

Rexroth HydraulicDrive

HDx-20
Pump control

Supplementary information
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Edition 02



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1 Configuration of sensors

1.1 Configuration of pressure sensors

For operating the pump controller various pressure sensors can be configured. Generally, we have to distinguish between operation in the closed and in the open circuit:

- | | |
|--|--|
| Operation in the open circuit | <ul style="list-style-type: none"> • P-0-2940, Pressure feedback value 1 • P-0-2941, Pressure feedback value 2 (optional) |
| Operation in the closed circuit | <ul style="list-style-type: none"> • S-0-0803, Pressure feedback value A (pressure in port A of the pump) • S-0-0804, Pressure feedback value B (pressure in port B of the pump) |

For acquiring the actual pressure value the pressure sensors can be connected to the various analog inputs. Alternatively, the actual pressure value can also be transmitted over the bus. In the case of transmission over bus it must, however, be noted that the actual pressure values have to be updated at least 2 ms. Moreover, in the case of a bus failure, no emergency mode can be run with pressure controls, since no valid actual pressure values are available. If an emergency mode (e.g. switching over to internal command values) should become necessary, the pressure sensors have to be connected via an analog input.

Filter time for analog input:

A filter time constant is assigned to each analog input for filtering the input value with a PT1-filter. In the factory settings this filter is deactivated (filter time = 0 ms). This filter can be used to filter out disturbance on the signal. For this the actual pressure value can be recorded when the motor is at standstill. If, while the motor is at standstill, disturbance is greater than ca. 1 bar, it is recommended that the filter be activated. The common filter time is 1 - 2 ms, since larger filter times have a negative influence on pressure control.

1.2 Configuration of swivel angle sensors

For the selection of the swivel angle sensor a predefined list is available. The signal range for each sensor type is firmly preset. Should a sensor be used, which is not contained in the list, another signal range may be set by means of manual selection (P-0-2948 = 0). For filtering the swivel angle signal, one filter is provided for filtering the swivel angle feedback value (P-0-2949.0.8) and one filter for the swivel angle feedback value derivative (P-0-2961). The filters are required, if disturbance on the signal becomes excessively large for the swivel angle feedback value. Should the disturbance be greater than 1 % while the motor is at rest (control not active), P-0-2949.0.8 can be set to a higher value. Usual value ranges for the filter time are as follows:

- P-0-2949.0.8, Filter time of swivel angle feedback value: 0 ms ... 4 ms
- P-0-2961, Filter time of swivel angle feedback value derivative: 3 ms ... 10 ms.

For larger pumps, longer filter times may usually be selected.

2 Selection of controller structure

2.1 Controller structure

Two controller structures (parallel structure/cascade structure) can be used for pump control. Generally, alternating pressure/swivel angle control can be employed with both controller structures. The parallel structure offers advantages in conjunction with small dead volumes and dynamic transitions from pressure to swivel angle control. In the past, the parallel structure was used with SYDFEx systems. The cascade structure offers advantages in conjunction with larger dead volumes and in the closed circuit. So far, the cascade structure has been selected for VPCD. During operation it is possible to switch between the two controller structures. To this end, bit 15 in "P-0-2950, Pump controller control word" has to be set accordingly.



Many applications switch between a large dead volume (normal operation) and a smaller dead volume (operation with pump control block only) during operation. In this case it turned out to be advantageous to switch also the controller structure over with the signal for the shut-off valve on the pump control block. The bit for changing the controller structure over can be connected to a digital input or assigned to the field bus control word.

2.2 Operating principle / controller optimization of swivel angle controller

The inherent structure of the swivel angle controller is identical in both, the parallel structure and the cascade structure. The swivel angle controller consists of a PD-controller.

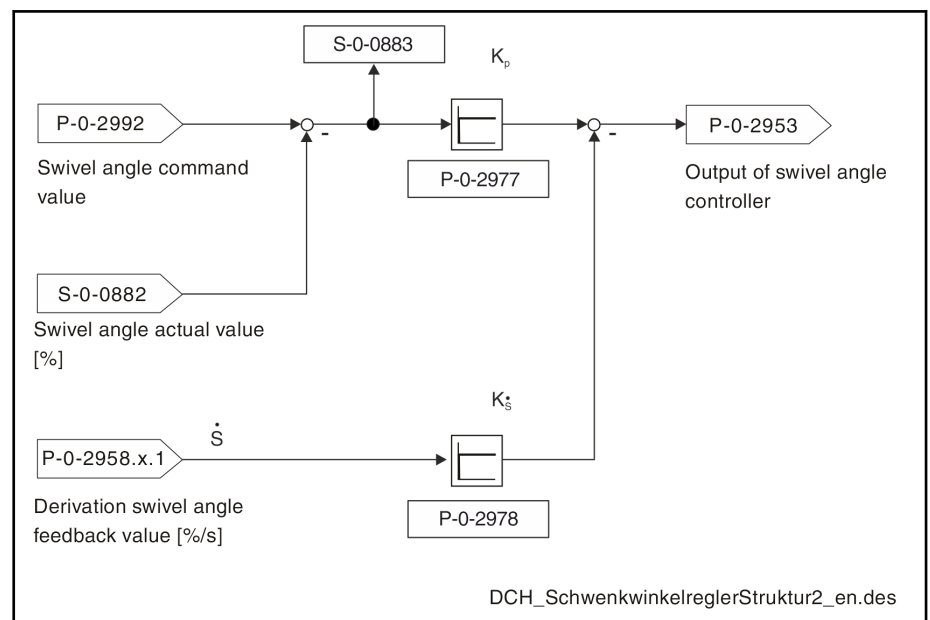


Fig. 2-1: Swivel angle controller structure

For most applications the swivel angle controller needs not to be adjusted. The cabinet-mounted pump controller (VT-HPC) requires a smaller P-gain than OBE systems (SY(H)DFEF and HS5E). For this reason, the VT-HPC is factory-set to 4 for "P-0-2977, Swivel angle controller P-gain", the OBE systems come with a factory setting of 8 for P-0-2977. To improve the dynamic

Selection of controller structure

behavior, the P-gain can be slightly increased for larger pumps, and "P-0-2978, Swivel angle controller time constant D-component" can be used to reduce overshoots in swivel angle control.

Usual value ranges

- P-0-2977, Swivel angle controller P-gain = 4 ... 12
- P-0-2978, Swivel angle controller time constant D-component = 0 ... 0.200

2.3 Operating principle / controller optimization in parallel structure

In the parallel structure the output of the swivel angle controller and the output of the pressure controller are compared with each other. The valid value is then passed on to output adjustment as valve command value.

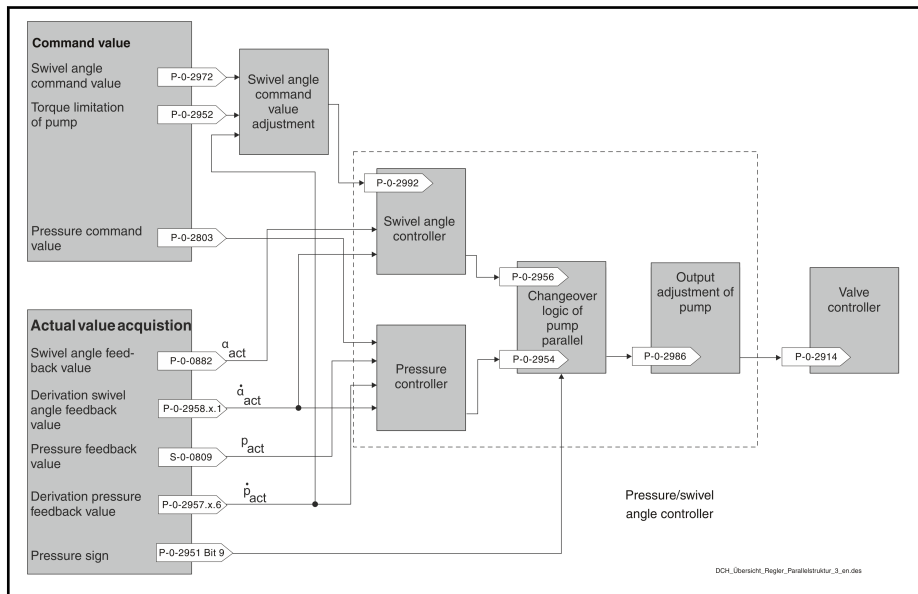


Fig. 2-2: Overview of controllers in parallel structure

The pressure controller in the parallel structure has the following structure:

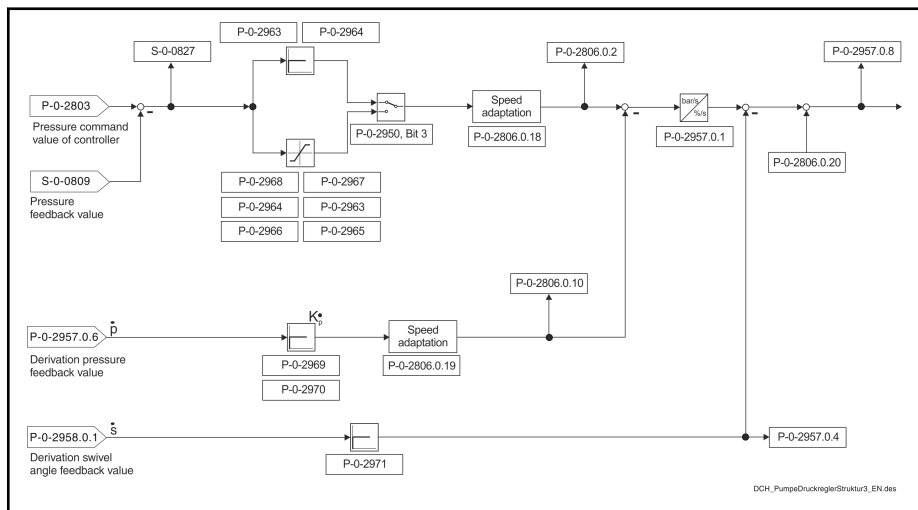


Fig. 2-3: Pressure controller structure of the pump in parallel structure

In the parallel structure, the pressure controller consists of a PD-controller with additional feedback of the derivative of the actual swivel angle value. For

the P-component and the D-component, there are two parameters provided each, which are used with positive or negative input variable. Additionally, in the P-component it is possible to activate an inflected characteristic curve and to use another gain value for the P-component from a certain control deviation on.

The inflected characteristic curve is required, if, for example, a hydraulic accumulator is installed in the system. The hydraulic accumulator leads to greater damping when charged. For this, it may be useful to provide a second P-gain for the pressure controller. Within the pressure controller the pressure is converted from unit [bar] into unit [%] via pressure normalization. This pressure normalization (P-0-2957.0.1) results from the normalization employed in the predecessor systems. SYDFEx systems are normalized to 315 bar, HS5 systems to 350 bar. The pressure normalization is factory-set and is usually not changed under normal circumstances.

Generally, the pressure controller has to be adapted to the existing dead volume. For this purpose, suggested values are listed in the table below. The suggested values are valid for systems with OBE (SY(H)DFED, SY(H)DFEF and HS5E). For the HS5 with external electronics the gains, especially in the case of small dead volumes, are significantly lower (in some cases, the P-gain has to be halved for HS5).

Controller parameters	Universal (default setting)	0 l	1 l	2.5 l	5 l	7.5 l	10 l
Pressure controller P-gain 1 positive (P-0-2963)	2.8	2.8	4.3	4.3	4.7	5	4.3
Pressure controller P-gain 1 negative (P-0-2964)	2.8	2.8	4.3	4.3	4.7	5	4.3
Pressure controller time constant D-component positive (P-0-2969)	0.19 s	0.04 s	0.2 s	0.2 s	0.41 s	0.44 s	0.45 s
Pressure controller time constant D-component negative (P-0-2970)	0.23 s	0.04 s	0.2 s	0.2 s	0.41 s	0.44 s	0.45 s
Pressure controller time constant swivel angle feedback (P-0-2971)	0.07 s	0.04 s	0.07 s	0.07 s	0.075 s	0.05 s	0.06 s
Gate time derivation actual pressure value 1 (P-0-2960)	22.5 ms	13.5 ms	13.5 ms	22.5 ms	22.5 ms	22.5 ms	22.5 ms

Tab. 2-1: Settings for OBE control parameters for different oil volumes

Selection of controller structure

Controller parameters	12.5 l	15 l	20 l	25 l	30 l	40 l
Pressure controller P-gain 1 positive (P-0-2963)	4.4	4.4	3.8	3.6	3.6	3.5
Pressure controller P-gain 1 negative (P-0-2964)	4.4	4.4	3.8	3.6	3.6	3.5
Pressure controller time constant D-component positive (P-0-2969)	0.52 s	0.535 s	0.59 s	0.68 s	0.7 s	0.72 s
Pressure controller time constant D-component negative (P-0-2970)	0.52 s	0.535 s	0.59 s	0.68 s	0.7 s	0.72 s
Pressure controller time constant swivel angle feedback (P-0-2971)	0.07 s	0.07 s	0.07 s	0.07 s	0.07 s	0.07 s
Gate time derivation actual pressure value 1 (P-0-2960)	22.5 ms	22.5 ms	22.5 ms	22.5 ms	22.5 ms	22.5 ms

Tab. 2-2: Settings for controller parameters for different oil volumes

The scaling factor for the feedback of the derivative of the actual swivel angle value depends on the pump size. In the case of smaller pumps (< size 45 cm³) the usual values for "P-0-2971, Pressure controller time constant swivel angle feedback" are 0.03 s to 0.04 s. For larger pumps, values from 0.04 s to 0.09 s are usually selected.

Setting the pressure controller PD-gain

The PD-gain corresponds to the summation of the P-component and the D-component as shown in the figure of the pressure controller in the parallel structure. The values of the P-parameters to be set ("P-0-2963, Pressure controller P-gain 1 positive", "P-0-2964, Pressure controller P-gain 1 negative", "P-0-2969, Pressure controller pos. Factor for D-component, parallel", "P-0-2970, Pressure controller neg. factor for D-component, parallel") vary depending on the application at hand. In general, it is valid that higher values lead to a faster responding control. However, excessively large values result in unstable behavior since the fed back actual value always changes and this change would then be excessively amplified (oscillation). The optimum value of the entire control gain is a compromise between balancing characteristics and stability.

Notes on the setting of the individual parameters are given in the following:

Example 1:

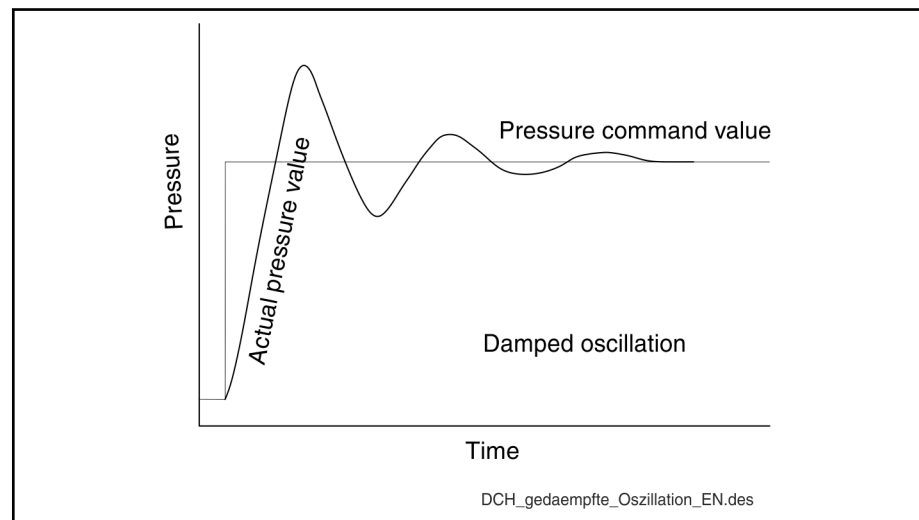


Fig. 2-4: Damped oscillation

Step	Behavior / result	Measure
1	Overshoots (damped oscillation)	Increase D-component (P-0-2969 or P-0-2970, respectively)
2	The actual pressure value still overshoots	Reduce P-gain (P-0-2963 or P-0-2964, respectively)

Tab. 2-3: Measures against overshoots

Example 2:

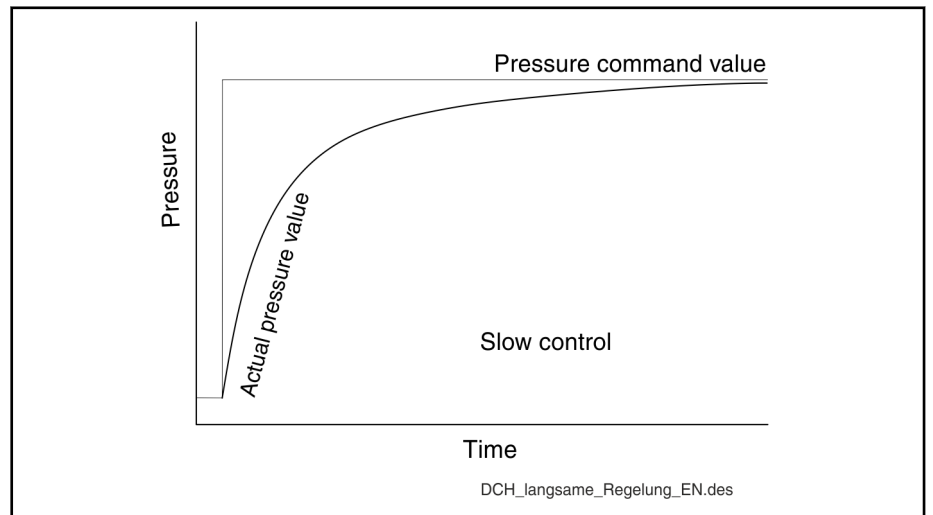


Fig. 2-5: Slow control

Step	Behavior / result	Measure
1	Slow reaction	Increase P-gain (P-0-2963 or P-0-2964, respectively)
2	Reaction still slow	Reduce D-component (P-0-2969 or P-0-2970, respectively)

Tab. 2-4: Measures against slow reaction

Example 3:

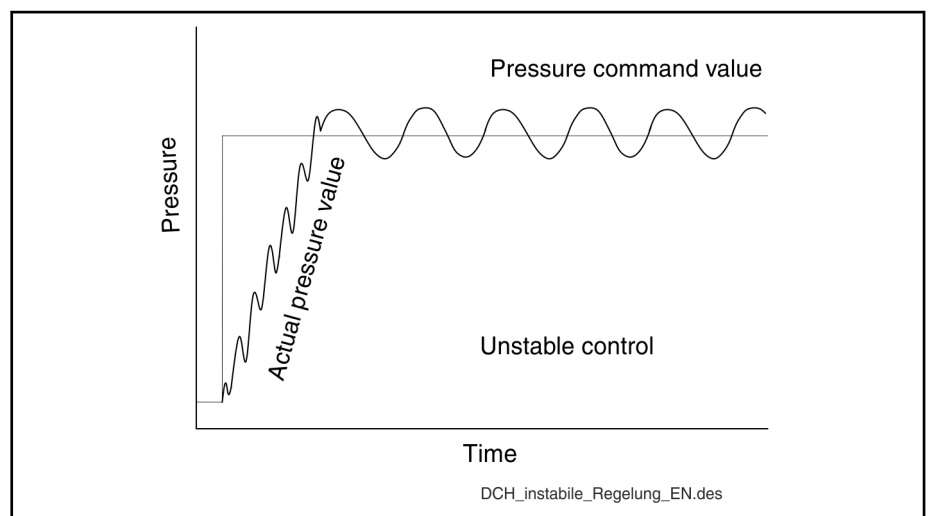


Fig. 2-6: Unstable control

Selection of controller structure

Step	Behavior / result	Measure
1	Fast, but unstable reaction	Reduce P-gain (P-0-2963 or P-0-2964, respectively)
2		Reduce D-component (P-0-2969 or P-0-2970, respectively)

Tab. 2-5: Measures against unstable reaction

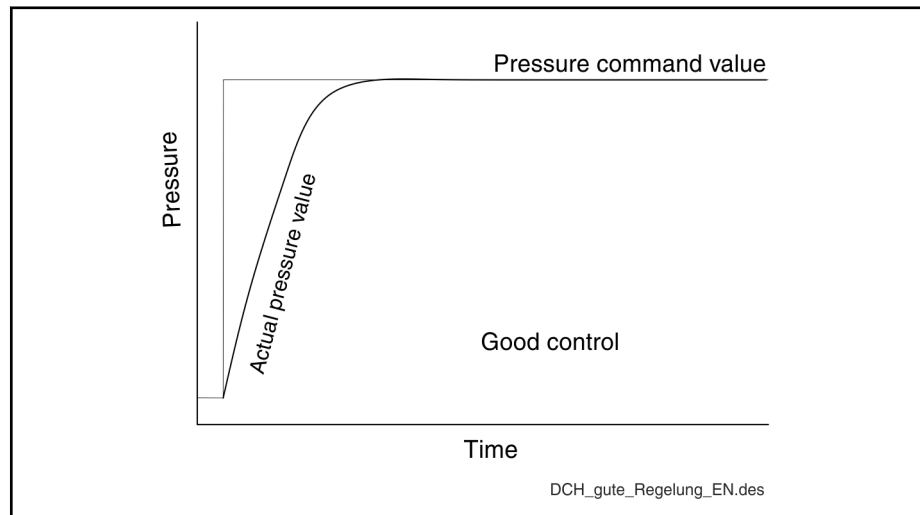
Example 4:

Fig. 2-7: Good control

If the control behavior is good, no measures need to be taken.

Variable-speed operation

During variable-speed operation the gain in the P- and in the D-component has to be adjusted in order to obtain the same controller dynamics. The adaptation factors "P-0-2806.0.18, Pressure controller adaptation, P-term" and "P-0-2806.0.19, Pressure controller adaptation, D-term" can be used for this purpose. These adaptation factors can be cyclically written in variable-speed operation in order to adjust the controller gain as required. For operation at fixed speed, these factors are pre-configured to the value 1.0 (for further information, see chapter [Adaptation of pressure controller in variable-speed operation](#))

Usual value ranges

- P-0-2963, Pressure controller P-gain 1 positive = 2 ... 6 s⁻¹
- P-0-2964, Pressure controller P-gain 1 negative = 2 ... 6 s⁻¹
- P-0-2969, Pressure controller pos. Factor for D-component, parallel = 0.15 ... 0.5
- P-0-2970, Pressure controller neg. factor for D-component, parallel = 0.2 ... 0.5
- P-0-2971, Pressure controller time constant swivel angle feedback = 0.03 ... 0.09 s

2.4 Operating principle / controller optimization in cascade structure

In the cascade structure the output of the pressure controller is compared with the output of swivel angle command value processing. The valid value is then handed over to the swivel angle controller as command value.

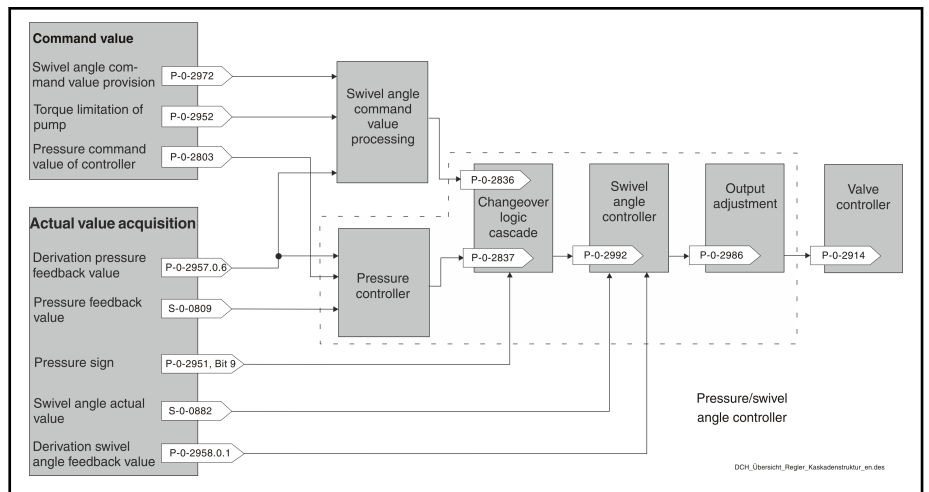


Fig. 2-8: Overview of controllers in cascade structure

The pressure controller in the parallel structure is structured as follows:

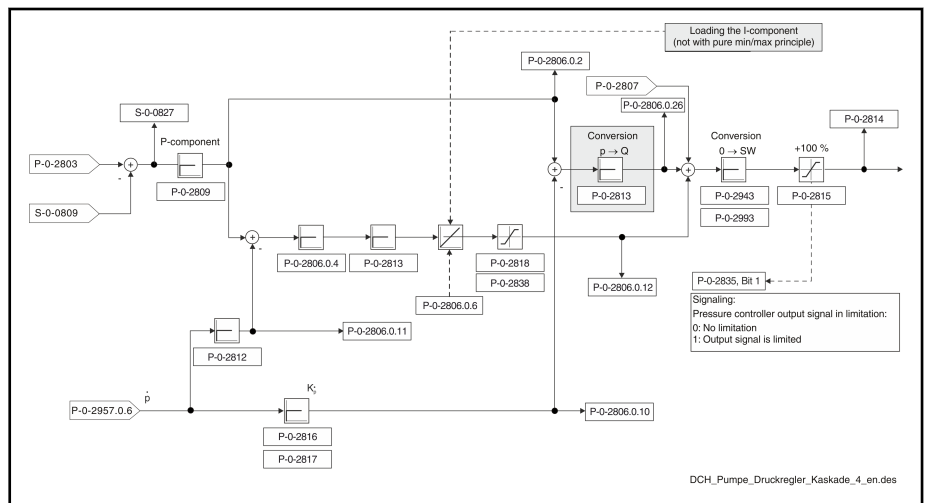


Fig. 2-9: Pressure controller structure of the pump in cascade structure

In the cascade structure, the pressure controller consists of a PID-controller. In addition, the derivative of the actual value is fed back to the integrator. This feedback can additionally reduce overshoots that result from "excessively high values" of the integrator. For this a suitable value has to be entered in "P-0-2812, Feedback of actual pressure value derivative to integrator". In the cascade structure, the pressure controller has also to be set to the current dead volume. Parameter "P-0-2813, Pressure controller dead volume" is available for this. In this parameter you have to enter the current dead volume. Similar to an increase in the P-gain "P-0-2809, Pressure controller P-gain, cascade structure", an increase in the dead volume results in a higher overall gain of the pressure controller. To eliminate disturbance during pressure control, an integrator is used in this pressure controller. And the integration time "P-0-2806.0.4, Pressure controller integration time constant" should approximately correspond to the swivel time of the pump from minimum limit stop to maximum limit stop. If the integrator value is very unstable, since, for example, the actual pressure value has a large noise component, then "P-0-2806.0.6, Pressure controller integrator accuracy window" may be activated (value about 1 to 5 bar). The integrator is then stopped within the accuracy window. The limitation of the integrator should be set to the actual displacement of the pump. In the condition as supplied, the limitation is set to the nominal flow of the pump (+100 % or -100 % swivel angle). If the pump

Selection of controller structure

has a limit stop for the upper and/or lower limitation, the corresponding value should be entered here. "P-0-2950, Bit 10, Pump controller control word" activates manual limiting of the integrator. In pressure control, the component of "P-0-2806.0.12, Output pump pressure controller I-part" shows the current disturbance variable, i.e. the component roughly corresponds to the displaced flow. The D-component can additionally be used to dampen the characteristics. Since the D-component is, however, required only for a part of the systems in the field, it is deactivated in the factory settings.

Setting the PID pressure controller

Example 1:

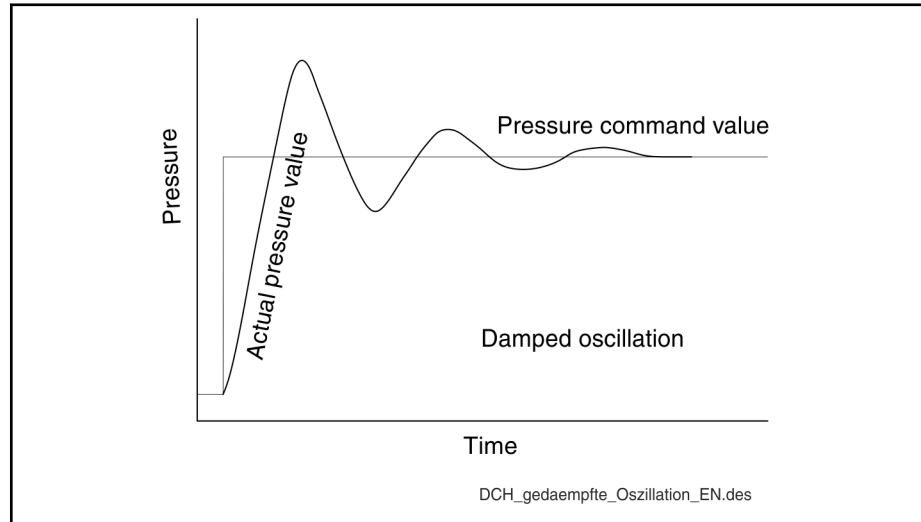


Fig. 2-10: Damped oscillation

Step	Behavior / result	Measure
1	Overshoots (damped oscillation)	Check value for dead volume (P-0-2813) and, if necessary, correct
2	Overshoots (damped oscillation)	Increase P-0-2812 in order to reduce first overshoots
3	The actual pressure value still overshoots	Reduce P-gain (P-0-2809) and, if necessary, increase D-component

Tab. 2-6: Measures against overshoots

Example 2:

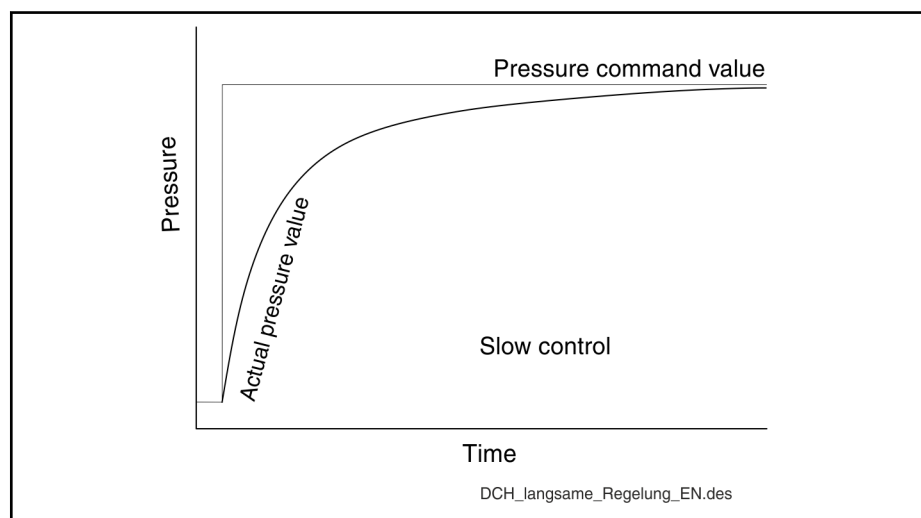


Fig. 2-11: Slow control

Step	Behavior / result	Measure
1	Slow reaction	Check value for dead volume (P-0-2813) and, if necessary, correct
2	Reaction still slow	Increase P-gain (P-0-2809) and, if necessary, reduce D-component
3	Reaction still slow	Reduce integration time (P-0-2806.0.4)

Tab. 2-7: Measures against slow reaction

Example 3:

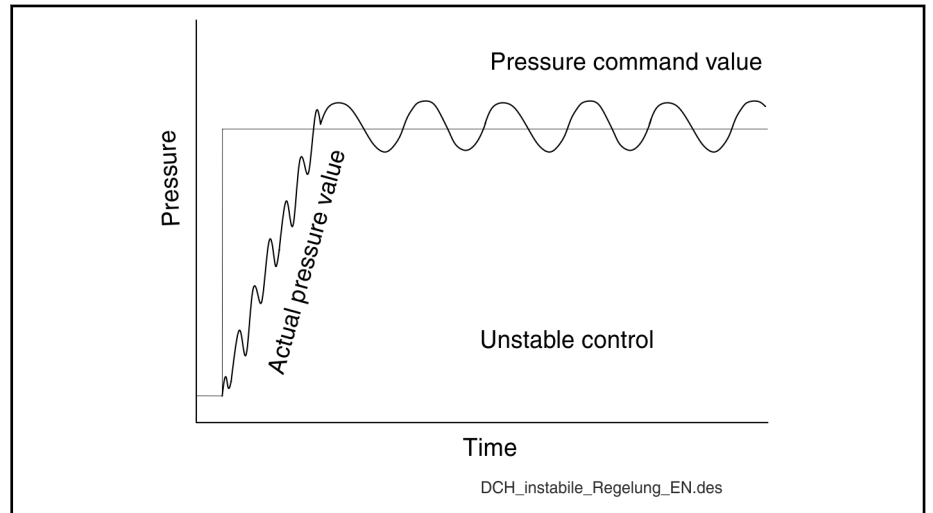


Fig. 2-12: Unstable control

Step	Behavior / result	Measure
1	Fast, but unstable reaction	Check value for dead volume (P-0-2813) and, if necessary, correct
2		Reduce P-gain (P-0-2809) and, if necessary, reduce D-component
3		Increase integration time (P-0-2806.0.4)
4		Reduce parameter for the feedback of the derivative of the actual pressure value (P-0-2812)

Tab. 2-8: Measures against unstable reaction

Example 4:

Selection of controller structure

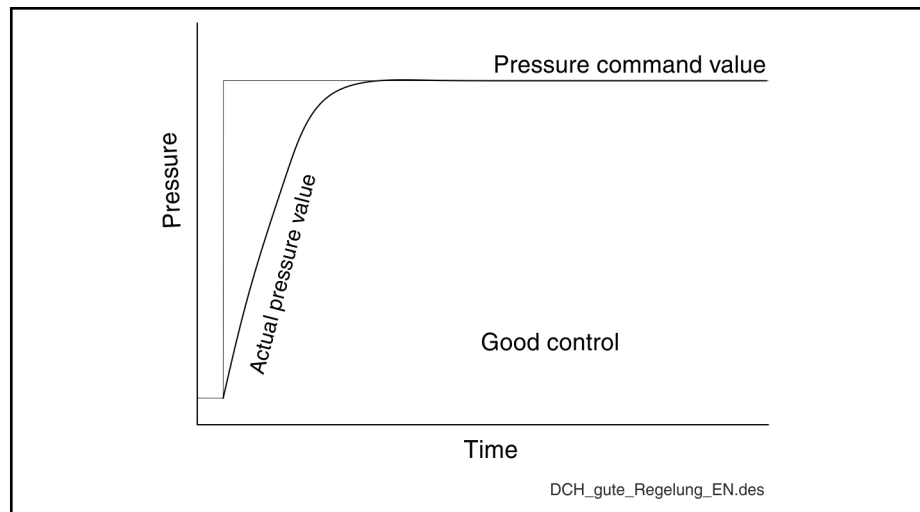


Fig. 2-13: Good control

If the control behavior is good, no measures need to be taken.

Changeover pressure/swivel angle controller

Switching between pressure/swivel angle controller can be based on various conditions: For switching from swivel angle → pressure, the condition "min/max value and switch-on threshold" is usually used. For the changeover from pressure → swivel angle, the "min/max value principle" is a precondition. Moreover, the switch-on and switch-off thresholds are usually referred to the pressure differential (reference of absolute thresholds to control difference). Alternatively, it is possible to activate the integrator continuously, and in this case, to use a pure min/max value principle for the changeover logic. The advantage of this variant is that in this case the integrator needs not to be initialized for the changeover. For this variant you have to select "min/max value principle with active integrator".

Initializing the integrator (not with selection "min/max value principle with active integrator")

For changing over to pressure control it may be necessary to initialize the integrator with a certain value. In this case, the integrator of the pressure controller is set to a certain value. The value is calculated so that the output of the pressure controller at the time of switching over is either equal to or slightly lower than the current swivel angle command value. This can be controlled via threshold 1 and threshold 2. If the thresholds are set to high values (>10000 bar/s), the output of the pressure controller corresponds to the current swivel angle command value. In the case of lower values the pressure controller output starts with a lower value, which may reduce any overshoots in the transition from swivel angle to pressure control.

Variable-speed operation

In the pressure controller the controller output is converted from l/min into % of swivel angle. The current drive speed is taken into account in this conversion. The speed is therefore automatically adapted. This is sufficient for most applications.

Usual value ranges

- P-0-2809, Pressure controller P-gain, cascade structure = 5 ... 30 s⁻¹
- P-0-2816, Pressure controller positive factor for D-component, cascade = 0 ... 0.3 s
- P-0-2817, Pressure controller negative factor for D-component, cascade = 0 ... 0.3 s
- P-0-2806.0.4, Pressure controller integration time constant = 100 ... 600 ms
- P-0-2806.0.6, Pressure controller integrator accuracy window = 0 ... 3 bar

- P-0-2812, Feedback of actual pressure value derivative to integrator = 0.0 ... 0.5 bar
- P-0-2806.0.15, Pressure controller preload integrator, threshold 1 = 500 ... 2000 bar/s (> 10000 bar/s threshold not active)
- P-0-2806.0.16, Pressure controller preload integrator, threshold 2 = 1500 ... 6000 bar/s (> 11000 bar/s threshold not active)
- P-0-2806.0.17, Pressure controller preload, pressure change filter time = 0 ... 20 ms
- P-0-2852.0.4 Pressure controller switch-on threshold, absolute = 10 ... 70 bar
- P-0-2852.0.7, Pressure controller switch-off threshold, absolute = 15 ... 100 bar
- P-0-2852.0.15, Pump changeover logic ramp time, cascade = 0 ms

3 Variable-speed operation for pump controls in HydraulicDrive

3.1 Variable-speed operation

For some products with pump control we offer the order option “variable-speed operation”. Variable-speed operation is a technology function, which is executed in the drive-internal MLD. For reasons of simplification, these systems are collectively referred to as “pump controllers” in the following chapters.

3.2 Activating the technology function of variable-speed operation for pump control (VT-HPC)

For activating the additional function in the VT-HPC the following step has to be carried out:

1. Switch the VT-HPC off and insert the SD card with the technology function into the memory card slot of the HPC. When being switched on, the VT-HPC reads the data from the SD card and recognizes that the technology function is to be activated. The status LED "MS" starts to blink alternately red and green. After the technology function was activated, the VT-HPC briefly switches all LEDs off and reboots.

The technology function is then ready for operation.

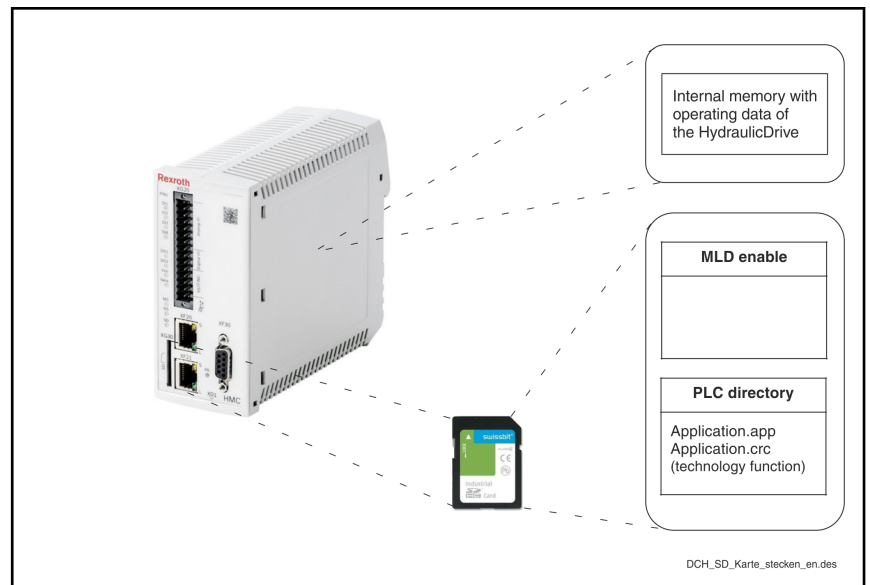


Fig. 3-1: Inserting the SD card

2. Check for the correct version in the “Project information” dialog

Variable-speed operation for pump controls in HydraulicDrive

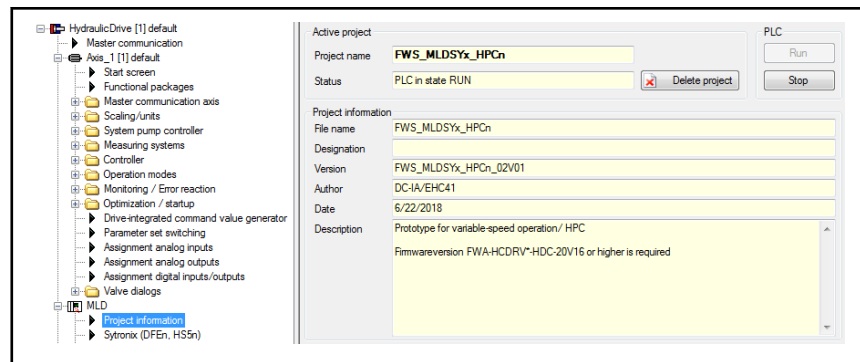


Fig. 3-2: Project information dialog

3.3 Updating the technology function of variable-speed operation for pump control (SY(H)DFED)

For SY(H)DFED systems the additional function “variable-speed operation” is activated in the factory, if the selection “Additional function controller: N “For variable-speed operation”” was selected in the order. The software for variable-speed operation is already installed when the SY(H)DFED system is manufactured. If the software for variable-speed has to be updated, follow the steps below:



While updating is carried out or the additional function is being re-loaded, all parameters of the additional function (MLD parameters) are set to their default values.

1. For updating the additional function you require a parameter file. This parameter file is made available by Bosch Rexroth (contact: support.nc-systems@boschrexroth.de).
2. Switch to the parameterization level “PM”.
3. Open the dialog MLD → Project information.

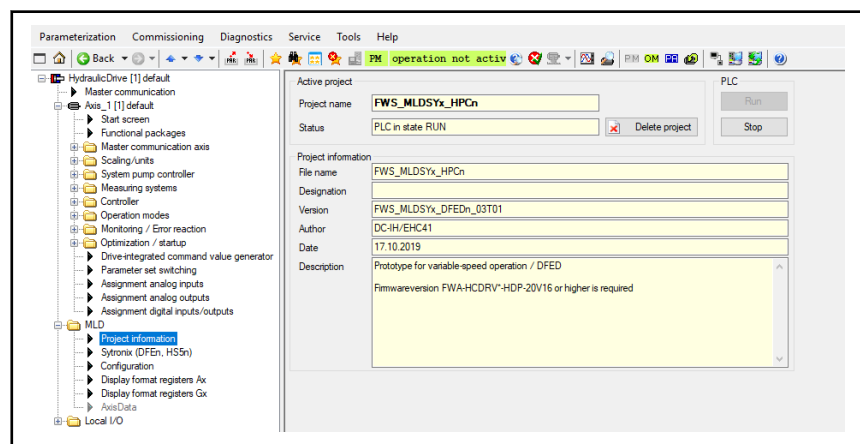


Fig. 3-3: Project information dialog

4. Select the button “Delete project”.
5. Load the parameter file with the software for the additional function. To this end, click the button “Load parameters” and select the parameter file for carrying out the update. Start the download by clicking the “Load” button.

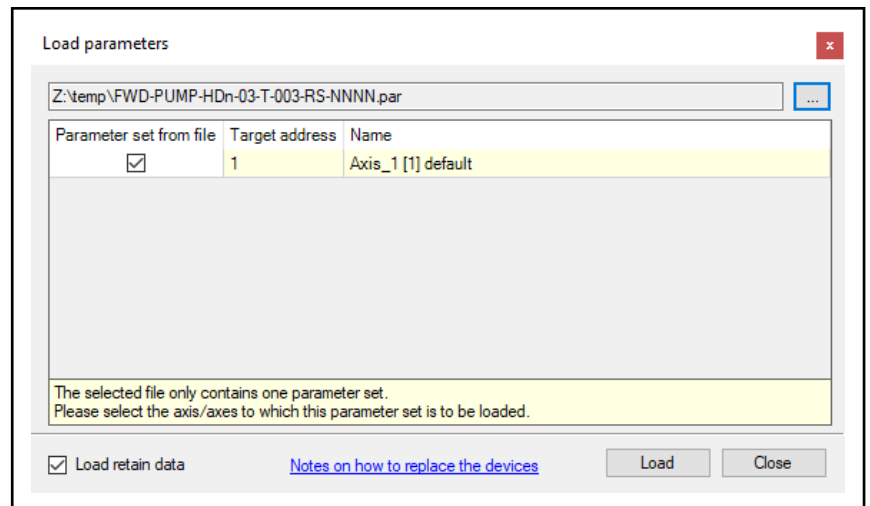


Fig. 3-4: Loading parameters



In the dialog “Load parameters” you have to tick the option “Load retain data”. Otherwise, this may result in invalid parameters.



After the parameter file was loaded, the new software is copied to the internal flash. This may take up to one minute. During copying, bit 8 in P-0-1350 is set to “1”. Only go on with step 6 when bit 8 in P-0-1350 is “0”.

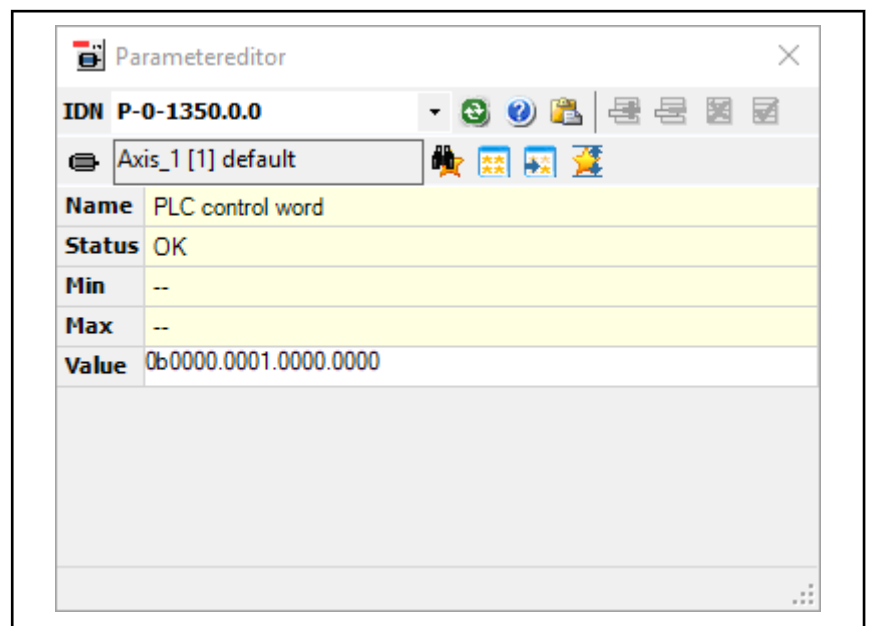


Fig. 3-5: Check of P-0-1350

- After step 5 carry out a power reset → the new software is loaded automatically.



The software for variable-speed operation **cannot** be installed on SY(H)DFED systems that were ordered without the additional function “for variable-speed operation”. These systems cannot be retrofitted. On these systems, the pilot valve VT-DFFD has to be replaced if variable-speed operation is required.



If the additional option “variable-speed operation” has been uploaded to SYDFED or HS5E systems, the task load is higher. Certain functions (e.g. command call-ups for switching between PM and OM, activation of the easy startup mode, ...) have a longer run-time.

3.4 Loading the basic parameters for the additional function “variable-speed operation”

The basic parameters for the additional function “variable-speed operation” can be loaded via the dialog MLD → Configuration using the PLC command “RESET cold”.

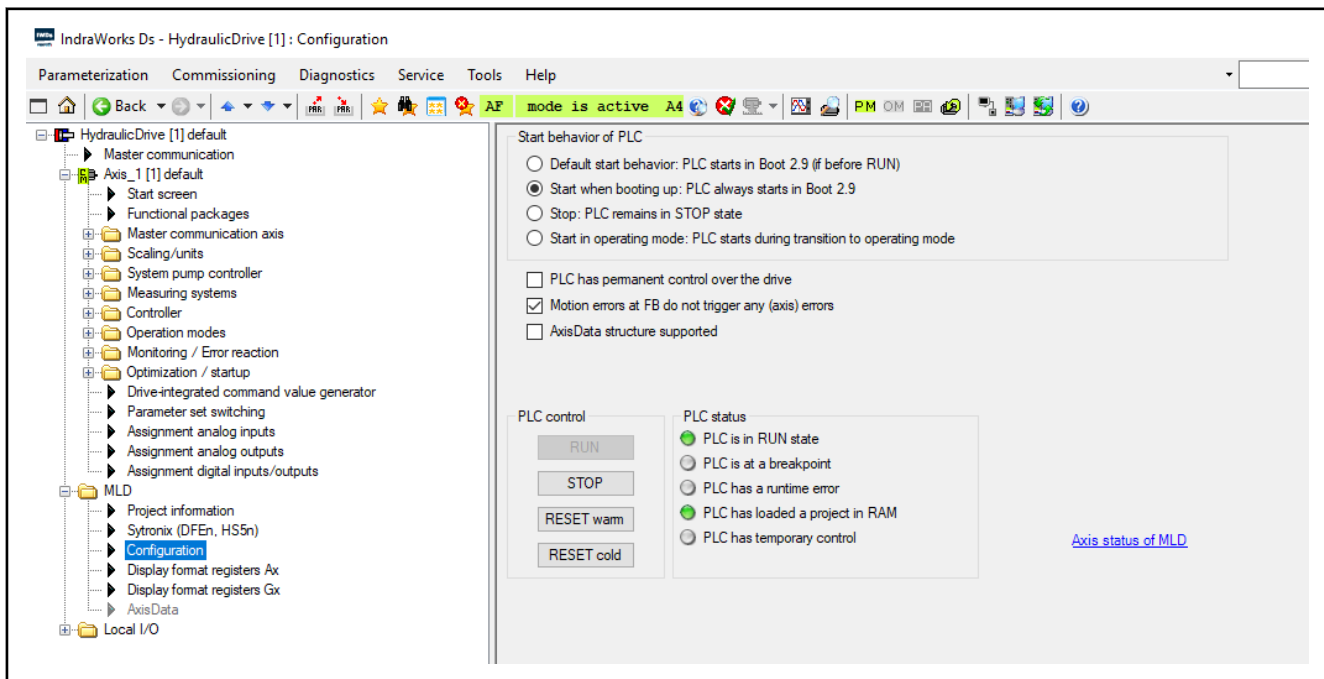


Fig. 3-6: PLC command “RESET cold”

The parameters of the additional function are within the parameter range of P-0-13xx. However, when the standard dialog “Load basic parameters” is selected in IndraWorks, these parameters are not reset to factory settings.

3.5 Functional description of real-time mode

The real-time mode is used for machines that do not feature cyclic operation. In the real-time mode, the optimum drive speed is calculated at all times and compared to the current speed. If a difference is detected between the two speeds, the setpoint speed is raised or lowered as required. As against the teach mode or the pump controller with fixed speed, in the real-time mode the speed adjustment in the case of major changes in flows also depends on the dynamics of the electric drive. To compensate for these lower dynamics, at least partially, various boost functions can be activated. All command values can be fed forward in analog form or via field bus.

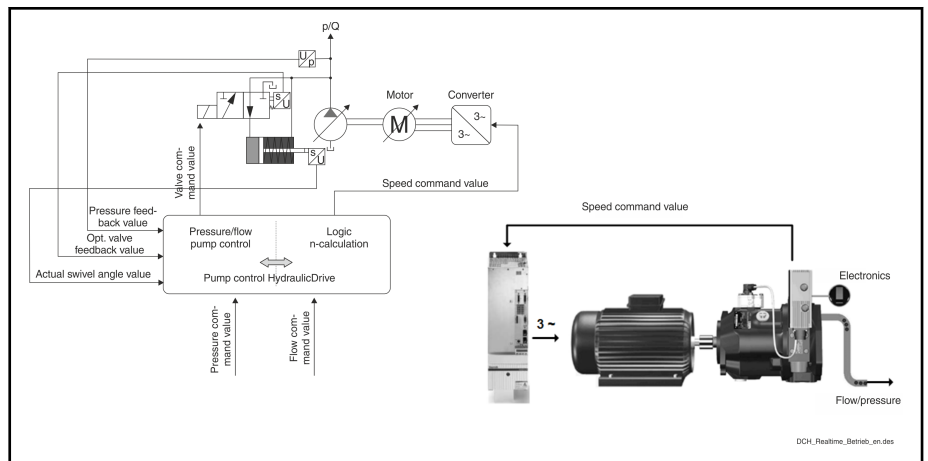


Fig. 3-7: Real-time mode

The optimum drive speed is calculated from the set optimum swivel angle while motor overloading is to be avoided. The drive speed thus calculated is then considered in swivel angle command value processing and in pressure controller adaptation.

3.6 Controlling variable-speed operation

Variable-speed operation is activated by means of bit 0 of control word DFE_n/HS5_n (P-0-1370). Withdrawing bit 0 deactivates variable-speed operation, and the electric motor then runs again at constant maximum speed (P-0-2987). The selection between real-time (0) or teach mode (1) is made using bit 5.

All bits can optionally be changed via digital inputs or via the field bus interface.

Bit	Designation/function
P-0-1370, bit 0	Variable-speed operation ON (1) / OFF (0)
P-0-1370, bit 4	Manual speed ON (1) / OFF (0)
P-0-1370, bit 8	Boost function pressure control deviation ON (1) / OFF (0)
P-0-1370, bit 9	Boost function actual swivel angle value change ON (1) / OFF (0)
P-0-1370, bit 10	Boost function swivel angle control deviation ON (1) / OFF (0)

Tab. 3-1: Control word DFE_n/HS5_n P-0-1370

The current status of variable-speed operation can be queried via the status word of DFE_n/HS5_n, P-0-1282 in diagnostics. Warnings and erroneous states can be queried using P-0-1281 / P-0-1280.

Bit	False	TRUE:
P-0-1282, bit 0	Variable-speed operation inactive	Variable-speed operation active
P-0-1282, bit 1	Real-time mode active	Teach mode active
P-0-1282, bit 2	No warning active	At least one warning active
P-0-1282, bit 3	No error active	At least one error active

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Bit	False	TRUE:
P-0-1282, bit 7	Boost function inactive	Boost function active
P-0-1282, bit 8	Ramp inactive	Ramp active
P-0-1282, bit 11	Speed masking inactive	Speed masking active
P-0-1282, bit 12	Derating inactive	Derating active
P-0-1282, bit 13	Manual speed inactive	Manual speed active
P-0-1282, bit 14	Boost offset inactive	Boost offset active
P-0-1282, bit 16	Standby (partial load) inactive	Standby (partial load) active
P-0-1282, bit 17	Boost function swivel angle control error inactive	Boost function swivel angle control error active
P-0-1282, bit 18	Boost function actual swivel angle value change inactive	Boost function actual swivel angle value change active
P-0-1282, bit 19	Boost function swivel angle control deviation inactive	Boost function swivel angle control deviation active
P-0-1282, bit 21	Current drive speed outside field weakening range	Current drive speed within field weakening range
P-0-1282, bit 23	Current drive speed externally provided	Drive speed internally calculated
P-0-1282, bit 24	Pressure controller adaptation (parallel structure) TechFunc not active	Pressure controller adaptation (parallel structure) TechFunc active

Tab. 3-2: Status word DFE_n/HS5_n P-0-1282

Condition	Warning Code	P-0-1281 Bit	Error Code	P-0-1280 Bit	Text
AF = 0	B5201	0			Variable-speed operation inactive
P-0-1376 = 0	B5202	1			P-0-1376 = 0: Invalid input value for speed ramp up
P-0-1377 = 0	B5203	2			P-0-1377 = 0: Invalid input value for speed ramp down
P-0-1379 = 0	B5205	4			P-0-1379 = 0: Threshold for pressure diff. boost "0" leads to permanently active boost function
P-0-1311 invalid	B5207	6	D5207	6	Configuration parameter entered in list P-0-1311 is invalid
P-0-1311 [11] = 0	B5208	7			P-0-1311 [11] = 0: Threshold for boost swa(diff) "0" leads to permanently active boost function
P-0-1311 [9] = 0	B5209	8			P-0-1311 [9] = 0: Threshold for boost swa(act) change "0" leads to permanently active boost function
P-0-1320 > P-0-2987	B5103	13	D5103	13	P-0-1320 > P-0-2987: Minimum speed exceeds maximum drive speed
P-0-1328 - P-0-1329 < P-0-1320	B5106	15			P-0-1328 - P-0-1329 < P-0-1320: Lower suppression window limit falls below minimum drive speed

Condition	Warning Code	P-0-1281 Bit	Error Code	P-0-1280 Bit	Text
P-0-1328 + P-0-1329 < P-0-2987	B5107	16			P-0-1328 + P-0-1329 < P-0-2987: Upper suppression window limit exceeds maximum drive speed
P-0-1320 < P-0-1385	B5301	20	D5301	20	P-0-1320 < P-0-1385: Minimum partial speed load is higher than minimum drive speed
P-0-2944 > P-0-1321	B5302	21			P-0-2944 > P-0-1321: Nominal speed is greater than synchronous speed
Wrong firmware version	B5313	28	D5313	28	Error in version check - firmware is too old for this additional Sytronix function
P-0-1321 > P-0-2987	B5315	30	D5315	30	P-0-1321 > P-0-2987: Synchronous rotation speed > Maximum drive speed

Tab. 3-3: Warning and error word DFEn/HS5n P-0-1281 / P-0-1280

Speed command converter P-0-1270

In variable-speed operation, the speed command value for the converter is output in parameter P-0-1270. This speed command value can be transmitted to the converter via field bus communication or via an analog output. The example below shows the configuration of the analog output for analog speed command value transmission.

Parameter IDN	Designation	Value range	Unit
P-0-1270	Speed command converter	0.0 - 6000.0	1/min

Tab. 3-4: Speed command converter

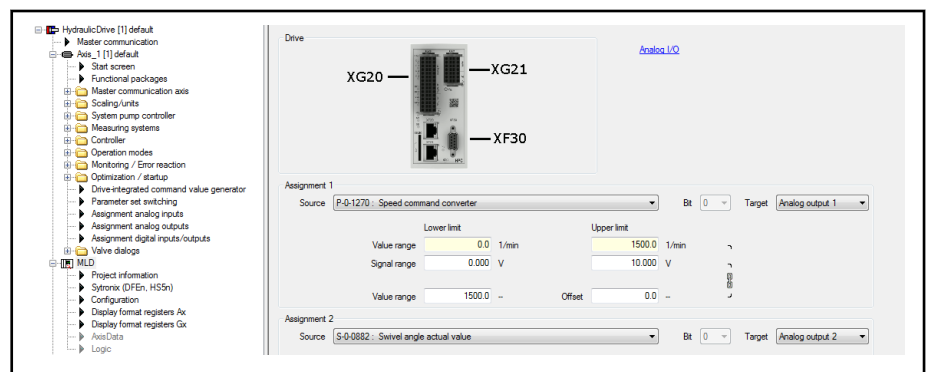


Fig. 3-8: Output of P-0-1270 as analog speed command value for the converter

With analog speed command value provision the analog input in the converter has to be configured to the same speed value.

In addition, via offset and the signal range, the speed value that arrives in the converter can be matched with the input value that is issued by the pump controller. This allows drifts in the value ranges to be compensated for that are caused by analog signal transmission.

3.7 Parameters pertinent to speed calculation

3.7.1 General information

The individual parameters described in this chapter can be accessed via the overview dialog of variable-speed operation "Sytronix" (DFEn, HS5n). The

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links in this dialog lead to further subdialogs, in which you can configure details and supplementary functions of variable-speed operation. With the buttons "Next" and "Previous" you can show or hide extended settings in the parameterization dialogs.

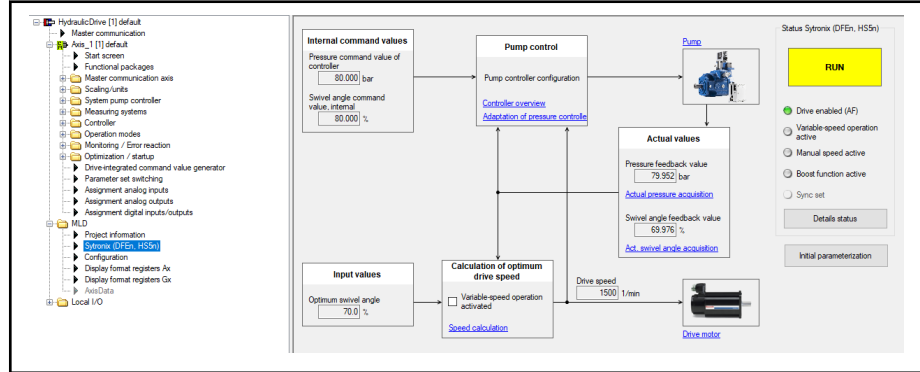


Fig. 3-9: Overview dialog of variable-speed operation "Sytronix" (DFEn, HS5n) in the structure tree

3.7.2 Parameters of the motor

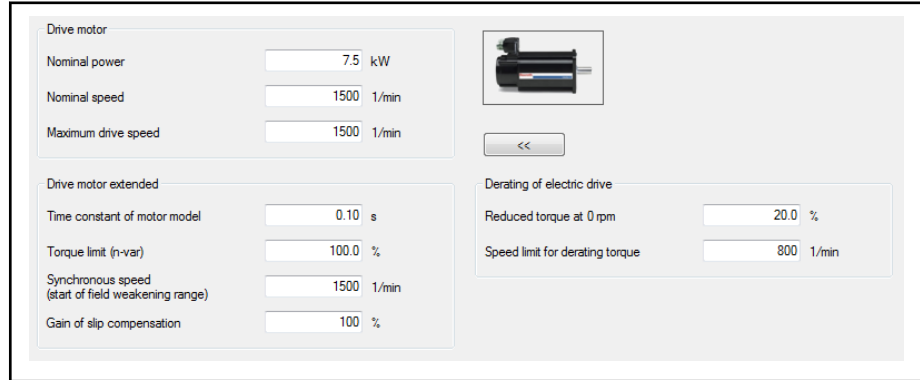


Fig. 3-10: Drive motor dialog

Nominal power motor P-0-1324

The nominal motor power is required for various internal calculations, e.g. loading of the asynchronous motor, by the pump controller. The nominal power can be read from the nameplate.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1324	Nominal power motor	7.5	0.1 - 200.0	kW

Tab. 3-5: Nominal motor power



In version 02V01, parameter P-0-1381 was used for the nominal power. As of version 04V01, P-0-1381 is used for indicating the TechFunc identifier. In older IndraWorks versions, an incorrect parameter is therefore displayed in the dialog.

Motor nominal speed P-0-2944

To be able to calculate the slip characteristic curve of the asynchronous motor the nominal speed at nominal loading of the asynchronous motor has to be known. The nominal speed can be read from the nameplate of the asynchronous motor.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-2944	Motor nominal speed	1500	100 - 6000	1/min

Tab. 3-6: Motor nominal speed

Maximum drive speed P-0-2987 The speed can be scaled using parameter "P-0-2987, Maximum drive speed".

Parameter IDN	Designation	Default value	Value range	Unit
P-0-2987	Maximum drive speed	1500	100 - 6000	1/min

Tab. 3-7: Maximum drive speed

Time constant of motor model P-0-1371 To compensate for the following error (dynamic error) of an electric motor, a motor model is activated for the variable-speed pump control. This motor model calculates the speed deviation of the motor when the speed changes and considers this error in the calculation of the speed command value. The actual speed value calculated by the motor model is written to parameter "P-0-2993, Current drive speed" to ensure a correct calculation of the internal swivel angle command value.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1371	Time constant motor model	0.1	0.002 - 10.000	s

Tab. 3-8: Time constant motor model

Motor torque limitation (n-var) P-0-1383 When the speed is reduced while the hydraulic power remains unchanged, the current motor torque is accordingly larger. If, while the speed is reduced, the motor is loaded with a torque higher than the nominal torque, the power loss increases significantly in the asynchronous motor. By means of parameter P-0-1383 the maximum torque in % referred to the nominal torque of the motor can be provided for variable-speed operation. Given the drive motor has its optimum efficiency at 80 % of the nominal torque, the torque limitation of the drive motor can be set to 80 %, if the motor is to be operated within its optimum efficiency range. If, however, the motor is to be subjected to up to a 1.5 fold overload, the value has to be set to 150 %.

Torque limitation can even be limited to a value of less than 100 %, if, due to an additional pump at the motor shaft (e.g. cooling/filtration pump), it is impossible to use the full drive power of the motor for the control pump.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1383	Torque limitation motor	100.0	1.0 - 350.0	%

Tab. 3-9: Torque limitation motor

Derating of electric drive P-0-1326, P-0-1327 Asynchronous motors are usually operated with an integrated fan. As the speed is reduced, the cooling capacity of the integrated fan falls accordingly. This results in the fact that at continuingly low speeds the nominal torque cannot be maintained since this would excessively overheat the motor.

In addition, on some motors, especially asynchronous motors, the energy efficiency at nominal torque falls at lower speeds so that it would be energetically more favorable to operate the motor at slightly higher speed and lower torque. In this case, derating can be activated at lower speeds. The speed limit, at which derating is to be activated can be set by means of parameter P-0-1327. Parameter P-0-1326 can be used to enter the theoretical torque at speed "zero". This value is to be entered in % of the nominal torque. Should

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an external fan be used for the asynchronous motor or derating be deactivated, the value for P-0-1326 can be set to 100 %.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1326	Reduced derating torque value at 0 rpm	100	0.0 - 100.0	%
P-0-1327	Speed limit for derating torque	800	1 - 6000	1/min

Tab. 3-10: Derating

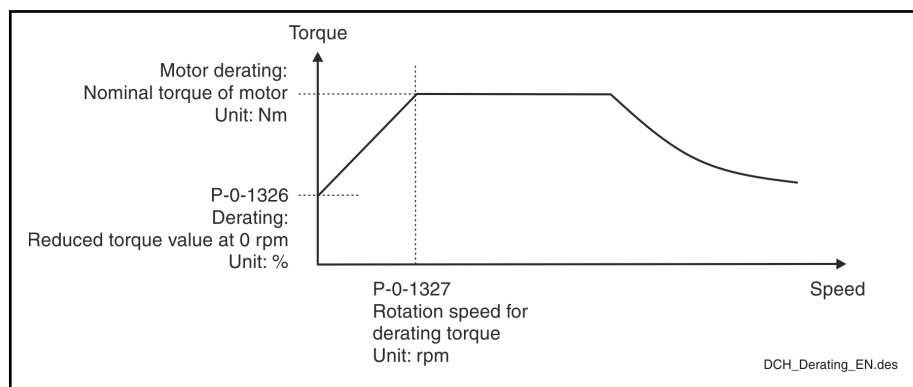


Fig. 3-11: Derating

Field-weakening operation

For some applications it may be useful to briefly activate higher speeds than the synchronous speed of the motor. For this the asynchronous motor is operated in the field-weakening range. In this context it must be noted that in the field-weakening range the available motor torque is reduced while the power loss increases. Moreover, care must be taken that the permissible maximum speeds of the pump and the motor are not exceeded. The course of nominal torque M_{nom} of an asynchronous motor in the speed range from 0 to 2100 1/min is shown with a solid line in [fig. 3-12 "Example of field-weakening operation" on page 25](#). The dotted line represents the course of torque limitation that is required when derating and field-weakening operation are active to protect the motor against overloading and stalling.

For activating field-weakening operation of the motor, the maximum drive speed P-0-2987 has to be greater than the synchronous speed P-0-1321 as shown in [fig. 3-12 "Example of field-weakening operation" on page 25](#). In the converter the corresponding settings have to be made too in order that the selected maximum drive speed can also be provided by the converter. Further notes can be found in the operating instructions of the converter.

Synchronous speed P-0-1321

Parameter P-0-1321 specifies the synchronous speed of the drive. The synchronous speed is determined by the mains frequency and the number of terminal pairs. With 50 Hz mains and a 4-pole motor, the synchronous speed is 1500 1/min.

To operate a motor exclusively within the basic speed range, the synchronous speed P-0-1321 and the maximum drive speed P-0-2987 have to have the same value. Within the basic speed range from 0 to synchronous rotation speed the torque limitation motor (n-var) P-0-1383 is used for calculating the speed.

If the maximum drive speed P-0-2987 is set higher than the synchronous rotation speed P-0-1321, the motor can be operated within the basic speed range and field weakening range. For speeds above the synchronous speed in field-weakening operation, the permissible torque can be limited with parameter P-0-1384 in order to prevent the motor from overloading.



When variable-speed operation is not active (P-0-1370, bit 0 = 0) or an error is detected and variable-speed operation is therefore exited, the synchronous speed is output as command speed.

**Permissible torque at max. speed
P-0-1384**

In order to activate torque limitation within the field weakening range as shown in figure [fig. 3-12 "Example of field-weakening operation"](#) on page 25, the permissible torque at maximum speed P-0-1384 has to be less than the motor torque limitation P-0-1383.

The limitation is realized as illustrated in the graphic with the help of exemplary values with $1/n^2$ of 80 % at 1500 1/min to 50 % at 2100 1/min.

Parameters P-0-1383 and P-0-1384 are percentage values and refer to the nominal torque M_{nom} of the asynchronous motor.

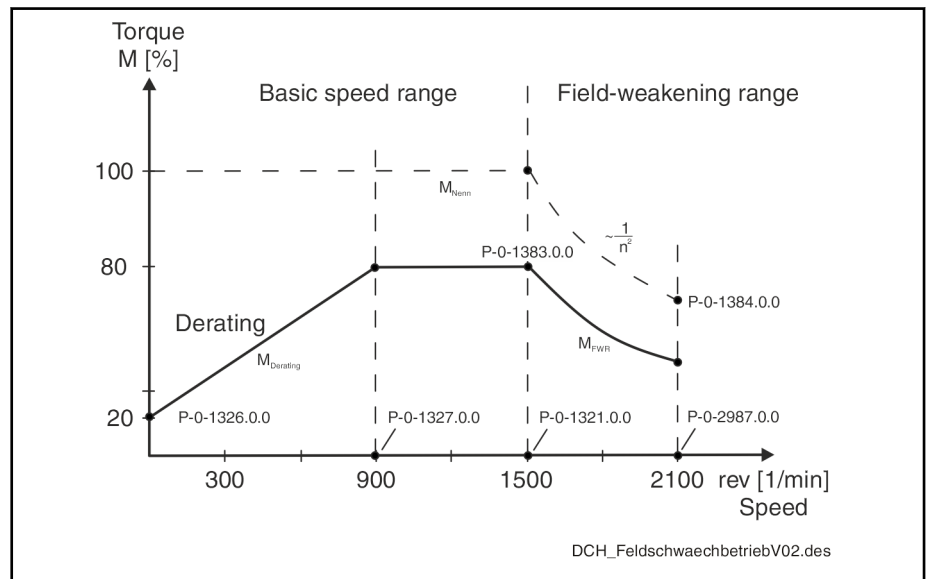


Fig. 3-12: Example of field-weakening operation

P-0-1327 Speed limit for derating torque - 800 [1/min]	P-0-1326 Reduced derating torque value at 0 rpm 20 %
P-0-1321 Synchronous speed -1500 [1/min]	P-1383 Motor torque limitation - 150 [%]
P-0-2987 Maximum drive speed - 2100 [1/min]	P-0-1384 Permissible torque at max. speed 110%
$M_{Nem}[Nm] = \frac{P_{Nem}[kW] \cdot 9550}{n_{Nem}[1/min]}$	$M_{FWR}[Nm] = \frac{P_{Nem}[kW] \cdot 9550}{n[1/min]}$

Tab. 3-11: Example of field-weakening operation

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1321	Synchronous rotation speed	1500	1 - 6000	1/min
P-0-1384	Permissible torque at max. speed	100.0	0.0 - 100	%

Tab. 3-12: Field-weakening operation

**Gain slip compensation P-0-1311
[10]**

Since the slip of the asynchronous motor has an effect on the actual displacement, the pump controller features an additional function to compensate for the slip of an asynchronous motor. The gain of this slip compensation can

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be adapted by means of parameter P-0-1311 [10]. If the converter features integrated slip compensation this value has to be reduced or set to 0.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1311 [10]	Gain slip compensation	100.0	0.0 - 150.0	%

Tab. 3-13: Gain of slip compensation

3.7.3 Parameters of speed calculation

Fig. 3-13: Speed calculation dialog

Minimum speed (P-0-1320 / Minimum speed, partial load P-0-1385 / threshold, from which partial load is active, referred to nominal power P-0-1311 [4])

Parameter P-0-1320 can be used to determine the minimum speed. For drives, which are operated with U/f characteristic curve, the manufacturers specify a minimum speed, up to which the nominal torque is briefly available. For partial load operation of the machine, a second, minimum partial load speed P-0-1385 can be specified. This speed limit is active, when the torque in the cycle is below 3 % (P-0-1311 [4]) of the nominal torque. Due to the second minimum speed it is, for example, possible to reduce the magnetization of the asynchronous motor in partial load operation of the machine in order to reduce power losses. More details can be found in the data sheet of the motor and converter manufacturer.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1320	Minimum rotation speed	300	50 - 2000	1/min
P-0-1385	Minimum speed stand-by	250	50 - 2000	1/min
P-0-1311 [4]	Power threshold standby active	3	0 - 100	%

Tab. 3-14: Minimum rotation speed

Ramp time / speed adjustment (P-0-1376, P-0-1377)

The ramp slope for speed ramps can be adjusted by means of parameters P-0-1376 and P-0-1377. The ramp slope is set in 1/min/s. The acceleration time should always be determined taking into account the possible minimum

acceleration time of the drive. The deceleration time should be selected so that the motor is not actively decelerated and thus does not regenerate energy.

In order not to affect the control behavior of the pump controller with the speed adjustment, a delay (P-0-1311 [7]) and a tolerance threshold can be set for the speed adjustment (P-0-1311 [1]).

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1376	Speed ramp slope, accelerating	1875	0 - 10000	1/min/s
P-0-1377	Speed ramp slope, decelerating	650	0 - -10000	1/min/s
P-0-1311 [7]	Delay deceleration ramp	0.000	0.000 - 10.000	s
P-0-1311 [1]	Speed lowering threshold	30	0 - 500	1/min

Tab. 3-15: Ramp time / speed adjustment

Filter for rounding the speed command value (P-0-1311 [2], P-0-1311 [3])

Due to the noise on the analog actual values of swivel angle and pressure, oscillations may occur on the speed command value. This oscillation may be dampened with the help of a filter for rounding the speed command value.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1311 [2]	PT1 ramp up (filter time constant for rounding the increasing speed command value)	0.008	0.002 - 1.000	s
P-0-1311 [3]	PT1 ramp down (filter time constant for rounding the falling speed command value)	0.2	0.002 - 1.000	s

Tab. 3-16: Filter for rounding the speed command value

Speed suppression window (P-0-1328, P-0-1329)

In order to minimize any possibly existing points of resonance a suppression window may be defined. Speed command values within the suppression window are not continuously activated. If the optimized speed is within the defined window, the upper limit of the speed suppression window is to be aimed at.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1328	Speed suppression window center	0	0 - 6000	1/min
P-0-1329	Speed suppression window	0	0 - 1000	1/min

Tab. 3-17: Speed suppression window

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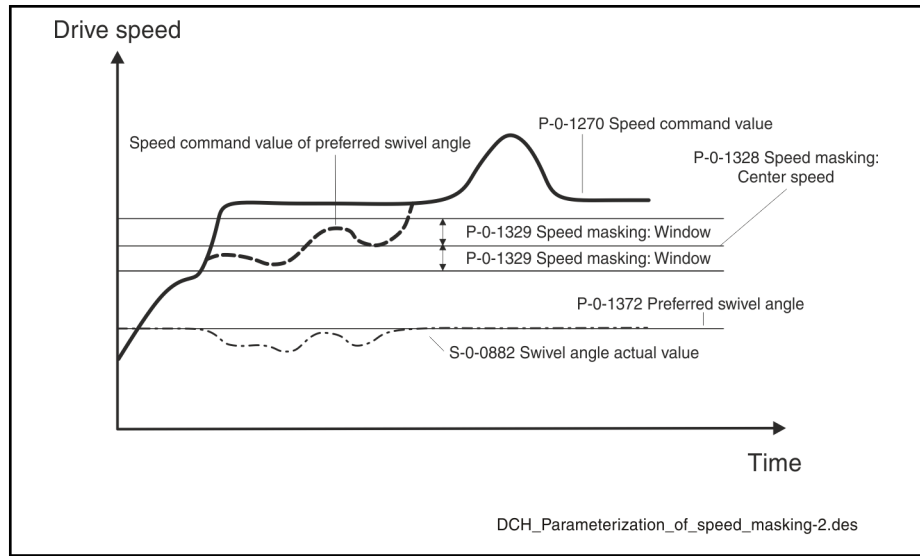


Fig. 3-14: Parameterization of speed suppression window

Manual speed selection value (P-0-1370, P-0-1316, P-0-1317)

The real-time mode offers two possibilities of influencing the speed manually by entering values. While variable-speed operation is active (P-0-1370, bit 0 set), a further minimum speed may be set via parameter P-0-1316. This function can be used shortly before a large flow requirement, e.g. start of a cylinder after standby, to raise the speed and thus to significantly increase the dynamics of the pump controller.

When variable-speed operation is switched off (P-0-1370 bit 0 cleared), a manual speed can be set by means of P-0-1317, e.g. for the setup mode.

In the factory settings, the value 0 rpm is entered for parameters P-0-1316 and P-0-1317.

The manual provision of speed values can be activated via bit 4 of parameter P-0-1370. This bit can be activated via both the field bus interface and a freely configurable digital input. In the factory settings, bit 4 for the manual speed selection is deactivated. At a value of 0 rpm, manual speed selection is also deactivated, irrespective of the state of bit 4.

Bit	Designation/function
P-0-1370, bit 0	Variable-speed operation ON (1) / OFF (0)
P-0-1370, bit 4	Manual speed ON (1) / OFF (0)

Tab. 3-18: Control word DFE/HS5n P-0-1370

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1316	Manual min. rotation speed - real-time on	0	10 - 6000	1/min
P-0-1317	Manual speed - real-time off	0	10 - 6000	1/min

Tab. 3-19: Manual speed input

Boost functions and feedforward of speed command value (P-0-1317, P-0-1311 [8], P-0-1311 [9], P-0-1311 [11], P-0-1311 [12], P-0-1378, P-0-1379)

In real-time operation, the boost functions can be used to enhance dynamics when the system is turned up. While boost is activated, the speed command value is raised according to the maximum speed ramp. For this, the boost functions evaluate various process variables in pressure and swivel angle control. The individual boost functions can be activated via bits 8-10 of parameter P-0-1370. With the factory setting, all boost functions are deactivated. The most common boost function is "pressure control deviation", be-

cause it can be used to realize a clearly faster reaction of the pressure controller to pressure breakdowns.

Bit	Designation/function
P-0-1370, bit 8	Boost function pressure control deviation ON (1) / OFF (0)
P-0-1370, bit 9	Boost function actual swivel angle value change ON (1) / OFF (0)
P-0-1370, bit 10	Boost function swivel angle control deviation ON (1) / OFF (0)

Tab. 3-20: Control word DFE_n/HS5_n P-0-1370

Boost pressure control deviation (P-0-1378, P-0-1379)

This function monitors the magnitude of the pressure breakdown in pressure control. When a defined threshold value (P-0-1379) is exceeded, the boost is activated. While the boost is activated, the deviation from this pressure differential is multiplied by a gain of (P-0-1378) and added to the speed command value as feedforward value. This boost is active only with active pressure controller.

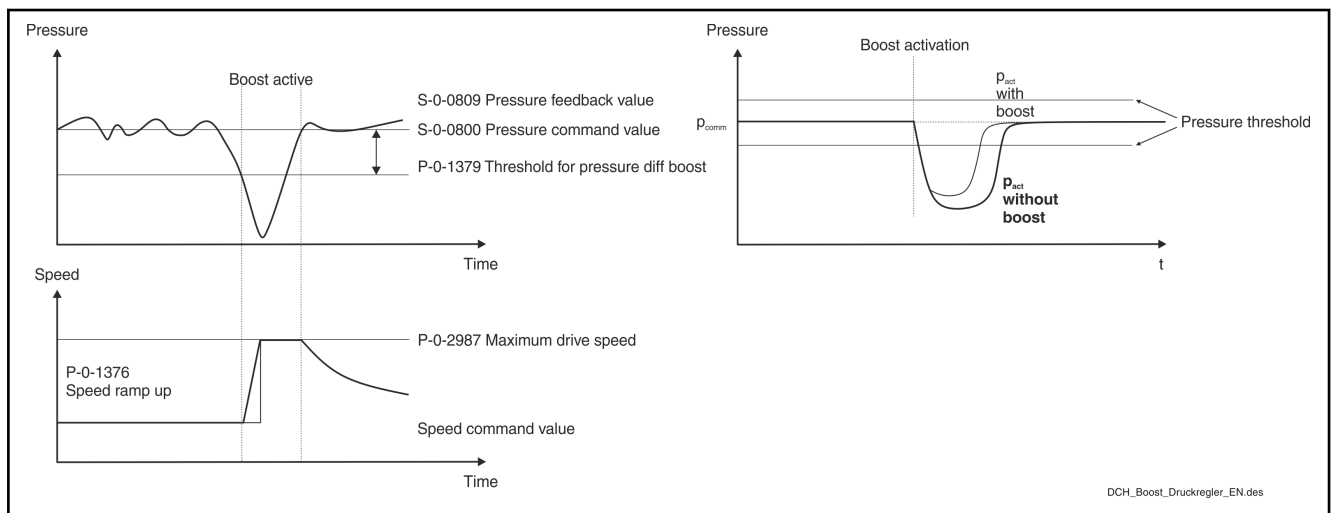


Fig. 3-15: Boost pressure controller

Boost actual swivel angle value change (P-0-1311 [8], P-0-1311 [9])

This function monitors the change in the actual swivel angle value. When the change rate exceeds a defined threshold value (P-0-1311 [9]), the boost is activated. To smooth the swivel angle change rate an additional low pass with defined filter time constants (P-0-1311 [8]) can be applied.

Boost swivel angle controller (P-0-1311 [11], P-0-1311 [12])

This function monitors the magnitude of the control deviation in swivel angle control. When a defined threshold value (P-0-1311 [11]) is exceeded, the boost is activated. While the boost is activated, the deviation from this swivel angle difference is multiplied by a gain (P-0-1311 [12]) and added to the speed command value as feedforward value. This boost is only active with active swivel angle controller.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1378	Gain for pressure control deviation boost feedforward	0	0.0 - 250.0	%
P-0-1379	Threshold for pressure diff. boost	5	1 - 315	bar
P-0-1311 [8]	Filter time constant for derivative of swivel angle actual value	0.01	0.000 - 0.100	s

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P-0-1311 [9]	Threshold for boost in case of swivel angle actual value change	400	0 - 4000	%/s
P-0-1311 [11]	Threshold for boost in case of swivel angle control deviation	5	0.0 - 100.0	%
P-0-1311 [12]	Gain for swivel angle control deviation boost feedforward	0	0.0 - 250.0	%

Tab. 3-21: Boost function

3.7.4 Parameters of the pump

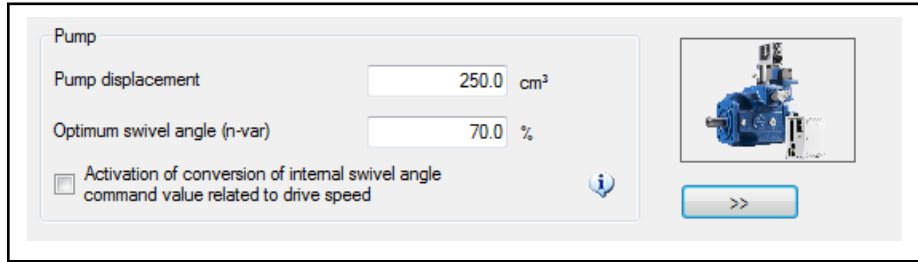


Fig. 3-16: Pump displacement

**Optimum swivel angle (n-var)
P-0-1372**

In variable-speed operation, the optimum swivel angle can be provided via parameter P-0-1372. The pump controller reduces the speed until this optimum swivel angle is reached to displace the required amount of fluid. Generally, the efficiency of the pump improves as the swivel angle increases. In order to minimize power losses in variable-speed operation, the speed should be reduced until the swivel angle comes close to its maximum. To get a sufficient control reserve for the swivel angle controller, the optimum is between 65 % and 95 % (depending on system).

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1372	Optimum swivel angle (n-var)	70.0	50.0 - 98.0	%

Tab. 3-22: Optimum swivel angle



For real-time operation, common settings range between ca. 65 and 80 %. This ensures a sufficient control reserve in order to compensate for minor changes in flow with the swivel angle of the pump.

Conversion of swivel angle command value (P-0-2950 Bit 4)

In the operation mode of pressure/swivel angle control, the box “Activation of conversion of internal swivel angle command value related to drive speed” has to be checked, if the given swivel angle command value refers to the maximum drive speed. In this case, the selected swivel angle command value is converted via this function according to the current drive speed.

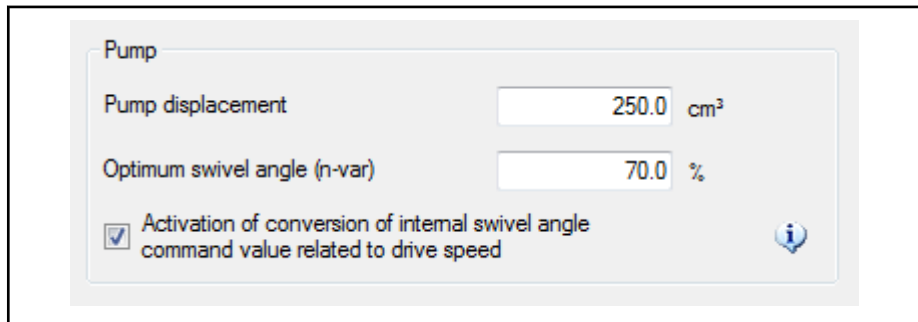


Fig. 3-17: Pump displacement

In the operation mode of pressure/flow control, this box needs not to be checked, since here the flow command value in l/min is automatically converted internally to the swivel angle command value in % using the current drive speed.

Pump displacement volume P-0-2943

For variable-speed operation the pump controller needs to know the size of the main pump, to which the high-response valve of the pump control is mounted. In the case of several closed-loop controlled pumps (pressure controller of master/slave system), the total of all control pumps which displace fluid into the hydraulic system is to be entered. This value is already queried within the framework of initial parameterization of the pump controller.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-2943	Pump displacement	100.0	0.1 - 6553.3	cm ³

Tab. 3-23: Selection of the size of the main pump

3.7.5 Pressure controller adaptation (parallel structure)

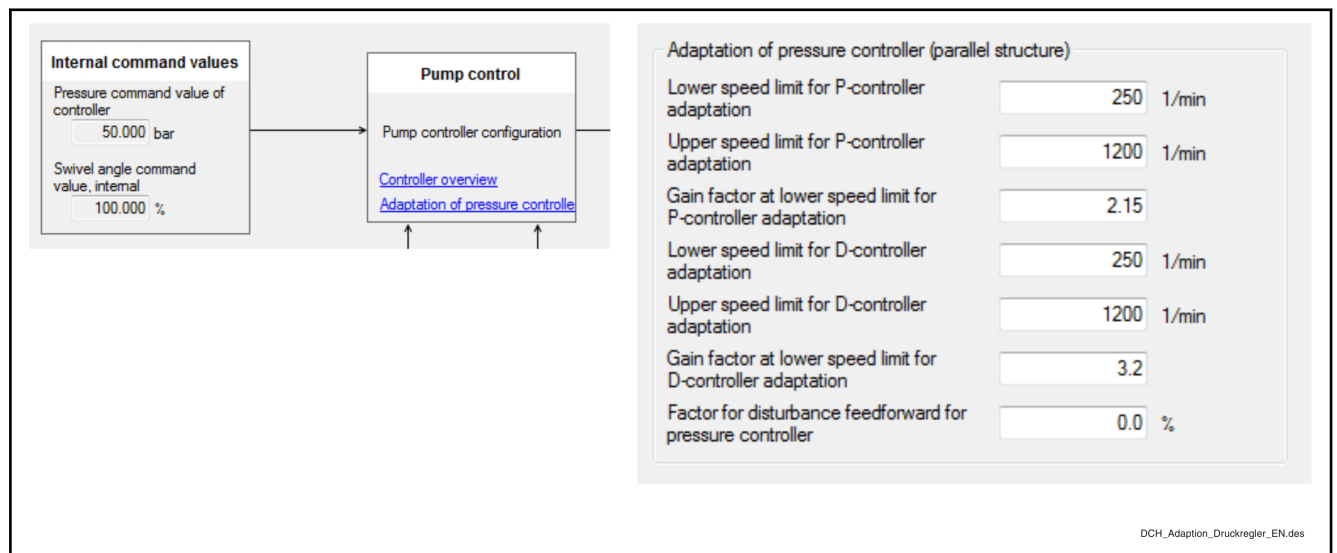


Fig. 3-18: Pressure controller adaptation

Input of characteristic curve for adapting the PD controller

At reduced speed, the control behavior of the pressure control of a control pump differs from that at nominal speed. By adapting the PD pressure controller the pump controller can achieve a largely similar control behavior, which is independent of the current speed.

Lower barrier adaption proportional term P-0-1311 [13] / P-0-1311 [16]

These values can be used for setting the lower limit value of the characteristic curve. Below this speed limit the PD pressure controller is no longer adapted.

Upper barrier adaption proportional term P-0-1311 [14] / P-0-1311 [17]

These values can be used for setting the upper limit value of the characteristic curve. Above this speed limit the PD pressure controller is no longer adapted.

Gain factor, lower speed limit P-0-1311 [15] / P-0-1311 [18]

By means of P-0-1311 [15] and P-0-1311 [18] the gain factor for the lower speed limit can be set. The gain factor for the upper limit speed is firmly set to 1.0. Between the upper and the lower speed limit the gain factor is linearly increased depending on the speed. The example below therefore results in

Variable-speed operation for pump controls in HydraulicDrive

the following course of the gain factor. From speed 0 - 250 1/min a gain factor of 2.15 is active in the adaptation of the P-controller. Between 250 and 1200 1/min the gain factor falls linearly to 1.0. Above 1200 1/min, the gain factor is constant at 1.0.

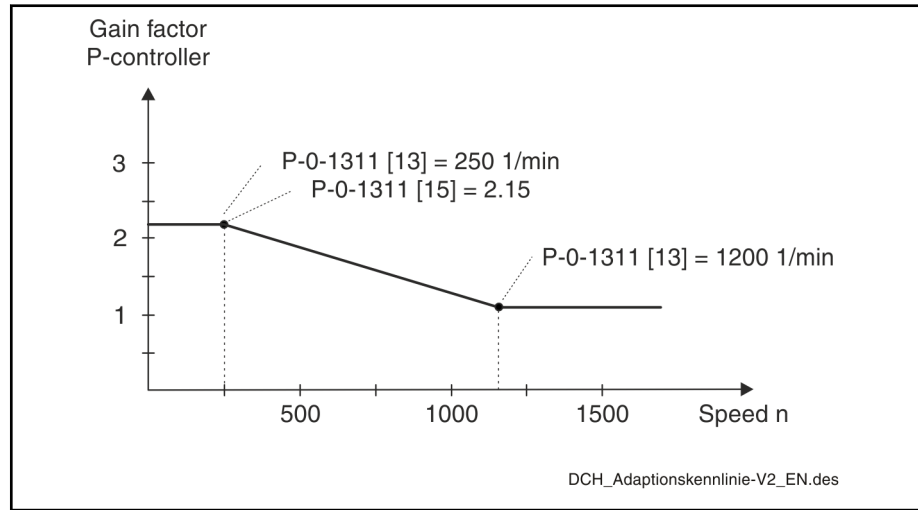


Fig. 3-19: Example of the adaptation characteristic curve of the P-component of the pressure controller

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1311 [13]	Lower barrier adaption proportional term	250	10 - 6000	1/min
P-0-1311 [14]	Upper barrier adaption proportional term	1200	10 - 6000	1/min
P-0-1311 [15]	Gain lower barrier adaption proportional term	2.15	0.00 - 10.00	
P-0-1311 [16]	Lower barrier adaption derivative term	250	10 - 6000	1/min
P-0-1311 [17]	Upper barrier adaption derivative term	1200	10 - 6000	1/min
P-0-1311 [18]	Gain lower barrier adaption derivative term	3.20	0.00 - 10.00	

Tab. 3-24: Parameters of the adaptation characteristic curve of the PD-controller

Factor disturb. feedforward pressure controller (P-0-1380)

Any change in speed acts like an external disturbance variable. To compensate for this disturbance it is possible to feed forward an additional factor, which is calculated in relation to the change in speed, to the controller output of the pressure controller. This factor can be scaled using parameter P-0-1380.

Parameter IDN	Designation	Default value	Value range	Unit
P-0-1380	Factor disturb. feedforward pressure controller	0	0.0 - 250.0	%

Tab. 3-25: Factor for disturbance variable feedforward

3.7.6 Reserve for revving up the motor at low speed - breakdown protection

With the help of torque limitation of the pump you can ensure a torque reserve in order to be able to rev up the motor optimally even at low speeds. In addition, this reserve acts as breakdown protection at low speeds. This is required, because at 300 1/min the breakdown torque is <50 % of the nominal torque and the motor could thus be easily stalled at low speeds. At higher speeds, this torque reserve allows faster speeding up and hence a better speed increase behavior of the pump control.

4 Description of special functions

4.1 Torque limit

To protect the drive motor against overloading, the maximum torque can be limited. The settings always refer to the maximum torque of the pump. The torque limit is active in every operational state, i.e. at both constant speed and reduced speed. When the speed is reduced while the hydraulic power remains unchanged, the current torque at the shaft is accordingly larger.

Since the power loss of the asynchronous motor increases significantly when it is operated above its nominal torque, the speed should be reduced only to the extent where the nominal torque is not exceeded. To this end, the limitation for speed calculation during variable-speed operation can be set by means of parameter P-0-1383.

However, at nominal speed, the current torque may be briefly significantly larger than the nominal torque of the motor. For this reason the torque limit has always to be set by means of P-0-2952 to a value higher than the limitation in P-0-1383. ¹⁾



This function "torque limitation" corresponds to the "power limitation" function of control systems SY(H)DFEE and SY(H)DFEC. However, since power depends on the current speed, this function is used to limit the torque for HydraulicDrive pump controllers.

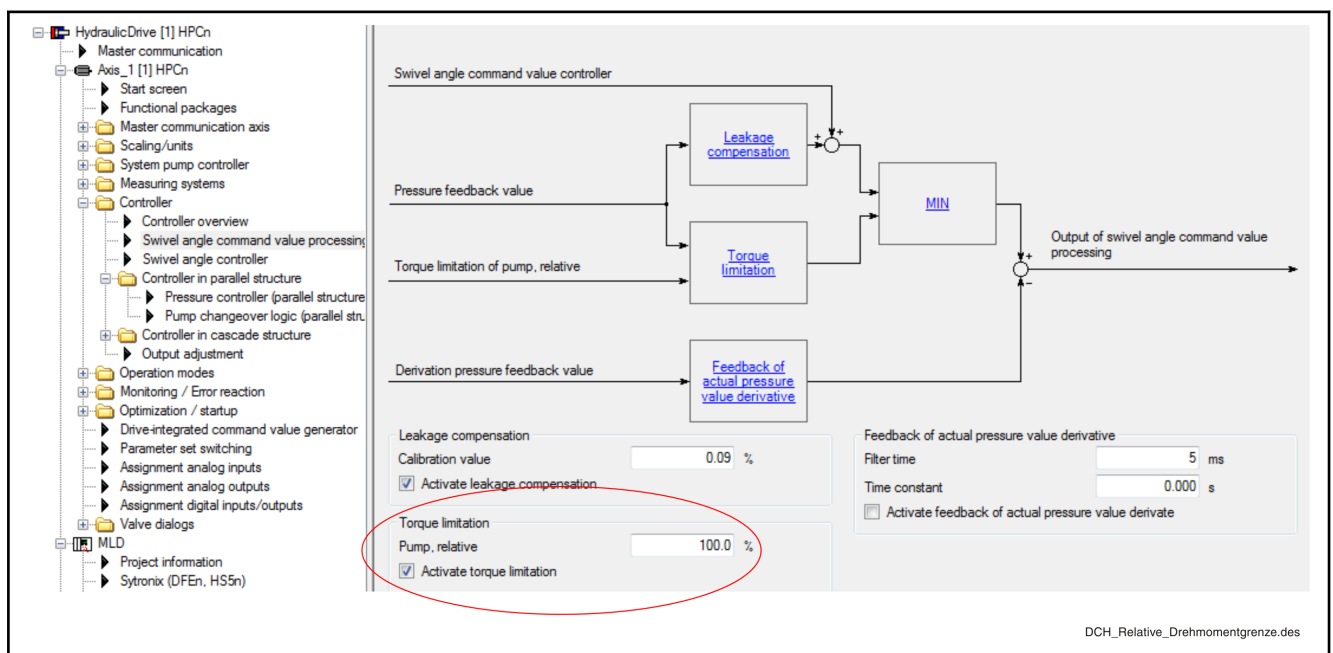


Fig. 4-1: Torque limit

Relative torque limitation

To protect the rotary drive motor against overloading, the maximum torque of the pump can be limited. Parameter "P-0-2952, Torque limitation of pump, relative" is a relative variable in percent and refers to the maximum torque of the pump at standard pressure (P-0-2957.0.1). The permissible maximum swivel angle command value for the pump is calculated from the current actual pressure value p_{act} and the setting for the relative torque limitation according to the following calculation rule:

Description of special functions

Max. permissible swivel angle command value = torque limitation of pump, relative (P-0-2952) $x p_{\text{standard}} / p_{\text{act}}$

The max. permissible swivel angle command value is shown in parameter "P-0-2958.0.3, Correction value: torque limitation".

A min/max value comparator switches between the permissible maximum swivel angle that results from torque limitation and "P-0-2958.0.4, Swivel angle command value after leakage compensation". By means of the pump controller control word "P-0-2950, Pump controller control word" bit 6, 7, the min/max value comparator can be firmly set to the swivel angle command value, which deactivates the torque limitation function.

The value range for torque limitation P-0-2952 is 0 %...125 %.

Example:

Calculation of the maximum torque of the pump (A10 NG71)

Pump size	VG	=	71 cm ³
Reference pressure of the control ²⁾	p_{max}	=	315 bar
Efficiency	η_{mh}	=	1 (theoretical value)
Nominal motor torque	M_{NomMotor}	=	191 Nm

Tab. 4-1:

$$M_{\text{Motor}} = \frac{P_{\text{Motor}}}{2 \cdot \pi \cdot n} = \frac{30 \text{ kW}}{2 \cdot \pi \cdot 1500 \text{ rpm}} = \frac{30.000 \text{ W}}{2 \cdot \pi \cdot 25 \text{ rev/s}} = 191 \text{ Nm}$$

$$M_{100\%} = \frac{1,59 \cdot V_G \cdot p_{\text{max}}}{n_{\text{mh}} \cdot 100} = \frac{1,59 \cdot 71 \text{ cm}^3 \cdot 315 \text{ bar}}{100} = 355 \text{ Nm}$$

DCH_Berechnung_Drehmomentgrenze_Motor_EN.des

Fig. 4-2: Torque limitation

Calculation of torque limit ($p \cdot \alpha$)

Overloading of asynchronous motor by 200 %

$$(p \cdot \alpha)_{\text{max}} = \frac{M_{\text{Motor}}}{M_{100\%}} \cdot 200\% = \frac{191 \text{ Nm}}{355 \text{ Nm}} \cdot 200\% = 107,6\%$$

DCH_Ueberlast_Asynchrontmotor.des

Fig. 4-3: Calculation of torque limit

¹⁾ When comparing the torque limit, take into account that the two parameters are subject to different normalizations. Parameter P-0-2952 refers to the maximum torque of the pump, P-0-1383 to the nominal torque of the motor.

²⁾ For A10 pumps it is always 315 bar, irrespective of the settings for the PT or the nominal system pressure.

4.2 Backup/restore with pump control

It is possible to make a complete backup (parameter setting + firmware) of the VT-HPC and to store it on the SD card. This backup can be used to restore the current condition or, in the case of a replacement of the VT-HPC, to

transfer the complete configuration. The backup/restore function is called via the following dialog:

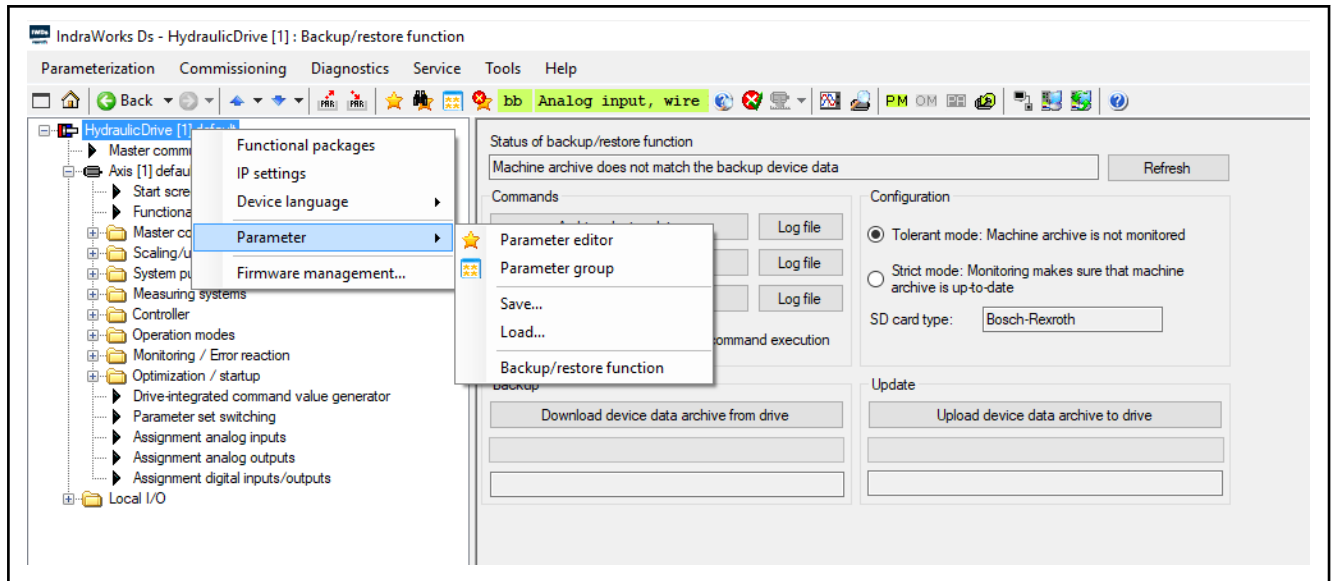


Fig. 4-4: Backup/restore function

As of version HDx20V20 the backup/restore function also makes a backup of the calibration values for the VT-HPC. However, when the VT-HPC is replaced, the electronics has to be re-calibrated to achieve the same accuracy.

4.3 Calibration of pump controller

The calibration functions of the pump controller improve the precision of the system. An uncalibrated pump controller system is generally operable, but it will not achieve the accuracy specified in the data sheet. It is therefore generally recommended that calibrating be carried out during commissioning.



When a parameter backup (par file) is loaded, the calibration values are not transmitted for any pump controller. Pump controller systems with integrated electronics in the pilot valve are calibrated in the factory. Hence, calibration values are already stored when the system is delivered. However, when the valve is replaced, calibrating has to be repeated also in this case to ensure the high accuracy. When case drain oil compensation is used, calibrating has generally to be repeated during commissioning.

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Notes

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