P 97 - PARA_DataSetLd [3] = ActID**.

Using **P 97 - PARA_DataSetLdCfg[6] - Para_Scale** and **P 97 - PARA_DataSetLdCfg[7] - Para_Offset**, the parameter value is now first multiplied by "Para_Scale" and then "Para_Offset" is added. The resulting value is rounded to the nearest integer to obtain the data set ID.



NOTE

- Currently, only float32 parameters are supported. If the specified parameter cannot be read or if it is not a float32 parameter, the data set ID generated is always "0".

Configuring the data set for the determined data set ID

The settings in parameters **P 98** and **P 99** must now be made for the data set ID that has been determined.

P 97 - PARA_DataSetLd [3] = ActId shows the currently determined or entered data set ID.

Enter this data set ID under **P 98 - PARA_DataSetLdID - Index X** for the required subindex. The system then uses the subindex of **P 98** to branch to the subindex of **P 99 - PARA_DataSetLdVal - Index X**. The configuration data for the new parameters must be entered in this index.

Select parameter **P 99 - PARA_DataSetLdVal - Index X**. This must be the same index as the index selected under **P 98 - PARA_DataSetLdID - Index X**.

Then enter the configuration data for the parameters for the selected index of **P99 - Para_DataSelLdVal** under "Value".

This must have the syntax

<INDEX>,<SUBINDEX>,<VALUE>;<INDEX>,<SUBINDEX>,<VALUE>;

17.1.3 Procedure

Activate the function using:

P 97 - PARA_DataSetLdCfg[0] = 1

Generate the data set ID using:

P 97 - PARA_DataSetLdCfg[1] = 2

Set Para_ID and Para_SubID using **97 - PARA_DataSetLdCfg[4]** and **P 97 - PARA_DataSetLdCfg[5]**.

Set Para_Scale and Para_Offset using **97 - PARA_DataSetLdCfg[6]** and **P 97 - PARA_DataSetLdCfg[7]**.

The data set ID is now displayed under **97 - PARA_DataSetLdCfg[2] = ActId**.

Enter the determined data set ID under **P 98 - PARA_DataSetLdID[x] = Subindex X**.

Now enter the configuration of the parameter under **P 99 - PARA_DataSetLdID[x] = Subindex X**.

Compare the data set ID with elements of P 98- PARA_DataSetLdID[x]

The parameter **P 98 - PARA_DataSetLdID[x]**, which consists of 100 elements (0 . . . 99), is run through completely and the values of the elements are compared to the determined data set ID (determination as described above).

If the data set ID in parameter **P 98- PARA_DataSetLdID[x]** was not found at least once, an error 15-21 is triggered ("Dataset to be loaded is not valid!"). This error can be acknowledged and the drive can subsequently be put into operation.

If the data set ID is found in element x, the string in the associated parameter **P 99 - PARA_DataSetLdVal[x]** is interpreted. This must have the format

<INDEX>,<SUBINDEX>,<VALUE>;<INDEX>,<SUBINDEX>,<VALUE>;...

(length: max 100 characters each). The consecutively specified parameter values are loaded accordingly. If the string cannot be interpreted due to input errors, an error message is generated.

It is possible to specify the same data set ID in several elements, x1, x2, x3.... In this case, all strings are interpreted from **P 99 - PARA_DataSetLdVal[x1]**, **P 99 - PARA_DataSetLdVal[x2]**.... If a parameter is written more than once here, the last value specified is valid.

Loading the data set

Loading of the parameters is initiated by:

- starting the device
- a change in data set ID.

Functional example:

P 98 - PARA_DataSetLdID[x]	SubID P 98		SubID P 99	P 99 - PARA_DataSetLdVal[x]
123	0	↔	0	456,0,300;451,0,Testmotor
456	1	↔	1	456,0,350; 451,0,Supermotor
456	2	↔	2	320,0,0.01;;; 321,0,20;
456	3	↔	3	
65535	4	↔	4	
65535	5	↔	5	
65535	6	↔	6	
456	7	↔	7	360,0,1e3
65535	8	↔	8	
123	9	↔	9	
789	10	↔	10	
65535	11	↔	11	
...	...	↔	...	.
..	...	↔	..	
	99	↔	99	

Table 16.6: Functional example

If, for example, a data set ID with the ID "123" is determined, the parameters 456[0]=300 and 451[0]="Testmotor" are written sequentially. For an ID "456" 456[0]=350, 451[0]="Supermotor", 320[0]=0.01, 321[0]=20 and 360[0]=1000. All aforementioned data sets are valid, i.e. leaving entries blank is permissible as is the insertion of any number of spaces or ";" separators. The string can be closed with ";" but this is not required.

If an entry needs to be disabled temporarily for test purposes, it is recommended that a data set ID which does not exist be entered (e.g. 4294967295).

If there is to be NO parameter loaded for a certain data set ID in use, it is STILL recommended that an entry be made in any element of PARA_DataSetLdID[x], to avoid triggering the error "No dataset available for given ID." In this case, the associated element in PARA_DataSetLdVal[x] can simply be left blank (as in the example above for the actuator of the ID "789"). This means that every data set ID used must be listed explicitly in order to prevent an incorrect data set from being active "inadvertently."

17.2 Upload and download of parameter data sets

The parameters **P 2009[0] - COM_CFG_File** and **P 2010[0] - COM_CFG_ID** can be used to write the configuration of the servo controller to the file system of the servo controller as a parameter data set or read it from there. The parameter data set is saved in a file with the syntax PDSxx.dmd. The xx in the filename stands for the data set number. Up to 100 data sets (0 to 99) can be saved.

This allows various different configurations to be saved in a servo controller as parameter data sets and then be called up as needed for the respective operational situation.

The parameter data sets can be loaded to the PC using an FTP script or from there back to the servo controller.

P No.	Index	Name	Unit	Description
2009	0	COM_CFG_File		Access to the file system: Loading and saving of configuration files -2 (ERROR) Error during RAM or MMC access -1 (Running) = File creation is running 0 (Ready) = File creation is finished 18 Create parameter data set on FS. 19 Read parameter data set from FS and write to device parameters.
2010	0	COM_CFG_ID		Access to file system: Assign additional parameter data set ID. With byte 0: Specification of the parameter data set number. Bit 0 of 2010[0] to bit 7 of 2010[0] With byte 1: Specification of the options Bit 0 = 1: Remove fieldbus-specific parameters from the data set. Bit 1 = 1: Remove scope parameters from the data set.

Table 16.7: Upload and download of parameter data sets

17.2.1 Write parameter data set to the file system.

No.	Action
1	Assign name for the parameter data set: With byte 0 of P 2010[0] - COM_CFG_ID : Specifies the name of the parameter data set. 0-99 means PDS00...PDS99.
2	Specify options: Using byte 1 of P 2010[0] - COM_CFG_ID specifies the options for the parameter data set. Bit 0 = 1: Remove fieldbus-specific parameters from the data set. Bit 1 = 1: Remove scope parameters from the data set.
3	Create parameter data set: P 2009[0] - COM_CFG_File = 18 Create a parameter data set in the file system /para/PDS00.dmd The parameter data set is now saved in the servo controller with the selected name.
4	Transfer the parameter data set to the PC using the FTP script: The following script can be used to transfer the parameter data set from the servo controller to the PC. open 192.168.39.5 Servo Drive get /para/PDS00.dmd quit

17.2.2 Loading the parameter data set from the file system

No.	Action
1	Load the parameter set from the PC to the file system of the servo controller via FTP script: <pre>open 192.168.39.5 Servo Drive mkdir /para cd /para put PDS00.dmd quit</pre> The parameter data set is now present in the servo controller file system.
2	Enter the name of the parameter data set to be read With byte 0 of P 2010[0] - COM_CFG_ID: Specifies the name of the data set to be read. 0-99 means PDS00...PDS99.
3	Specify options: With byte 1 of P 2010[0] - COM_CFG_ID: Specification of the options. Bit 0 = 1: Save the data set permanently to the non-volatile axis controller.
4	Read the parameter data from the file system and write to the device parameters. P 2009[0] - COM_CFG_File = 19.
5	If everything has worked properly, P 2009[0] - COM_CFG_File is automatically set to 0 = Ready once again. If there is an error, P 2009[0] - COM_CFG_File is set to -2 = error.

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