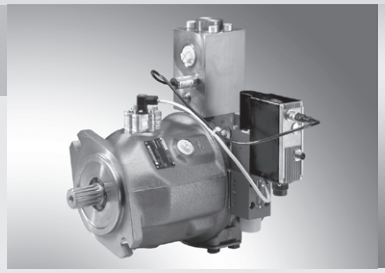
Rexroth
Bosch Group

Variable-speed pressure and flow control system
Sytronix DFEn 5000

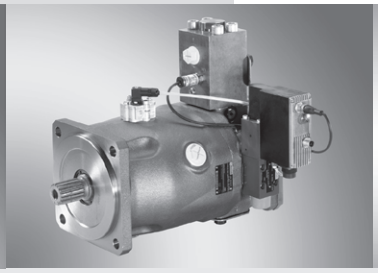
RE 30014-B/02.12

Replaces: 11.10
English

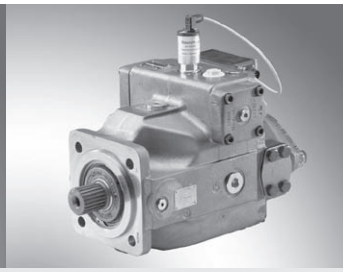
Operating instructions



SYDFEn-2X



SYDFEn-3X



SYHDFEn-1X

Valid for the following types:

Pressure/flow control system
Type SYHDFEn
Type SYDFEn

The data specified above only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

An example configuration is shown on the title page. The delivered product may, therefore, differ from the product which is pictured.

The original operating instructions were created in the German language.

Contents

1 About this document

1.1 Validity of the documentation

This documentation is valid for the following Sytronix 5000 products:

- SYDFEn series 2X
- SYDFEn series 3X
- SYHDFEn series 1X

This documentation is intended for engineers, fitters, operators, service technicians and plant operators.

These instructions contain important information on the safe and appropriate installation, transport, commissioning, maintenance, disassembly and simple troubleshooting of the pressure and flow control systems SYDFEn series 2X, 3X and SYHDFEn series 1X.

This documentation describes the functions for both software options “teach-in for cyclic operation” as well as the “real-time version” (speed calculation without teach-in). These options are determined by code 12 in the ordering code as specified in the individual data sheets listed below.

▶ Read these instructions completely, especially Chapter 2 “Safety instructions“ on page 7, before working with the product.

1.2 Required and supplementary documents

▶ Only commission the product, when you have the documents marked with the book symbol 🕮 at hand and have understood and observed them.

Table 1: Required and supplementary documents

	Title	Document number	Type of document
🕮	Order confirmation		
🕮	Installation drawing		
🕮	General operating instructions for axial piston units	RE 90300-B	Operating instructions
🕮	Variable-speed pressure and flow control system Sytronix DFEn 5000, type SYDFEn..2X	RE 62240	Data sheet
🕮	Variable-speed pressure and flow control system Sytronix DFEn 5000, type SYHDFEn	RE 62242	Data sheet
🕮	Variable-speed pressure and flow control system Sytronix DFEn 5000, type SYDFEn-3X	RE 62241	Data sheet
	CANopen interface für speed-controlled SYDFEn pumps	RE 30014-02-Z	Supplementary information
	Axial piston variable displacement pump A10VSO series 31, sizes NG18 to 140	RE 92711	Data sheet
	Axial piston variable displacement pump A10VSO series 32, sizes 45 to 180	RE 92714	Data sheet

	Title	Document number	Type of document
	Axial piston variable displacement pump A4VSO series 10, 11 and 30, sizes 40...1000	RE 92050	Data sheet
	Axial piston variable pump A4VSO for HFC fluids	RE 92053	Data sheet
	Axial piston units for use with HF fluids	RE 90223	Data sheet
	Hydraulic fluids on mineral oil basis for axial piston units	RE 90220	Data sheet
	Pump pre-load valve for control system SYDFE, type SYDZ 0001-1X	RE 29255	Data sheet
	3/3 proportional directional valves, direct operated, with electrical position feedback as pilot valves for control systems SY(H)DFE, type VT-DFP	RE 29016	Data sheet
	Swivel angle sensor, type VT-SWA-1	RE 30268	Data sheet
	Swivel angle sensor, type VT-SWA-LIN	RE 30263	Data sheet
	Pressure transducers, types HM 12 and HM 13	RE 29933	Data sheet
	Pressure transducer with integrated electronics, type HM 16	RE 30266	Data sheet
	Pressure transducer with integrated electronics, type HM 17	RE 30269	Data sheet
	Installation, commissioning and maintenance of hydraulic systems	RE 07900	Data sheet
	Declaration on environmental compatibility	RE 30030-U	Compliance data sheet

1.3 Representation of information

In order that this documentation allows you to work directly and safely with your product, standardized safety notes, symbols, terms and abbreviations are used. For a better understanding, these are explained in the following sections.

1.3.1 Safety notes

In this documentation, safety instructions precede a sequence of activities whenever there is a risk of personal injury or damage to equipment. The precautions described to avoid these hazards must be observed.

Safety instructions are set out as follows:

⚠ SIGNAL WORD

Type and source of hazard

Consequences in the case of non-observance

- ▶ Measures to avert the hazard
- ▶ <List>

- **Warning symbol:** draws attention to a hazard
- **Signal word:** identifies the degree of hazard
- **Type and source of hazard:** identifies the type or source of the hazard
- **Consequences:** describes the consequences in the case of non-observance
- **Precautions:** states, how the hazard can be avoided

Table 2: Hazard classes according to ANSI Z535.6-2006

Warning sign, signal word	Meaning
⚠ DANGER	Indicates a hazardous situation which, if not avoided, will certainly result in death or serious injury.
⚠ WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Damage to property: The product or the environment can be damaged.

1.3.2 Symbols

The following symbols refer to notes, which are not relevant to safety, but increase the legibility of the documentation.

Table 3: Meaning of symbols

Symbol	Meaning
	If this information is disregarded, the product cannot be used or operated in an optimum manner.
▶	Single, indented step of action
1. 2. 3.	Numbered instruction for action: The numbers indicate that the activities are to be carried out consecutively.

1.3.3 Terms used

The following terms are used in this documentation:

Table 4: Terms

Term	Meaning
A10VSO	Axial piston variable displacement pump, open circuit
A4VSO	Axial piston variable displacement pump, open circuit
HM12/HM13/HM17	Pressure transducer, types HM12, HM13 and HM17
Project	Project file for PC program WIN-PED® for parameterizing, editing and diagnosis for the control system SY(H)DFEn
SYDFEn-2X	Pressure/flow control system, series 2X
SYDFEn-3X	Pressure/flow control system, series 3X
SYHDFEn-1X	Pressure/flow control system, high pressure, series, 1X

Term	Meaning
SY(H)DFEn	Pressure/flow control system with integrated digital electronics, variable speed
VT-DFPn	Pilot valve with integrated digital electronics, variable speed
VT-SWA-1	Swivel angle sensor
VT-SWA-LIN	Swivel angle sensor for control system SY(H)DFE
WIN-PED®	Windows program for parameterization, editing, diagnosis

1.3.4 Abbreviations used

The following abbreviations are used in this documentation:

Table 5: Abbreviations

Abbreviation	Meaning
CAN	**C**ontroller **A**rea **N**etwork
COM	**Com**munication Port (serial PC interface)
EEPROM	**E**lectrically **e**raseable **p**rogrammable **r**ead **o**nly **m**emory
EMC	**E**lectro**m**agnetic **C**ompatibility
FIR	**F**inite **I**mpulse **R**esponse
GND	Ground
LP	**L**ow-**p**ass
p	Pressure (symbol)
p_{act}	Actual pressure value
PC	**P**ersonal **C**omputer
P_{comm}	Pressure command value
PCV	**Pre**compression **V**olume
p_{diff}	Control difference between pressure command value and actual pressure value
PE	**P**rotective **E**arth
PT	**P**ressure **T**ransducer
RE	**R**exroth document in **E**nglish language
RS232	**R**ecommended **S**tandard 232
SWA	**Sw**ivel **A**ngle
SWA_{act}	Actual swivel angle
SWA_{comm}	Swivel angle command value
U_B	Supply voltage

2 Safety instructions

2.1 About this chapter

The SY(H)DFEn control system has been manufactured according to the generally accepted rules of current technology. There is, however, still a risk of personal injury or damage to equipment if you do not observe this chapter and the safety instructions contained in this documentation.

- Read these instructions completely and thoroughly before working with the SY(H)DFEn control system.
- Keep this documentation in a location where it is accessible to all users at all times.
- Always pass the product together with the required documentation on to third parties.

2.2 Intended use

The product is electrical/hydraulic equipment.

You may use the product as follows:

- for the electrohydraulic pressure and swivel angle control of an axial piston variable displacement pump

The SY(H)DFEn control system is technical equipment, which is not intended for private use.

Use according to the intended purpose implies that you have read and understood these instructions, especially Chapter 2 “Safety instructions”.

2.3 Improper use

Any use other than described in the section “Intended use” is considered as improper and is therefore not permitted.

If unsuitable products are installed or used in safety-relevant applications, unintended operational states may occur in the application that can cause personal injury and/or damage to property. For this reason, use the product only in safety-relevant applications, if this use is expressly specified and allowed in this documentation. For example in explosion-protected areas or in safety-related parts of a control (functional safety).

For damage resulting from improper use, Bosch Rexroth AG will not assume liability. The risks arising from improper use lie exclusively with the user.

You use the product improperly:

- if you do not adhere to the technical data, operating conditions and performance limits given in the data sheet and the order confirmation;
- if you do not comply with national EMC regulations for the application at hand. If required, notes on proper installation in line with EMC regulations can be found in the EMC test documentation from Bosch Rexroth AG (declaration on environmental compatibility RE 30030-U). The manufacturer of the system or machine is responsible for complying with the limit values stipulated in national regulations (European countries: EC Directive 2004/108/EC (EMC Directive); USA: See National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA) as well as regional engineering regulations;
- if you use the SY(H)DFEn control system in a potentially explosive atmosphere.

2.4 Personnel qualifications

The activities described in this documentation require basic knowledge of mechanics, electrics and hydraulics as well as knowledge of the associated technical terms. To ensure safe usage, these activities may therefore only be carried out by qualified personnel or under the direction and supervision of qualified personnel.

Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge and experience, as well as their understanding of the relevant conditions pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area.

2.5 General safety instructions

- Observe the valid regulations for accident prevention and environmental protection.
- Observe the safety regulations and rules of the country where the product is used/operated.
- Only use Rexroth SY(H)DFEn control systems in good technical order and condition.
- Observe all notes given on the product.
- Persons who install, commission, operate, demount or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- Only use accessory and spare parts released by the manufacturer in order to rule out personnel hazards arising from unsuitable spare parts.
- Adhere to the technical data and ambient conditions provided in the product documentation.
- If unsuitable products are installed or used in safety-relevant applications, unintended operational states can occur in these applications, which can cause personal injury and damage to property. Therefore, use the product only in safety-relevant applications, if this use is expressly specified and permitted in the documentation.
- You may commission the product only when it has been established that the final product (for example, a machine or system), in which the Rexroth products are installed, comply with national regulations, safety regulations and standards relevant for the application.

2.6 Product- and technology-related safety instructions

⚠ WARNING

Control system falling down!

SY(H)DFEn control systems are heavy. In the case of improper handling, they can fall down and cause severe injuries and crushing, because the parts can be, for example, sharp-edged, heavy, oily, loose or bulky.

- Transport the SY(H)DFEn control system using suitable lifting gear at the point provided for this purpose.
- Ensure a stable position while transporting the control system to the place of installation.
- Wear personal protective equipment when transporting the control system.
- Observe national laws and regulations for accident prevention and safety at work during transport.

Systems not shut down!

Working on systems in operation poses a danger to life and limb. The work steps described in these operating instructions must only be performed on systems after they were shut down. Before beginning work:

- Make sure that the drive motor cannot be switched on.
- Make sure that all power-transmitting components and connections (electric, pneumatic, hydraulic) are switched off according to the manufacturer's instructions and secured against being switched on again. If possible, remove the main fuse of the system.
- Ensure that the system is completely hydraulically relieved and depressurized. Please follow the system manufacturer's instructions.
- Only qualified personnel (see Chapter 2.4 "Personnel qualifications" on page 11) are authorized to install the SY(H)DFEn control system.

Lines under pressure!

Risk of injury.

- Never disconnect, open or cut pressurized lines!
- Before carrying out any installation or other work, depressurize the control system.

High electrical voltage!

Risk of death and risk of injury from electric shock.

- Before starting installation work, plugging and unplugging connectors and carrying out any work, switch the control system off. Secure the electrical equipment against being switched on.
- Before switching the control system on, check the protective conductor on all electrical devices for proper connection according to the wiring diagram.

High noise emission during operation!

The noise emission of SY(H)DFEn control systems depends, among others, on speed, operating pressure and the installation situation. Under normal operating conditions, the noise pressure level may rise above 70 dB(A). This can cause hearing damage.

- Always wear hearing protection when you work in the vicinity of a running SY(H)DFEn control system.

⚠ WARNING

Hot surfaces!

Risk of burning.

The SY(H)DFEn control system heats up considerably during operation. The pilot valve of the SY(H)DFEn control system gets so hot during operation that you may burn yourself.

- Let the SY(H)DFEn control system cool down before touching it.
- Protect yourself by wearing heat-resistant protective clothing, e.g. gloves.

Health-damaging hydraulic fluid!

Risk of intoxication and injury! Contact with hydraulic fluids can be damaging to your health (e.g. eye injuries, skin damage, intoxication upon inhalation and swallowing).

- Always check the lines for wear and damage before each commissioning.
- While performing these checks, wear safety gloves, safety goggles and suitable working clothes.
- If hydraulic fluid should, nevertheless, come into contact with your eyes or penetrate your skin, consult a doctor immediately.
- When handling hydraulic fluids, strictly observe the safety notes of the hydraulic fluid manufacturer.

Easily inflammable hydraulic fluid!

Risk of fire!

- Keep open fire and sources of ignition away from the SY(H)DFEn control system.
- Ensure sufficient ventilation.

⚠ CAUTION

Improperly installed lines and cables!

Risk of stumbling!

- Install cables and lines in a way that nobody can stumble over them.

Uncontrolled system behavior!

The failure of individual components can lead to malfunction of the assembly and therefore to unforeseeable behavior!

- Replace or have defective components replaced immediately.

2.7 Personal protective equipment

Personal protective equipment for users of the product consists of:

- Protective gloves and safety shoes for transporting the SY(H)DFEn control system.
- Hearing protection for working in the direct vicinity of the running system.

All components of personal protective equipment must be intact.

3 General notes on damage to material and the product

NOTICE

Impermissible mechanical loading!

Hitting or impulsive forces on the drive shaft or the pilot valve can damage or even destroy the SY(H)DFEn control system.

- Do not hit the coupling or drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft or the pilot valve.
- Never use the SY(H)DFEn control system as a handle or step. Do not place/lay any objects on it.

Foreign bodies and contaminants in the control system!

Risk of damage, wear and malfunction due to the ingress of contaminants and foreign bodies.

- When installing the control system, observe strictest cleanliness to prevent foreign bodies such as welding beads or metal cuttings from entering hydraulic lines.
- Before commissioning, make sure that all hydraulic connections are tight and that all seals and closing elements of plug-in connections are correctly installed and not damaged.
- Take care that no detergents enter the hydraulic system.
- Do not use cotton waste or linty cloths for cleaning.
- Never use hemp as sealant.

Wear!

Wear can cause malfunction.

- Carry out the prescribed maintenance work at the time intervals specified in the operating instructions.

Hydraulic fluid is detrimental to the environment!

Hydraulic fluid leakage leads to environmental contamination.

- Remove any leakage immediately.
- Dispose of the hydraulic fluid according to the national regulations in your country.

Insufficient pressure!

If the pressure falls below the specified value, damage can occur or the product be destroyed.

- Make sure that the pressure cannot fall under the prescribed minimum value.

Insufficient hydraulic fluid!

If you commission or operate the SY(H)DFEn control system without or with insufficient hydraulic fluid, the control system is immediately damaged or even destroyed.

- When commissioning or re-commissioning a machine or system, make certain that the housing chamber as well as the suction and working lines of the control system are filled with hydraulic fluid and remain filled during operation.

4 Scope of delivery

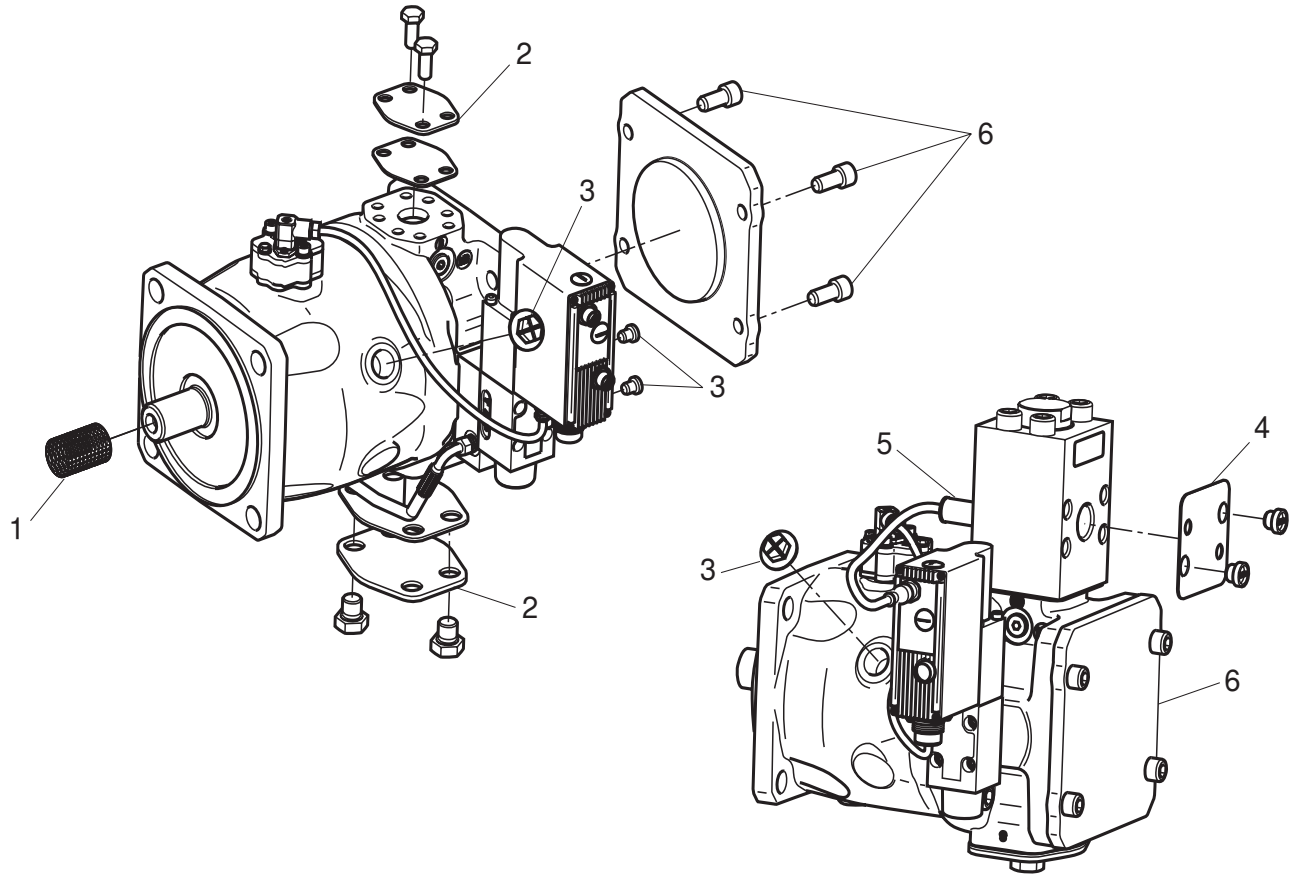


Fig. 1: SYDFEn control system

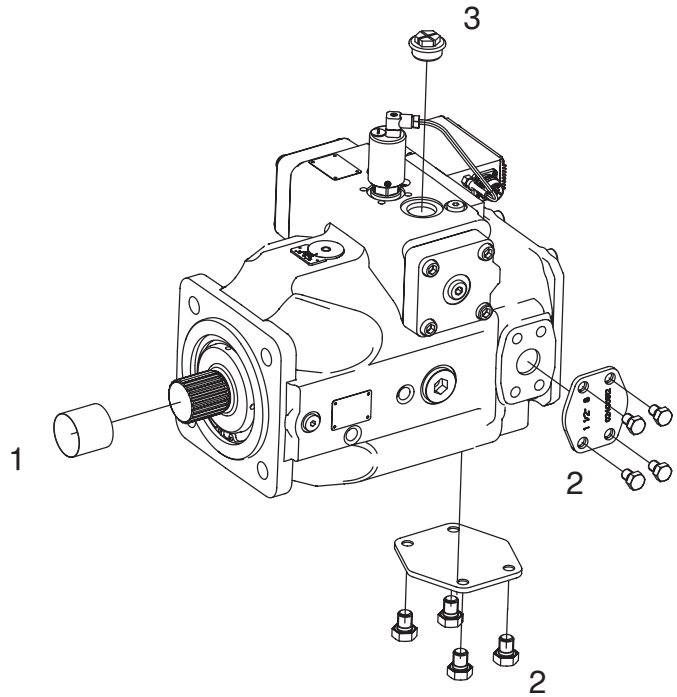


Fig. 2: SYHDFEn control system

The delivery contents comprise:

- 1 control system SY(H)DFEn

The following parts are mounted:

- Transport protection for drive shaft end (**1**) in the case of keyed shafts
- Protective covers (**2, 4**)
- Plastic plugs/plug screws (**3**)
- Pressure transducer (optional) (**5**)
- The connection flange is operationally safely closed with a cover (optional on variant with through-drive) (**6**)

5 Product description

5.1 Performance description

The SY(H)DFEn control system is designed and built for the electrohydraulic control of swivel angle, pressure and power/torque of an axial piston unit. It is intended for stationary applications.

Please refer to the data sheet and order confirmation for the technical data, operating conditions and operating limits of the SY(H)DFEn control system.

5.2 Device description

The SY(H)DFEn control system is based on an axial piston variable displacement pump of swashplate design for hydrostatic drives in the open circuit. The flow is proportional to drive speed and displacement. The flow can be steplessly changed by adjusting the swashplate.

Open circuit

With an open circuit, the hydraulic fluid flows from the tank to the variable displacement pump and is transported from there to the consumer through a directional valve. From the consumer, the hydraulic fluid flows back to the tank via the directional valve. In the regenerative operating mode (see Chapter 5.3.4.1 on page 23) the hydraulic fluid can also be returned to the tank from the consumer via the pump.

5.2.1 Functional description, section of the SY(H)DFEn

In the following description, the numbers given in brackets refer to Figs. 3, 4 and 5 on pages 17 and 18.

The pressure and swivel angle of the A10VSO variable displacement pump of the SY(H)DFEn control system is controlled using an electrically operated proportional valve (**2**). The proportional valve determines the position of the swashplate (**1**) via the actuating piston (**4**). The displaced flow is proportional to the position of the swashplate. The counter-piston (**3**), which is pre-loaded by a spring (**5**), is permanently pressurized to pump pressure.

With a non-rotating pump and depressurized actuating system, the swashplate is held by the spring (**5**) in position +100 %. With a driven pump and a de-energized proportional solenoid (**8**) the system swivels to zero stroke pressure as the valve spool (**9**) is pushed to the initial position by the spring (**10**) and, therefore, pump pressure *p* is applied to the actuating piston (**4**) via valve port “A”. A balance between the pump pressure on the actuating piston and the spring force (**5**) is achieved at a pressure of 8 to 12 bar. This basic position (= zero stroke operation) is obtained when, e.g. the valve electronics is de-energized.

In contrast to this, a pump with external supply swivels to the negative limit stop (regenerative operation). See section “Basic positions of swivel angle adjustment feature“ on page 19.

The proportional valve is controlled by analog electronics (**11**), which is integrated in the valve. The closed-loop control electronics processes all of the control signals required to operate the A10VSO or A4VSO variable displacement pump under closed-loop pressure and flow control.

The control electronics receives the command values for pressure, swivel angle and torque limit over the CAN bus (**14**). Alternatively, the command values for pressure and swivel angle can be provided via an analog input each. An external pressure transducer can be connected via the central plug-in connector (**12**). Alternatively, under certain conditions (see Chapter 7.6.4), an HM16 pressure

transducer may be installed at port P of the pump or, provided that a SYDZ pre-load valve is used, to port MP1 and connected to the M12 mating connector (**13**).

A position transducer with integrated electronics (**7**) on the pump acquires the actual swivel angle value. The acquired actual values are processed in the amplifier and compared with the given command values. The minimum value comparator ensures that automatically only the controller is active that is assigned to the required working point. Thereby, one system variable (pressure, swivel angle or torque) is exactly controlled, whereas the other two variables are below the specified command values. The output signal of the minimum value comparator becomes the command value for the valve control loop.

The actual value of the valve spool position is sensed using an inductive position transducer (**6**). The output value of the valve position controller determines via the amplifier output stage the current through the proportional solenoid (**8**). As soon as the working point is reached the proportional valve control spool (**9**) is held in the central position.

When the higher-level controllers demand an increase in the swivel angle (increase in flow), the valve spool (**9**) must be moved from the central position (connection of the actuating piston (**4**) A → T) until the swivel angle reaches the required value. The movement of the valve spool against the force of the spring (**10**) is achieved by a corresponding increase in the electrical current through the proportional solenoid (**8**).

The reduction of the swivel angle (reduction in flow) is achieved by connecting the actuating piston (**4**) from P –> A.

There are three ways of supplying the pump‘s hydraulic actuating system with pilot oil:

1. Internal, without pre-load valve (only possible for operating pressures > 20 bar)
2. Internal, with pre-load valve (operating pressure 0…100 %)
3. External supply via a shuttle valve - automatic changeover between internal/ external using a shuttle valve sandwich plate (see Chapter 5.4.1 “Internal/ external pilot oil“, page 26).

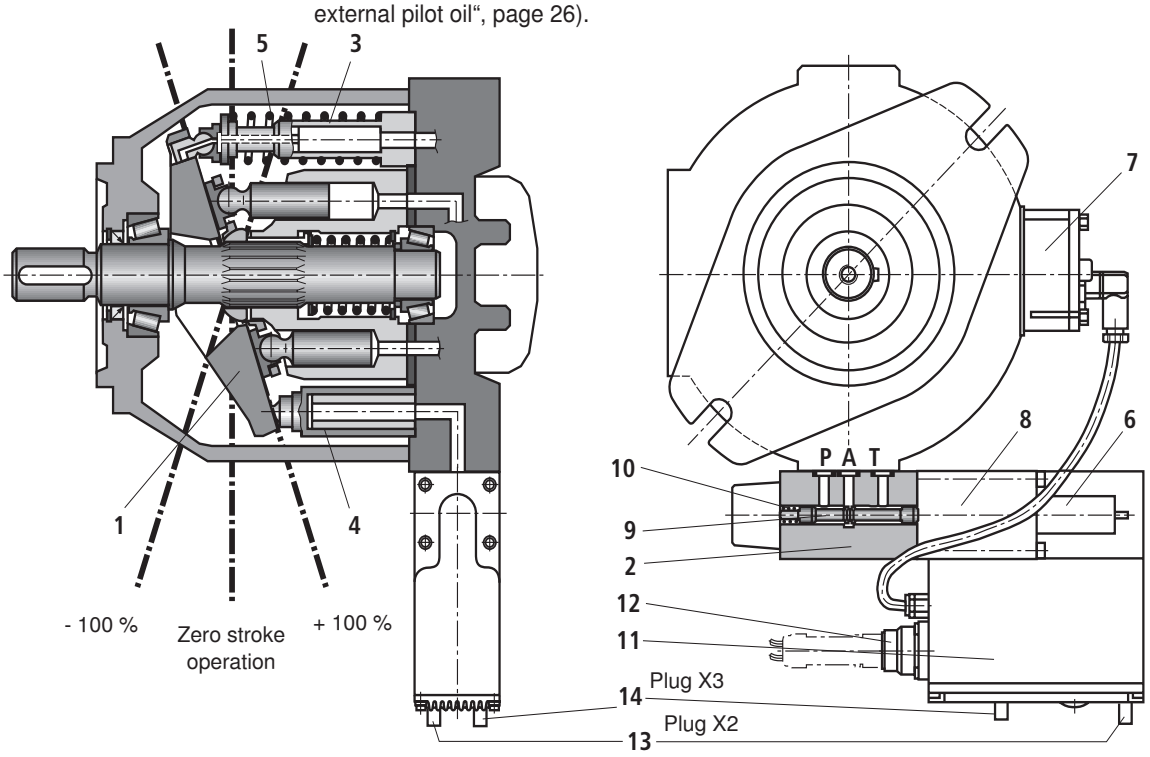


Fig. 3: Section of type SYDFEn, series 2X

Product description

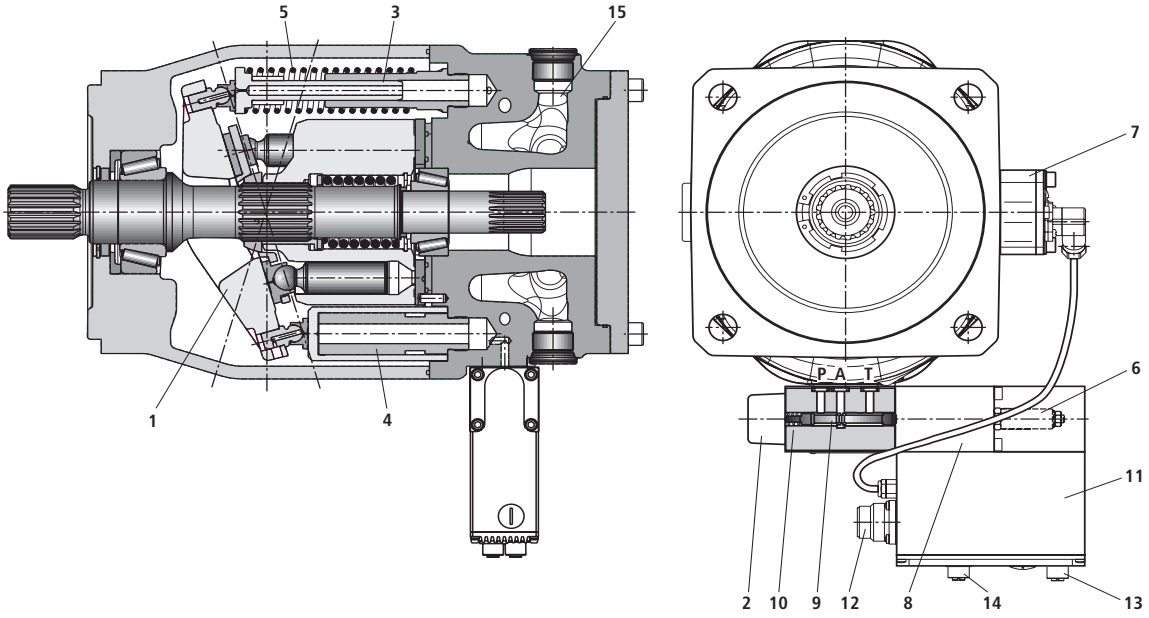


Fig. 4: Section of type SYDFEn, series 3X

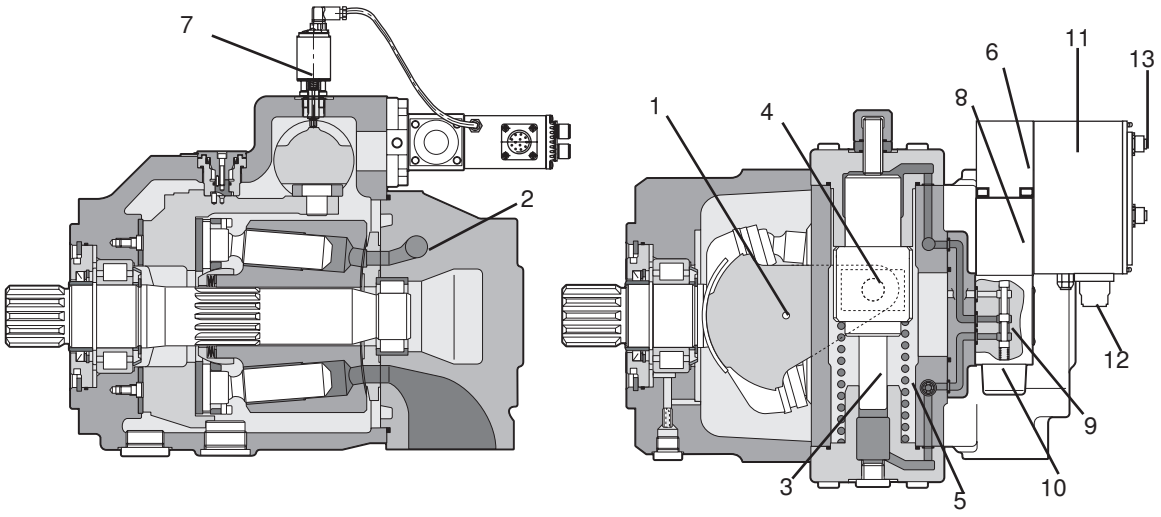


Fig. 5: Section of type SYHDFEn, series 1X

Item		Item	
1	Swashplate	**2**	Proportional valve
3	Counter-piston	**4**	Actuating piston
5	Spring	**6**	Inductive position transducer
7	Integrated electronics	**8**	Proportional solenoid
9	Control spool of proportional valve	**10**	Spring
11	Digital electronics	**12**	Central plug-in connector
13	Plug-in connector X2	**14**	Plug-in connector X3
15	Pre-compression volume PCV		

Basic positions of swivel angle adjustment feature

The sectional drawings above show the mechanical basic position “+100 %“ of the pump (depressurized, drive at rest). This corresponds to the maximum swivel angle of the pump.

Zero stroke pressure: Pressure, which the pump with internal supply generates for its own supply without activation of the pilot valve. The pressure level is usually within the range of 8 to 12 bar, but this level can only be achieved when the maximum oil flow, which the pump can deliver, is not exceeded. The pump with **internal supply** automatically swivels in to zero stroke operation after the electric drive was started while the control electronics is disconnected from the power supply, if the required pilot pressure can build up (consumer line is closed).

In contrast to this, the pump with **external supply** swivels in to the **negative limit stop “-100%“**!

NOTICE! Cavitation of the pump!

Risk of damage to the pump in the case of systems with external supply.

- To avoid damage to the pump, provide a pressure relief/anti-cavitation valve for systems with external supply. If a fault occurs during operation - not while starting up - the motor must be switched off.

5.2.1.1 Variable-speed operation

The SYDFEn control system features an operating mode, in which the drive speed can be varied. To this end, it is indispensable that the electric motor is controlled using a suitable converter. In this variable-speed operating mode, the speed is reduced in the part-load range of the machine cycle. This results in advantages in the noise characteristics and the overall efficiency of the system. Two software variants are provided for variable-speed operation.

Teach-in

For the teach-in version and cyclic operation, the machine cycle (p, Q course) must be read in by the SY(H)DFEn control system. To this end, the starting point of the machine cycle must be provided by way of a synchronization bit (DI1). On the basis of this machine cycle the SY(H)DFEn control system calculates the optimum drive speed and internal control parameters for each operating point. The drive speed is passed on to the converter via an analog output.

Real time

In the real-time version, the currently required drive speed is continuously re-calculated without any teach-in and passed on to the converter as command value.

In the normal operating mode, the SY(H)DFEn control system is operated at a speed of, for example, 1500 rpm. The swivel angle of the pump is then determined by the requested flow rate:

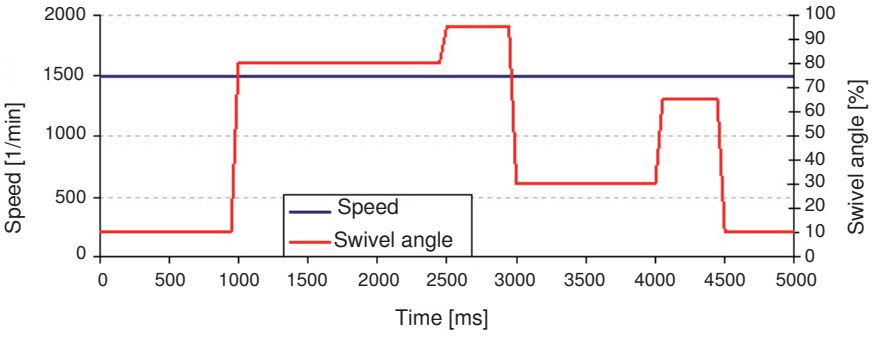


Fig. 6: Cycle with constant speed

In the variable-speed mode, the drive speed is to be reduced and the swivel angle optimized to a certain value for each working point. As the electric drive is not operated with high dynamics for this, the drive speed must be increased shortly before the displacement is increased or an associated boost function is evaluated.

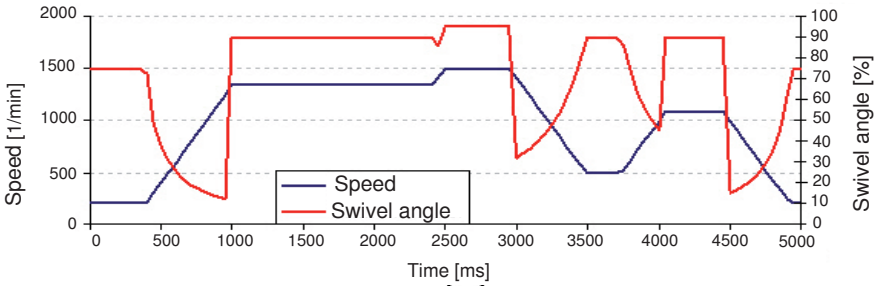


Fig. 7: Cycle with variable speed with teach-in version

The flow rate is the product of swivel angle and speed. The SY(H)DFEn control system internally calculates the current swivel angle command value so that at both, fixed and variable speed, exactly the same flow rate is obtained during the cycle.

5.3 Control of the SY(H)DFEn control system

Basic operating modes

Up to two controllers are continuously active in the possible operating modes:

- Swivel angle controller
- Pressure controller

The controllers override each other automatically and without jerks through evaluation of minimum value comparators.

The controller whose actual value has come closest to the command value becomes active.

In general, for the transition of a system from a given initial state to a given final state, a fast transition and steady state are envisaged. To meet this requirement, various control algorithms are used in closed-loop control technology.

The digital control SY(H)DFEn is provided with 16 controller parameter sets (0...15) for the optimum adjustment to system-specific requirements. A controller parameter set contains several controller parameters, which are related to specific functions. The setting of the individual controller parameters depends on the control characteristics of the system as a whole. Here, the following factors must be taken into account:

- Hydraulic structure of the system (e.g. piping, branches)
- Connected oil volume

5.3.1 Structure of closed-loop control

The control structure is shown in the following figure.

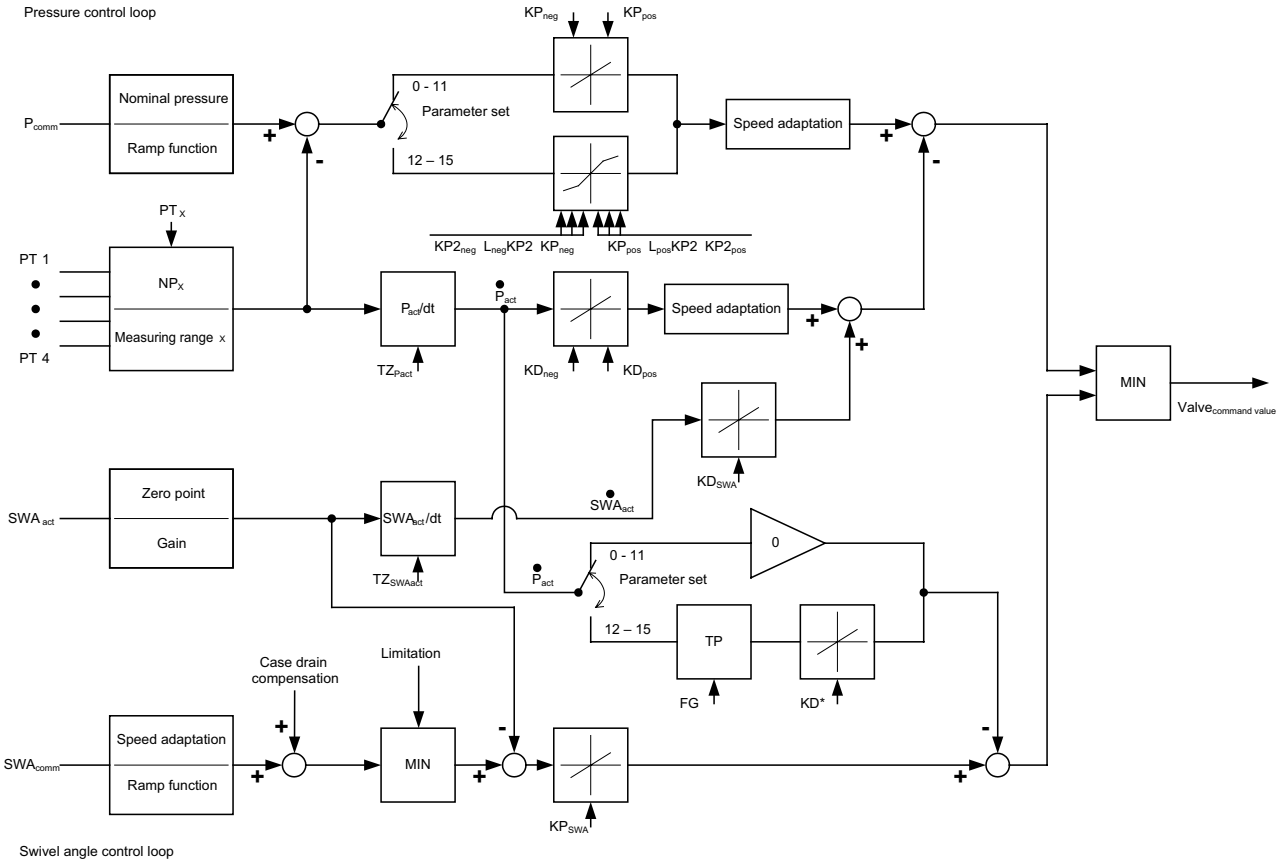


Fig. 8: Structure of the control

5.3.2 Controller parameter sets

The controller parameter sets are provided in WIN-PED® and are accessible by selecting “Project“ → “R parameter“. As standard, controller parameter sets are rated for various connected oil volumes. The controller settings in the individual parameter sets can be used as a guideline and can be changed individually by the user at any time. However, we recommend that only controller parameter sets 12 to 15 be overwritten with user-specific values. In this way, it is possible to use the default settings of controller parameter sets 0 through 11.

Table 6: Controller parameter sets for connected oil volumes

Controller parameter set	0	1	2	3	4	5	6	7
Oil volume (l)	universal	0	1	2.5	5	7.5	10	12.5

Controller parameter set	8	9	10	11	12	13	14	15
Oil volume (l)	15	20	25	30	40	10	1	universal

It is possible to switch between the individual controller parameter sets during operation. The active values of the controller parameters are always those of the currently selected controller parameter set.

5.3.3 Controller parameters

Every controller parameter set contains the following controller parameters, which are used for adapting the system to the application at hand.

Table 7: Controller parameter sets 1 - 11

Description of the controller parameters	Abbreviation
P-gain of pressure controller (positive)	$KP_{pos.}$
P-gain of pressure controller (negative)	$KP_{neg.}$
D-component of pressure control (positive)	$KD_{pos.}$
D-component of pressure control (negative)	$KD_{neg.}$
SWA-der. feedback for pressure control	KD_{sw}
Gate time of pressure actual value	TZ_{pist}
Gate time of SWA actual value	TZ_{swist}
Selection of PT input [1-4]	
P-gain of swivel angle controller	KP_{sw}
Pilot control factor for slave	

The following controller parameters are available in controller parameter sets 12 to 15.

Table 8: Controller parameter sets 12 - 15

Description of the controller parameters
DT1 pressure feedback of SWA controller
Pressure differential threshold pos. [bar]
P-gain above positive threshold
Pressure differential threshold (neg.) [bar]
LP filter time feedback of SWA controller
P-gain under negative threshold
P-gain 2nd value for SWA adaptation

5.3.4 Special operating modes

This chapter describes certain applications. In these cases, the basic operating modes (see page 20) are active.

Starting up at zero pressure

For starting up SY(H)DFEn systems, no hydraulic circuitry needs to be provided for the classical start-up at zero pressure.

When small command values for pressure and swivel angle are provided, starting up under almost no-load conditions is possible.

Circulation operation (by-pass filtration, cooling)

In the case of systems with internal supply and without pre-load valve, hydraulic circulation circuits must be dimensioned so that a minimum pressure between 8 and 12 bar is obtained, because the pump requires this pressure level to be able to respond to electrical control signals.

Stand-by operation

Operating mode of the pump, in which an operating point is statically closed-loop-controlled with a corresponding command value over a longer period of time. Observe the notes on permitted pressures in Chapter 5.4.1 “Internal/external pilot oil” (page 26).

Zero stroke operation

Operating mode of the pump that refers to the smallest, achievable swivel angle, to which the pump usually changes over when closed-loop control is not active.

Zero stroke operation can definitely only be achieved with minimum command value feedforward in the swivel angle control loop.

The feedforward of “0 bar” via the pressure command value branch is not permitted. This is valid for both, actuating systems with internal and external supply.

The following is valid when the valve electronics is de-energized:

- Zero stroke operation for the internally supplied pump
- Swiveling out to “-100%“ of the externally supplied pump

5.3.4.1 Regenerative operation

Regenerative operation is a special application of the SY(H)DFEn control system, since in this case the SY(H)DFEn control system is operated as both, generator and motor.

Continuous regenerative operation

We can distinguish between continuous regenerative operation and brief regenerative operation. In the first case, by this we understand coupling of the variable displacement pump with a fixed displacement pump. Here, the two pump displacements are combined and fed to a common consumer.

This operating mode can be utilized in conjunction with a fixed displacement pump in order to increase the displacement. To achieve “zero” displacement, the controlled pump must “take over” the entire flow from the fixed displacement pump and therefore swivels to the negative swivel angle range (motor operation). It must be noted here that both pump sizes must be matched to each other in a way that the controlled pump (in regenerative operation) must swivel in to max. “–70 %“. The fixed displacement pump should be mounted to a through-drive of the SY(H)DFEn control system.

The following pump variants are available for continuous regenerative operation:

0487: Continuous regenerative operation with external supply

0541: Continuous regenerative operation without external supply (for SYDFEn-3X only)

In the case of pump variants with external supply this operating mode is somewhat complicated in terms of design and commissioning, because the pump‘s swiveling in too far (e.g. -75 % instead of -70 %) results in cavitation. We therefore recommend master/slave operation as an alternative with two closed-loop-controlled SY(H)DFEn systems or pump variant 0541 for control system SYDFEn-3X.

For regenerative operation, the SYDFEn control pump should be selected preferably with external supply (= external pilot oil supply). In this case, order code “9” is “0487“. This option includes all the required technical modifications compared with the standard version.

Continuous operation is possible when the given operating limits are adhered to. At a total displacement of “zero” (that is, at a negative swivel angle of the SY(H)DFEn pump) and at high pressures, the noise level increases and efficiency deteriorates.

For working points with a negative swivel angle of the control pump, continuous operation shows a poorer overall efficiency than a comparable master/slave pump system or a comparable single pump. With an energy-saving machine, continuous regenerative operation would diminish the energy-saving effect. In such an application, a comparable master/slave pump system or a comparable single pump would achieve greater energy savings.

For pumps with external supply, the use of a pressure relief and anti-cavitation valve as shown in Fig. 9 is indispensable to prevent the pump’s running dry.

The parameter for continuous regenerative operation (R626) will be described in more detail in conjunction with the real-time and the teach-in version. The parameters for continuous regenerative operation are described on page 66. To simplify the command value provision, the command value can be changed over to “flow”. Then, 0...10 V at the analog input corresponds to 0...100 % displacement of the pump combination.

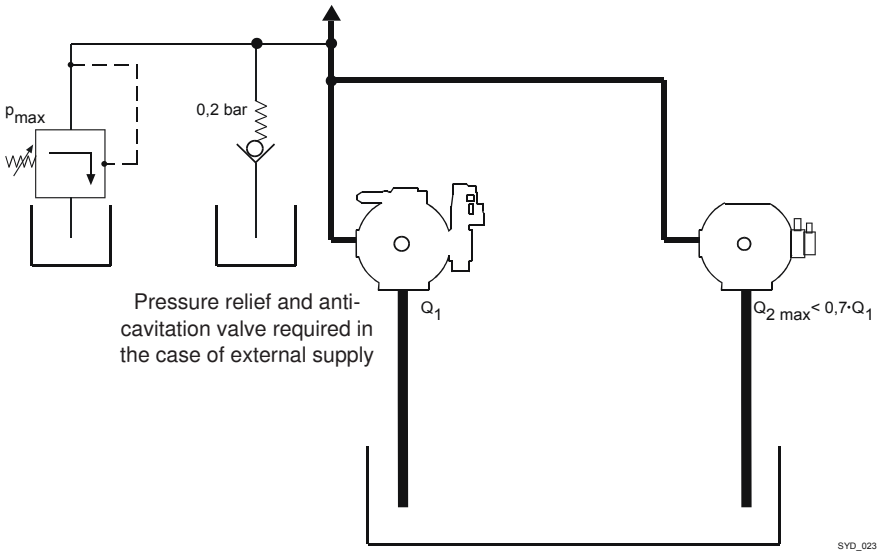


Fig. 9: Circuit diagram for "continuous regenerative operation"

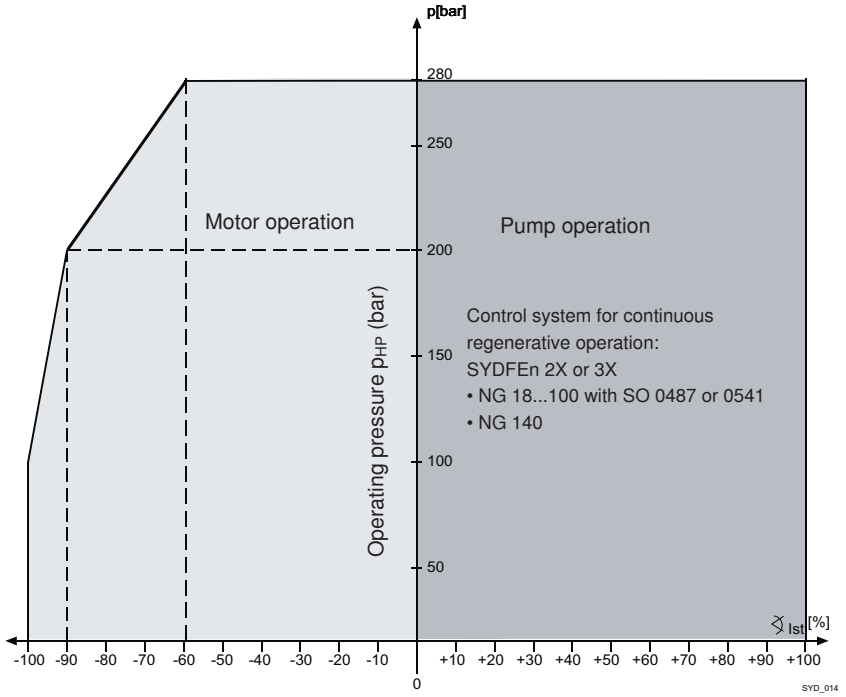


Fig. 10: Operating limits for continuous regenerative operation of series SYDFEn-2X and SYDFEn-3X with special rotary groups

Brief regenerative operation

In brief regenerative operation the variable displacement pump changes over to motor operation for a limited period of time, e.g. for pressure reduction or lowering a load. During this, the voltage in the intermediate circuit of the frequency converter rises. To prevent the frequency converter from shutting down, a braking chopper is required for a whole series of applications. Alternatively, a regenerative inverter may be used. If the requirement profile remains within the limits according to Fig. 10, the standard version of the pump with standard rotary group 0000 or 0479 can be used.

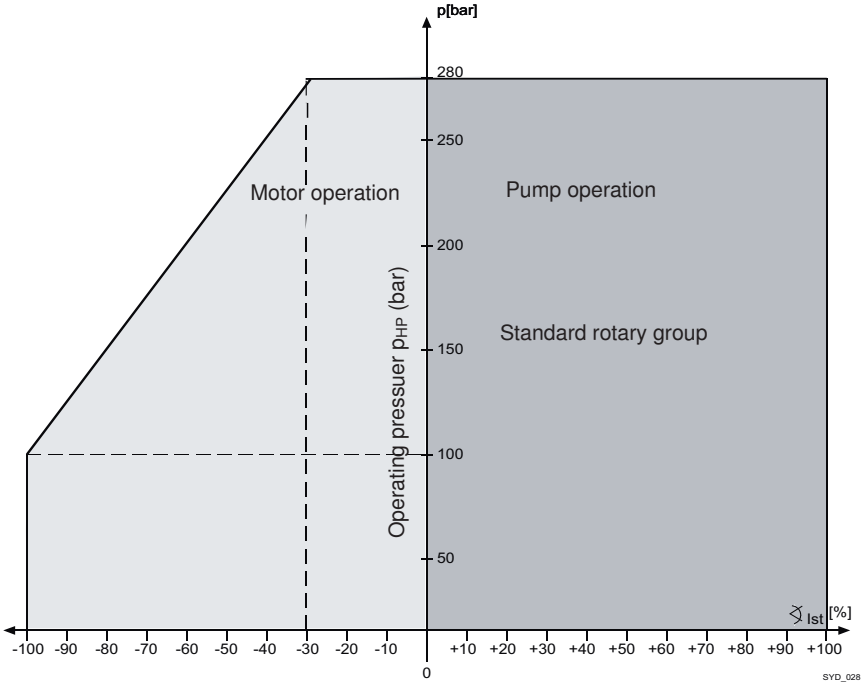


Fig. 11: Operating limits for brief regenerative operation for series SYDFEn-2X and SYDFEn-3X with standard rotary group

Regenerative operation with SYHDFEn-1X

With series SYHDFEn-1X we do not differentiate between brief and continuous regenerative operation. The operating limits are shown on Fig. 12, otherwise observe the notes given on continuous regenerative operation and brief regenerative operation on the previous pages.

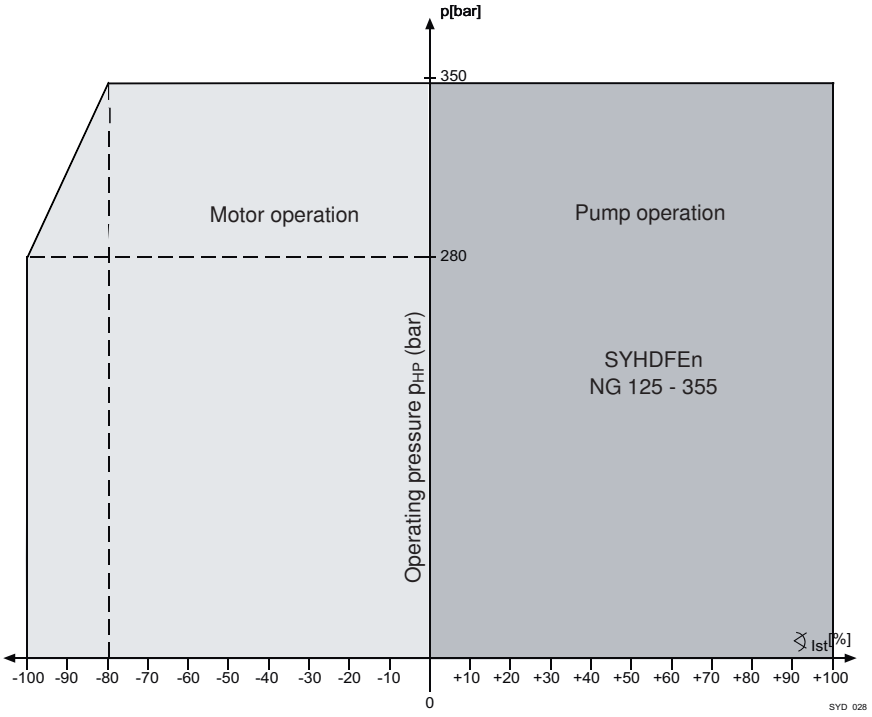


Fig. 12: Operating limits for SYHDFEn

5.4 Operating pressure limits

⚠ WARNING

Forcefully ejected parts and hydraulic fluid jet!

Risk of severe injury! The electrical pressure control does not assume a pressure relief function.

- Make certain that the maximum operating pressure is never exceeded.
- If a pre-load valve is installed, you can utilize its pressure relief function. If no pre-load valve is installed, provide a pressure relief valve, the pressure setting of which is 10 % (recommended) higher than the operating pressure, in the pressure line. Operating the system without this valve can lead to malfunction.

Maximum operating pressure

The operating pressure specified in the data sheet must not be exceeded.

At a pressure of ≥ 250 bar the following restrictions must be observed for SYDFEn **(not SYHDFEn)**:

- The pressure transducer must be located downstream of a pulsation damper or the high-pressure hose.
- When a standard pilot valve spool is used (version “A”), the pressure controller P gain may have to be reduced. This has an influence on the accuracy and dynamics of the closed pressure control loop.

Minimum operating pressure

The minimum operating pressure depends on the pilot oil supply and is described in the following chapter.

5.4.1 Internal/external pilot oil

Internal pilot oil supply

If the operating pressures in the application are always >20 bar, the version with internal pilot oil supply should be selected, because cavitation due to too small command values is impossible with this version.

Operation at ca. 12 bar or less is possible as well, but dynamics is restricted within the range below 20 bar.

This minimum (pilot) pressure level ensures that the pump can respond to the electrical swivel signal at any time. When the consumer line is blocked, the smallest achievable swivel angle is zero stroke.

In applications, in which smaller operating pressures occur or must be controlled, a pre-load valve (SYDZ on SYDFEn) should be installed. In this case, the minimum pressure is ≥1 bar.

Pre-load valve

The advantage of the pre-load valve is that the pilot oil pressure of the pump cannot fall below the value preset on the pre-load valve and that pressures ≤10 bar on the output side can be continuously controlled.

Being equipped with a pre-load valve, the pump cannot permanently swivel back over zero, irrespective of electrical actuating signals or any control errors. The smallest achievable swivel angle in steady-state operation is therefore the zero stroke. This is not valid for applications, in which, for example, a suspended load can cause operating pressures ≥12 bar. In such cases the pump can also be used in motor operation (for lowering the load). A check valve integrated in the pre-load valve permits, within certain limits, a reversal of the direction of oil flow.

When pump combinations

- NG45 with 45/28/18 or
- NG28 with 28/18 or
- NG18 with 18

are used in conjunction with the SYDZ pre-load valve on the main pump, there is a mechanical conflict of port “P1” of the pre-load valve with the position transducer housing of the rear pump fitted. For this reason, we suggest that in the case of the above combination you should use an SAE flange plate ¾“ (NG28) or 1“ (NG45) having a height of h = 45 mm on the main pump. Accordingly, the height of the pump assembly will change by dimension “h“.

External pilot oil supply

An additionally built-on sandwich plate with shuttle valve automatically switches the pilot oil supply between the internal or external pilot oil source, with always the higher pressure level being selected.

A pump with external pilot oil supply can be recognized by

- the sandwich plate mounted below the pilot valve and
- the hose routed around the pump case.

With external pilot oil supply, the actuating system of the SY(H)DFEn pump operates independently of the actual high-pressure circuit, thus allowing an actual adjustment within the range of ”±100 %“ (change in the direction of displacement!) also at an operating pressure of less than 14 bar.

When the control electronics is deactivated, the pump swivels to position “-100 %” (motor operation) in an uncontrolled manner. This can lead to cavitation and damage to the pump.

For this reason, special features are to be provided such as a pressure relief and anti-cavitation valve and an actual swivel angle value monitoring feature.

The pressure relief and anti-cavitation feature diminishes the risk of the pump’s running dry, the effects of which result in a reduction in the pump’s service life.

The actual swivel angle value monitor could, for example, switch off the entire drive or selectively shut off the pilot oil flow.

The following is valid for the actuating pressure:

Pilot oil pressure ≤ minimum operating pressure +30 bar

Recommendation: Absolute pilot oil pressure ≈ 20 bar

Further notes on operation with external pilot oil supply:

- With external pilot oil supply, the pump will not swivel to zero stroke when the pilot valve is de-energized.
- Command values for pressure and flow must always be greater than 1 bar or 5 %, because there is no exact “zero” pressure or “zero” swivel angle due to drift or inaccurate settings. For this reason, selections equal to zero or slightly greater can lead to cavitation in the worst case.
- In order to ensure sufficient lubrication for the pump system at all times, the actual pressure value must not be less than 10 bar for longer than 10 minutes!

Notes on dimensioning

At a pilot oil pressure of 20 bar, the brief pilot oil requirement during swiveling is ca. 17 l/min, and at 50 bar ca. 25 l/min. In practice, this amount of pilot oil is required only, when the operating pressure is less than 20 bar during the entire swiveling movement and thus the entire pilot oil demand must be supplied by the external source.

In the steady-state and balanced condition, the pilot oil requirement is less than 1 l/min.

Experience has shown that, depending on the operating pressure and swiveling frequency, the actual pilot oil demand is in the order of 5...15 l/min. In the case of external pilot oil supply, the pump size may be reduced by installing an accumulator.

5.5 Ambient conditions

5.5.1 Oil-immersed applications

Only the SY(H)DFE1 control system is suitable for use in oil-immersed applications. SY(H)DFEx systems with integrated electronics must not be immersed.

5.5.2 Ambient temperature

The permissible maximum ambient temperature for SY(H)DFEn control systems is 50 °C. Strictly observe the details given in current RE data sheets for the SY(H)DFEn control systems.

We recommend the installation within a ventilated area with moved ambient air, e.g. air flow of an electric motor.
This is valid in particular in view of the place of installation of the on-board electronics.

5.6 Notes on the selection of hydraulic fluids

The SYDFEn control system is designed for use of hydraulic fluids in accordance with DIN 51 524 (HL/HLP). The use of HFC is only permitted for SYHDFEn.

- ▶ Adhere to the limits with regard to temperature, viscosity, cleanliness of the hydraulic fluid as specified in the data sheet.

Operating viscosity

We recommend that the operating viscosity (at operating temperature) be within the following range, which is optimum in terms of efficiency and service life

- v_{opt} = optimum operating viscosity 16...36 mm²/s

This range is referred to the tank temperature in the open circuit.

Viscosity limits

The following values are valid for limiting operating conditions:

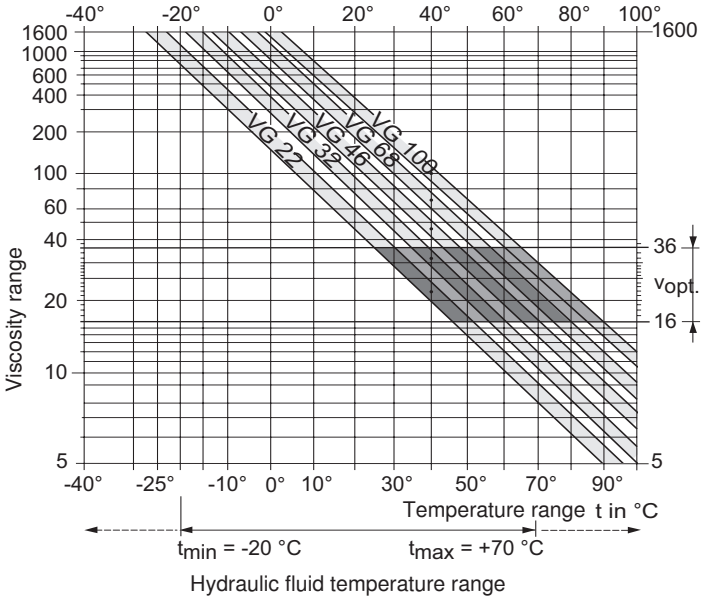
- v_{min} = 10 mm²/s
  Briefly, at max. permissible case drain oil temperature of 90 °C
- v_{max} = 1000 mm²/s
  Briefly, during cold start

Temperature range

The temperature of the hydraulic fluids lies between the following values: (cf. selection diagram)

- t_{min} = -20 °C
- t_{max} = 70 °C

Selection diagram for the hydraulic fluid



Explanations with regard to the selection:
To be able to select the right hydraulic fluid, the operating temperature in the tank (open circuit) in relation to the ambient temperature must be known.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity is within the optimal range (v_{opt}). This range is shown as shaded area in the selection diagram.

We recommend that you select the next higher viscosity class.

Example:

At an ambient temperature of X °C, the resulting operating temperature in the tank is 60 °C. Within the optimum operating viscosity range (v_{opt}; grey-shaded area) this corresponds to viscosity classes VG 46 and VG 68. You should select: VG 68.

The case drain temperature, which is subject to the influences of pressure and pump revving speed, is always higher than the tank temperature. However, the temperature must not exceed 90 °C at any point in the system.
If the conditions described above cannot be complied with due to extreme operating parameters or high ambient temperatures, please consult us.

Filtration of the hydraulic fluid

The finer the filtration of the hydraulic fluid, the better is the achieved cleanliness class, which, in turn, prolongs the service life of the SY(H)DFEn control system.

To ensure operational reliability of the SY(H)DFEn control system, at least cleanliness class 18/16/13 according to ISO 4406 (for particle sizes 4/6/14 µm) is required.

5.6.2.1 HFC fluids

The use of HFC fluids is permitted only for SY**H**DFEn control systems with option “F”. For applications using HFC fluids, it must be noted that, due to the reduced lubrication ability of HFC fluids, the service life of the SYHDFEn control system is reduced compared with standard applications.
For applications with HFC fluids, the 4-groove spool must be used for the pilot valve. The spool is specified by “C” in the ordering code of the SYHDFEn control system.

For commissioning pump systems that are operated with HFC fluids, please read the relevant commissioning instructions, which are contained in a separate document (among others, RE 92053).

5.7 Noise level

For design-inherent reasons, axial piston pumps generate greater changes in flows and thus higher pressure pulsations than, for example, vane pumps. Apart from the propagation of air- and structure-borne noise, this can have an influence on fluid-borne noise. In the end, these factors together result in the total perception of “noise”.

Noise often induces vibration on other components, which, in turn, also generate noise. For example, on check valves, which may be installed, the integrated springs must be adapted to the conditions of the systems, if they are a cause of excitations that lead to the generation of noise.

The details given in the data sheets for the noise pressure level refer to measurements taken in an anechoic room. Influences of the surroundings such as place of installation, general mechanical concept, piping, etc. are not taken into account.

5.7.1 Generation of noise in the power unit

“Noise“ is composed of different elements. The total result of “noise” is influenced not only by air-borne noise, but also by structure- and fluid-borne noise.

As a result of unfavorable installation and piping conditions, the noise pressure level of the complete system can be 5 to 10 dB(A) higher than the value of the pump alone.

The following measures can be used for reducing noise:

- Low-noise tank
- Damping ring between pump and pump mounting bracket
- Flexible pipe conduit
- Anti-vibration rails under the motor
- Installation of the pump at a sufficient distance to the tank wall

5.7.2 Pulsation damper

For some special applications, the use of a pulsation damper is recommended. Due to the reduction of typical pump pressure pulsation, this has a positive effect on the noise level of the hydraulic system as a whole.

Further information can be found in data sheet RE 50142.

5.8 Shaft variant

The SY(H)DFEn control system is available with keyed or splined shaft. Compared with the keyed shaft, the splined shaft is not only advantageous with regard to its degrees of freedom in terms of assembly and operation, but also due to its increased torque load-carrying capacity and its stability under changing loads.

This increased torque load-carrying capacity is advantageous in particular when pump combinations are to be installed. In the case of multiple pumps, all built-on units are fitted with splined shafts.

In view of the dynamic load carrying capacity and standardization, we recommend the use of standard types with splined shafts. This offers advantages with regard to availability and future spare parts requirements.

When a splined shaft is selected, a clamp coupling must be used for the mechanical connection to the electric motor. Otherwise, frictional corrosion may occur that leads to damage to the pump.

Notes on the permissible maximum transmission of torques can be found in the data sheet.

Keyed shaft

Due to the advantages of the splined shaft, keyed shafts are not recommended for new applications. Keyed shafts are no longer used for applications with through-drive.

If a single pump is to be used later as “end pump” in a multiple-pump system, we recommend the use of a splined shaft right from the start.

Splined shaft

Splined shaft profiles depend on the size (NG) of the pump. Two different splined shaft profiles are available in conjunction with “SY(H)DFEx“ :

- “S“-profile for NG18, NG100 and NG140
- “R“-profile for NG28 ... 71

When compared with the “S”-profile, the “R”-profile offers further improved properties with regard to the torque carrying capacity of the shaft. This version represents the optimum for a wide variety of applications.

5.9 Spool variants of the VT-DFPn-x-2X pilot valve

The standard spool according to the ordering code is spool type “A“ (360° spool). The 4-groove spool of type “C“ is also allocated to SYHDFEn as standard for applications using HFC media.

5.10 Master/slave operation

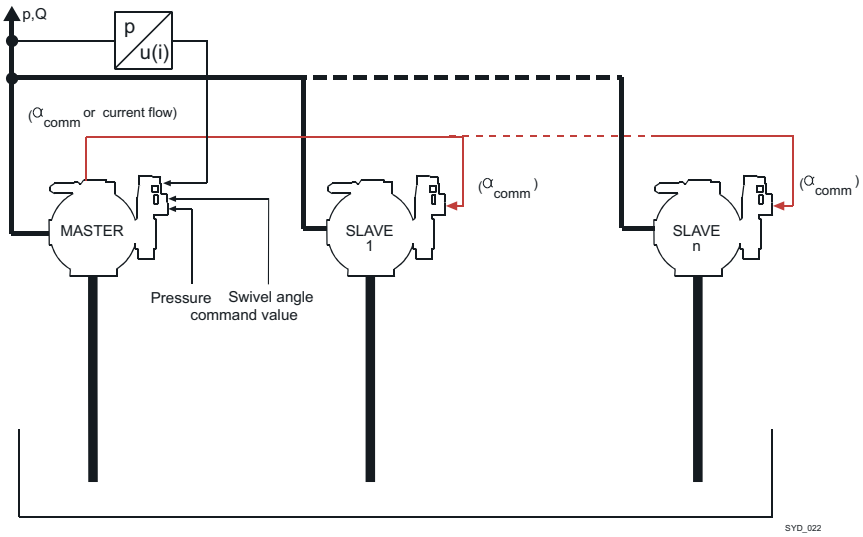


Fig. 13: Hydraulic coupling of SY(H)DFEn control systems

The master/slave function described in this chapter refers to the control of pressure and swivel angle of several pumps that are operated at the same speed

and displace hydraulic fluid into one hydraulic circuit (and cannot be separated). A further solution, in which several SY(H)DFEn pumps are operated at one shaft and displace fluid into different hydraulic circuits, is the multiple-circuit function. More information on the multiple-circuit function can be found in supplementary information RE 30014-02-Z.

Theoretically, an optional number of SY(H)DFEn control systems can be hydraulically coupled to achieve greater flows.

In this case, it is just required to determine a master pump to which the pressure transducer has to be connected.

The master controls both, pressure and swivel angle, in accordance with the externally provided command values and passes its actual swivel angle value or actual flow value on to the slave pumps. On the basis of this value and the current speed, the pumps calculate their own swivel angle command value. This ensures smooth and synchronous swiveling of the pumps.

Consequently, the slave pumps operate exclusively in the closed swivel angle control loop, which is the reason why in this operating mode no pressure transducer signal may be fed to their control electronics.

Flow command value provision for the slave can only be used in conjunction with a CAN bus. For more detailed information, please refer to the CAN bus description RE 30014-02-Z. In pure analog master/slave operation, merely the actual swivel angle value is passed on to the slave. To this end, “SWA command value for slave” must be selected as output variable for analog output 2 (R608).

5.10.1 Circuitry of SY(H)DFEn

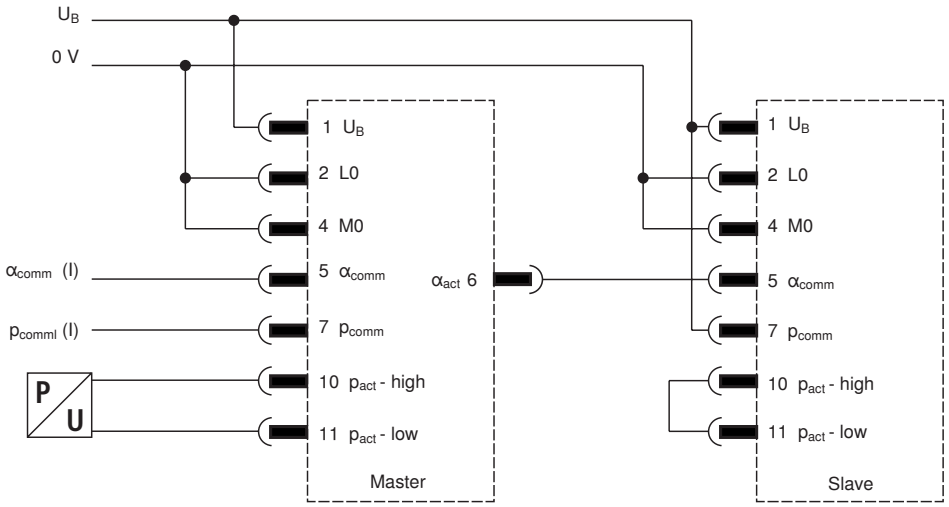


Fig. 14: Circuitry of SY(H)DFEn for master/slave operation (analog)

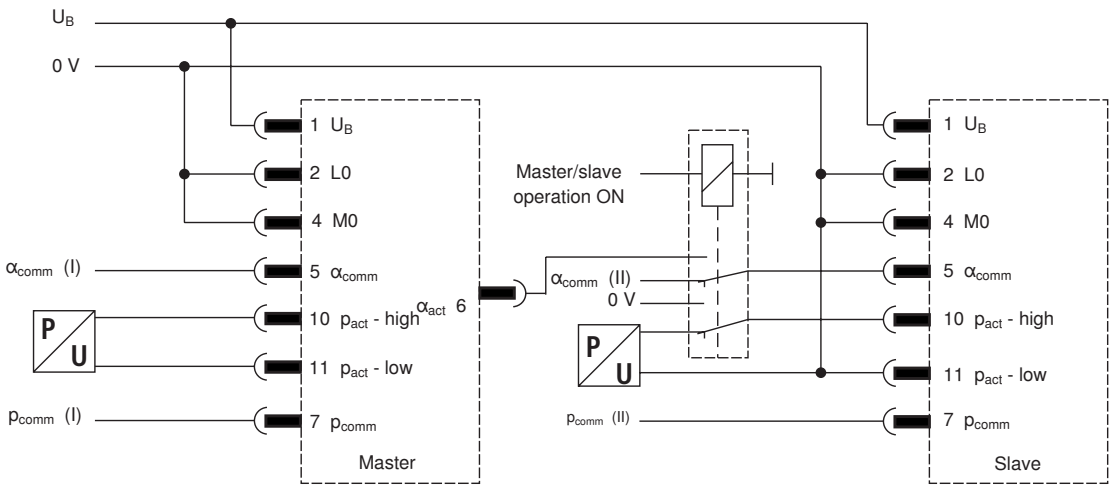


Fig. 15: Circuitry of SY(H)DFEn for master/slave operation and independent individual operation (analog)

Notes:

- Select the electronics for the slave axis in the variant “pressure transducer with voltage input 0...10 V“ (“SY(H)DFEn/...V...“).
- The connection for the position transducer of the pumps is not drawn here.
- The coupling element (relay, analog switch) can be optionally installed to control both pumps independently of one another. With the proposal shown here, both, swivel angle and pressure control, are possible with the slave pump.
- For the master/slave operating mode, the signal p_{comm}(II) must be set to maximum (+10 V).
- If closed-loop pressure control is to be possible in the master/slave operating mode, only the pressure transducer of the master is evaluated for controlling purposes. If hydraulically separated operation should also be possible, a separate pressure transducer is required also for the slave.
- If the signal branch of the slave axis’ pressure transducer is not provided with a specific circuitry, its pressure controller could interfere with the swivel angle control, when the actual pressure value p_{act}(II) reaches values in the order of ca. 80 % or higher of the command value p_{comm}(II). This can be avoided by connecting a “0 V” signal instead of the pressure transducer output signal to pin 10 via a second channel of coupling element “K1” in the master/slave operating mode. Make sure that the P- and D-controller parameters on the slave are not set higher than those of the master.

5.10.1.1 Changing over to master/slave operation (analog)

Starting point 0 V reference potentials of the PLC/command value source and M0/L0 of the SYDFEn electronics must be connected.

▶ Operate both pumps until they reach the point shortly **before** they change over to closed-loop pressure control (low, identical pressure level) and are still hydraulically uncoupled from each other. Approximately identical actual swivel angle values would be optimal. Both flow command values (usually 100 %) are still provided by the control.

When a pre-load valve is used, the pump fitted with the pre-load valve should preferably be used as master pump.

Changing over to master/slave operation

At a small operating pressure, the flow command value, which was received from the control, is withdrawn from the slave pump and the actual swivel angle value provided by the SY(H)DFEn electronics of the master pump is fed forward to the slave pump via a changeover contact (or, alternatively, a wear-free analog switch), which is suitable for small signal voltages.

The pressure command value of the slave pump is set to 100 % (if required, via a second changeover contact or by means of software) in order that closed-loop pressure control of this unit is quasi switched off.

Now, the hydraulic short-circuit valve (connection of the previously separated pressure circuits) can be activated. An adjustment of delayed activation of this valve may be required, depending on whether this would improve the system characteristics in the changeover process (the activation would also be conceivable with hydraulic switching delay).

Deactivating master/slave operation

In the master/slave operating mode it is also useful that the control keeps the two swivel angle command values for the master and the slave pump synchronized in order that striking differences in the signal level are prevented when the swivel angle command value source for the slave pump is changed (from actual swivel angle value of the master pump back to the control output).

Before the slave pump is changed over to individual operation, the pressure command value of the slave pump must be set to the same level as that of the master pump (jerk-free changeover).

Connection of unused, electrical signal inputs

All the analog inputs that are not used, e.g. actual pressure value input in the case of flow control, should preferably be connected to “0” Volt.

In contrast to this, unused differential amplifier inputs may also be short-circuited.

5.11 Description of the PC program WIN-PED®

The SY(H)DFEn control system can be configured and parameterized in two different ways:

1. Connection to the field bus system CANopen (see RE 30014-02-Z; if required, please ask your responsible contact in the sales organization of Bosch Rexroth).
2. Use of the Bosch Rexroth Software WIN-PED®

The software WIN-PED® 5.10 can be downloaded free of charge at the Rexroth web site in the section “SYDFEn“ under “Download“:

`http://www.boschrexroth.com/sydfe`

5.11.1 Configuration interface

The data exchange between the PC program WIN-PED® and the SY(H)DFEn control system is handled via the serial interface (COM interface). The SY(H)DFEn’s RS232 interface is an M12 mating connector.

For the pinout of the plug, see page 56.

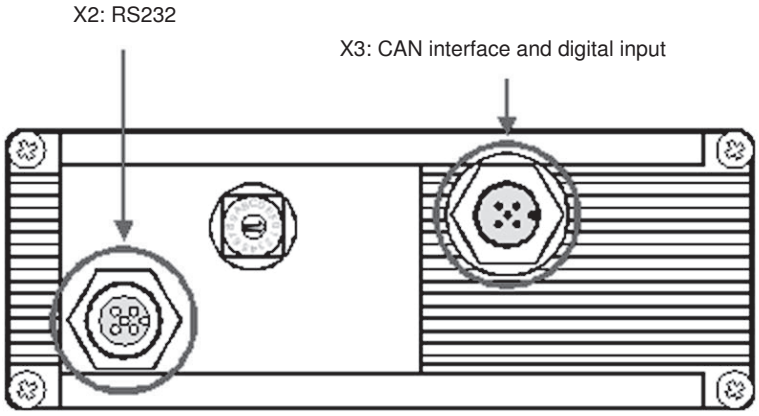


Fig. 16: Configuration interface

5.11.2 System requirements

Install the Bosch Rexroth software WIN-PED® version 5.10 on a PC with operating system Windows 95 or higher.

Under Windows Vista or Windows 7 you must start WinPed 5.10 and WinView 2.3.1 in the Compatibility Mode for Windwos XP.

5.11.3 Firmware update

⚠ CAUTION

Uncontrolled movements of the drive!

Risk of injury! All data in the control are overwritten and a software reset is executed on the control!

- Switch the drive motor off! A software reset corresponds to a power-on reset of the control and may only be carried out when the system is in a safe condition..

The latest firmware is made available by Rexroth together with the project files. You can transfer a new firmware to the control by selecting menu item “Communication” → “Send firmware” in the “Bus overview” view. The subsequent initialization of the control can be started by selecting menu item “Communication” → “Initialize control”.

For transferring a new firmware, the PC must be connected directly to the control via a serial interface (point-to-point connection). In addition, it is recommended that the CAN bus connection to other CAN stations (SY(H)DFEC and SY(H)DFEn) be interrupted before the firmware is transferred to the SY(H)DFEn control system.

The latest firmware projects are also made available on our Rexroth website in the section “SYDFEn” under “Download”:
`http://www.boschrexroth.de/sydfe`

5.11.4 Program parts of the PC program WIN-PED®

The PC program WIN-PED® for control type SY(H)DFEn comprises several program parts as shown below.

The general handling of the software is explained in the Online Help, which you download together with the program. The parameters relevant for the SY(H)DFEn control system are described in Chapter 8 “Commissioning“ from page 60 on.

Table 9: Program parts of the PC program WIN-PED®

Program parts	Description
MACHINE DATA	- Calibration function for the SY(H)DFEn control system - Fault log (error memory)
R-PARAMETER	Display and changing of R-parameter values
DIAGNOSIS	Visualization of process variables and status messages
MEASUREMENT	Recording of values or states of the SY(H)DFEn control system

The program parts are displayed when you double-click to the relevant control (e.g. DFEn_v830_) in view “Overview“ .

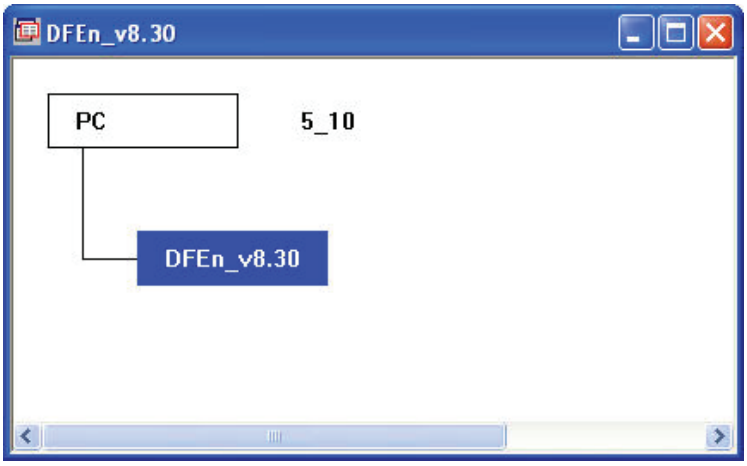


Fig. 17: “Overview” view in WIN-PED®

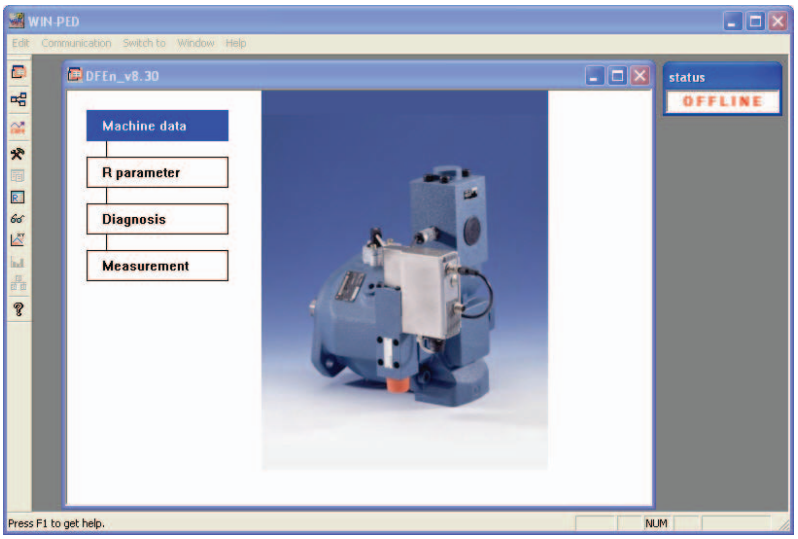


Fig. 18: View of current control in WIN-PED®

5.11.5 Program part “Machine data“

The program part “Machine data“ includes calibration functions for the SY(H)DFEn control system as well as a fault log (“error memory”) containing the last 10 faults.

Detailed information about the calibration of the SY(H)DFEn control system can be found in Chapter 8.1.10 “Calibrating the SY(H)DFEn control system“ on page 75.

5.11.6 Program part “R parameter”

In the program part “R Parameter“ you can view and edit numerical values of R parameters. The R parameters are assigned to several groups and can be accessed by selecting menu item “Switch to” → “R parameters“.

Changing R parameters

Each R parameter can be changed within the valid limits shown. To this end, select the R parameter to be changed with the help of the cursor key and enter a new numerical value.

Note: Changed values are not automatically transferred to the SY(H)DFEn control system.

Changed R parameter values can be sent to the SY(H)DFEn control by selecting menu item “Communication” → “Send changed” in the ONLINE mode. A transfer to the control is only possible, if an ONLINE connection has been established with the SY(H)DFEn control.

Retrieving R parameters

To retrieve all R parameter values from the control to the PC, select menu item “Communication” → “Fetch all parameter values” in the ONLINE mode.

This function can only be executed after the operating mode was switched to ONLINE with the help of menu command “Communication” → “Online”.

5.11.7 Program part “Diagnosis“

The “diagnosis“ program part shows all current states and values of process data.

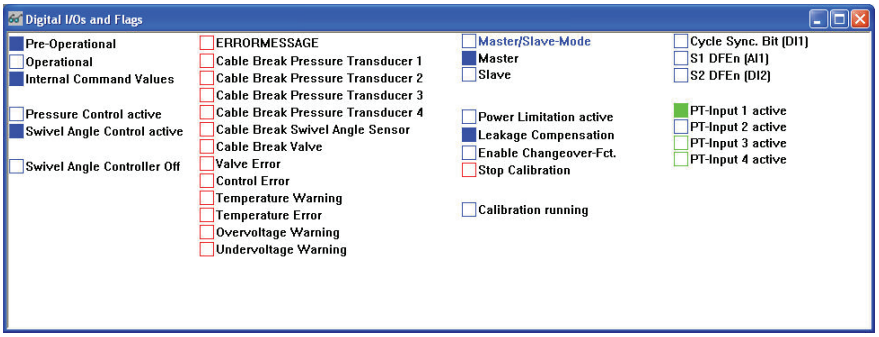


Fig. 19: Error messages in the program part “Diagnosis

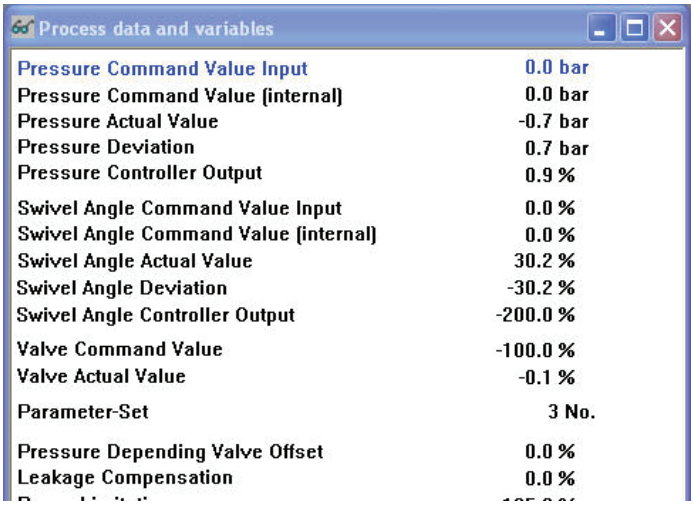


Fig. 20: Process data and variables

5.11.8 Program part “Measurement“

In the “Measurement“ program part, current states and values of process data can be recorded. Up to 4 parameters can be recorded simultaneously. Recording can be started by a trigger variable. The trigger variable can be both, a state or a value of a process datum.

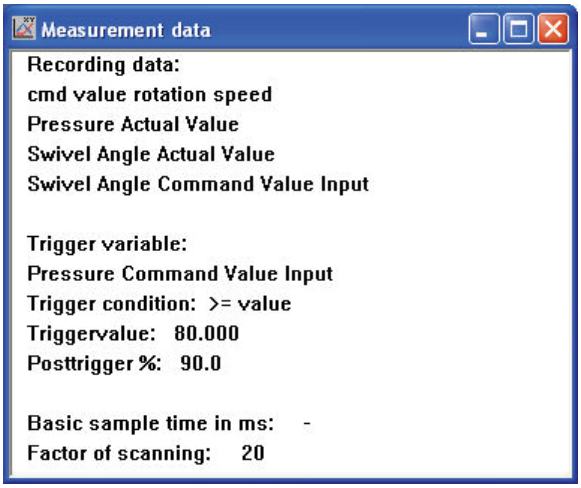


Fig. 21: Measured data

The variables to be recorded and the trigger variables can be set by selecting menu item “Edit”. The recording and displaying of values is determined in menu item “Communication“.

5.12 Activation sequence of electronics/hydraulics

Due to various monitoring routines that are implemented in the electronics, unfavorable activation sequences may result in error messages. These error messages lead to uncertainty, even if they have no “real” cause of error.

In principle, it is valid that all SY(H)DFEn control systems that are provided with internal pilot oil supply, automatically swivel to the operationally safe “zero stroke” position when no voltage is supplied or when an error message is present.

However, a precondition for zero stroke is a minimum pressure between 8 and 12 bar, which the pump has to build up as pilot pressure. This can always be ensured, when no oil can flow away from the pump output (e.g. actuator line hydraulically blocked).

Please observe special characteristics in the case of suspended loads!

Digital electronics SYDFEn:	ON:	• Voltage supply of the electronics • Switch motor on • Suppress error messages until setpoint speed is reached • Open check valve (if provided)
	OFF:	• Command value provision: α_{comm} = 5 % and p = 10 bar • Close check valve (if provided) • Suppress error message • Switch electric motor off • Switch voltage supply of electronics off

5.13 Identification of the product

The SY(H)DFE control system can be identified by the nameplate. The example below shows the example of a SY(H)DFEE nameplate.

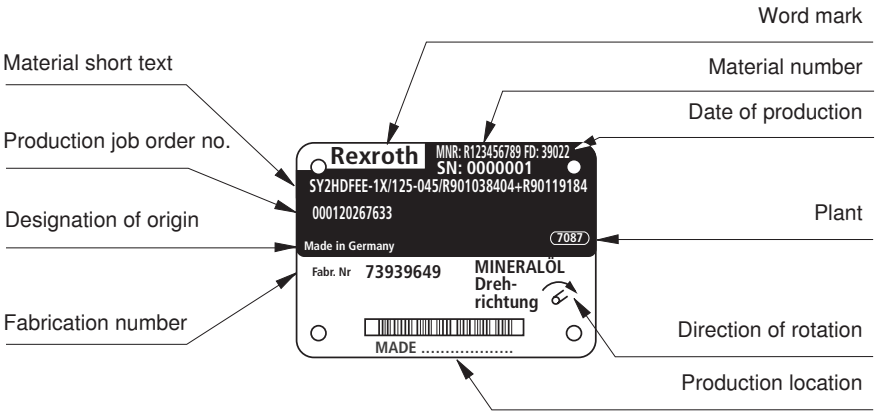


Fig. 22: Nameplate

For queries with regard to the pump combination you must have the material number and the fabrication number at hand.

6 Transport and storage

6.1 Transporting the SY(H)DFEn control system

Transport SY(H)DFEn control systems with a fork lift truck or suitable lifting gear and observe the safety instructions.

Dimensions and weights

Table 10: Dimensions and weights

SYDFEn 2X / size			18	28	45	71	100	140
Weight	Pump without through-drive, incl. pilot valve	kg	14	17	23	35	47	62
	In addition, pre-load valve	kg	3.3	3.3	3.3	6.3	6.3	6.3
	In addition, with external actuating system supply	kg	2	2	2	2	2	2

SYDFEn 3X / size			71	100	140
Weight	Pump without through-drive, incl. pilot valve	kg	49	71	75
	In addition, pre-load valve	kg	6.3	6.3	6.3
	In addition, with external actuating system supply	kg	2	2	2

SYHDFEn 1X / size			125	180	250	355
Weight	Pump without through-drive, incl. pilot valve	kg	100	115	197	220

The dimensions vary with the unit type. The values applicable to your SY(H)DFEn control system can be found in the installation drawing or the data sheet of the control system.

Carrying the SY(H)DFEn control system

SY(H)DFEn control systems of a low weight can be transported manually, if required (the weight for brief lifting should not exceed 15 kg for women and 25 kg for men).

CAUTION! Risk of health damage!

Lifting heavy control systems involves the risk of health damage!

- ▶ When transporting the SY(H)DFEn control system, apply suitable techniques for lifting, lowering and relocating or use suitable lifting gear.

6.1.1 Transporting with lifting gear

Please observe the following points for transporting:

- Properties of the load (e.g. weight, center of gravity, mounting and attachment points).
- Way of attaching or suspending the load
- Make sure that the load carrying capacity of the lifting gear is sufficient for transporting the SY(H)DFEn control system without any risks.
- Use textile lifting slings in accordance with DIN EN 1492-2.

For further information on transportation, please contact Bosch Rexroth.

For transporting, the SY(H)DFEn control system can be connected to a lifting device using an eye bolt or a lifting strap.

Transport with eye bolt

The drive shaft can be used to transport the SY(H)DFEn control system as long as only outward axial forces occur. Thus, you can suspend the SY(H)DFEn from the drive shaft.

- To do this, screw an eye bolt completely into the female thread on the drive shaft. The size of the thread is stated in the installation drawing.
- Make sure that the eye bolt can bear the total weight of the SY(H)DFEn control system plus approx. 20 %.

You can lift the SY(H)DFEn control system without any risk of damage as shown on Fig. 23 using the eye bolt screwed into the drive shaft.

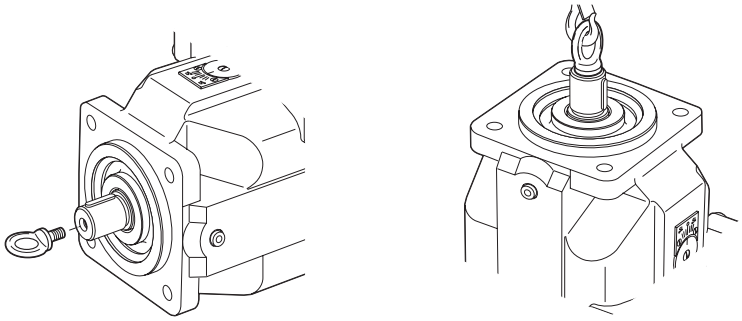


Fig. 23: Fixing the eye bolt

Transport with lifting strap

- Place the lifting strap around the SY(H)DFEn control system in such a way that it neither passes over the attached parts (e.g. valves) nor such that the SY(H)DFEn control system is hung from attached parts (see Fig. 25).

CAUTION! Control system falling down!!

During transport with a lifting device, the control system can fall out of the lifting strap and cause injuries.

- Hold the control system with your hands to prevent it from falling out of the lifting strap.
- Use the widest possible lifting strap.

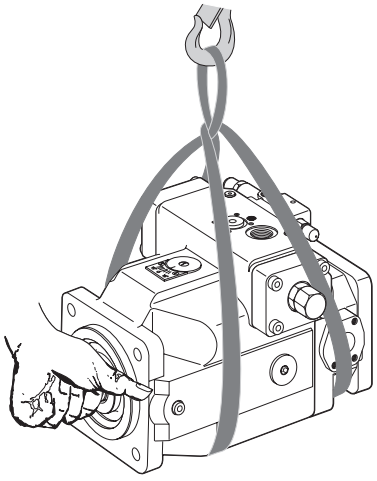


Fig. 24: Transport with lifting strap

Transport damage must be reported to your contact in the Bosch Rexroth sales organization within one week. The addresses of sales subsidiaries can be found on the Internet at:
http:/www.boschrexroth.com/adressen

6.2 Storing the SY(H)DFEn control system

Some SY(H)DFEn control systems are shipped in an anti-corrosion foil (max. storage time: 12 months). Without anti-corrosion foil, corrosion protection is limited to transport (a few days). If these control systems are to be stored, then you must provide preservation like for storage after disassembly (see below).

Requirements

- Storage rooms must be free from corrosive materials and gases.
- Storage rooms must be dry.
- The ideal temperature for storage lies between +5 °C and +20 °C.
- Avoid intense light.
- Do not stack SY(H)DFEn control systems and store them shock-proof and slip-proof.
- SY(H)DFEn control systems are very heavy (see table 10 “Dimensions and weights” on page 40). Also take account of the permissible weight-bearing capacity of your storage system.

▶ Check the SY(H)DFEn control system monthly for proper storage.

After delivery

Procedure after expiration of the maximum storage time:

1. Check the entire SY(H)DFEn control system for damage and corrosion prior to its installation.
2. Check the SY(H)DFEn control system for proper function and leaks during a test run.
3. Replace the shaft seal ring when the storage time of 24 months is exceeded.

After expiration of the maximum storage time, we recommend that you have the SY(H)DFEn control system inspected by your responsible Rexroth Service partner.

Should you have questions regarding spare parts, contact your responsible Rexroth Service partner for the SY(H)DFEn control system, see Chapter 10.5 “Spare parts” on page 111 for further information.

After demounting

If a demounted SY(H)DFEn control system is to be stored, it must be preserved against corrosion for the duration of storage.

The following instructions only refer to SY(H)DFEn control systems, which are operated with a mineral-oil based hydraulic fluid. Other hydraulic fluids require preservation methods that are specifically tailored to them. In such a case, consult with the Rexroth Service (see chapter 10.5 “Spare parts” on page 111).

Rexroth recommends the following proceeding:

1. Clean the SY(H)DFEn control system, see also Chapter 10.1 “Cleaning and care“ on page 110.
2. Drain the SY(H)DFEn control system completely.
3. For storage times of more than 12 months: Wet the SY(H)DFEn control system internally by filling in about 100 ml of mineral oil.
   For storage time up to 24 months: Fill the SY(H)DFEn control system with anti-corrosion agent VCI 329 (20 ml).
   Filling via the case drain port.

4. Plug all ports air-tight.
5. Wet non-varnished external metal surfaces of the SY(H)DFEn control system with a suitable anti-corrosion agent.
6. Pack the SY(H)DFEn control system air-tight together with a desiccant in an anti-corrosion foil.
7. Protect the SY(H)DFEn control system against impacts during storage. For further conditions, see “Requirements” in this chapter.

Always observe the general laws and regulations when handling water-endangering and harmful substances.

7 Installation

Before starting with the assembly and installation work, the following documents must be available:

- Hydraulic circuit diagram for the system (can be obtained from the system manufacturer)
- Data sheet of the SY(H)DFEn control system (contains the technical data)
- Order confirmation (contains the preset data of the SY(H)DFEn control system)

7.1 Unpacking

⚠ CAUTION

Parts falling out!

If the packaging is not opened correctly, parts may fall out and cause injuries or damage the parts.

- ▶ Place the packaging on a flat and solid surface.
- ▶ Only open the packaging from the top.

Some SY(H)DFEn control systems are delivered in an anti-corrosion foil made of polyethylene material.

- ▶ Dispose of the packaging according to the national regulations of your country.

7.2 Installation conditions

- ▶ To achieve favorable noise values, separate all connecting lines from all components that can vibrate (e.g. tank) using elastic elements.
- ▶ Make certain that the suction line, case drain line, and return line flow into the tank below the minimum fluid level in all operational states.
- ▶ Strictly observe utmost cleanliness. The SY(H)DFEn control system must be installed without any contamination. Contamination of the hydraulic fluid can significantly affect the service life of the SY(H)DFEn control system.
- ▶ Do not use any cotton waste or linty cloths for cleaning.
- ▶ Use suitable liquid detergents to remove lubricants and other difficult-to-remove contamination. Detergents must not get into the hydraulic system.

7.3 Installation positions and piping of SY(H)DFEn systems

7.3.1 General

- The installation orientation and installation position of the SY(H)DFEn control system generally determine the procedures during installation and commissioning (such as for filling the axial piston unit).
- Note that you can expect certain installation positions to affect the control behavior. Because of gravity, dead weight and case pressure, minor characteristic curve offsets and changes in the actuating time may occur.

The installation instructions are tailored to the use of the SY(H)DFEn control system. Adhering to these instructions is one of the decisive factors for the service life of the units.

The instructions refer to standard types and standard installation situations. Special installation situations require additional measures to be taken on the unit, which are documented separately.

In the following, we distinguish between the installation position (pump/motor in relation to tank) and the installation orientation (position of the pump/motor shaft end vertical, horizontal, etc.).

Installation positions

The following installation positions are possible (see Fig. 25):

- Pos. a): Pump/motor above tank (above minimum oil level)

NOTICE! Risk of damage due to loss of hydraulic fluid!

With above-tank installation, the case interior may drain through the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the unit is recommissioned.

▶ Check the hydraulic fluid level in the case interior regularly; if necessary, recommission.

- Pos. b): Pump/motor next to or below tank (below minimum oil level), with the upper edge of the case being flush with the minimum oil level.
- SY(H)DFEn control systems cannot be installed in the tank. For oil-immersed applications, use control system variant SY(H)DFE1.

The following installation positions are permitted. The pipe routing shown represents the routing principle.

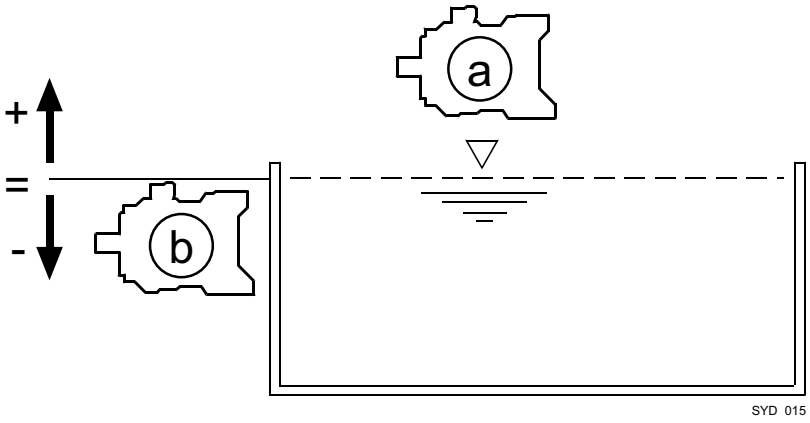


Fig. 25: Installation position

Installation orientation

The following installation orientations are possible:

- Position 1 horizontal: Shaft end horizontal
- Position 2 vertical: Shaft end upwards
- Position 3 vertical: Shaft end downwards (only possible with pump version “0975)

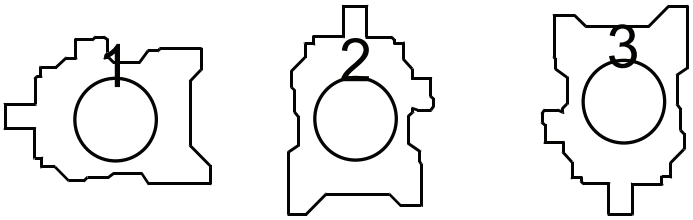


Fig. 26: Installation orientations

7.3.2 Piping

The installation positions and installation orientations shown in Figs. 25 and 26 determine the installation of

- suction lines
- case drain lines
- bleed lines.

Make sure for all installation positions that always the higher of the two drain ports “L” or “T” is piped. Moreover, the distance between the end of installed pipes and the minimum oil level must not be shorter than the specified minimum distance (immersion depth “E”).

Special points

When installing suction and drain lines, take care that the routing is straight, short and has as few bends as possible.

When the system is at rest, the lines drain automatically in the course of time due to the own weight of the hydraulic fluid.

Moreover, the different specific densities of hydraulic fluids must be taken into account, since fluids with a higher density are more difficult to aspire and also flow down more quickly. The limit speeds for hydraulic fluids with high density (≥ mineral oil 0.87 g/ml) are specified in data sheet RE 90223.

For pumps, a minimum suction pressure is prescribed for port “S” independently of installation positions and installation orientations:

minimum suction pressure ≥ 0.8 bar abs.

To establish the suction pressure (inlet pressure) p_{abs} in dependence on the displacement or speed, please observe the technical data according to RE 62240, RE 62241 and RE 62242.

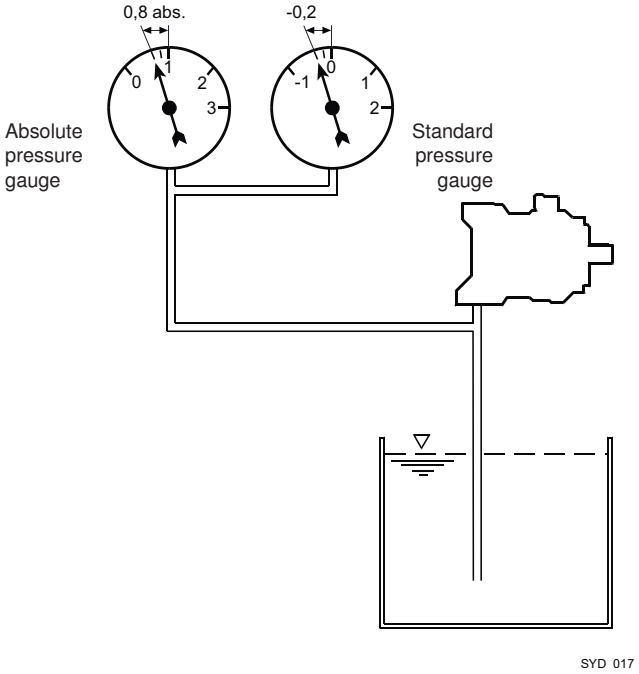


Fig. 27: Minimum suction pressure

Case drain piping

Dynamic swiveling processes result in increased case pressures that are caused by the acceleration phase of the drain oil column. They occur within milliseconds and must not exceed 6 $bar_{abs.}$. They are influenced by the inductive resistance of the drain line (Δpi = *f* (diameter, length)). Here, the flow resistance at the drain fitting on the pump case plays a subordinate role.

The Δpi value can only be improved by a larger nominal width of the case drain line.

General notes

Generally, the following must be observed:

- Pipe each pump preferably with a separate case drain line.
- Direct the case drain fluid in the case chamber via the highest case drain port and as shortly as possible (ca. 1 m) directly to the tank. Use a pipe size, which corresponds to the port size.
- If the specified line lengths are exceeded, we recommend that the nominal width be increased by one size per additional meter.
- The nominal width of the case drain line determined by the threaded connection on the pump case must not be reduced. Use “light series” pipes.
- Do not use check valves in the case drain lines.
- The case drain line should always enter the tank in the return flow chamber below the oil level. For tank designs without direct separation of the suction chamber, the drain line should be returned to the tank as far away from the suction port as possible.
- External influences of pressure, e.g. from manifold tank lines, on the pump drain port or the pump case are not permitted.

7.4 Installing the SY(H)DFEn control system

⚠ CAUTION

Uncontrolled movements of the control system!

Risk of injury.

- Make sure that the SY(H)DFEn control system is safely mounted!

NOTICE

Damage caused by missing seals and plugs!

Fluids and foreign particles can enter and destroy the product.

- Before installing the SY(H)DFEn control system, make sure that all seals and plugs are tight.

Ingress of fluid!

Fluid in the product can cause short-circuits.

- Do not install the SY(H)DFEn constrol system in a tank below fluid level (in-tank installation)!.

7.4.1 Preparation

1. Check the delivery contents for completeness and transport damage.
2. Compare the material number and designation (type code) with the details in the order confirmation.

If the material number for the SY(H)DFEn control system does not correspond to the one in the order confirmation, contact Rexroth Service for clarification. For addresses, see Chapter 10.5 “Spare parts” on page 111.

3. Before installing the SY(H)DFEn control system, completely empty it to prevent mixing with the hydraulic fluid used in the system.
4. Check the direction of rotation of the SY(H)DFEn control system (on the nameplate) and make sure that this corresponds to the direction of rotation of the motor.

The direction of rotation as specified on the nameplate determines the direction of rotation of the SY(H)DFEn control system as viewed on the drive shaft. For information on the direction of rotation of the motor, please refer to the motor manufacturer’s operating instructions.

7.4.2 Dimensions of connections

The data sheet contains the dimensions for all connections to the SY(H)DFEn control system. Also observe the instructions provided by the manufacturers of the other components when selecting the required tools.

7.4.3 General notes

When mounting and demounting the SY(H)DFEn control system, observe the following general instructions and instructions for action:

- Mount the SY(H)DFEn control system so that the expected forces and torques can be transmitted without any risks.
- The permissible axial and radial loading of the drive shaft, the permissible torsional vibration, the optimum direction of load force, as well as the limit speeds can be found in the data sheet.

7.4.4 Installation with coupling

The SY(H)DFEn control system is usually flange-mounted to a motor with a coupling. If you plan to install the unit differently, please consult us.

How to install the SY(H)DFEn control system with a coupling is described in detail in the following:

1. Mount the specified coupling half onto the drive shaft of the SY(H)DFEn control system according to the instructions of the coupling manufacturer.

The drive shaft end of the SY(H)DFEn control system is provided with a threaded bore. Use this threaded bore to pull the coupling element onto the drive shaft. Refer to the installation drawing for the dimensions of the threaded bore.

2. Make sure that the mounting spot is clean and free from dirt and foreign particles.
3. Clamp the coupling hub onto the drive shaft or ensure permanent lubrication of the drive shaft. This prevents the formation of frictional corrosion and associated wear.
4. Transport the SY(H)DFEn control system to the place, where it is to be installed.
5. Mount the coupling to the drive in accordance with the instructions of the coupling manufacturer.

The SY(H)DFEn control system must not be tightened down until the coupling has been correctly installed.

6. Mount the SY(H)DFEn control system at the installation location.
7. If necessary, details on the required tools and tightening torques for the mounting screws are available from the machine or system manufacturer.
   - For bell housing installation, check the coupling axial play through the bell window according to the manufacturer's instructions.
   - For flange mounting, align the support of the SY(H)DFEn control system with the drive.
8. When using flexible couplings, check that the drive is free of resonance after completing the installation.

7.4.5 Completing the installation

⚠ CAUTION

Ejected plastic plugs!

Risk of personal injury. Operating the SY(H)DFEn control system with plastic plugs can cause injuries or damage to the SY(H)DFEn control system.

- Before commissioning, remove all plastic plugs and replace them with suitable, pressure-proof metal plug screws, because plastic plugs are not pressure-proof.

1. Remove transport screws, if mounted.
2. Remove the transport protection.
   The axial piston unit of the SY(H)DFEn control system was delivered with protective covers and plastic plugs or plug screws. These must be removed before connecting the system. Use appropriate tools for this.
3. Make certain that the sealing and functional surfaces are not damaged.

Setscrews, if provided, are protected against unauthorized resetting by means of protective caps. Removing protective caps will void the warranty. If you need to modify the setting, please contact the responsible Rexroth Service (for address, see chapter 10.5 “Spare parts“ on page 111).
For the variant with through-drive, mount the auxiliary pump in accordance with the instructions of the pump manufacturer.

7.5 Connecting the SY(H)DFEn control system hydraulically

NOTICE

Hydraulic pipes and hoses installed under stress!

Hydraulic lines, which are installed under mechanical stress, generate additional forces during operation, which reduces the service life of the SY(H)DFEn control system and the machine or system as a whole.

- Install pipes and hoses stress-free.

Insufficient suction pressure!

Generally, a minimum permissible suction pressure at port “S” is prescribed for SY(H)DFEn control systems in all installation positions. If the pressure at port “S” drops below the specified values, damage may occur which can lead to the destruction of the SY(H)DFEn control system.

- Make certain that the necessary suction pressure is reached.
  This is influenced by:
  – appropriate piping of the suction cross-sections
  – appropriate pipe diameters
  – appropriate position of the tank
  – appropriate viscosity of the hydraulic fluid

The machine or system manufacturer is responsible for dimensioning the lines. The SY(H)DFEn control system must be connected to the rest of the hydraulic system in accordance with the hydraulic circuit diagram of the machine or system manufacturer.

Notes on the routing of lines

Observe the following notes when routing the suction, pressure and case drain lines.

- See to it that the suction line (pipe or hose) is as short and straight as possible.
- Dimension the line cross-section of the suction line so that the pressure in the suction port does not fall below the minimum permissible value and the maximum permissible pressure is not exceeded.
- Observe the air tightness of the junctions and the pressure resistance of the hose, also with respect to atmospheric pressure.
- With regard to pressure lines, make certain that the pipes, hoses and connecting elements are approved for the operating pressure range.
- Always route the case drain lines so that the housing is constantly filled with hydraulic fluid and ensure that no air enters through the shaft seal ring even over extended periods of standstill. The pressure inside the case must not exceed the limit values specified for the SY(H)DFEn control system in the data sheet under any operating conditions. The case drain line in the tank must in any case end up below the minimum fluid level (see Chapter 7.3 “Installation positions and piping of SY(H)DFEn systems” on page 44).

The ports and fixing threads are designed for the operating pressures specified in the data sheet. The machine or system manufacturer must ensure that the connecting elements and lines comply with the specified operating conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

The pressure port of the SY(H)DFEn control system of size 71 is provided with threads for two standard flange patterns:

SAE 1“ (dot-and-dashed line) for pressures above 250 bar and

SAE 1 ¼“ (dotted line) for pressures up to 250 bar.

Because standard flanges according to SAE 1 ¼’’ are permitted up to 250 bar only, the porting pattern to SAE 1” must be used in the case of operating pressures higher than 250 bar.

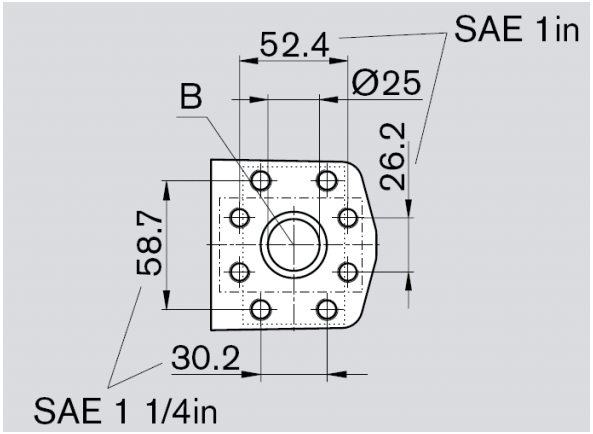


Fig. 28: Flange pattern

Procedure

To connect the SY(H)DFEn control system to the hydraulic system:

1. Remove the plug screws from the ports that are to be connected according to the hydraulic circuit diagram.
2. Use only clean hydraulic lines.
3. Connect the lines according to the hydraulic circuit diagram.
   All pipes or hoses must either be connected to the relevant ports according to

the installation drawing and machine or system circuit diagram or the ports be plugged using suitable plug screws.

The installation drawing contains the dimensions for all connections to the SY(H)DFEn control system. Also observe the instructions of the manufacturers of other hydraulic components when selecting the required tools.

4. Make sure
   - that the cap nuts are correctly tightened on the fittings and flanges (observe tightening torques!). Mark all checked fittings using e.g. a permanent marker,
   - that the pipes and hoses and every combination of connecting pieces, couplings or connecting points with hoses or pipes have been inspected by a technically qualified person for their safe working condition.

Tightening torques

The tightening torques for the SY(H)DFEn control system are listed in Table 11:

- Threaded hole in the axial piston unit:
  The maximum permissible tightening torques M_{Gmax} are the maximum values of the threaded holes and must not be exceeded. For values, see the following table.
- Fittings:
  Observe the manufacturer's instructions regarding tightening torques for the fittings used.
- Mounting screws:
  For mounting screws according to DIN 13/ISO 68, we recommend checking the tightening torque in each individual case as per VDI 2230.
- Plug screws:
  For the metal plug screws that come with the SY(H)DFEn control system, the required tightening torques of plug screws M_V apply. For values, see the following table.

Risk of mix-ups with threaded connections

SY(H)DFEn control systems are used in application areas with metric as well as with imperial systems of units.

Both, the system of units as well as the size of threaded hole and threaded plug (e.g. plug screw) must match.

Since the systems cannot be distinguished visually, there is a risk of mixing up.

WARNING! Wrong threaded plugs!

Serious risk of injury, if threaded plugs are used that differ from the threaded hole in terms of unit system and size and are pressurized. The threaded plug may loosen itself or even be ejected from the hole in a projectile-like manner. Hydraulic fluid can be discharged from this leakage point.

- ▶ Use the drawings (installation drawing/data sheet) to determine the required threaded plug for each fitting.
- ▶ Make certain that there are no mix-ups when installing valves, mounting screws and plug screws.
- ▶ For all threaded holes, use a threaded plug from the same system of units and of the correct size.

Table 11: Tightening torques for threaded holes and plug screws

Thread size of ports		Max. permissible tightening torque of threaded holes M_{Gmax}	Required tightening torques for plug screws M_V	A/F hexagon socket
M10x1	DIN 3852	30 Nm	12 Nm	5 mm
M12x1.5	DIN 3852	50 Nm	25 Nm	6 mm
M14x1.5	DIN 3852	80 Nm	35 Nm	6 mm
M16x1.5	DIN 3852	100 Nm	50 Nm	8 mm
M18x1.5	DIN 3852	140 Nm	60 Nm	8 mm
M22x1.5	DIN 3852	210 Nm	80 Nm	10 mm
M26x1.5	DIN 3852	230 Nm	120 Nm	12 mm
M27x2	DIN 3852	330 Nm	135 Nm	12 mm
M33x2	DIN 3852	540 Nm	225 Nm	17 mm
M42x2	DIN 3852	720 Nm	360 Nm	22 mm
5/16-24 UNF-2B	ISO 11926	10 Nm	7 Nm	1/8 in
3/8-24 UNF-2B	ISO 11926	20 Nm	7 Nm	5/32 in
7/16-20 UNF-2B	ISO 11926	40 Nm	15 Nm	3/16 in
9/16-18 UNF-2B	ISO 11926	80 Nm	25 Nm	1/4 in
3/4-16 UNF-2B	ISO 11926	160 Nm	62 Nm	5/16 in
7/8-14 UNF-2B	ISO 11926	240 Nm	127 Nm	3/8 in
1 1/16-12 UN-2B	ISO 11926	360 Nm	147 Nm	9/16 in
1 5/16-12 UN-2B	ISO 11926	540 Nm	198 Nm	5/8 in
1 5/8-12 UN-2B	ISO 11926	960 Nm	320 Nm	3/4 in
1 7/8-12 UN-2B	ISO 11926	1200 Nm	390 Nm	3/4 in

7.6 Connecting the SY(H)DFEn control system electrically

The machine or system manufacturer is responsible for the layout of the electrical control.

For electrically controlled SY(H)DFEn control systems, the electrical control must be connected according to the circuit diagram of the machine or system manufacturer.

Damage caused by incorrect installation is not covered by the warranty!

1. Disconnect the relevant system part from the power supply.
2. Connect the SY(H)DFEn control system electrically (24 V).

7.6.1 Cabling of electronic components

Generally, the following is valid:

- Keep the number of intermediate terminals to a minimum.
- The arrangement of electromagnetic sources of interference in the direct vicinity of the pilot valve is not permitted.
- Installing power cables in the vicinity of the pilot valve is not permitted.
- Due to the use in a hydraulic environment, use only cable material that is specified as “oil-proof”. Otherwise, possible hardening of the cable jacket

could lead to hardening/embrittlement and thus to breaking of individual wires.
- Select only cables that have the actually required number of wires (avoid superfluous wires).
- Cables for command and actual values should be as short as possible.
- The signal cable to the pilot valve must in any case be shielded. The cable shield must be connected to ground on one end in the control cabinet.
- Strip the shield as short as possible and connect it in accordance with the data given in the RE data sheets.
- The contacts on the mating connector must not be exposed to mechanical stress. This can lead to a defective connection between the mating connector and the plug-in connector.

Due to the fact that the control electronics is integrated in the valve housing in the factory, no additional cabling is required for the position transducer systems of the pump and the valve.

Cabling of the control system is therefore restricted to the connection of the 12-pin central connector of the integrated electronics to the customer's control, the connection of the pressure sensor and the connection to the CAN bus, if provided.

For this connection, ready-to-connect and standardized cable kits are available in different lengths. On request, the 12-pin mating connector can be supplied separately for the individual assignment of contacts. See data sheet.

The HM16-1X/C13 pressure transducer is fitted with a ready-to-connect, standardized connection cable for direct connection to the VT-DFPn-x-2X/...F... electronics.

7.6.2 Electrical connection of the pilot valve

Pinout of the central plug-in connector

The following table shows the pinout of central plug 11 +PE for pilot valve VT-DFPn. The column "Code" refers to the cable kit that is available as optional extra.

The following cable kits can be ordered from Bosch Rexroth:

Type: Connection plug 11 +PE for central plug-in connector X1

- Without cable (construction kit) Mat. no. R900884671
- With cable kit 2 x 5 m Mat. no R900032356
- With cable kit 2 x 20 m Mat. no. R90086039

Table 12: Signals to the central plug-in connector

Pin	Signal	Description	Signal direction	Signal level	Code
1	+ UB	Voltage supply	IN	+24 V (-5 % +40 %)	1
2	L0	Reference potential for voltage supply	-	-	2
⏚	Ground	Grounding connection for electronics	-	-	Yellow/ green
3	Fault	Signals faults: - Cable break - Control monitor - Temperature - Voltage monitor	OUT	0 V = error +24 V = no error	White
4	M0	Reference potential for analog signals	-	-	Yellow
5	U in 2	Analog input 2	IN	±10 V	Green
6	U out 2	Analog output 2	OUT	±10 V	Violet

Pin	Signal	Description	Signal direction	Signal level	Code
7	U in 1	Analog input 1	IN	0 to +10 V	Pink
8	U out 1	Analog output 1	OUT	±10 V	Red
9	Digital IN1	Digital input DI1: Depending on option (code “12” in the ordering code): - Teach-in version: Synchronization bit - Real-time version: Activate real-time operation	IN	Logic 0 (low) < 8V Logic 1 (high) > 14V	Brown
10	Actual pressure value High	Actual pressure value signal from pressure transducer	IN	0-5 V 0.5-5 V 0-10 V 0.1-10 V 1-10 V 0-20 mA 4-20 mA	Black
11	Actual pressure value Low	Reference potential to actual pressure value signal (p_{act} High)	-	-	Blue
n.c.					Gray

Note: Connections M0 and L0 must be connected in the control cabinet to avoid potential shifts.

7.6.3 Connection to the swivel angle sensor

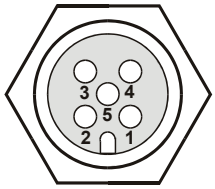
The swivel angle of the pump is sensed by swivel angle sensor VT-SWA, which is connected to the VT-DFPn pilot valve in the factory. The sensor is supplied by the VT-DFPn pilot valve.

7.6.4 Connection X2 (M12 mating connector, RS232, HM16 or digital input)

For connection to the serial interface (RS232), pilot valve VT-DFPn is provided with an M12 mating connector (5-pin). In addition, pilot valve VT-DFPn features an analog/digital changeover input. The input is changed over depending on the selected option (code “12” of the ordering code).

Table 13: Pinout of connection X2

Pin	Pinout X2	Signal type
1	$+U_B$	+24 V
2	RxD	
3	Reference (L0)	
4	Analog input 0.5 V ... 5 V for HM16 or digital input 0 V low, 10 V high (max. 12 V) Depending on selected option (code “12” of the ordering code): - Teach-in version: Digital input “variable-speed on, S1“ - Real-time version: Input as analog input for pressure transducer HM16	0 V low; +10 V high
5	TxD	



The status of digital input S1 of the option “Teach-in version“ in the various machine modes is shown in table 118 on page 126.

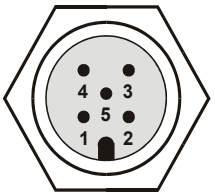
With the option “teach-in version“, pressure transducer HM16 can only be connected to X2, if the SYDFEn control system system is activated over CAN bus.

7.6.5 Connection to CAN bus and digital input 2 (M12 plug-in connector, X3)

For connection to the CAN bus and to digital input S2 (DI2), pilot valve VT-DFPn is provided with an M12 plug-in connector (5-pin).

Table 14: Pinout of the M12 mating connector

Pin	Assignment	Signal type
1	Not used	
2	Digital input DI2 Depending on selected option (code “12“ of ordering code): - Teach-in version: Start teach-in, S2 - Real-time version: Manual provision of speed value active; speed is taken over according to the status of real-time operation and the setting of R parameters (see table 106 “Manual speed provision” on page 105).	0V low; +24 V high
3	CAN GND	
4	CAN-High	
5	CAN-Low	



The status of digital input S2 of the option “teach-in version“ in the various machine modes is shown in table 118 on page 126.

Use a shielded data cable as bus cable. The shield should be connected to the connector housing on both ends.

7.6.6 Voltage supply of the VT-DFPn pilot valve

The VT-DFPn pilot valve is supplied with 24 V DC voltage. If this voltage supply is not provided on the part of the system, power supply unit VT-NE30-2X/according to RE 29929 can be used. The 24 V supply of the power supply unit is to be connected to connections 1 (+24 V) and 2 (L0) of the mating connector.

In the case of the optional connection cable, this refers to the 2 black wires of the 3-pin cables with a cross-section of 1 mm². Connect the wire marked with “1“ to +24 V and the wire marked with “2” to L0 (ground). Connect the yellow/green wire to ground.

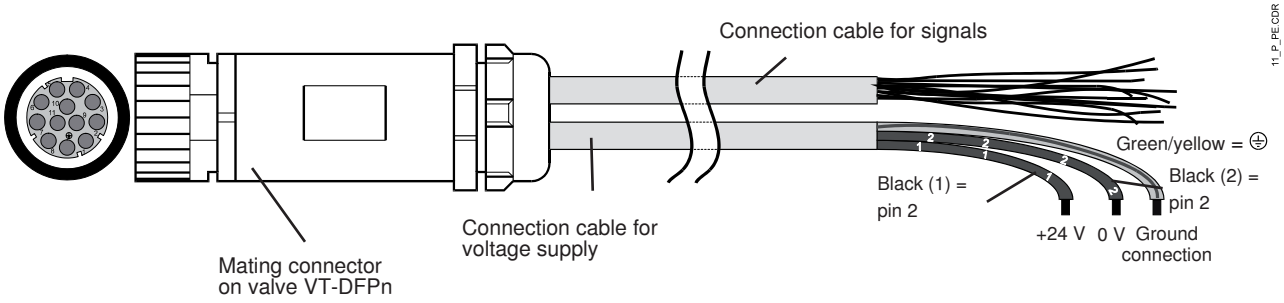


Fig. 29: Connection of voltage supply

Recommendation:

The voltage supply for the VT-DFPn pilot valve should be protected with a 1.6 A/ slow-blowing fuse on the system side.

The pilot valve is not provided with an enable input to block the function of the valve!
In the case of a fault, the pilot valve should be de-energized. Any further safety-relevant interventions must be made by the higher-level control (e.g. drive motor OFF, check valve closed, etc).

7.6.7 Selection, place of installation and mounting orientation of the pressure transducer

Selection of the pressure transducer

To reduce the number of variants, only pressure rating “315 bar” is given in the ordering code of the SY(H)DFEn control systems. If required, other pressure ratings can be combined (in conjunction with the suitable electrical interface). Such pressure transducers must, however, be ordered separately for the SY(H)DFEn control system.

In terms of signals, the sensors have to be distinguished as follows:

- Sensors with current interface
- Sensors with voltage interface.

Here, the usual signal limits are between 0...20 mA or 0...10 V, respectively.

Within these limits, further modifications are available that depend on further options, such as monitoring for cable break.

From a technical point of view, the efficiency of the pressure transducer must match with the SY(H)DFEn system in order that the best possible results can be obtained with regard to accuracy, dynamics and repeatability.

The pressure transducers recommended by us are listed in the RE data sheets of the relevant SY(H)DFEn system.

- Our pressure transducer model “HM12“ with current interface (4...20 mA) is provided with a 2-conductor connection and allows the fail-safe transmission of signals – even over greater distances (depending on the cable and permissible load of the pressure transducer).
  Further pick-offs can be looped in taking into account the relevant input resistances.
- Our pressure transducer model “HM13“ with voltage interface (0...10 V) has a 3-conductor connection and an integrated DC/DC converter, which effectively rules out disturbances on the analog signal caused by the voltage supply.
  A signal transmission over greater distances should be avoided. Parallel picking-off of the signal for evaluation purposes is also unfavorable.
  The advantage of this pressure transducer lies in the simple verification of

signals through measurement using a voltmeter, without intervention into the connection cables.

- The “HM16-1X/C13” pressure transducer has a voltage interface (0.5...5 V) with a ready-to-connect, standardized connection cable for direct connection to X2. For the “teach-in” version option, observe the notes given in Chapter 7.6.4.

CAUTION! Uncontrolled pressure increase!

Risk of injury!

- Wiring must be carried out so that the pressure transducer is not short-circuited, because the control electronics can no longer recognize the pressure when the pressure signal is missing and hence pressure increases in an uncontrolled manner.

Place of installation of the pressure transducer

Favorable places of installation of pressure transducers turned out to be not in the direct vicinity of the pump, but, for example, downstream of the (flexible) pressure hose:

- Always between pump and check valve (if fitted)
- Do not use minimess lines

For reasons of dimensions, a connection to port “MP1“ of pre-load valve SYDZ is only possible with pressure transducer HM16-1X/C13. In this case, it may be required to reduce the pressure controller gain due to higher pressure pulsation.

Mounting orientation of the pressure transducer

We recommend that the pressure transducer be suspended so that bleeding problems (and thus control oscillations) can be ruled out right from the start.

If, due to the installation orientation of the pump, a pressure transducer is installed “vertically” directly in the pump or in the pre-load valve, we recommend another place of installation for the pressure transducer.

The SY(H)DFEn control system is provided with four inputs, which can be used as pressure transducer inputs. Information on commissioning can be found in Chapter 8.1.6.4 “Adjusting the pressure transducer (PT)“ on page 66).

Pressure transducer HM12

Pressure transducers of type HM12-1X are provided with a 2-wire current interface and can be connected to the pilot valve using the central plug as shown on the figure below.

The voltage supply for the pressure transducer must be provided in accordance with the specification.

For more details about the pressure transducer, see RE 29933.

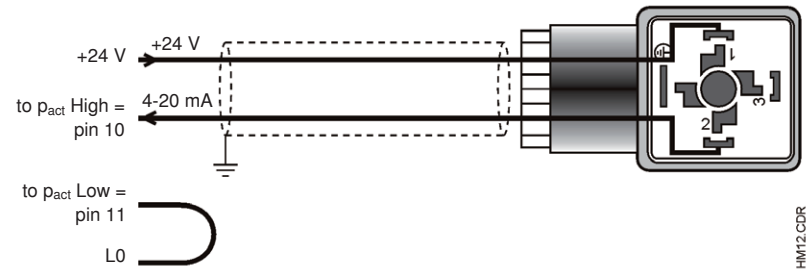


Fig. 30: Connections of HM12

Pressure transducer HM13

Pressure transducers of type HM13 are provided with a voltage output of 0...+10 V as actual pressure value signal and can be connected to the pilot valve using the central plug as shown on the figure below.

The voltage supply for the pressure transducer must be provided in accordance with the specification.

For more details about the pressure transducer, see RE 29933.

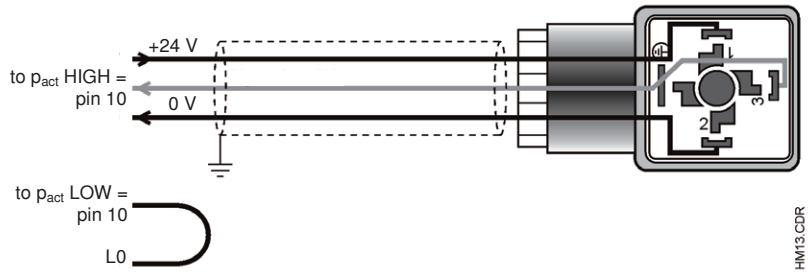


Fig. 31: Connections of HM13

8 Commissioning

⚠ WARNING

Danger while working in the danger zone of a machine or system!

Risk of serious injury caused by unsafe work in the danger zone of a machine or system.

- The machine or system may only be operated when safe working is ensured.
- Pay attention to and eliminate potential danger sources before commissioning the machine or system.
- Nobody may stand in the danger zone of the machine or system.
- The emergency stop button for the machine or system must be within the operator's reach.
- Always strictly observe the instructions of the machine or system manufacturer during commissioning.

Uncontrolled system behavior!

Non-connected electrical and hydraulic connections can cause unforeseeable functions and hydraulic fluid jets to be ejected, which can injure you.

- Only commission a completely installed product.

NOTICE

Loss of protection class due to missing seals and plugs!

Fluids and foreign bodies can enter and destroy the product.

- Before commissioning, make sure that all seals and plugs of plug-in connections are tight.

Insufficient hydraulic fluid!

Insufficient amounts of hydraulic fluid can destroy the product.

- Make sure that the housing of the SY(H)DFEn control system is filled with hydraulic fluid during commissioning and during operation. This must also be observed during longer periods of standstill, because the SY(H)DFEn control system can empty via the hydraulic lines.

Ingress of dirt!

Damage to the SY(H)DFEn control system! Contamination of the hydraulic fluid results in wear and malfunction. Especially foreign bodies such as welding beads and metal chips in the hydraulic lines can damage the SY(H)DFEn control system.

- Observe utmost cleanliness during commissioning.
- When closing measuring ports, make sure that no contamination can enter.

NOTICE

Air pocket around the bearings!

The control system can be destroyed.

- Make certain that with the “drive shaft upwards” installation position the pump case is completely filled with hydraulic fluid during commissioning and during operation.
- Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-tank installation, the case interior may drain through the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.
- Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation.

8.1 First commissioning

- When carrying out any commissioning work in conjunction with the SY(H)DFEn control system, observe the basic safety instructions and the intended use in Chapter 2 “General safety instructions“ on page 10.
- Let the product acclimate itself for several hours before commissioning, otherwise water may condense in the housing.

8.1.1 Filling the SY(H)DFEn control system

NOTICE

Spilled hydraulic fluid!

Environmental damage and contamination of the groundwater by hydraulic fluid spilled while filling the SY(H)DFEn control system

- When filling and changing the hydraulic fluid, always place a catch pan under the SY(H)DFEn control system.
- Observe the information in the safety data sheet for the hydraulic fluid and the instructions provided by the system manufacturer.

You will require an approved hydraulic fluid:

The machine or system manufacturer can provide you with precise details on the hydraulic fluid. Details on minimum requirements for mineral-oil based hydraulic fluids or HFC hydraulic fluids (for SYHDFEn) can be found in the Rexroth publications RE 92053 and RE 90223.

To ensure functional reliability of the SY(H)DFEn control system, the hydraulic fluid must comply at least with cleanliness class 18/16/13 according to ISO 4406 for particle sizes 4/6/14 µm. For permissible temperatures, please see the data sheet of the relevant control system.

The SY(H)DFEn control system should be filled using a filling and filtration unit (10 μm filtration rating). The control system must not be operated while being filled.

1. Fill and air-bleed the SY(H)DFEn control system through the appropriate ports, see Chapter 7.3 “Installation positions and piping of SY(H)DFEn systems” on page 44. The hydraulic lines of the system must also be filled.

2. Test the direction of rotation of the drive motor. To do this, rotate the drive motor briefly at the lowest rotational speed (inching). Make sure that the direction of rotation of the axial piston unit corresponds to the arrow shown on the nameplate, see also Chapter 5.13 “Product identification”, Fig. 22 on page 39.
3. Operate the SY(H)DFEn control system at low speed (inching mode) until the pump system is completely filled and bled. For checking purposes, drain the hydraulic fluid at the case drain port and wait until it drains without any bubbles.
4. Make certain that all ports are either connected to pipes or plugged according to the general circuit diagram.

8.1.2 Testing the hydraulic fluid supply

The SY(H)DFEn control system must always be supplied with sufficient hydraulic fluid. For this reason, it is essential to ensure the supply with hydraulic fluid at the beginning of the commissioning process.

When you test the hydraulic fluid supply, constantly monitor the noise development and check the hydraulic fluid level in the tank. If the SY(H)DFEn control system becomes louder (cavitation) or the case drain fluid is discharged with bubbles, this is an indication that the SY(H)DFEn control system is not sufficiently supplied with hydraulic fluid.

Notes on troubleshooting can be found in Chapter 15 “Troubleshooting” on page 117.

To test the hydraulic fluid supply:

1. Allow the motor to run at slowest speed.
   The SY(H)DFEn control system must be operated under no-load conditions. Pay attention to leakage and noise.
2. Check the SY(H)DFEn control system’s case drain line during the test. The case drain fluid should flow out bubble-free.
3. Check the suction pressure at port “**S**” of the SY(H)DFEn control system. The permissible value can be found in data sheet RE 92050.
4. Check the case drain pressure at connected port “**K_1**“ or “**K_2**“. Refer to data sheets RE 92711, RE 92714 and RE 92050 for permissible values.

8.1.3 Performing a flushing cycle

To remove foreign particles from the system, flush the entire system.

- Carry out flushing with an additional flushing unit.
- Observe the instructions of the flushing unit manufacturer for the detailed flushing procedure.

8.1.4 Connection to the control (online mode)

It is assumed that the program WIN-PED® is already installed. If not, install WIN-PED® as described in Chapter 5.11.2 “System requirements“ on page 35. Then, a project file (file with extension “_pr”) must be loaded by selecting menu item “Open” (if no project file is available, please get in touch with your contact in the Bosch Rexroth sales organization). The project will then appear on the start screen and forms the starting point for navigating through the program parts. In the following, we will use the term “Project” in the descriptions.

If a SY(H)DFEn control system is connected using an RS232 interface cable, the connection to the SY(H)DFEn control system can be established by selecting menu item “Communication” → “Online” in the “Active control” view.

Further information with regard to the handling of the PC program “WIN-PED®” can be found in the online help of the program.

Note: On the product website `www.boschrexroth.de/SYDFE` → SYDFEn you can find an overview of the latest projects for the SY(H)DFEn. Moreover, in the download section you can download the operator software WIN-PED® and current projects.

8.1.5 Setting the address

The VT-DFPn pilot valve is fitted with a rotary switch with 16 positions (0 ... F). The switch positions allow the setting of node addresses from 1 to 16. To take over a changed node address, a power-on reset must be executed.

Note: Switch positions 0...F correspond to CAN addresses 1...16 (e.g. switch position 1 = address 2).

Address = switch position + 1

In order to enable the communication with the SY(H)DFEn control system, the same address must be entered in the PC program WIN-PED® under menu item “Edit” → “Configure” → “Settings”.

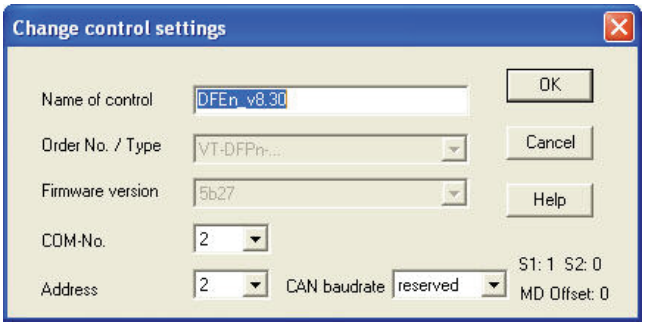


Fig. 32: Address setting

8.1.6 Making basic settings on the control electronics

To be able to make any settings, the PC program WIN-PED® must be installed. The user must configure the SY(H)DFEn control system according to the customer’s requirements. This refers mainly to the following settings:

- Setting of the nominal pressure
- Determination of the command value source
- Selection of the controller parameter set
- Setting of the pressure transducer (type, measuring range)
- Settings for variable-speed operation (SY(H)DFEn control, parameters for speed calculation, additional functions/filters, …)

Note: The configuration of the SY(H)DFEn described in the following is carried out in the program part “R parameter“ of the PC program WIN-PED®.

8.1.6.1 Setting the nominal pressure

To make the selection, click “Project“ → “R parameter“ → “Configuration“ → “Command value settings“.

Table 15: Parameter group “command value settings“

R parameter	Designation	Range of values
R660	Nominal pressure	1 - 450

By setting the nominal pressure you determine the range of values of the pressure command value and the actual pressure value, i.e. when the maximum pressure command value is fed forward (CAN bus 0x3FFF, analog +10 V), this nominal pressure is obtained.

Attention: For the indication of actual values, various normalization factors are created during the initialization process. If the nominal pressure is changed, these factors have to be re-calculated. As a result of this, a voltage reset needs to be carried out after the nominal pressure was changed.

8.1.6.2 Selecting the command value source

To make the selection, click “Project“ → “R parameter“ → “Configuration“ → “Command value settings“.

Table 16: Parameter group “command value source“

R parameter	Designation
R602	Command value source

R parameter R602 can be used for selecting the command value source.

The following table lists the different activation options for command values.

Table 17: Options “command value source”

Selection
Command values via CAN bus
Command values via the PC program WIN-PED®
Analog command value provision
Provision of command values for pressure step-changes (p-steps)
Provision of command values for swivel angle step-changes (SWA-steps)
Analog command values/regenerative (flow from 0-100 %)
Call-up command values
Pressure analog, SWA internal
Pressure load sensing

Command values over CAN bus

The command values for pressure and swivel angle are fed forward over the CAN bus (see RE 30014-02-Z; if required, please ask your responsible contact in the sales organization of Bosch Rexroth).

Command values via PC program WIN-PED®

Table 18: Command value source WIN-PED®

R parameter	Designation	Range of values
R600	Pressure command value [bar]	0 - 450
R601	SWA command value [%]	-110…+110

If the command value is provided via the PC program “WIN-PED®” the desired values can be set directly.

Analog command values

With analog command value provision, the command values for pressure or swivel angle are provided via analog input AI1 or analog input AI2.

Table 19: Analog command values

Analog input	Meaning	Connection	Pin	
			Signal	Reference
1	Pressure command value	Central plug 11 + PE	7	4
2	SWA command value	Central plug 11 + PE	5	4

For the pressure command value, a voltage between 0 V...+10 V (0 bar...xx bar) can be selected. A voltage value of +10 V corresponds to the nominal pressure set in R parameter R660 (nominal pressure [1..xx bar]).

Via analog input AI2 a swivel angle command value can be set within the range of -100 %...+100 % (-10 V...+10 V).

Analog command values/ regenerative

Alternatively, you can also feed forward the flow command value within the range from -100 %...+100 % (-10 V...+10 V) via analog input AI2. To this end, you must select “analog cmd values/regenerative” as command value source. With a regenerative pump combination, the command value refers to the total flow of the pumps.

Call-up command values

For call-up command values, the command value inputs (pin 7 and pin 4 on the central plug-in connector) are used as digital inputs. As a result, 4 different command values can be selected per input. A “high“ level is recognized at a voltage of 9.5 V or higher.

Pressure analog, SWA internal

With this command value provision, the pressure command value can be provided via an analog input. The swivel angle command value is determined by an R parameter.

Pressure load sensing

This option allows the pressure command value to be created on the basis of two actual pressure value signals using a “load-sensing” function. To this end, two actual pressure values (PT3 and PT4) are read in via the two analog inputs AI1 and AI2. These actual pressure values can be smoothed by an additional filter with pre-defined filter time constants (R216). Moreover, an offset value (R631 and R632) can be added to each actual pressure value. The new pressure command value value is then generated from the greater of the two pressure values. The swivel angle command value can be provided by means of parameter R630.

8.1.6.3 Selecting the controller parameter set input

To make the selection, click “Project“ → “R parameter“ → “Configuration“ → “Controller parameter set input“.

Table 20: Parameter group “controller parameter set input“

R-Parameter	Bezeichnung
R615	Input selection of controller parameter sets

The digital SY(H)DFEn control is provided with 16 controller parameter sets (0...15) for the optimum adjustment to customer-specific requirements. R parameter R615 can be used to choose the type of selection of the controller parameter set.

The following table lists the different control options for the controller parameter set selection.

Table 21: Parameter set input

Value	Meaning
0	Controller parameter set provision via CAN bus
1	Controller parameter set provision via the PC program WIN-PED®

Controller parameter set input over CAN bus

The controller parameter sets are provided over CAN bus (see RE 30014-02-Z; if required, please ask your responsible contact in the sales organization of Bosch Rexroth).

Controller parameter set input via PC program WIN-PED®

With controller parameter set provision via the PC program WIN-PED®, the desired controller parameter set is set with the help of R parameter R616.

Table 22: R parameter R616

R parameter	Designation	Range of values
R616	Controller parameter set	0 - 15

8.1.6.4 Setting the pressure transducers (PT)

For some applications it may be advantageous to switch between several pressures transducers. The SY(H)DFEn control system offers the possibility of connecting up to 4 pressure transducers. The relevant PT input is selected through a controller parameter in each of the 16 controller parameter sets. The PT input of the currently selected controller parameter set is active at that time.

For the setting of the pressure transducers, we recommend the following order:

1. Select the physical pressure transducer input (“Project“ → “R parameter“ → “Controller parameter set ...“).
2. Select the type of pressure transducer (voltage or current) (to this end, select “Project“ → “R parameter“ → “Configuration“ → “Settings pressure transducers“).
3. Set the PTs’ measuring range.
4. Select the PT input in the controller parameter sets to be used, see Chapter 5.3.3 “Controller parameters“, page 22).
5. Carry out a “Power-on“ reset to take over the new settings for the PT type.

Assignment of pressure transducer inputs

The following assignment to the physical inputs is valid:

Table 23: Assignment to physical inputs

PT input	Connection	Pin	
		Signal	Reference
1	Central plug 11 + PE	10	11
2	M12 mating connector	4	3
3	Central plug 11 + PE	7	4
4	Central plug 11 + PE	5	4

8.1.6.5 Types of pressure transducers

PT input 1 (central plug-in connector pin 10/11)

Table 24: Parameter group “settings pressure transducers“

R parameter	Designation
R603	Type of pressure transducer 1

It is possible to connect various types of pressure transducers to PT input 1 of the SY(H)DFEn control system. To take the changes of the pressure transducer over, a power-on reset must be executed on the SY(H)DFEn control system.

Table 25: Pressure transducer selection

Pressure transducer type	Connection
PT input 2	M12 mating connector
0...5 V	Central plug 11 + PE
0.5...5 V	
0...10 V	
0.1...10 V	
1...10 V	
0...20 mA	
4...20 mA	

For reasons of compatibility with older versions, when you use PT input 1 with type “PT input 2”, the signal input of the M12 mating connector must be selected. This corresponds to PT input 2 (see PT input 2).

PT input 2 (M12 mating connector pin 4/3)

A pressure transducer with a signal voltage of 0.5...5 V can be connected to PT input 2 of the SY(H)DFEn control system. In this context, observe the notes given in Chapter 7.6.4.

It is recommended that when the signal input of the M12 mating connector is used, you should always select PT input 2 in the controller parameter sets in order to ensure a clear error diagnosis.

PT input 3 (central plug-in connector pin 7/4), PT input 4 (central plug-in connector pin 5/4)

Table 26: R parameter group “pressure transducer”

R parameter	Designation
R666	Type of pressure transducer 3
R667	Type of pressure transducer 4

It is possible to connect various types of pressure transducers to PT input 3 or 4 of the SY(H)DFEn control system.

Table 27: Pressure transducer types

Pressure transducer type
0...10 V
0.1...10 V
1...10 V

8.1.6.6 Adjusting the measuring range of the pressure transducer

The measuring range of the pressure transducer can be adjusted for the relevant PT input by way of the following R parameters. To make an adjustment, click “Project.“ → “R parameter“ → “Configuration” → “Settings pressure transducers”.

Table 28: Measuring range of the pressure transducer

PT input	R parameter	Designation
1	R605	Measuring range PT input 1 [bar]
2	R654	Measuring range PT input 2 [bar]
3	R657	Measuring range PT input 3 [bar]
4	R661	Measuring range PT input 4 [bar]

8.1.6.7 Setting variable-speed operation

Table 29: R parameter group for the provision of speed

R parameter	Designation
R607	Output variable of the analog output 1
R608	Output variable of the analog output 2

Parameters R607 and R608 can be used to determine the output variable for analog outputs 1 and 2. To be able to output the speed command value for the electric drive at one of the two analog outputs, the selection “Motor speed command” must be made here (“Project“ → “R parameter“ → “Analog outputs”).

8.1.6.8 Speed calculation

For speed calculation, some R parameter settings must be made. These settings differ for the options “teach-in version” and “real-time version”. The relevant process variables are explained in more detail in Chapter 8.1.11 “Variable-speed operation” on page 86.

8.1.7 Switching on the drive motor of the pump

In order to prevent undefined states, the voltage supply of the valve electronics should generally be switched on first, followed by the drive motor of the pump (see Chapter 5.12 “Activation sequence of electronics/hydraulics” on page 38).

The following points should be checked (while the motor is still switched off!).

1. The error signal output ERROR (pin 3) is at status “HIGH“ (= 24 V/reference L0); no error messages over CAN bus.
2. The actual swivel angle value (SWA_{act}) of the pump is within the range of +100 % ±3 % (mechanical limit stop).

Table 30: Faults and their remedy/cause

Fault	Remedy/cause
No voltage supply available	Check voltage supply at the central plug of the electronics
CAN bus communication not working	Inspect CAN bus cabling Check configuration of the CAN network Check address
Control error	Control difference between command and actual values too large (SWA_{comm} < 95 %)
Fault in the pressure measurement branch	Read out the actual pressure value (p_{act}); it must be 0 bar. If the values are negative, a cable break of the pressure transducer must have occurred. The output signal of the pressure transducer must match with the type of the control electronics (current, voltage, zero point)
Fault in the swivel angle measurement branch	Read out the actual swivel angle value (SWA_{act}). In the case of deviations from value +100 % ±3 %, check the cable connection of the swivel angle sensor.

For further explanations on the analysis of faults, please read Chapter 15 “Troubleshooting” on page 117.

1. Close all directional valves to consumers.
2. Open the directional valve to the oil tank for pressureless circulation.
3. Before cutting in the motor, feed forward small command values (e.g. p = 15 bar, SWA = 10 %).

In this state, pilot valve VT-DFPn signals a “fault“ (control difference too high). When proper operation is reached, the fault message disappears after the motor was switched on (control difference now equal to zero).

- Switch on the drive motor of the pump!

8.1.8 Bleeding the pre-load valve

⚠ WARNING

Interior under high pressure!

Risk of injury! Loosening the screw too far can cause parts and jets of hydraulic fluid to be ejected.

- Do not turn the bleed screw out too far (max. 2 turns)!

If a pump unit is operated with a pre-load valve, this valve must be air-bled for the initial start-up, provided that the pump does not deliver and aspire oil. Bleeding is not required, when the pump displaces oil. Bleed the pump while the system is running at low operating pressure. To this end, loosen the screw (see figure below) by a maximum of 2 turns and wait until bubble-free oil flows out. Then, re-tighten the screw.

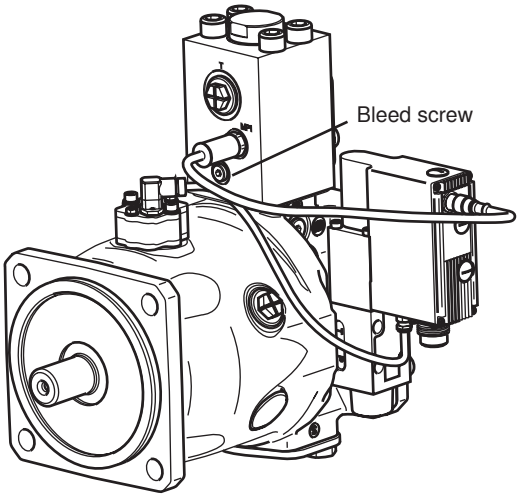


Fig. 33: Bleeding of the pre-load valve

8.1.9 Setting the controller parameters

The following description is intended to make the setting of controller parameters easier for you. Depending on the application, not all of the parameters listed here need to be adjusted. We explain **exemplarily** controller parameter set 15 in more detail (“Project“ → “R parameter“ → “Controller parameter set 15”).

8.1.9.1 P-gain (proportional gain)

Table 31: P-gain

R parameter	Designation	Range of values
R550	P-gain of pressure controller (positive) F15	1 - 1000
R551	P-gain of pressure controller (negative) F15	1 - 1000
R558	P-gain of swivel angle controller F15	1 - 1000

These controller parameters represent a linear gain, i.e. the output signal and the control deviation are proportionally related to each other. It must be noted here that when pressure is being built up, the positive controller parameter (positive system deviation R550) is used, whereas when pressure is being reduced, the negative controller parameter (negative system deviation R551) is used. The smaller the set value, the slower is the response of the controller to changes in pressure. However, if this value is too high, the system may become unstable.

8.1.9.2 Second P-gain

Table 32: Second P-gain

R parameter	Designation	Range of values
R591	Pressure diff. threshold pos. [bar] F15	0 - 450
R592	P-gain above positive threshold F15	1 - 1000
R593	Pressure diff. threshold negative [bar] F15	0 - 450
R594	P-gain under negative threshold F15	1 - 1000

In controller parameter sets 12...15 an additional P-gain is provided, which is active in closed-loop pressure control only. This targeted gain helps to achieve optimized closed-loop control characteristics. As can be seen in the following

diagram, the second P-gain becomes effective only above the selected threshold.

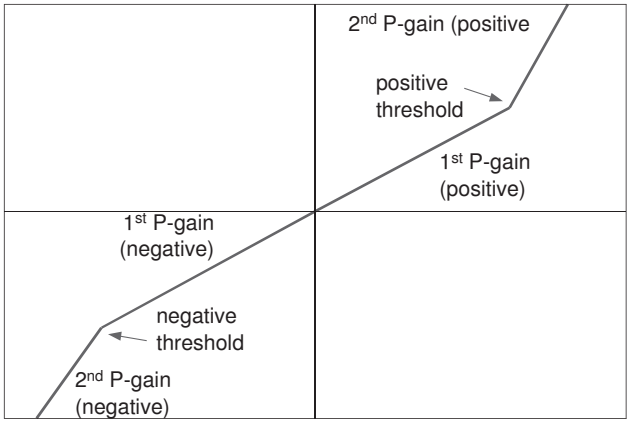


Fig. 34: Second P-gain

8.1.9.3 D-component

Table 33: D-component

R parameter	Designation	Range of values
R552	D-component of pressure controller positive F15	0 - 30000
R553	D-component of pressure controller negative F15	0 - 30000
R554	SWA-der. feedback pressure controller F15	0 - 2000

The D-component weighs the change in the actual value signal and ensures a damped transient response of the pressure controller. Due to differentiation the sensitivity is very high, which responds also to undesirable signals such as interference and can result in instability of the system. In the case of a constant actual value, the D-component does not respond, since the change rate is zero.

The higher the D-component, the slower is the system's response. Nevertheless, too high a value results in instability.

8.1.9.4 Setting the PD-gain

The PD-gain corresponds to the summation of the P-gain and D-components mentioned before, as described in Chapter 5.3.1 "Structure of the control" on page 21.

The values of the PD parameters to be adjusted (R550, R551, R552, R553) vary depending on the individual application. In general, it is valid that higher values result in a faster reacting closed-loop control. However, an excessive increase leads to unstable characteristics, since the actual value that is fed back is continuously increasing or decreasing (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

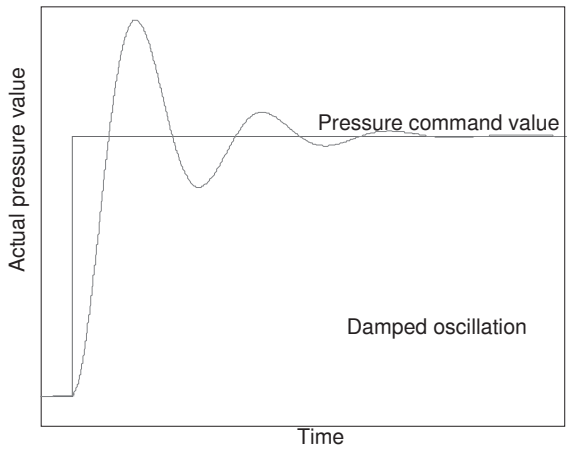


Fig. 35: Damped oscillation

Table 34: Setting damped oscillation

Step	Behavior/result	Measure
1	Overshoots (damped oscillation)	Increase D-component
2	Actual pressure value still overshooting	Reduce P-gain

Example 2

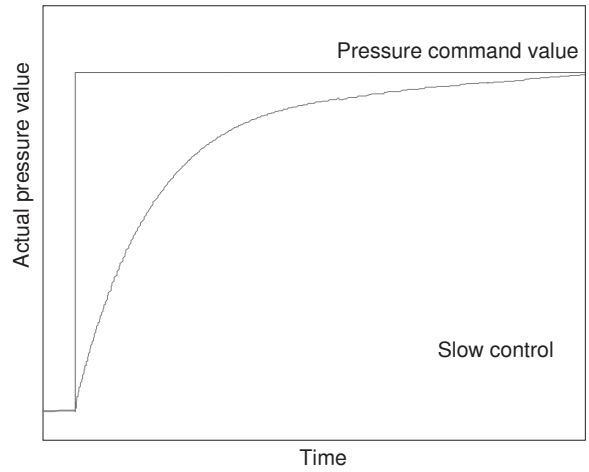


Fig. 36: Slow control

Table 35: Slow control

Step	Behavior/result	Measure
1	Slow reaction	Increase P-gain
2	Reaction still slow	Reduce D-component

Example 3

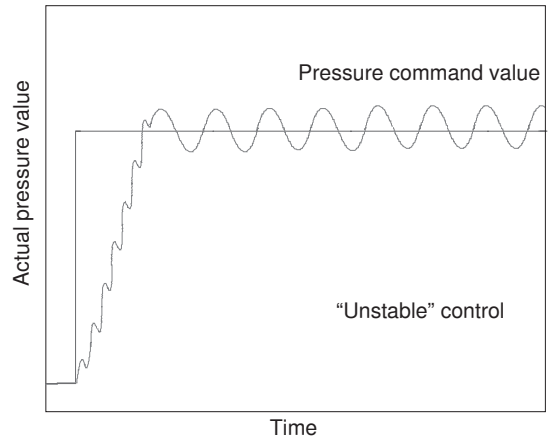


Fig. 37: Unstable control

Table 36: Steps in the case of fast, but unstable reaction

Step	Behavior/result	Measure
1	Fast, but unstable reaction	Reduce P-gain
2		Reduce D-component

Example 4

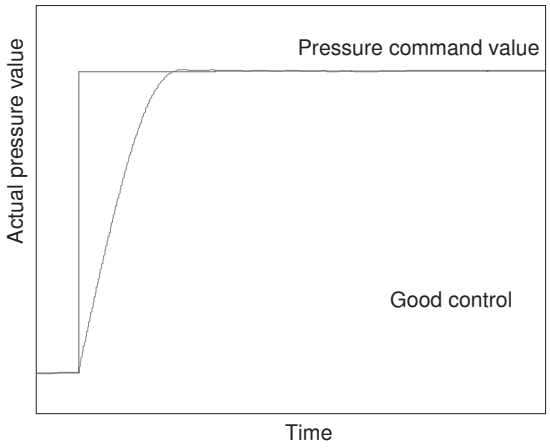


Fig. 38: Good control

With good control characteristics, no measures need to be taken.

8.1.9.5 Speed-adaptive pressure controller

During variable-speed operation, the pressure controller needs to be adjusted, if the control characteristics are to remain largely unchanged in relation to a constant speed. At low speeds, the gain of the controlled system decreases, which results in the fact that the P-gain and the D-component of the SYDFEn control system have to be increased. For this purpose, the SYDFEn control system features a function for adapting the pressure controller in relation to speed. The R parameters involved in this function are described in more detail in Chapter 8.1.11 "Variable-speed operation" from page 86 onwards.

Gate time

The gate time exercises an influence exclusively on the D-component and reduces susceptibility to interference. These parameters are used for setting the number of actual values to be acquired. It must be noted that an increase in the gate time means a time delay of the averaged actual value, which may, under certain circumstances, result in phase shifting and thus in instability. Moreover, the gate time should be a multiple of the pump pulsation (225 Hz at 1500 rpm), i.e. for

- 50 Hz machines -> gate time 6 / 12 / 18 . . . ,
- 60 Hz machines -> gate time 5 / 10 / 15 . . . .

Table 37: Gate time

R parameter	Designation	Range of values
R555	Gate time pressure actual value F15	1 - 120
R556	Gate time of SWA actual value F15	1 - 120

When the digital FIR filters of the SYDFEn control system are activated, the gate time is deactivated. The FIR filters of the SYDFEn control system suppress pump pulsation at different speeds. The activation of FIR filters is described in more detail on page 93.

8.1.9.6 Selecting the PT inputs

Table 38: Selection of the PT input

R parameter	Designation
R557	Selection of PT input [PT 1 - PT4] F15

For some applications it may be advantageous if it possible to switch between several pressure transducers. This selection of the 4 PT inputs can be made in controller parameter R557, that is, the value assigned to the PT input must be entered according to the following table.

Table 39: Changing over between several PTs

PT input	Connection	Pin
1	Central plug 11 + PE	10 / 11
2	M12 mating connector	4 / 3
3	Central plug 11 + PE	7 / 4
4	Central plug 11 + PE	5 / 4

Information about the setting of pressure transducers can be found in Chapter 8.1.6.4 “Setting the pressure transducer (PT)“ on page 66.

If several controller parameter sets are used, it is indispensable to check the selection of the PT inputs. Otherwise, a PT input may be addressed, to which no pressure transducer is connected.

8.1.9.7 DT1 pressure feedback of SWA controller

Table 40: DT1 pressure feedback

R parameter	Designation	Range of values
R590	DT1 pressure feedback of SWA controller F15	0 - 15000

In the case of low-frequency systems, e.g. cylinders with long strokes or large moved masses, poorly damped vibration may occur under SWA control. With the help of DT1 pressure feedback, this vibration can be actively dampened. For this,

the derivative of pressure with negative sign is added to the control output of the SWA controller. The gate time is used for deriving the pressure.

With the factory setting, the DT1 pressure feedback is set to the default value of 0, i.e. the function is deactivated.

8.1.9.8 Low-pass filter time of the D-component in the pressure controller

Table 41: LP filter time of D-component

R parameter	Designation	Range of values
R595	LP filter time of D-component of pressure controller F15	0 ms - 800 ms

Controller parameter R595 can be used for determining the filter time constant for a low-pass filter for smoothing the pressure feedback in the swivel angle controller. The filter time constant can be selected from values between 0 (deactivated) and 800 ms.

With the factory setting the filter time constant is set to the default value of 0, i.e. the function is deactivated.

8.1.9.9 Pilot control factor for slave

Table 42: Reduction of the swivel angle difference between master and slave

R parameter	Designation	Range of values
R559	Pilot control factor for slave F15	0 - 16383

The displacement can be increased by coupling several SY(H)DFEx pumps. In order that these SY(H)DFEx systems operate approximately synchronously, the swivel angle difference between the master and slave can be significantly reduced with the help of controller parameter R559 in dynamic cases.

Detailed information about the set-up of master/slave operation can be found in Chapter 5.10 “Master/slave operation“ on page 31.

8.1.9.10 P-gain 2nd value for speed adaptation for swivel angle controller (R596)

Speed adaptation of the swivel angle controller may become necessary, if the swivel angle controller of the SYDFEn control system is used as inner-loop controller for a machine function. Speed adaptation of the swivel angle controller can only be used in parameter sets 12 - 15. By means of R parameter R596, a second gain value, which is used as lower limit for adaptation, can be specified for the swivel angle controller. The speed limits for adaptation can be entered under R parameters R614 and R617 (see Chapter 8.1.11.8).

Table 43: P-gain 2nd value for speed adaptation for swivel angle controller

R parameter	Designation	Range of values
R596	P-gain 2nd value of SWA adaptation	0-1000

8.1.10 Calibrating the SY(H)DFEn control system

With the help of regular calibration with the calibration functions of the SY(H)DFEn control system, stable system characteristics can be achieved, because long-term drifts are compensated for.

For the calibration of the SYDFEn control system we recommend the following order:

1. Calibration of the pressure transducer
2. Calibration of the valve
3. Calibration of the swivel angle sensor offset
4. Calibration of the swivel angle sensor gain
5. Calibration of leakage compensation

The calibration functions can be started either over CAN bus (see RE 30014-02-Z; if required, please ask your responsible contact in the sales organization of Bosch Rexroth) or from the program part “machine data” of the PC program WIN-PED®.

For calibrating the SY(H)DFEn control system, the hydraulic fluid must have reached operating temperature.

8.1.10.1 Calibrating the pressure transducer

If the zero point signal of the pressure transducer deviates from the ideal value for 0 bar, it can be compensated within the calibration tolerance through calibration of the pressure transducer.

Determination of the maximum calibration tolerance

Parameter group “adjustment PT inputs“

The maximum calibration tolerance of the pressure transducer for the relevant PT input can be set by means of the following parameters. To this end, select “Project” → “R parameter” → “Adjustment PT-inputs”.

Table 44: Maximum balancing tolerance

PT input	R parameter	Designation
1	R609	Maximum balancing tolerance [PT 1]
2	R655	Maximum balancing tolerance [PT 2]
3	R658	Maximum balancing tolerance [PT 3]
4	R662	Maximum balancing tolerance [PT 4]

The range of values for the maximum calibration tolerance is -10 % to +10 %.

Starting the calibration process

The calibration process of the pressure transducer for the relevant PT input can be started from the machine data of the PC program WIN-PED® by selecting “Project“ → “Machine data“ → “Calibration“ → „OK“ → “Selection of Calibration“ → “PT Calibration“ → “Start“.

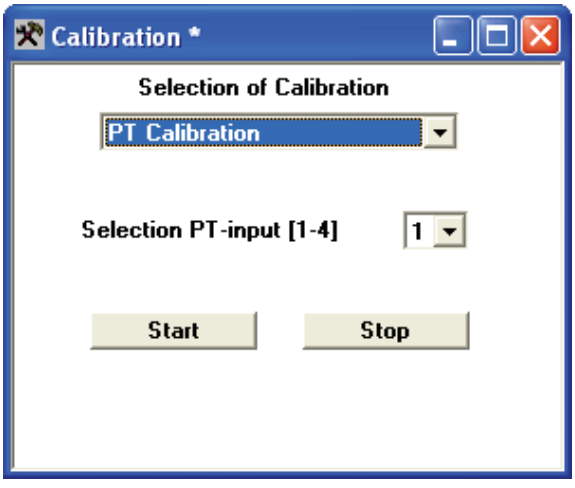


Fig. 39: Selection of calibration

Before starting the calibration of the relevant pressure transducer, make sure that the drive motor of the pump is switched off and the system is depressurized, i.e. **this state is calibrated as 0 bar**.

The calibration process takes about 1 second.

Status of the calibration process

The status of the calibration process of the pressure transducer is displayed in the program part “Diagnosis” of the PC program WIN-PED® in the view “Process data and variables”.

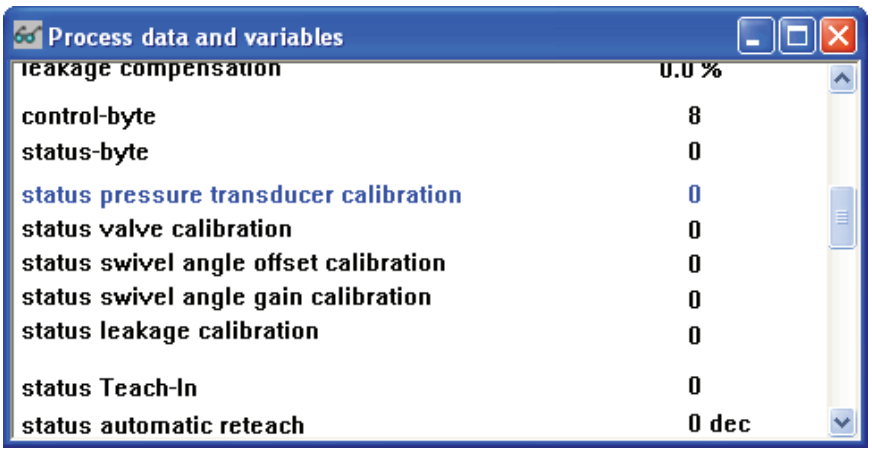


Fig. 40: Status of the calibration process

The meaning of the calibration process status is listed in the following table.

Table 45: Status of the calibration process

Value	Status of calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process started before
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the PT outside preset calibration tolerance)

Offset of the pressure transducer

Parameter group “Adjustment PT-inputs”

After successful calibration, the offset established (corrective value) for the pressure transducer for the relevant PT input can be read using the following R parameters. The established corrective values can be retrieved from the control to the PC by selecting menu item “Communication” → “Fetch all parameter values” in the online mode.

Table 46: Offset of the PTs

PT input	R parameter	Designation
1	R604	Offset of pressure transducer input 1
2	R653	Offset of pressure transducer input 2
3	R656	Offset of pressure transducer input 3
4	R659	Offset of pressure transducer input 4

8.1.10.2 Calibrating the valve zero point

The non-linear valve characteristic curve can be corrected through calibration of the valve (valve characteristic curve correction).

Prerequisites:

- Pump drive motor ON
- All consumers disconnected from the pump

Valve calibration points

4 given pressure calibration points are used for compensating for the valve offset. The given pressure command values for calibration must be distributed over the required working range in ascending order. The default factory settings for the 4 pressure calibration points are 20 bar, 50 bar, 100 bar and 150 bar.

Starting the calibration process

To start the calibration process in the PC program WIN-PED®, select “Project” → “Machine data” → “Calibration” → “OK” → “Selection of Calibration” → “Valve Calibration” → “Start”.

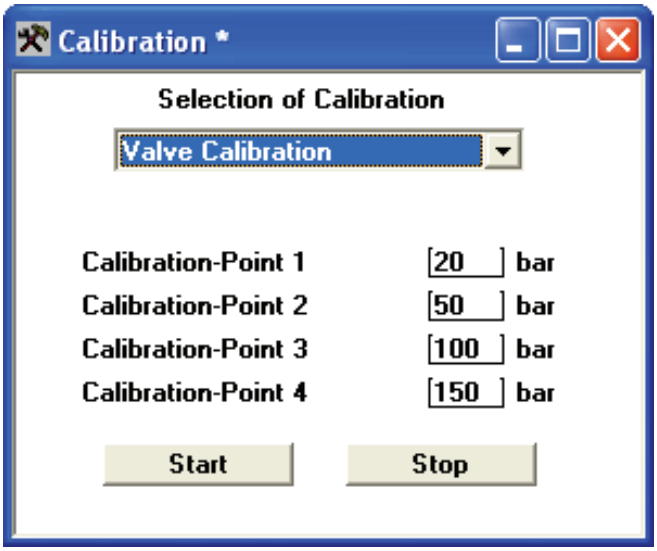


Fig. 41: Valve calibration

During the calibration process the pump operates in the closed-loop control mode with the given pressure command values. The calibration process takes about 60 seconds.

During calibration, the SY(H)DFEn control system uses the given pressure command values, i.e. the command values provided by the machine control are ineffective. In the event of a critical situation, the calibration process can be interrupted at any time with the help of the “stop button”. The command values valid before the calibration was started are re-validated.

Status of the calibration process

The status of valve calibration is displayed in the program part “Diagnosis” of the PC program WIN-PED® in the view “Process data and variable”.

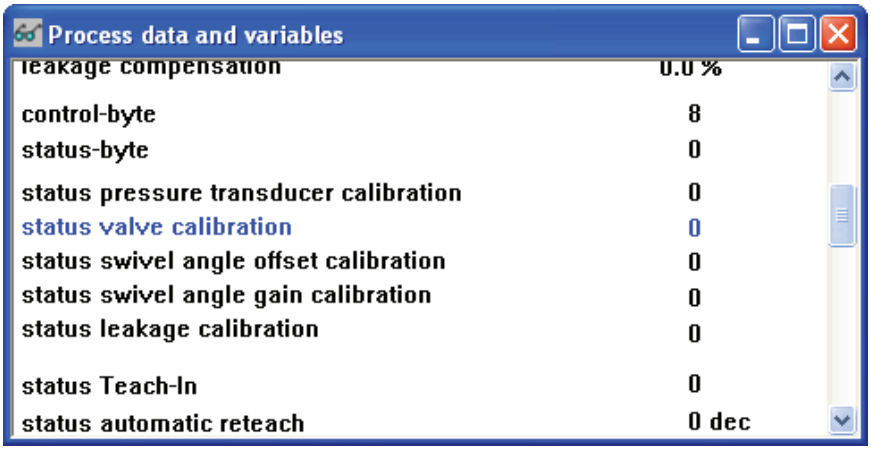


Fig. 42: Status of the calibration process

The meaning of the calibration process status is listed in the following table.

Table 47: Status of the calibration process

Value	Status of calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process started before
0x0004	Calibration interrupted by the user
0x0008	Supporting points not in ascending order
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the valve outside the permissible balancing tolerance of ±10 %)
0x2000	Calibration error (actual pressure value fluctuating)
0x4000	Calibration error (control deviation "p_{diff}" > 15 bar)

Offsets of valve calibration

Parameter group "adjustment valve"

After successful calibration, the offset established (corrective value) for the valve in the relevant calibration point can be read using the following R parameters. The established corrective values can be retrieved from the control to the PC by selecting menu item "Communication" → "Fetch all parameter values" in the online mode.

Table 48: Valve offsets

R parameter	Designation
R642	Valve offset compensation point 1 [bar]
R643	Valve offset compensation point 2 [bar]
R644	Valve offset compensation point 3 [bar]
R645	Valve offset compensation point 4 [bar]
R646	Valve offset point 1
R647	Valve offset point 2
R648	Valve offset point 3
R649	Valve offset point 4

The offset value range is –10 %...+10 %. In the case of a calibration error, all offsets of the valve are set to the default value of 0.

8.1.10.3 Calibrating the swivel angle sensor

The swivel angle sensor must be calibrated in two steps in the following order:

- **Calibration of the swivel angle offset (zero point)**
- **Calibration of the swivel angle gain**

Calibrating the offset of the swivel angle sensor

Prerequisites:

- Pump drive motor ON
- All consumers disconnected from the pump, that is, no oil flow to the oil tank and no oil withdrawal

The offset of the swivel angle sensor cannot be calibrated in the regenerative mode!

Starting the calibration process

Start the offset calibration in the PC program WIN-PED® by selecting “Project” → “Machine data” → “Calibration” → “OK” → “Selection of calibration” → “SWA Offset Calibration” → “Start”.

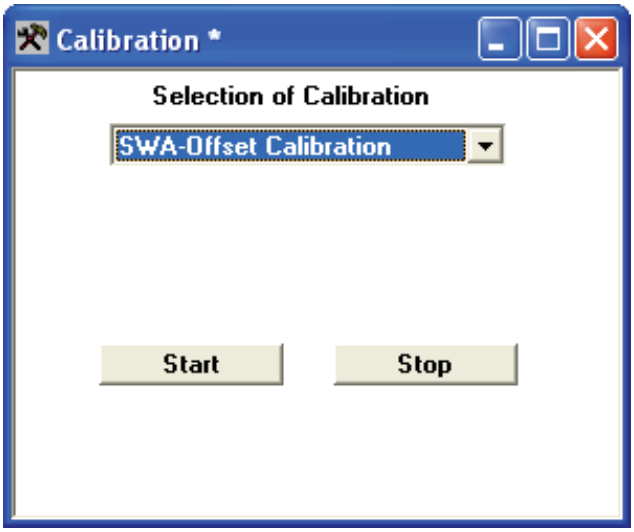


Fig. 43: Calibration of the swivel angle sensor offset

During the calibration process, the pump operates in the closed-loop pressure control mode with a fixed internal pressure command value of 20 bar. The calibration process takes about 20 seconds.

During the calibration, the SY(H)DFEn control system uses internal command values, i.e. the command values provided by the machine control are ignored. In the event of a critical situation, the calibration process can be interrupted at any time with the help of the “stop” button. The command values valid before the calibration was started are re-validated.

Status of the calibration process

The status of SWA offset calibration is displayed in the program part “Diagnosis” of the PC program WIN-PED® in the view “Process data and variables”.

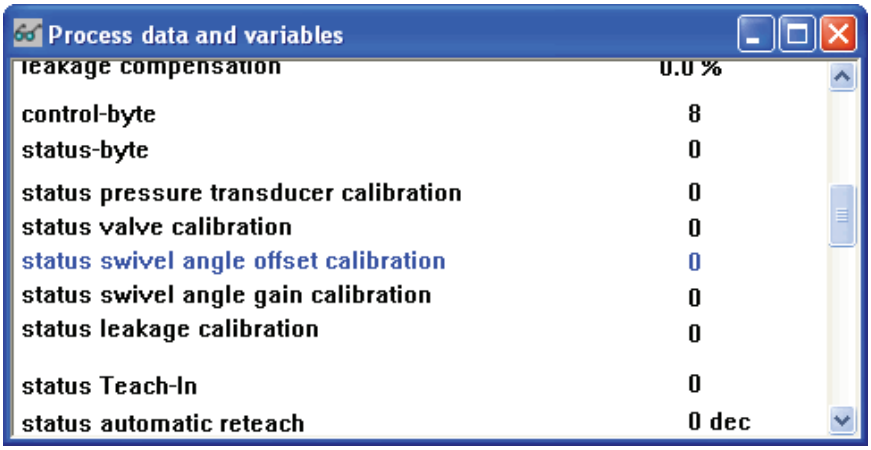


Fig. 44: Status of swivel angle offset calibration

The meaning of the calibration process status is listed in the following table.

Table 49: Status of the calibration process

Value	Status of calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process started before
0x0004	Calibration interrupted by user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the SWA sensor outside the permissible balancing tolerance of ±10%)
0x2000	Calibration error (actual swivel angle value is fluctuating)
0x4000	Calibration error (actual pressure value outside the tolerance of 12 bar...28 bar)

Offset of the swivel angle sensor

Parameter group “adjustment swivel angle“

After successful calibration, the offset established (corrective value) for the swivel angle sensor can be read using the following R parameter. The established corrective values can be retrieved from the control to the PC by selecting menu item “Communication” → “Fetch all parameter values” in the online mode.

Table 50: Offset swivel angle sensor

R parameter	Designation
R610	Offset swivel angle sensor

The offset value range is -10 % to +10 %. In the case of a calibration error, the offset of the swivel angle sensor is determined to be the default value of 0.

Calibrating the gain of the swivel angle sensor

Prerequisites:

- Pump drive motor ON
- Direct full flow to the actuator (e.g. activate hydraulic motor) or set pressure relief valve to 20 to 80 bar

Starting the calibration process

The gain of the swivel angle sensor can be calibrated by selecting “Project” → “Machine data” → “Calibration” → “OK” → “Selection of Calibration” → “SWA Factor Calibration” → “Start”.

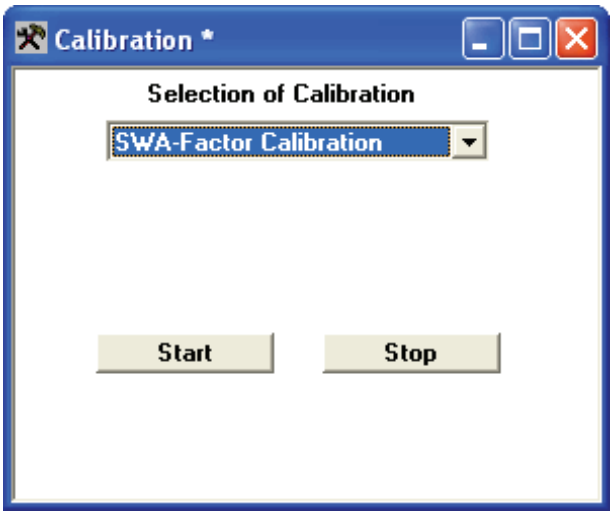


Fig. 45: Selection for calibrating the gain of the swivel angle sensor

During the calibration process, the pump operates in the closed-loop pressure control mode with a fixed internal pressure command value of 100 bar. The calibration process takes about 20 seconds.

While executing the calibration, the SY(H)DFEn uses internal command values, that is, the command values provided by the machine control are ignored. If a critical situation occurs, the calibration can be interrupted at any time using the “stop” button. The command values valid before calibrating was started become valid again.

Status of the calibration process

The status of SWA factor calibration can be viewed in the program part “Diagnosis” under “Process data and variables” of the PC program WIN-PED®.

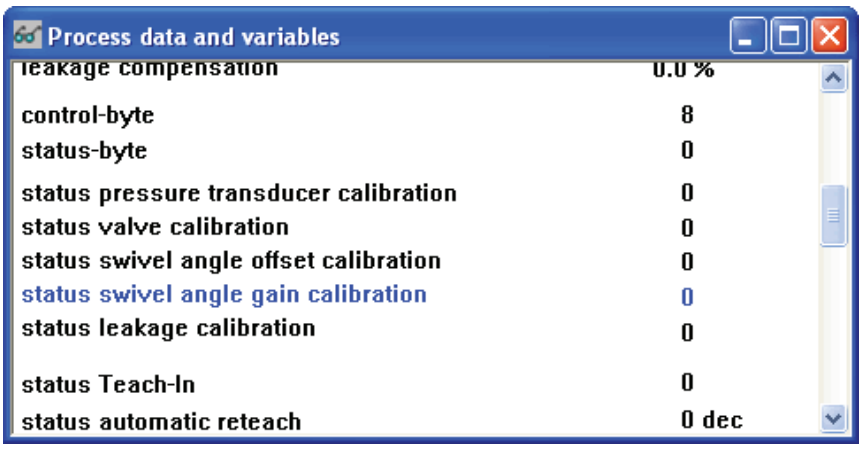


Fig. 46: Status of the calibration process for the swivel angle gain

The meaning of the status of the calibration process is listed in the following table.

Table 51: Status of calibration process

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process started before
0x0004	Calibration interrupted by user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (gain of SWA sensor outside permissible calibration tolerance [10 %])
0x2000	Calibration error (actual swivel angle value is fluctuating)
0x4000	Calibration error (actual pressure value exceeded 80 bar)
0x8000	Calibration error (cable break of swivel angle sensor)

Gain of the swivel angle sensor

Parameter group “adjustment swivel angle“

After successful calibration, the offset established (corrective value) for the swivel angle sensor can be read using the following R parameter. The established corrective values can be retrieved from the control to the PC by selecting menu item “Communication” → “Fetch all parameter values” in the online mode.

Table 52: Gain of swivel angle sensor

R parameter	Designation
R611	Gain swivel angle sensor

The value range of the factor for the SWA sensor is 0 to 2. In the case of a calibration error the gain of the swivel angle sensor is determined to be the default value of 1.

8.1.10.4 Calibrating leakage compensation

As additional function, the swivel angle control loop offers the possibility of compensating for pump leakage. To this end, an offset, which corresponds to the leakage value, is added to the swivel angle command value in dependence upon pressure.

Prerequisites:

- Pump drive motor ON
- All consumers disconnected from the pump
- Swivel angle offset calibrated

Starting the calibration process

The calibration process can be started from the machine data of the PC program WIN-PED®, selection “Project” → “Machine data” → “Calibration” → “OK” → “Selection of Calibration” → “Leakage Calibration” → “Start”.

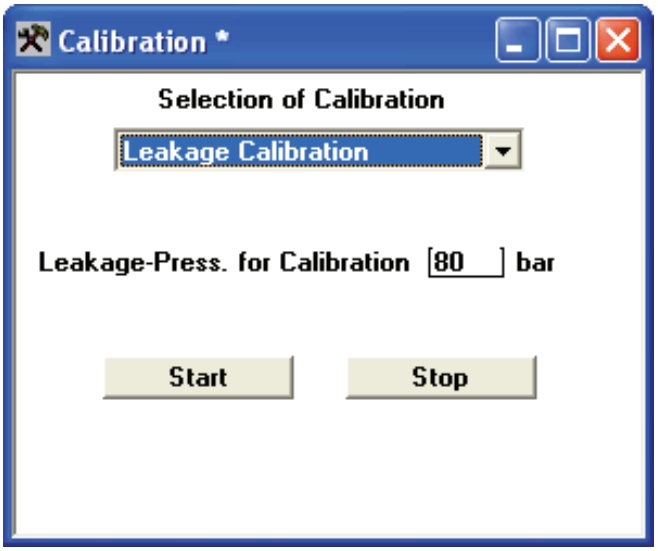


Fig. 47: Calibration of leakage compensation

During the calibration process, the pump operates in the closed-loop pressure control mode with the selected pressure command value. The calibration process takes about 60 seconds.

The selected pressure command value must be higher than 50 bar. We recommend that a pressure of the upper end of the working range be selected which is of particular importance for leakage compensation. This allows a higher accuracy to be achieved with the calibration.

Attention: During the calibration process, the SY(H)DFEn control system uses the given pressure command value, i.e. the command values provided by the machine control are ineffective. In the event of a critical situation, the calibration process can be interrupted at any time with the help of the “stop button”. The command values valid before the calibration was started are re-validated.

Status of the calibration process

The status of leakage calibration is displayed in the program part “Diagnosis” of the PC program WIN-PED® in the view “Process data and variables”.

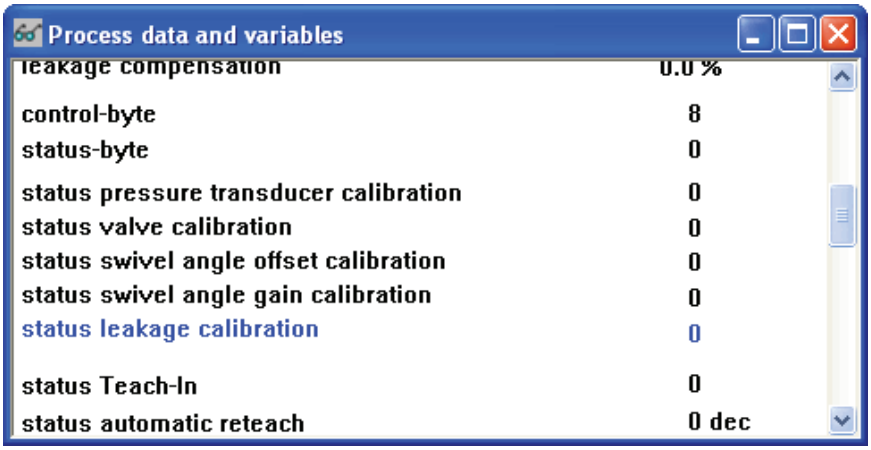


Fig. 48: Status of leakage calibration

The meaning of the calibration process status is listed in the table below.

Table 53: Status of the calibration process

Value	Status of the calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process already started
0x0004	Calibration interrupted by the user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (value of leakage compensation outside the permissible balancing tolerance of +30 %)
0x2000	Calibration error (actual swivel angle value is fluctuating)
0x4000	Calibration error (actual pressure value < 50 bar or control deviation "p_{diff}" > 10 bar)

Leakage compensation factor

Parameter group "leakage compensation"

After successful calibration, the factor established (corrective value) for leakage compensation at 315 bar can be read using the following R parameter. The established corrective values can be retrieved from the control to the PC by selecting menu item "Communication" → "Fetch all parameter values" in the online mode.

Table 54: Leakage compensation

R parameter	Designation
R625	Leakage compensation

The range of values for the leakage compensation factor is 0 % to +30 % at 315 bar. In the case of a calibration error, the leakage compensation factor is determined to be the default value of 9 % at 315 bar.

8.1.10.5 Resetting the calibration values

You can reset the established calibration values to the default values by selecting "Machine data" → "Calibration" → "OK" → "Reset Calibration" in the PC program WIN-PED®.

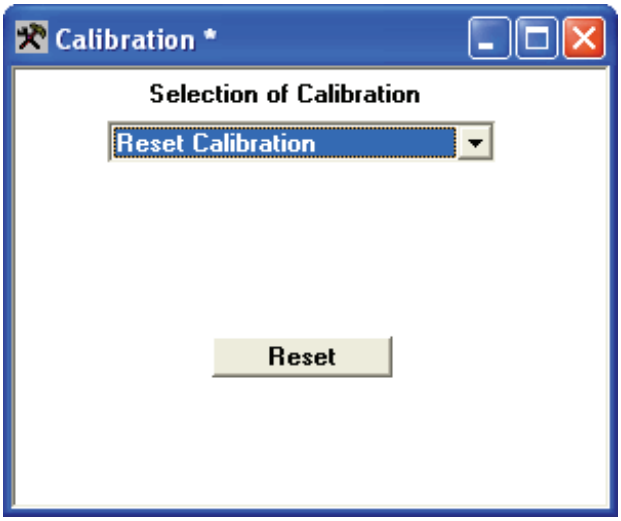


Fig. 49: Reset of the calibration values

Table 55: Default values

R parameter	Designation	Default value
R604	Offset PT-input 1	0
R653	Offset PT-input 2	0
R656	Offset PT-input 3	0
R659	Offset PT-input 4	0
R646	Valve offset point 1	0
R647	Valve offset point 2	0
R648	Valve offset point 3	0
R649	Valve offset point 4	0
R610	Offset swivel angle sensor	0
R611	Gain swivel angle sensor	1
R625	Leakage compensation	9 %

8.1.11 Variable-speed operation

The principle of variable-speed operation depends on the selected option. Two options are provided:

- Teach-in version for cyclic operation
- Real-time version (speed calculation without teach-in)

You can identify the drive with the help of code “12“ of the type code. Alternatively, you can also read out the software number from the installed project:

Table 56: Software function

Description of software function	Code “12“ in the type code	Valid software number
Teach-in version for cyclic operation	A	8.xx
Real-time version (speed calculation without teach-in)	R	9.xx

8.1.11.1 Teach-in version

The operating principle of the teach-in version is described in more detail in the following chapter. The teach-in version is selected for cyclically operating machines. The teach-in version employs a teaching cycle for analyzing the current machine cycle and for calculating the optimum speed command values. The result thus obtained is used to save a cycle course with the calculated speed command values in the memory of the SY(H)DFEn. When this is completed, the optimized speed course can be followed in the subsequent machine cycles. The SY(H)DFEn control system can recognize differences between the saved and the actual machine cycle and respond according to its parameterization.

8.1.11.1.1 Controlling variable-speed operation

Variable-speed operation is controlled either via the three digital inputs S1 (X2, pin 4), S2 (X3, pin 2) and D1 (X1, pin 9) or over CAN bus. Information relating to CAN bus can be found in the supplementary information RE 30014-02-Z. If required, please ask your responsible contact in the sales organization of Bosch Rexroth.

8.1.11.1.2 Changing over to variable-speed operation (S1)

Changing over between the normal and the variable-speed operating mode is triggered by a high signal at switch S1. Switch S1 can be operated either via the digital input (X2, Pin 4) or over CAN bus. If S1 is not switched, the nominal speed is always fed as speed command value to the motor. Switch S1 must always be deactivated when the machine is no longer operated in cyclic operation.

8.1.11.1.3 Starting the teach-in mode (S2)

To be able to start the teach-in mode, a rising edge must be applied at switch S2 of the M12 plug-in connector (X3). Switch S2 can be operated either via the digital input (X3, Pin 2) or over CAN bus. Following the rising edge at S2, the SY(H)DFEn control system starts to learn the machine cycle and to calculate the optimum drive speed and control parameters. The status of the teach-in mode can be read under the process variable “Status Teach-In“. Upon completion of the teach-in process the SY(H)DFEn control system starts variable-speed operation. A setpoint speed is passed via the analog output on to the converter. As long as a High signal is present at S2 the learnt machine cycle is run. When S2 is reset, the learnt machine cycle is cleared.[1)]

As long as only S2 , but not S1, is active the teach-in mode is run until status 7 is reached, but the speed command value remains set to 100 %.

[1)] Switch S2 must be reset for at least 1 s. Only after this time has elapsed is the stored cycle cleared and a new machine cycle can be learnt.

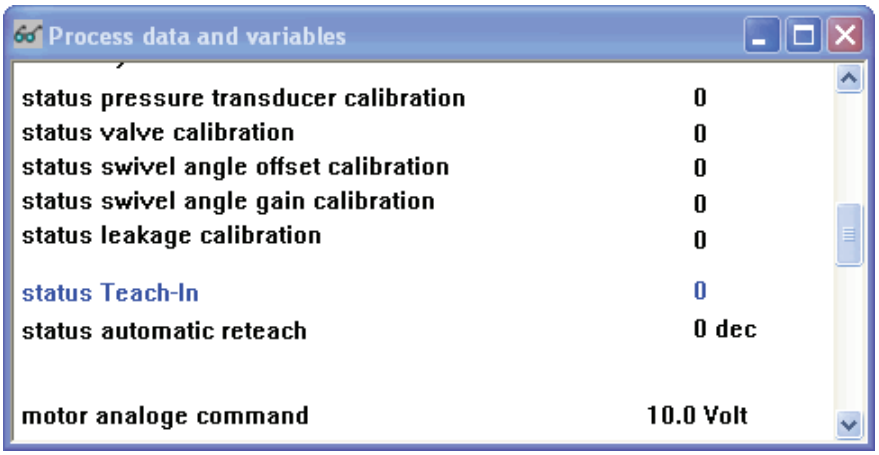


Fig. 50: Status of teach-in

Table 57: Status values

Value	Status Teach-In
0	S2 switch not set, teach-in not started
1	S2 switch set; waiting for cycle synchronization
2	Cycle length is being established
3	Calculating speed command values from current values
5	Creating ramp times and cycle table
7	Computation completed, variable-speed operation possible

8.1.11.1.4 Synchronizing the machine cycle (DI1)

For variable-speed operation and the teach-in mode, the SY(H)DFEn system and the machine PLC must be synchronized. For synchronization, the machine PLC must set a rising edge at digital input DI1 (Sync.). Digital input DI1 is located at pin 9 on central plug X1. To be able to set the rising edge again for the next cycle, DI1(Sync.) can be reset after about 0.5 s. Optionally, the cycle can also be synchronized over the CAN bus.

8.1.11.1.5 Process variables involved/electric drive

You can access the individual parameters described in Chapters 8.1.11.1.5 to 8.1.11.1.9 by selecting “Project“ → “R parameter” → “Teach-In”.

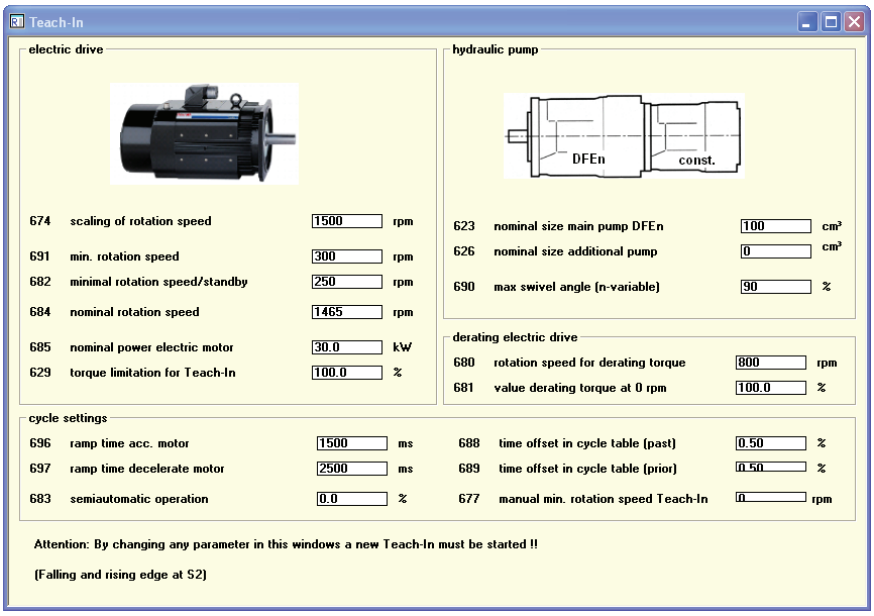


Fig. 51: Selection of the electric drive

Scaling of speed (R674)

The speed can be scaled using parameter R674. This value corresponds to the speed command value at 10 V (100 %).

Table 58: Scaling of speed

R parameter	Designation	Range of values	Unit
R674	Scaling of rotation speed	300 - 2500	rpm

Minimum speed (R691, R682)

The minimum speed can be determined using parameter R691. For some drives, which are operated with U/f characteristic curve, the manufacturers specify a minimum speed, at which the nominal torque is briefly available. For part-load operation of the machine, a second minimum speed can be specified. This speed limit is active, when the torque in the teach-in cycle is below 3.1 % of the nominal torque. For example, due to this second minimum speed, it is possible to reduce the magnetization of the asynchronous motor during part-load operation of the machine in order to reduce power losses. For more detailed information, please refer to the data sheet of the drive manufacturer.

Table 59: Minimum speed

R parameter	Designation	Range of values	Unit
R691	Minimum rotation speed	50 - 2000	rpm
R682	Minimal rotation speed/stand-by	50 - 2000	rpm

Nominal rotation speed (R684)

To be able to compute the slip characteristic curve of the asynchronous motor, it is necessary to enter, among others, the nominal speed of the asynchronous motor under rated load. The nominal speed is indicated on the nameplate of the asynchronous motor.

Table 60: Nominal motor speed

R parameter	Designation	Range of values	Unit
R684	Nominal rotation speed	100 - 2500	rpm

Nominal electric motor power (R685)

The nominal motor power is required for various internal calculations by the SY(H)DFEn control system, e.g. utilization of the asynchronous motor's capacity. The rated power can be read off from the nameplate.

Table 61: Rated motor power

R parameter	Designation	Range of values	Unit
R685	Nominal power electric motor	0.1 - 200.0	kW

Torque limitation for speed calculation (R629)

At reduced speed and with unchanged hydraulic output, the current motor torque is accordingly higher. If, at reduced speed, the motor is loaded with a greater torque than the nominal torque, the power loss in the asynchronous motor rises significantly. By means of parameter R629 the maximum torque referred to the nominal torque of the motor can be specified for variable-speed operation.

Table 62: Motor torque limitation

R parameter	Designation	Range of values	Unit
R629	Torque limitation for speed calculation	1 - 350	%

Derating of the electric drive (R680, R681)

Asynchronous motors are usually operated with self-ventilation. As the speed is reduced, the cooling power of the ventilator falls accordingly. Consequently, the nominal torque cannot be maintained continuously at low speeds, because the motor would heat up excessively. In this case, a derating function can be activated at low speeds to protect the electric motor. Parameter R680 can be used to specify the speed limit, from which on the derating function is to be activated. With parameter R681 you can enter the theoretical torque at "zero" speed. This value must be entered in % of the nominal torque. Should an external ventilator be used for the asynchronous motor or if the derating function is to be deactivated, you can set the value "100 %" for R681.

Table 63: Derating

R parameter	Designation	Range of values	Unit
R680	Rotation speed for derating torque	1 - 2500	rpm
R681	Value derating torque at 0 rpm	0.0 - 100.0	%

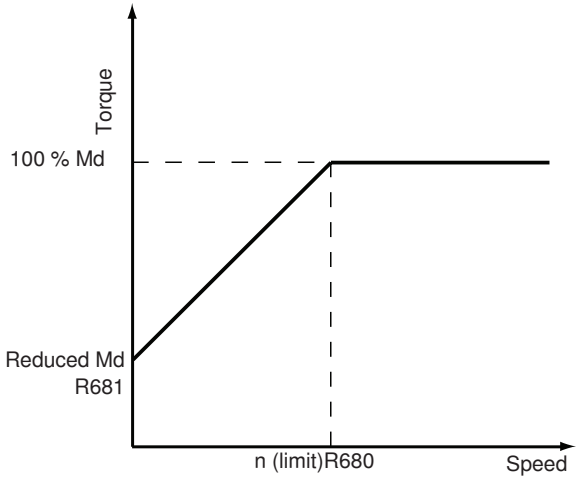


Fig. 52: Derating

8.1.11.1.6 Hydraulic pump(s)

Size of main pump (R623)

For variable-speed operation, the SY(H)DFEn control system must know the size of the main pump, to which the VT-DFPn valve is mounted. With several controlled pumps (pressure controller master/slave, single-circuit), you have to enter the sum of all control pumps that displace hydraulic fluid into the same hydraulic system.

Table 64: Selection of the main pump size

R parameter	Designation	Range of values	Unit
R623	Nominal size main pump DFEn	10-356	cm^3

Size of additional pump (R626)

For a regenerative combination consisting of one or several pumps, the size of the additional fixed displacement pump must be specified in parameter R626. Should several fixed displacement pumps be used, you have to enter the sum of all fixed displacement pumps that displace hydraulic fluid into the hydraulic system. In case that only one main pump is used for operation, the value “0” must be entered for R626.

Table 65: Size of mounted pump

R parameter	Designation	Range of values	Unit
R626	Nominal size additional pump	0-250	cm^3

Maximum swivel angle for variable speed (R690)

The maximum swivel angle for variable-speed operation can be determined using parameter R690. The SY(H)DFEn control system reduces the speed until this maximum swivel angle is reached for displacing the required flow. Generally, the efficiency of the pump improves at a greater swivel angle. To minimize power losses in variable-speed operation, the speed should be reduced to a value, where the swivel angle comes close to its maximum (100 %). To obtain a sufficient control reserve for the swivel angle controller, the optimum is between 80 % and 90 % (depending on the relevant system).

Table 66: Maximum swivel angle

R parameter	Designation	Range of values	Unit
R690	Max. swivel angle (n-variable)	50-98	%

8.1.11.1.7 Cycle settings

Ramp time (R696, R697)

Parameters R696 and R697 can be used for setting the ramp times for speed ramps in cyclic operation. The ramp time defines the time that is required for accelerating from standstill to maximum speed. These ramp times are computed in the SY(H)DFEn control system and added automatically to the speed value input for the converter. The ramp times should be selected greater than the maximum acceleration times of the frequency converter and the times entered for the internal ramps R694 and R695. The deceleration ramp should be set so that the asynchronous motor needs not to actively decelerate and feeds energy back to the converter.

Table 67: Ramp times

R parameter	Designation	Range of values	Unit
R696	Ramp time accelerate motor	100-4000	ms
R697	Ramp time decelerate motor	100-4000	ms

Adjustment to machine cycle (R688, R689)

To compensate for minor differences between the synchronization of the SY(H)DFEn control system and the machine PLC, it is possible to add additional time offsets using parameters R688 and R689. This time can be used to bring forward the start of an acceleration ramp and delay the deceleration ramp. This forward and delay time offsets are to be specified in % of the entire cycle time.

Table 68: Integral action and derivative time

R parameter	Designation	Range of values	Unit
R688	Time offset in cycle table (past)	0.0-5.0	%
R689	Time offset in cycle table (prior)	0.0-5.0	%

Duration of fast ramps/semi-automatic operation (R683)

With the help of an R parameter (R683) the ramp time can be shortened for a certain time at the beginning of a new cycle. During this time, the ramp times set under R696 and R697 are shortened by half. This means that the acceleration and deceleration ramps are passed twice as fast. The value entered in R683 determines the duration, for which the fast ramps are used at the beginning of a cycle. The duration is to be entered in percent of the entire cycle time. If you enter the value “0 %”, the fast ramps are deactivated. If you use a CAN bus, the control byte must be set accordingly in order that these ramps can be used.

Table 69: Duration of fast ramps/semi-automatic operation

R parameter	Designation	Range of values	Unit
R683	Duration of fast ramps, semi-automatic operation	0.0 – 25.0	%

Manual minimum speed teach-in (R677)

This function is only available in conjunction with a CAN bus. In order that a minimum speed can be provided manually during the teach-in or also during variable-speed operation, this function must be activated over CAN bus (see RE 30014-02-Z). The value for this minimum speed can be determined using R parameter R677.

Table 70: Manual minimum speed

R parameter	Designation	Range of values	Unit
R677	Manual min. speed teach-in	0-2500	rpm

8.1.11.1.8 Settings for variable speed

You can access the individual parameters described in this chapter by selecting “Project“ → “R parameter” → “variable rotation speed”.

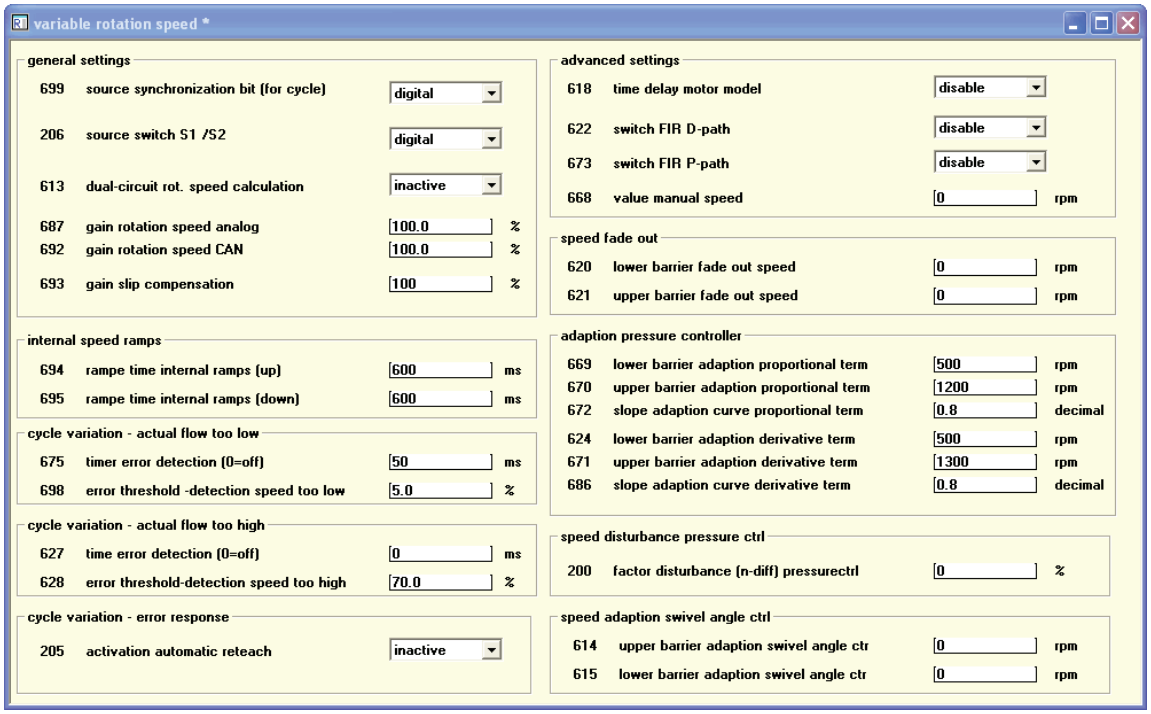


Fig. 53: Screen for variable speed settings

Cycle control

The SY(H)DFEn control system can be operated as both, analog/digital variant or also over CAN bus. With the analog/digital variant, switches S1 and S2 as well as synchronization are activated via digital inputs. The speed command value can be passed on to the frequency converter via an analog output. With the CAN variant, switches S1 and S2 and synchronization are controlled over the bus. The speed command value is sent over the bus as well. Parameter R699 can be used to switch between CAN bus and digital signals for the input for cycle synchronization as well as for the activation of various functions. R parameter R206 determines the input for switches S1/S2.

Multiple-circuit rotation speed calculation (R613)

The SY(H)DFEn control system offers the possibility of operating several independent SY(H)DFEn control pumps, which displace fluid into two different circuits, on one motor shaft. R613 can be used to activate this function and to select either the main pump or a secondary pump. The multiple-circuit function requires a CAN bus system. A more detailed description of the multiple-circuit function can be found in RE 30014-02-Z.

Gain of speed command value (R687, R692)

The speed command value is issued via analog output 1 (pin 6 or pin 8 on central plug X1) or over the CAN bus. To adjust the factor for the speed command value output, parameter R687 respectively R692 can be changed accordingly.

Table 71: Gain of the speed command value

R parameter	Designation	Range of values	Unit
R687	Gain rotation speed command analog	0-100	%
R692	Gain rotation speed CAN	0-100	%

Gain slip compensation (R693)

Because slip of the asynchronous motor affects the actual displacement, the SY(H)DFEn control system offers an additional function for compensating for slip of an asynchronous motor. The gain of this slip compensation can be adapted using parameter R693.

Table 72: Gain of slip compensation

R parameter	Designation	Range of values	Unit
R693	Gain slip compensation	0-150	%

Ramp times - internal real-time ramps (R694, R695)

R parameters R694 and R695 can be used for determining the ramp times for internal real-time ramps. These speed ramps are always active when, in the event of a fault, the speed is raised to nominal speed and switch S1 is reset. On the one hand, this prevents the converter from receiving speed command value step-changes which it cannot follow. On the other hand, this ramp ensures that the calculation of the swivel angle command value of the pump is not falsified in the case of a fault. This ramp times should be set to the same values as the ramp time in the converter.

Attention: The internal ramps should always be set somewhat faster than the ramp times for the cycle (R696 and R697).

Table 73: Internal real-time ramp times

R parameter	Designation	Range of values	Unit
R694	Ramp time internal ramps (up)	100 - 4000	ms
R695	Ramp time internal ramps (down)	100 - 4000	ms

8.1.11.1.9 Additional settings

Time delay motor model (R618)

To compensate for the lag of an electric motor (dynamic error), you can activate an additional motor model for closed-loop controlling. In the case of a change in speed, this motor model computes the speed deviation of the motor and takes this lag into account when calculating the flow. For the selection of these time constants, various pre-defined values are available.

Table 74: Time constant of the motor model

R parameter	Designation	Range of values	Unit
R618	Time constant motor model	0 - 800	ms

FIR filter (pulsation filter, R622, R673)

Flow pulsation of the pump is related to the current speed of the electric drive. Depending on the hydraulic system this flow pulsation has a more or less strong influence on pressure. With the SY(H)DFEn control system, various filters can be activated to compensate for this pulsation in the control loop. These filters can be activated using parameters R622 and R673.

Table 75: Pulsation filter

R parameter	Designation
R622	Switch FIR D-path
R673	Switch FIR P-path

Speed suppression window (R620, R621)

To avoid speed values, at which resonsance occurs, a suppression window can be defined. Continuous operation at speed values within the suppression window is prevented. If the optimized speed is within the defined window, the upper limit of the speed suppression window is taken as operating speed.

Table 76: Speed suppression window

R parameter	Designation	Range of values	Unit
R620	Lower limit speed suppression window	0 - 2500	rpm
R621	Upper limit speed suppression window	0 - 2500	rpm

Input of the characteristic curve for adapting the PD-controller

At reduced speed, the pressure control of a control pump shows other control characteristics than at nominal speed. Through adaptation of the PD pressure controller, the control behavior of the SY(H)DFEn control system can be kept largely constant, irrespective of the current speed.

R669/R624 – lower limit for adaptation (lower barrier adaption proportional term/lower barrier adaption derivative term)

With the help of this value you can set the lower limit value of the characteristic curve. Below this speed limit, the PD pressure controller is no longer adapted.

R670/R671 – upper limit for adaptation (upper barrier adaption proportional term/upper barrier adaption derivative term)

With the help of these values you can set the upper limit of the characteristic curve. Above this speed limit, the PD pressure controller is no longer adapted.

R672/R686 – slope of the adaptation characteristic curve (slope adaption curve proportional term/slope adaption curve derivative term)

The slope of the characteristic curve can be adapted using parameters R672 and R686. The slope refers to a speed step-change of 750 rpm. With a slope of 0, the pressure controller is not adapted. With a factor of 1, the controller factors are doubled when speed is reduced from 1500 rpm to 750 rpm, and the corresponding limits for adaptation are set to a value higher than 1500 rpm and less than 750 rpm, respectively.

If, for example, a factor of 0.8 is selected and the limits are set to 1250 rpm and 500 rpm, at 500 rpm, the controller factors are raised to the 1.8-fold of the starting value.

Table 77: Slope of the adaption curve

R parameter	Designation	Range of values	Unit
R669	Lower barrier adaption proportional term	1 - 2500	rpm
R670	Upper barrier adaption proportional term	1 - 2500	rpm
R672	Slope adaption curve proportional term	-5,0 - 5,0	decimal
R624	Lower barrier adaption derivative term	1 - 2500	rpm
R671	Upper barrier adaption derivative term	1 - 2500	rpm
R686	Slope adaption curve derivative term	-5.0 – 5.0	decimal

Factor for disturbance feedforward for pressure controller (R200)

Any change in speed acts on the active pressure controller like an external disturbance. To compensate for this disturbance, it is possible to feed forward an additional factor, which is calculated in dependence upon the change in speed, to the controller output of the pressure controller. This factor can be scaled using R parameter R200.

Table 78: Factor for disturbance feedforward

R parameter	Designation	Range of values	Unit
R200	Factor disturbance (in-diff) pressure ctrl	0 - 1000	%

Value of manual speed selection (R668)

This function is available only in conjunction with CAN bus. You can activate this function over CAN bus to determine a specific speed of the SYDFEn for certain operational states (e.g. set-up mode). R parameter R668 determines the value for manual speed provision. Manual speed can only be used in teach-in status 0.

Table 79: Value of manual speed provision

R parameter	Designation	Range of values	Unit
R668	Value of manual speed selection	0 - 2500	rpm

Speed adaptation of swivel angle controller (R614, R617)

Speed adaptation of the swivel angle controller may become necessary, if the swivel angle controller of the SYDFEn control system is used as inner-loop controller for a machine function. The limits for this adaptation can be selected under parameters R614 and R617. Speed adaptation is deactivated when you enter the value “0“. Moreover, speed adaptation of the swivel angle controller can only be used in parameter sets 12-15. In addition, as lower limit for adaptation, a second gain value for the swivel angle controller can be entered in these parameter sets.

Table 80: Speed adaptation

R parameter	Designation	Range of values	Unit
R614	Upper limit for SWA controller adaptation	0 - 2500	rpm
R617	Lower limit for SWA controller adaptation	0 - 2500	rpm

Displacement monitoring/response to cycle fluctuations (R675, R698, R627, R628, R205)

The SYDFEn control system offers the possibility of comparing the current displacement with the displacement during the teach-in. In this way, differences between the learnt cycle and the current cycle can be recognized.

Current displacement too low:

By means of R parameters R675 and R698 you can determine the limits for the detection of too low a displacement in relation to the learnt cycle.

Table 81: Displacement too low

R parameter	Designation	Range of values	Unit
R675	Fault detection duration (0 = OFF)	0 - 1000	ms
R698	Fault detection threshold too low	0.0 - 10.0%	%

Current displacement too high:

By means of R parameters R627 and R628 you can determine the limits for the detection of too great a displacement in relation to the learnt cycle.

Table 82: Displacement too high

R parameter	Designation	Range of values	Unit
R627	Fault detection duration (0 = OFF)	0-1000	ms
R628	Fault detection threshold too low	0.0-100.0%	%

Fault response:

By means of R parameter R205 you can activate the automatic re-teach function of the SYDFEn control system. If a deviation of the displacement is detected during the cycle, this function adapts the saved speed table to the new cycle profile.

The status of this re-teach function can be read off in “Diagnosis” under variable “Status re-tea”.

Table 83: Variable „Status re-teach“

Value	Description
-2	Re-teaching not active - no comparative cycle recorded
-1&0	Re-teaching active - comparative cycles are being recorded
1	Re-teaching active - cycle error recognized and comparative cycle is recorded until the end
3	Re-teaching active - saved cycle is compared with new cycle profile
4	Re-teaching active - ramps are re-calculated for re-taught cycle

8.1.11.2 Real-time version

The operating principle of the real-time version is described in the following chapter. The real-time version is used on machines without cyclic operation. This real-time version computes the optimum drive speed at any time and compares it with the current speed. If a difference is detected between the two speeds, the setpoint speed is raised or lowered as required. Compared with the cyclic version or the DFE system with fixed speed, with this version, the speed adjustment in the case of major changes in flows also depends on the dynamics of the electric drive. To compensate for this poor dynamics, at least partially, various boost functions can be activated.

8.1.11.2.1 Controlling variable-speed operation

Variable-speed operation is controlled by means of switch S1. When this switch S1 is set, real-time operation is activated. When switch S1 is reset, speed is accelerated to maximum speed. Switch S1 can be changed via the digital input (X1, pin 9) or over CAN bus. The current status of real-time operation can be queried through process variable “status real time operation“:

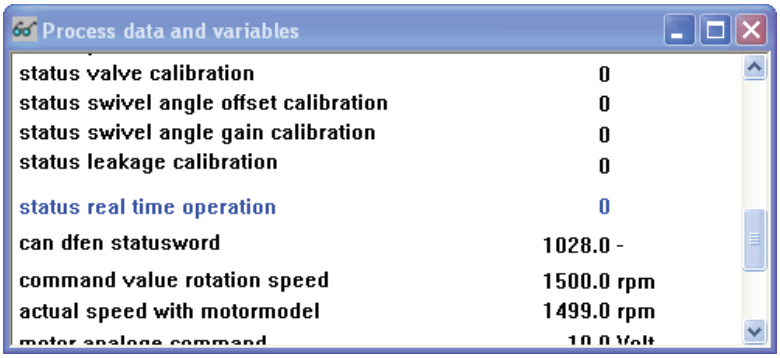


Fig. 54: Status of real-time operation

Table 84: Status values

Value	Status of real-time operation
0	Real-time operation off
1	Real-time operation on

8.1.11.2.2 Process variables involved/speed calculation

The individual parameters described in this chapter can be found by selecting “Project” →”R parameter“→”Speed calculation .

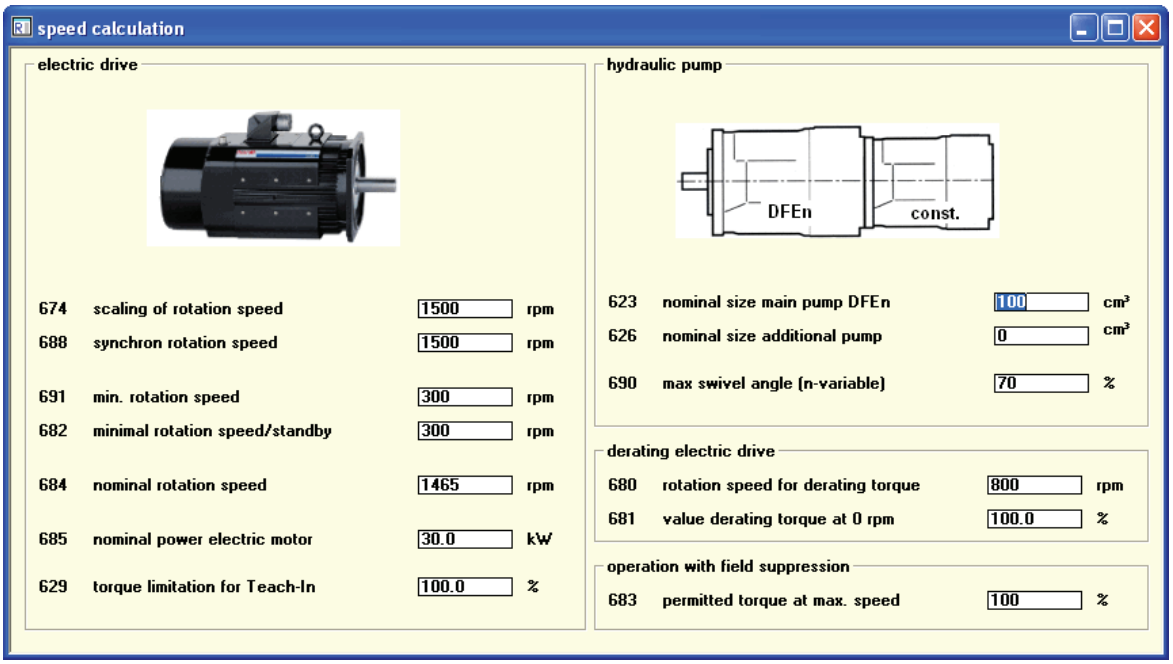


Fig. 55: Speed calculation

Scaling of speed (R674)

The speed can be scaled using parameter R674. This value corresponds to the speed command value at 10 V (100 %).

Table 85: Scaling of speed

R parameter	Designation	Range of values	Unit
R674	Scaling of rotation speed	300 - 2500	rpm

Synchronous rotation speed (R688)

Parameter R688 is used to indicate the synchronous speed of the drive. The synchronous speed results from the mains frequency and the number of pole pairs. With a 50 Hz mains and a 4-pole motor, the synchronous speed is 1500 rpm.

Up to synchronous speed, the torque defined with parameter R629 is used. In field weakening operation, tor speeds above the synchronous speed the permissible torque can be limited by means of parameter R638.

Table 86: Synchronous speed

R parameter	Designation	Range of values	Unit
R688	Synchron rotation speed	50 - 2000	rpm

Minimum speed (R691, R682)

The minimum speed can be determined using parameter R691. For some drives, which are operated with U/f characteristic curve, the manufacturers specify a minimum speed, at which the nominal torque is briefly available. For part-load operation of the machine, a second minimum speed can be specified. This speed limit is active, when the torque in the teach-in cycle is below 3.1 % of the nominal torque. For example, due to this second minimum speed, it is possible to reduce the magnetization of the asynchronous motor during part-load operation of the machine in order to reduce power losses. For more detailed information, please refer to the data sheet of the drive manufacturer.

Table 87: Minimum speed

R parameter	Designation	Range of values	Unit
R691	Minimum rotation speed	50 - 2000	rpm
R682	Minimal rotation speed/stand-by	50 - 2000	rpm

Nominal rotation speed (R684)

To be able to compute the slip characteristic curve of the asynchronous motor, it is necessary to enter, among others, the nominal speed of the asynchronous motor under rated load. The nominal speed is indicated on the nameplate of the asynchronous motor.

Table 88: Nominal motor speed

R parameter	Designation	Range of values	Unit
R684	Nominal rotation speed	100 - 2500	rpm

Torque limitation for speed calculation (R629)

At reduced speed and with unchanged hydraulic output, the current motor torque is accordingly higher. If, at reduced speed, the motor is loaded with a greater torque than the nominal torque, the power loss in the asynchronous motor rises significantly. By means of parameter R629 the maximum torque referred to the nominal torque of the motor can be specified for variable-speed operation.

Table 89: Motor torque limitation

R parameter	Designation	Range of values	Unit
R629	Torque limitation for speed calculation	1 - 350	%

Derating of the electric drive (R680, R681)

Asynchronous motors are usually operated with self-ventilation. As the speed is reduced, the cooling power of the ventilator falls accordingly. Consequently, the nominal torque cannot be maintained continuously at low speeds, because the motor would heat up excessively. In this case, a derating function can be activated at low speeds to protect the electric motor. Parameter R680 can be used to specify the speed limit, from which on the derating function is to be activated. With parameter R681 you can enter the theoretical torque at “zero” speed. This value must be entered in % of the nominal torque. Should an external ventilator be used for the asynchronous motor or if the derating function is to be deactivated, you can set the value “100 %” for R681.

Table 90: Derating

R parameter	Designation	Range of values	Unit
R680	Rotation speed for derating torque	1 - 2500	rpm
R681	Value derating torque at 0 rpm	0.0 - 100.0	%

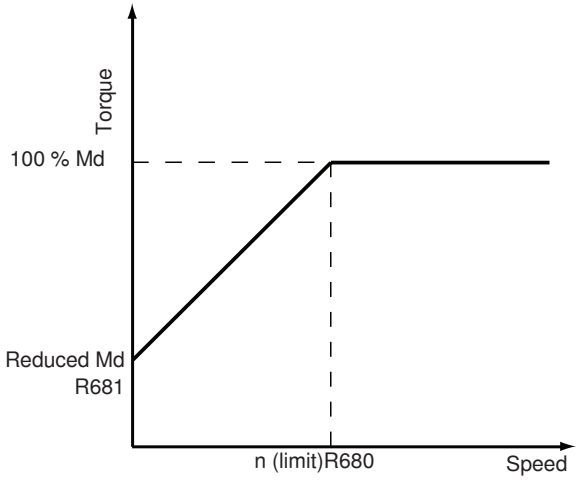


Fig. 56: Derating

Size of main pump (R623)

For variable-speed operation, the SY(H)DFEn control system must know the size of the main pump, to which the VT-DFPn valve is mounted. With several controlled pumps (pressure controller master/slave, single-circuit), you have to enter the sum of all control pumps that displace hydraulic fluid into the same hydraulic system.

Table 91: Selection of the main pump size

R parameter	Designation	Range of values	Unit
R623	Nominal size main pump DFEn	10-356	cm^3

Size of additional pump (R626)

For a regenerative combination consisting of one or several pumps, the size of the additional fixed displacement pump must be specified in parameter R626. Should several fixed displacement pumps be used, you have to enter the sum of all fixed displacement pumps that deliver hydraulic fluid into the hydraulic system. In case that only one main pump is used for operation, the value “0” must be entered for R626.

Table 92: Size of mounted pump

R parameter	Designation	Range of values	Unit
R626	Nominal size additional pump	0-250	cm^3

Maximum swivel angle for variable speed (R690)

The maximum swivel angle for variable-speed operation can be determined using parameter R690. The SY(H)DFEn control system reduces the speed until this maximum swivel angle is reached for displacing the required flow. Generally, the efficiency of the pump improves at a greater swivel angle. To minimize power losses in variable-speed operation, the speed should be reduced to a value, where the swivel angle comes close to its maximum (100 %). To obtain a sufficient control reserve for the swivel angle controller, the optimum is between 65 % and 85 % (depending on the relevant system).

Table 93: Maximum swivel angle

R parameter	Designation	Range of values	Unit
R690	Max. swivel angle (n-variable)	50-98	%

Field-weakening operation (R683)

For some applications, it may be useful to run the motor briefly at speeds higher than the motor‘s synchronized speed. In this case, the asynchronous motor is operated in field-weakening operation. In this context, please note that in field-weakening operation, the motor torque is reduced and the power loss increases. Moreover, the permissible maximum speed of the pump and the motor must not

be exceeded. To be able to start field-weakening operation of the motor, the maximum speed of the drive must be entered in R674. The relevant maximum speed settings must also be made for the converter. Please observe the notes in the converter manual. To limit the permissible maximum torque in field-weakening operation, you can enter the permissible torque at maximum speed in parameter R683. Parameter R683 refers to the nominal torque. Between the permissible torque and the nominal torque at nominal speed, linear interpolation is performed. This characteristic curve can be used to prevent the asynchronous motor from overloading during field-weakening operation.

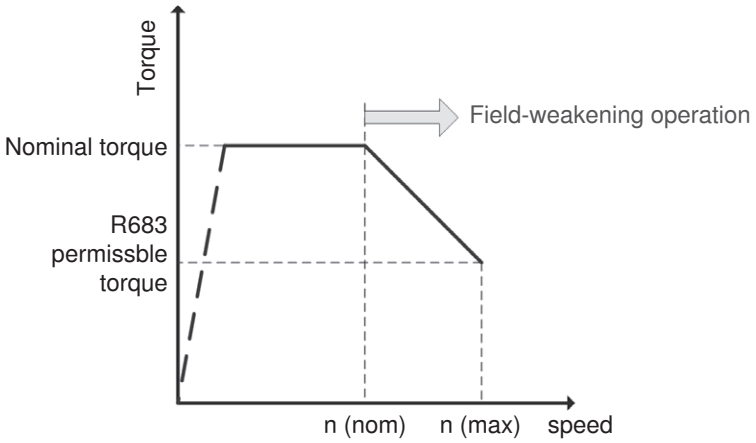


Fig. 57: Field weakening operation

Table 94: Field weakening operation

R parameter	Designation	Range of values	Unit
R683	Permitted torque at max. speed	0 - 100	%

8.1.11.2.3 Setting of variable speed

The individual parameters described in this Chapter are accessible by selecting “Project“ →”R parameter“→”Variable rotation speed“ .

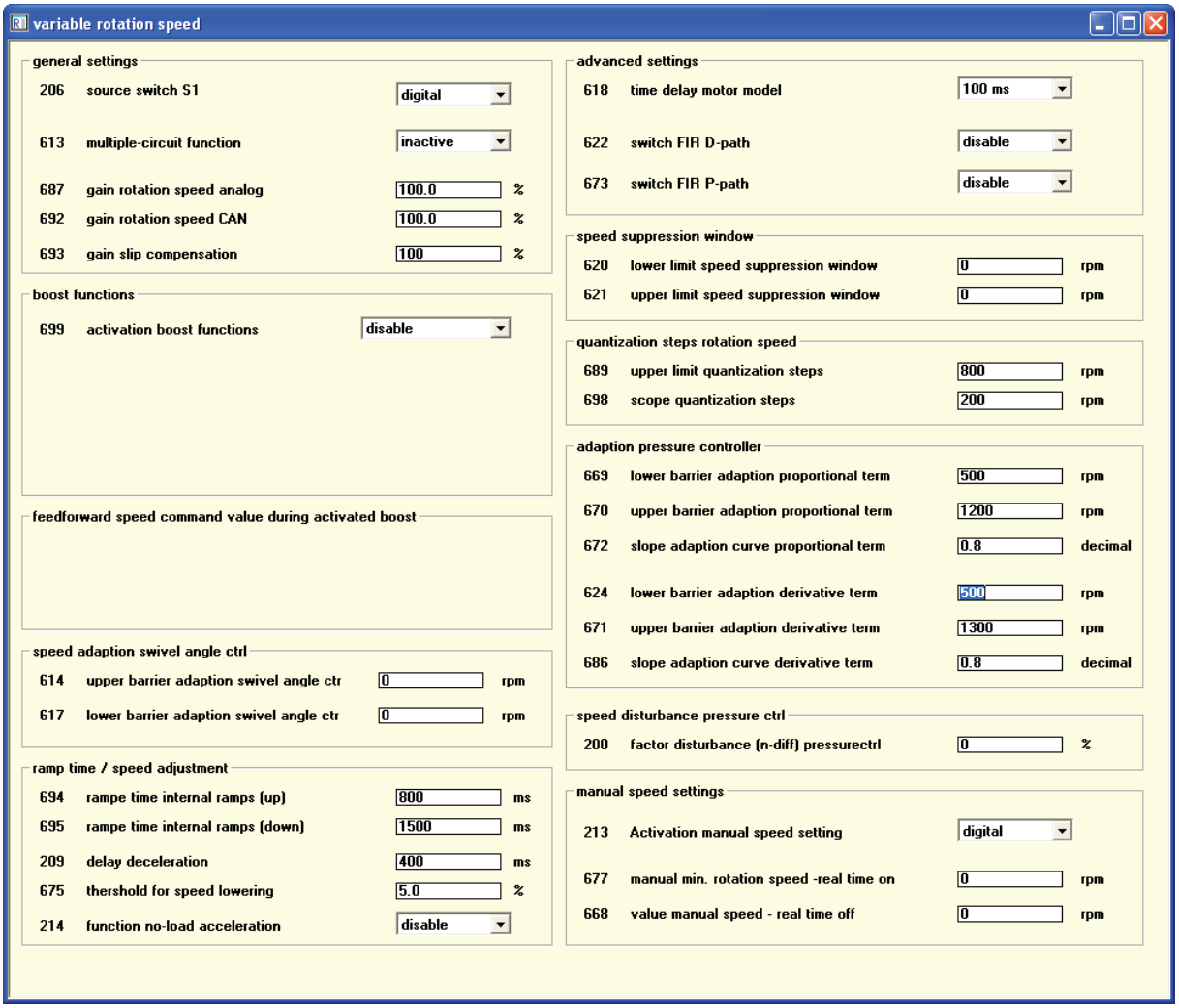


Fig. 58: Setting of variable speed

Control of real-time operation

Real-time operation of the SY(H)DFEn control system is controlled by means of switch S1. This switch can be operated either via a digital input or over CAN bus. R parameter R206 (“source switch”) determines the operation of switch S1.

Multiple-circuit rotation speed calculation (R613)

The SY(H)DFEn control system offers the possibility of operating several independent SY(H)DFEn control pumps, which displace fluid into two different circuits, on one motor shaft. R613 can be used to activate this function and to select either the main pump or a secondary pump. The multiple-circuit function requires a CAN bus system. A more detailed description of the multiple-circuit function can be found in RE 30014-02-Z.

Gain of speed command value (R687, R692)

The speed command value is issued via analog output 1 (pin 6 or pin 8 on central plug X1) or over the CAN bus. To adjust the factor for the speed command value output, parameter R687 respectively R692 can be changed accordingly.

Table 95: Gain of the speed command value

R parameter	Designation	Range of values	Unit
R687	Gain rotation speed command analog	0-100	%
R692	Gain rotation speed CAN	0-100	%

Gain slip compensation (R693)

Because slip of the asynchronous motor affects the actual displacement, the SY(H)DFEn control system offers an additional function for compensating for slip of an asynchronous motor. The gain of this slip compensation can be adapted using parameter R693.

Table 96: Gain of slip compensation

R parameter	Designation	Range of values	Unit
R693	Gain slip compensation	0-150	%

Boost functions and feedforward of speed command value (R699, R697, R627, R696, R204, R210, R205, R628)

The boost functions of the real-time version can be used to improve the dynamics of the system while speeding up. When the boost functions are activated, the speed command value is increased in accordance with the max. speed ramp. The boost functions evaluate various process variables in closed-loop pressure and swivel angle control. Parameter R699 is provided for activating the boost functions. The parameters involved in the individual boost functions are displayed only when the function is activated. With the factory settings, all boost functions are deactivated.

Boost of pressure controller (R697, R210)

This function monitors the amount of pressure breakdown in pressure control. When a defined threshold value (R697) is exceeded, the boost function is activated. While the boost is activated, the error from this pressure difference is weighted with a gain (R210) and added to the speed command value.

Boost of swivel angle controller (R627, R205, R628)

This function monitors the amount of the control deviation in swivel angle control. When a defined threshold value (R627) is exceeded, the boost function is activated. While the boost function is activated, the error from this swivel angle difference is weighted with a gain (R205) and added to the speed command value. In addition, with the swivel angle controller, the required min. speed resulting from the flow command value is compared with the current actual speed. If the required min. speed is greater than the current speed, the boost function is also activated. While the boost function is activated, the error between the two speed values is weighted with a gain (R628) and added to the speed command value.

Boost of actual swivel angle value change rate (R696, R204)

This function monitors the change rate of the actual swivel angle value. When the change rate exceeds a defined threshold value (R696), the boost function is activated. To smoothen the swivel angle change rate, an additional low-pass filter with defined filter time constants (R204) can be used.

Table 97: Boost functions

R parameter	Designation	Range of values	Unit
R699	Activation boost functions	-	-
R697	Threshold for pressure diff. boost	0 - 250	bar
R627	Threshold for swa diff. boost	0 - 100	%
R696	Threshold for change swa(act) boost	0 - 15000	%/s
R204	Filter delay time - derivation swa(act)	0 - 100	ms
R210	Gain for intrusion p-diff (boost)	0 - 250	%
R205	Gain for intrustion swa-diff. (boost)	0 - 250	%
R628	Gain intrusion diff. swa and speeds	0 - 250	%

Speed adaptation of swivel angle controller (R614, R617)

Speed adaptation of the swivel angle controller may become necessary, if the swivel angle controller of the SYDFEn control system is used as inner-loop controller for a machine function. The limits for this adaptation can be selected under parameters R614 and R617. Speed adaptation is deactivated when you enter the value “0“. Moreover, speed adaptation of the swivel angle controller can only be used in parameter sets 12-15. In addition, as lower limit for adaptation, a second gain value for the swivel angle controller can be entered in these parameter sets.

Table 98: Speed adaptation

R parameter	Designation	Range of values	Unit
R614	Upper limit for SWA controller adaptation	0 - 2500	rpm
R617	Lower limit for SWA controller adaptation	0 - 2500	rpm

Ramp time / speed adjustment (R694, R695, R209, R675, R214, R215)

The times for speed ramps can be adjusted by means of parameters R694 and R695. The ramp times refer to a speed change from zero to maximum speed. The acceleration time should be matched with the maximum acceleration time of the drive. The deceleration time should be selected so that the motor is not actively decelerated, thus allowing energy to be recovered.

In order to prevent any influence by the speed adjustment on the control characteristics of the DFE controller, you can specify a delay (R209) and a tolerance threshold for the speed change (R675).

In addition, in order to reduce the acceleration time while boost is activated, you can activate the function “no-load acceleration” (R214, R215) .

Table 99: Ramp time / speed adjustment

R parameter	Designation	Range of values	Unit
R694	Ramp time internal ramps (up)	100 - 4000	ms
R695	Ramp time internal ramps (down)	100 – 4000	ms
R209	Delay deceleration	0 – 2500	ms
R675	Threshold for speed lowering	0.0 – 25.0	%
R214	Function no-load acceleration	-	-
R215	Threshold activation no-load acceleration	0 – 200	%

Time delay motor model (R618)

To compensate for the lag of an electric motor (dynamic error), you can activate an additional motor model for closed-loop controlling. In the case of a change in speed, this motor model computes the speed deviation of the motor and takes this lag into account when calculating the flow. For the selection of these time constants, various pre-defined values are available.

Table 100: Time constant of the motor model

R parameter	Designation	Range of values	Unit
R618	Time constant motor model	0 - 800	ms

FIR filter (pulsation filter, R622, R673)

Flow pulsation of the pump is related to the current speed of the electric drive. Depending on the hydraulic system this flow pulsation has a more or less strong influence on pressure. With the SY(H)DFEn control system, various filters can be activated to compensate for this pulsation in the control loop. These filters can be activated using parameters R622 and R673.

Table 101: Pulsation filter

R parameter	Designation
R622	Switch FIR D-path
R673	Switch FIR P-path

Speed suppression window (R620, R621)

To avoid speed values, at which resonsance occurs, a suppression window can be defined. Continuous operation at speed values within the suppression window is prevented. If the optimized speed is within the defined window, the upper limit of the speed suppression window is taken as operating speed.

Table 102: Speed suppression window

R parameter	Designation	Range of values	Unit
R620	Lower limit speed suppression window	0 - 2500	rpm
R621	Upper limit speed suppression window	0 - 2500	rpm

Quantization steps of speed (R689, R698)

Inaccuracies in the actual value acquisition (swivel angle, actual speed) can result in minor deviations in speed calculation. These minor fluctuations can have an effect on the SY(H)DFEn control. It is therefore useful to subdivide the setpoint speed of the drive into individual quantization steps, especially in the case of low speeds below 800 rpm. You can enter both, the scope of the quantization steps (R698) and the upper limit for the quantization step (R689).

Table 103: Quantization steps

R parameter	Designation	Range of values	Unit
R689	Upper limit quantization steps	300 - 2500	rpm
R698	Scope quantization steps	0 - 1000	rpm

Input of the characteristic curve for adapting the PD-controller

At reduced speed, the pressure control of a control pump shows other control characteristics than at nominal speed. Through adaptation of the PD pressure controller, the control behavior of the SY(H)DFEn control system can be kept largely constant, irrespective of the current speed.

R669/R624 – lower limit for adaptation (lower barrier adaption proportional term/lower barrier adaption derivative term)

With the help of this value you can set the lower limit value of the characteristic curve. Below this speed limit, the PD pressure controller is no longer adapted.

R670/R671 – upper limit for adaptation (upper barrier adaption proportional term/upper barrier adaption derivative term)

With the help of these values you can set the upper limit of the characteristic curve. Above this speed limit, the PD pressure controller is no longer adapted.

R672/R686 – slope of the adaptation characteristic curve (slope adaption curve proportional term/slope adaption curve derivative term)

The slope of the characteristic curve can be adapted using parameters R672 and R686. The slope refers to a speed step-change of 750 rpm. With a slope of 0, the pressure controller is not adapted. With a factor of 1, the controller factors are doubled when speed is reduced from 1500 rpm to 750 rpm, and the corresponding limits for adaptation are set to a value higher than 1500 rpm and less than 750 rpm, respectively.

If, for example, a factor of 0.8 is selected and the limits are set to 1250 rpm and 500 rpm, at 500 rpm, the controller factors are raised to the 1.8-fold of the starting value.

Table 104: Slope of the adaption curve

R parameter	Designation	Range of values	Unit
R669	Lower barrier adaption proportional term	1 - 2500	rpm
R670	Upper barrier adaption proportional term	1 - 2500	rpm
R672	Slope adaption curve proportional term	-5,0 - 5,0	decimal
R624	Lower barrier adaption derivative term	1 - 2500	rpm
R671	Upper barrier adaption derivative term	1 - 2500	rpm
R686	Slope adaption curve derivative term	-5.0 – 5.0	decimal

Factor for disturbance feedforward for pressure controller (R200)

Any change in speed acts on the active pressure controller like an external disturbance. To compensate for this disturbance, it is possible to feed forward an additional factor, which is calculated in dependence upon the change in speed, to the controller output of the pressure controller. This factor can be scaled using R parameter R200.

Table 105: Factor for disturbance feedforward

R parameter	Designation	Range of values	Unit
R200	Factor disturbance (in-diff) pressure ctrl	0 - 1000	%

Manual speed settings (R213, R677, R668)

The SY(H)DFEn real-time version features an option of influencing the speed with manually entered values. While real-time operation is active you can enter an additional, minimum speed in parameter R677. This function can be used to raise the speed shortly before a greater flow is required, e.g. for starting a cylinder after stand-by, thus significantly increasing the dynamics of the DFEn system.

When real-time operation is deactivated, a speed value entered in R668 can be used, e.g. for set-up operation. Manual speed settings can be activated either over CAN bus or via a digital input (X3, pin 2). The selection is made with parameter R213. With the factory setting, the value 0 rpm is selected for the parameters R677 and R668. When the value “0 rpm” is entered, the manual speed input is deactivated as well, irrespective of the state of the digital input or the CAN bus provision.

Table 106: Manual speed settings

R parameter	Designation	Range of values	Unit
R213	Activation manual speed settings		
R677	Manual min. rotation speed - real-time on	0 - 2500	U/min
R668	Value manual speed - real-time off	0 - 2500	U/min

8.1.12 Description of special functions

8.1.12.1 Torque limit

To protect the drive motor against overloading, the maximum torque can be limited. The settings refer to the maximum torque of the pump. This torque limit is active in every operating state, that is, at both, constant speed and reduced speed. At reduced speed and unchanged hydraulic output, the momentary torque at the shaft is correspondingly higher. Because the power loss of the asynchronous motor rises significantly when it exceeds its nominal torque, the speed should only be reduced to a level, at which the nominal torque is not exceeded. To this end, the limitation for the calculation of speed can be set by means of R parameter R629 in variable-speed operation.

At nominal speed, the momentary torque can, however, briefly be remarkably higher than the nominal torque of the motor. For this reason, the torque limit must always be set higher in R612 than the limitation for teach-in (R629)[1)].

1) When comparing the torque limits, please note that the two R parameters have different normalizations. Parameter R612 refers to the maximum torque of the pump, R629 to the nominal torque of the motor.

This “torque limit” function corresponds to the “power limit” function of the control systems SY(H)DFEE and SY(H)DFEC. However, since power depends on the current speed, with control system SY(H)DFEn, this function is used for limiting the torque.

Table 107: Parameter group “torque limitation“

R parameter	Designation
R612	Torque limitation (PL pump)

You can adjust the torque limit by means of R parameter R612 (“Project” → ”R parameter” → “Torque limitation”). The value range for torque limitation is 0 %...125 %.

The default value for the torque limit is 125 %, i.e. no torque limitation active.

Example Calculation of the maximum torque of the pump (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_{motor}	=	191 Nm

2) For SY(H)DFEn always 315 bar, irrespective of the settings for the PT or the nominal system pressure.

$$M_{motor} = \frac{P_{motor}}{2 \cdot \pi \cdot n} = \frac{30\ kW}{2 \cdot \pi \cdot 1500\ rpm} = \frac{30{,}000\ W}{2 \cdot \pi \cdot 25\ U/s} = 191\ Nm$$

$$M_{100\ \%} = \frac{1.59 \cdot V_G \cdot p_{max}}{\eta_{mh} \cdot 100} = \frac{1.59 \cdot 71\ cm^3 \cdot 315\ bar}{100} = 355\ Nm$$

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

Overloading of the asynchronous motor by 200 %

$$(p \cdot \alpha)_{max} = \frac{M_{motor}}{M_{100\ \%}} \cdot 200\ \% = \frac{191\ Nm}{355\ Nm} \cdot 200\ \% = 107.6\ \%\ (= 0x44DD_{hex})$$

8.1.13 Master/slave – analog command value provision to the slave

By coupling several SY(H)DFEn pumps you can achieve an increase in flow output.

The communication between the SY(H)DFEn pumps is handled by means of analog command value provision. For this, the swivel angle command value for the slave can be selected with R607 and R608 for the analog outputs (“Project” → “R parameter” → “Analog outputs”).

Table 108: R parameter group for analog command value provision

R parameter	Designation
R607	Output variable of the analog output 1
R608	Output variable of the analog output 2

8.1.14 Internal command value ramps

For some applications, it is required to apply the pressure or swivel angle using ramp functions. To meet the requirements of these applications, the SY(H)DFEn control system is equipped with an internal ramp generator for acceleration and deceleration ramps. Acceleration (change in the positive direction) and deceleration (change in the negative direction) can be adjusted separately for pressure and swivel angle (“Project” → “R parameter” → “Internal ramps”).

Table 109: Parameter group “internal ramps“

R parameter	Designation	Range of values
R638	Delta for P-ramps (positive) [0 = off]	0 - 6500
R639	Delta for P-ramps (negative) [0 = off]	0 - 6500
R640	Delta for SWA-ramps (positive) [0 = off]	0 - 6500
R641	Delta for SWA-ramps (negative) [0 = off]	0 - 6500

When a new command value is fed forward, the set ramp gradient is used to accelerate or decelerate from the previous command value to the current command value. With the factory setting, the ramp function is set to the default value of 0, i.e. the ramp functions are deactivated.

The set ramp gradients are used independently of the selected command value source.

8.1.15 Pressure command value curve

With the real-time version, an additional pressure command value curve can be activated. You can access the parameters by selecting “Project” → “R parameter“ → “Internal setpoint treatment“.This pressure command value curve can be used as an alternative to the master/slave function, if several SYDFEN systems displace hydraulic fluid into one hydraulic system. Here, the pressure command value is reduced in dependence on the current actual flow value. The factor for this can be set with parameter R211. With the factory setting, the factor R211 is set to zero, that is, the pressure command value curve is deactivated. To smoothen the actual flow value, an additional low-pass filter with pre-defined filter time constants (R212) can be used.

When several pressure controllers are used in parallel, the reduction of the pressure command value results in the fact that the contol pumps can synchronize themselves to deliver approximately the same displacement.

Table 110: Pressure command value characteristic curve

R parameter	Designation	Range of values	Unit
R211	Gain for characteristic pressure curve	0.000 – 1.000	bar / %
R212	Filter delay time for act. flow	0 - 400	ms

8.1.16 Analog outputs

Table 111: Analog outputs

D/A output	Connection	Pin	
		Signal	Reference
1	Central plug 11 + PE	8	4
2	Central plug 11 + PE	6	4

Table 112: Parameter group “analog outputs“

R parameter	Designation
R607	Output variable of the analog output 1
R608	Output variable of the analog output 2

Parameters R607/R608 can be used to select the output variable, which is to be issued via an analog output. The output variables are normalized to 10 V.

Table 113: Output variables

Output variable
0V
Pressure command value
Internal pressure command value
Pressure actual value
Pressure deviation
Swivel angle command value
Internal swivel angle command value
Swivel angle actual value
Swivel angle deviation
Pressure controller output
Swivel angle controller output
Valve command value
Valve actual value
Swivel angle command value for slave
Temperature (0...100 degrees Celsius = 0...10 V)
+10 V (not suitable for supplying external actuators!)
-10 V (not suitable for supplying external actuators!)
Actual flow (10 V = maximum flow of pump combination) [1)]
Actual swivel angle at constant speed
Motor speed command

[1)] The analog output with current flow cannot be utilized for master/slave operation. The flow command value can only be provided over CAN bus.

With the factory setting, the speed command value is fed to analog output 1 (U_{out} 1), and the actual pressure value is fed to analog output 2 (U_{out} 2).

For more details with regard to the speed command value, see also Chapter 8.1.11.1.8 “Settings for variable speed“ on page 92.

8.2 Recommissioning after standstill

Depending on the installation conditions and ambient conditions, changes may occur in the system which make recommissioning necessary.

Among others, the following reasons may render recommissioning necessary:

- Air in the hydraulic system
- Water in the hydraulic system
- Aged hydraulic fluid
- Contamination

▶ For recommissioning, proceed as described in Chapter 8.1 “First commissioning” on page 61.

8.3 Running-in phase

NOTICE
Viscosity too low! Risk of damage! The increased temperature of the hydraulic fluid during the running-in phase can cause the viscosity to drop to impermissible levels. ▶ Monitor the operating temperature during the running-in phase. ▶ Reduce the loading (pressure, speed) of the SY(H)DFEn control system, if impermissible operating temperatures and/or viscosities occur.

Bearings and sliding surfaces are subject to a running-in period. Increased friction at the beginning of the running-in phase results in increased heat generation which decreases with increasing operating hours. The volumetric and mechanical-hydraulic efficiency rises as well by the end of the running-in phase of approx. 10 operating hours.

For the use of HFC fluids, observe the notes on the running-in phase/ commissioning in RE 92053 and RE 90223!

9 Operation

The SY(H)DFEn control system is a component which requires no settings or changes during operation. For this reason, this chapter of the manual does not contain any information on adjustment options. Only use the product within the performance range provided in the technical data. The machine or system manufacturer is responsible for the proper project planning of the hydraulic system and its control.

10 Maintenance and repair

10.1 Cleaning and care

NOTICE

Solvents and aggressive detergents!

Aggressive detergents can damage the seals on the SY(H)DFEn control system and cause them to age faster.

- Never use solvents or aggressive detergents.

Ingress of contaminants and fluids!

This will result in the fact that safe operation of the SY(H)DFEn control system can no longer be ensured.

- When carrying out any work on the SY(H)DFEn control system, observe strictest cleanliness.
- Do not use high-pressure cleaners.

For cleaning and care of the SY(H)DFEn control system, observe the following:

- Plug all openings with suitable protective caps/devices.
- Check that all seals and plugs of the plug connections are securely seated to ensure that no moisture can enter the SY(H)DFEn control system during cleaning.
- Use only water and, if necessary, a mild detergent to clean the SY(H)DFEn control system.
- Remove coarse dirt from the outside of the machine and keep sensitive and important components, such as solenoids, valves and displays, clean.
- Do not use high-pressure cleaners for cleaning the SY(H)DFEn control system.

10.2 Inspection

In order to ensure a long service life and reliable operation of the SY(H)DFEn control system, Rexroth recommends that you inspect the SY(H)DFEn control system regularly and document the following operating conditions:

Table 114: Inspection schedule

Work to be carried out		Interval
Hydraulic system	Check level of hydraulic fluid in the tank.	Daily
	Check operating temperature (comparable load state).	Weekly
	Analyze quality of the hydraulic fluid.	Annually or every 2000 h (which ever occurs first)

Work to be carried out		Interval
SY(H)DFEn control system	Inspect the SY(H)DFEn control system for leakage. Early detection of hydraulic fluid loss can help identify and rectify faults on the machine or system. For this reason, Rexroth recommends that the SY(H)DFEn control system and the system as whole be always kept in a clean condition.	Daily
	Check the SY(H)DFEn control system for generation of noise.	Daily
	Check mounting elements for proper fit. Inspect all mounting elements while the system is switched off, depressurized and cooled down.	Monthly

10.3 Maintenance

The SY(H)DFEn control systems requires little maintenance when used in accordance with the intended purpose.

The service life of the SY(H)DFEn control system is heavily dependent on the quality of the hydraulic fluid. For this reason, we recommend changing the hydraulic fluid at least once a year or every 2000 operating hours (whichever occurs first) or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use.

The service life of the SY(H)DFEn control system is limited by the service life of the built-in bearings. The service life can be requested on the basis of the load cycle from the responsible Rexroth Service partner, see Chapter 10.5 “Spare parts” below for address. Based on these details, a maintenance interval is to be determined by the system manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system.

Should a firmware update be required, please observe Chapter 5.11.3 “Firmware update“ on page 35.

10.4 Repair

Rexroth offers a comprehensive range of services for the repair of Rexroth SY(H)DFEn control systems.

Repairs of the SY(H)DFEn control system may only be performed by authorized, skilled and instructed staff.

- Only use genuine spare parts from Rexroth for repairing Rexroth SY(H)DFEn control systems.

Tested and pre-assembled original Rexroth units allow for successful repairs within a minimum of time.

10.5 Spare parts

When ordering spare parts, please state the material number of the relevant spare parts.

On some components, the material number is shown on a nameplate or a label.

Please address all questions regarding spare parts to your responsible Rexroth Service partner.

Bosch Rexroth AG
Service Hydraulics
Bgm.-Dr.-Nebel-Str. 8

97816 Lohr am Main

Tel: +49 (0) 9352 - 18 0
Fax: +49 (0) 9352 - 18 39 83

spareparts.bri@boschrexroth.de

For the addresses of foreign subsidiaries, please refer to
www.boschrexroth.com/adressen

- Please state the following data from the nameplate on your order:
  - material number
  - serial number
  - production job order number
  - production date

10.5.1 Replacement of components

The replacement of some components of the SY(H)DFEn control system is described in the following.

Swivel angle sensor VT-SWA-1-1X for SYDFEn systems

The operating principle of VT-SWA-1-1X swivel angle sensors, which work with a Hall sensor, is based on the evaluation of a magnetic field that depends on the swivel angle. The system operates contactless and is therefore wear-free.

In case that repairs have to be carried out on the swivel angle transducer of the SYDFEn system, observe the installation notes for the VT-SWA-1-1X swivel angle sensor and its magnet carrier.

The material number for the kit, magnet carrier and seals included, is R900868651.

General

The magnet carrier is a sensitive component and must therefore be handled with care. It must not be subjected to impacts and be kept away from magnetizable or magnetic parts! Until the carrier is installed in the pump housing, the original packaging is the safest place of storage.

Installing the magnet carrier

- Installation orientation with clockwise rotating pump:
  The locating pin of the magnet carrier points towards the subplate of the pump (away from the drive motor). The bore for the locating pin is marked with a color point.
- Insert the magnet carrier into the receptacle provided for it in the housing of the A10 pump.
  A special tool (plastic installation sleeve, material no. R900846331) is required for inserting and tightening the countersunk screw! If this installation sleeve is not available, use a suitable tool made of non-magnetic material for inserting the fixing screw and for guiding a screw driver between the poles of the magnet.
- Tighten the countersunk M6 x 12 screw to 10.5 Nm.
- After having installed the magnet carrier, check with your fingers, whether the magnets positively adhere to the carrier.

Installing swivel angle sensor VT-SWA-1-1X

- "Glue" the O-ring of the kit into the groove using some grease.
- Tighten mounting screws M6 x 35 with washers to 15.5 Nm.
- Adjust the swivel angle sensor. Notes on the adjustment can be found in Chapter 15.3.1 "Checking the swivel angle measurement" on page 123.

Miscellaneous

- If the magnet carrier must be removed, also use a suitable installation sleeve for loosening the countersunk screw (see note "installing the magnet carrier" above).

If the swivel angle sensor fails, the SY(H)DFEn system cannot work properly.

Swivel angle sensor VT-SWA-LIN-1X for SYHDFEn systems

General

The test prod is a sensitive component and must therefore be handled with care. In particular with regard to the magnetic properties, the test prod must not be subjected to hard impacts and must be kept away from metal parts! Keep the test prod in the original packaging until it is installed in the pump housing.

Installing swivel angle sensor VT-SWA-LIN-1X

- Tighten sensor to 25 +5 Nm (27 A/F).
- Adjust the swivel angle sensor. Notes on the adjustment can be found in Chapter 15.3.1 "Checking the swivel angle measurement" on page 123.
- Measure the actual swivel angle value and adjust it to 100.5 % ±0.1 % using potentiometer "G" (corresponds to maximum stroke).
- In some cases, the pump will not swivel out to the positive stop. For this reason, switch the motor on briefly, then switch off, wait until the pump has swiveled out and then measure the actual swivel angle value. If a higher voltage is measured, correct the value. Repeat this procedure as required.

Seal kits for the pump

Stating the Mat. no. of the pump you can order seal kits, which are either tailored to certain individual components or are offered in a complete package.

Pilot valve VT-DFPn-x-2X

The pilot valve is a component, which is sensitive to contamination. When replacing it, take care that no contaminants can enter fluid-carrying parts of the valve and the pump. To replace the pilot valve, loosen the 4 screws at the recessed corners of the nameplate on the pilot valve. After the replacement, tighten the screws to a tightening torque of 7 Nm ±10 %. Newly installed valves with integrated electronics need to be adjusted:

- Take the parameter setting of the coding switch over from the valve to be replaced.
- If the parameter settings (R parameters) in the replaced valve differ from the factory settings, they must be adjusted on the new valve.
- Calibrate the valve as described in Chapter 8.1.10 "Calibrating the SY(H)DFEn control system" on page 75.

Pre-load valve SYDZ0001

To replace the pre-load valve, loosen the mounting screws and remove the pre-load valve.

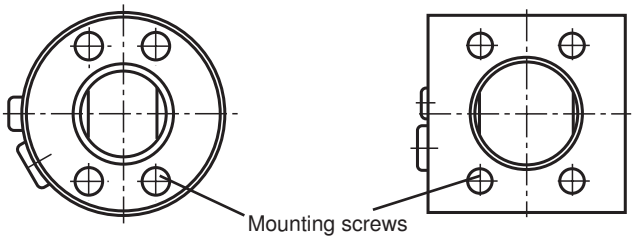


Fig. 59: Mounting bores: left-hand side (round) for NG18, 28, 25; right-hand side (rectangular) for NG 71, 100, 140

When mounting the new pre-load valve, take care that the seal on the pump side of the pre-load valve is inserted in the recess provided for that purpose. Tighten the mounting screws to the following tightening torques:

Sizes 18, 28 and 45: 45 Nm

Size 71: 55 Nm

Sizes 100 and 140: 100 Nm

After having mounted the pre-load valve on the pump, connect the pipes for high pressure and case drain oil as described in Chapter 7.3 “Installation positions and piping of SY(H)DFEn systems“ on page 44. For recommissioning, bleed the pre-load valve. Notes on bleeding can be found in Chapter 8.1.8 “Bleeding the pre-load valve” on page 69.

Pressure transducer HM16-1X

Disconnect the electrical connection on the pilot valve. Replace the pressure transducer by turning the old pressure transducer out and screwing the new one in. Tighten the pressure transducer to a tightening torque of 15 Nm.

10.5.2 Test devices, assembly tools and note on commissioning

Test box for SYDFEn

We offer a hand-held control box, designation “VT-PDFE-1-1X/V0/V0“ (Mat. no. R900757051), for control systems “SY(H)DFEn“ and “SY(H)DFEC“ for looping in into the existing cabling.

The hand-held control box requires a 24 V voltage supply to be provided by the customer for the internal reference voltage and is equipped with:

- Command value potentiometer for swivel angle and pressure
- Measuring points for all connection pins
- Additional connection option for a pressure transducer

Fitting tool for swivel angle transducer VT-SWA-1 (Hall sensor) for SYDFEn-2X

The following fitting tool is available for the magnet carrier:

- For mounting: Plastic sleeve Mat. no. R900846331

11 Decommissioning

The SY(H)DFEn control system is a component that does not require decommissioning. For this reason, this chapter of the present instructions does not contain any information.

12 Demounting and replacement

12.1 Required tools

Demounting can be performed with standard tools. No special tools are necessary.

12.2 Preparing demounting

1. Decommission the entire system as described in the general instructions for the machine or system.
2. Depressurize the hydraulic system according to the instructions of the machine or system manufacturer.

12.3 Demounting the SY(H)DFEn control system

Proceed as follows to demount the SY(H)DFEn control system:

1. Make sure that the hydraulic system is depressurized.
2. Check whether the SY(H)DFEn control system has cooled down sufficiently so that you can demount it without any risks.
3. Place a catch pan under the SY(H)DFEn control system to collect any hydraulic fluid that may escape.

NOTICE! Spilled or discharged hydraulic fluid!

Environmental pollution and contamination of the groundwater!

- When draining the hydraulic fluid, always place a catch pan under the SY(H)DFEn control system.
- Observe the information in the safety data sheet of the hydraulic fluid and the specifications provided by the system manufacturer.

1. Loosen the lines and collect the escaping hydraulic fluid in the collector provided for this purpose.
2. Remove the SY(H)DFEn control system. Use suitable lifting gear for this.
3. Drain the SY(H)DFEn control system completely.
4. Plug all openings.

12.4 Preparing the components for storage or further use

- Proceed as described in section 6.2 “Storing the SY(H)DFEn control system” on page 42.

13 Disposal

Observe the following points when disposing of the SY(H)DFEn control system:

1. Drain the control system completely.
2. Dispose of the hydraulic fluid in accordance with the national regulations of your country and in accordance with the safety data sheet for the hydraulic fluid.
3. Dismantle the control system for recycling.
4. Separate by:
   - Cast iron
   - Steel
   - Non-ferrous metals
   - Electrical waste
   - Plastic
   - Seals

13.1 Environmental protection

Careless disposal of the SY(H)DFEn control system, the hydraulic fluid and the packaging material could lead to pollution of the environment.

- Therefore, dispose of the SY(H)DFEn control system, the hydraulic fluid and the packaging material in accordance with the currently applicable regulations in your country.
- Dispose of hydraulic fluid residues according to the applicable safety data sheets for these hydraulic fluids.

14 Extension and conversion

The SY(H)DFEn control system may only be converted or extended in the cases described below using genuine Rexroth SY(H)DFEn components. Other conversions or extensions, also the readjustment of lead-sealed adjustment potentiometers, render the warranty void. The replacement of a component with a component of identical design is described in Chapter 10.5 “Spare parts“ from page 111 on.

An extension by adding a SYDZ pre-load valve is possible on the SYDFEn control system, but not on the SYHDFEn control system. Please ensure that the size of the pre-load valve and the size of the pump are identical. If the system was shipped with an HM16 pressure transducer mounted to the pump, it must be removed and mounted to the pre-load valve, because the pressure at the pump and the pressure in pressure port P1 of the pre-load valve may differ.

If an HM16 pressure transducer is mounted to the pre-load valve or the pump of the control system, the pressure transducer may be removed and installed at another position within the system, if required. The port for the pressure transducer must be plugged with a plug, which is suitable for high pressure applications. For the installation, observe the notes given in Chapter 7.6.7 “Selection, place of installation and mounting orientation of the pressure transducer“ on page 57.

15 Troubleshooting

The following table may assist you in troubleshooting. The table is not exhaustive. In practice, problems which are not listed here may also occur.

15.1 How to proceed for troubleshooting

- Always act systematically and targeted, even under pressure of time. Random and imprudent disassembly and readjustment of settings might result in the inability to ascertain the original error cause.
- First obtain a general overview of how your product works in conjunction with the entire system.
- Try to determine whether the product worked properly in conjunction with the entire system before the troubles occurred.
- Try to determine any changes of the entire system in which the product is integrated:
  - Were there any changes to the product's operating conditions or operating range?
  - Were any changes made (e.g. retrofit) or repairs carried out on the complete system (machine/system, electrics, control) or on the product? If yes, which?
  - Was the product or machine used as intended?
  - How did the malfunction become apparent?
- Try to get a clear idea of the error cause. If possible, ask the direct (machine) operator.
- If you cannot rectify the error, contact one of the contact addresses which can be found at:
  `www.boschrexroth.com/adressen`.

15.2 Error memory

For diagnosis purposes, the SY(H)DFEn control system is provided with an internal fault log that stores the last 10 faults occurred. To open the error memory, click **"Project" → "Machine data" → "Error memory".**

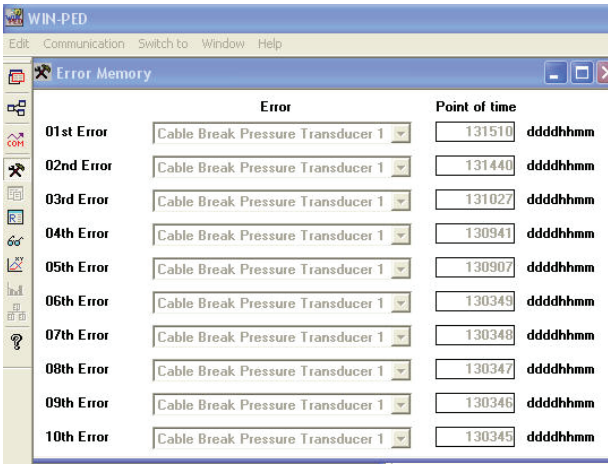


Fig. 60: Internal error memory

Control errors as well as the error messages “error master/slave CAN communication” and “error CAN communication multiple circuits” are not saved in the internal fault log of the SY(H)DFEn control system!

15.2.1 Fault diagnosis

The “fault” signal can be evaluated at pin 3 of the central plug-in connector.

In this context, the following is valid:

- If the SY(H)DFEn control system does not recognize an error, this means that the signal output issues a voltage level, which is about 0.2...2 V lower than the U_B voltage supply. The signal output is overload-proof. At load currents of ca. 100 mA or higher, the output voltage continues to fall.
- If the SY(H)DFEn recognizes a fault, a voltage of 0 V can be measured at the fault signaling output. (In this case, the signal output is connected to U_B with a high resistance (in the order of MΩ).

Table 115: Messages

Meaning of the message	Output signal at pin 3
Electronics OK	24V (U_B...2 V)
Fault	0...2V

The fault message of the SY(H)DFEn control system at pin 3 of the central plug is used for all internal fault messages (collective fault output). The fault message is not saved, that is, the fault message is present at pin 3 of the central plug as long as the fault is present.

In addition, the fault messages can be displayed individually in the program part “Diagnosis” → “Digital I/Os and flags” of the PC program WIN-PED®.

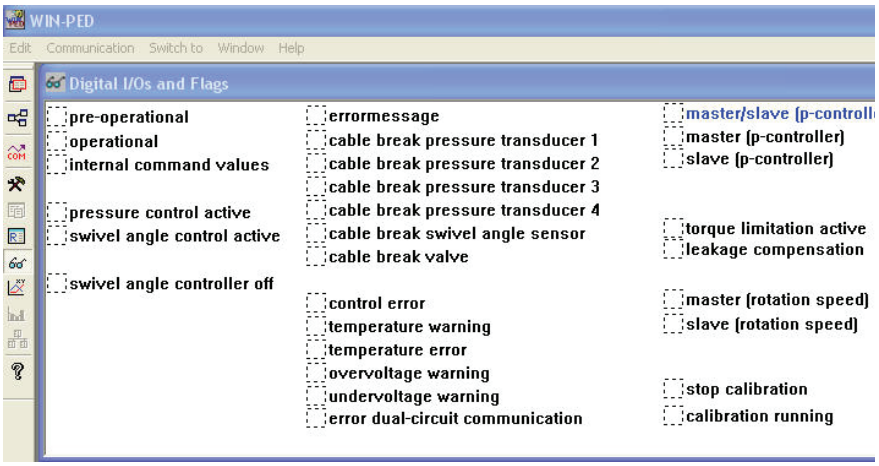


Fig. 61: Fault messages in the program WIN-PED®

Table 116: Faults of the SY(H)DFEn:

Error message
Cable break pressure transducer 1
Cable break pressure transducer 2
Cable break pressure transducer 3
Cable break pressure transducer 4
Cable break swivel angle sensor
Cable break valve
Valve error
Control error
Overvoltage warning (> 37 V)
Undervoltage warning (< 19 V)
Temperature warning (ca. 85 °C)
Temperature limit value exceeded in housing (ca. 95 °C)
Error master/slave CAN communication
Error CAN communication multiple circuits

15.3 Fault table

Table 117: Fault table of SY(H)DFEn control systems

Fault	Possible cause	Remedy
Message in WIN-PED® “Diagnosis”: “Cable break pressure transducer"	Actual pressure value of the relevant pressure transducer fell below or exceeded the limit value, that is, the value is outside the permissible measuring range of the A/D converter.	Test the actual pressure value signal (X1, pins 10 and 11 and X2, respectively) (wire rupture, operating range, signal type, polarity).
Message in WIN-PED® “Diagnosis”: “Cable break of swivel angle sensor"	Defective swivel angle sensor cable (visual inspection)	Have the pilot valve repaired by Rexroth Service or replace pilot valve
	Defective swivel angle sensor	Replace swivel angle sensor
	Outside the permissible measuring range of the A/D converter as a result of maladjustment	Re-calibrate the SWA offset, SWA factor
	Internal electronics fault	Have the pilot valve repaired by Rexroth Service or replace pilot valve
Message in WIN-PED® “Diagnosis”: “Cable break valve” (valve current lower or higher than limit values for cable break)	Outside the permissible measuring range of the A/D converter due to improper calibration	Re-calibrate the valve zero point (see Chapter 8.1.10.2 on page 78)
Message in WIN-PED® “Diagnosis”: “Valve fault" (deviation between command and actual position of the valve spool for >0.5 s)	Valve spool jammed due to contamination	Replace pilot valve (see page 113), contact Rexroth Service
	Internal electronics fault	Replace pilot valve, see page 113
Message in WIN-PED® “Diagnosis”: “Control error” (difference between command and actual value for pressure or swivel angle control for >1.5 s)	Backpressure cannot be built up (minimum pressure at the pump 8...10 bar)	Check, whether the hydraulic system is leak-free and the withdrawal is not excessively high
	Drive motor switched off or speed too low	Check electrical control and frequency converter
	Valve spool does not move as a result of an electronics fault	Replace pilot valve, see page 113
	Valve spool jams due to contamination	Replace pilot valve, contact Rexroth Service
Message in WIN-PED® “Diagnosis”: “Warning Temperature”	Temperature threshold of ca. 85 °C exceeded in housing. ATTENTION: Shortening of service life of electronic components!	Reduce ambient temperature and/or increase air circulation around the housing.

Table 117: Fault table of SY(H)DFEn control systems

Fault	Possible cause	Remedy
Message in WIN-PED® “Diagnosis”: “Temperature fault”	Temperature limit value of ca. 95 °C exceeded in housing ATTENTION: Risk of destruction of electronics!	Reduce ambient temperature and/or increase air circulation around the housing.
Message in WIN-PED® “Diagnosis”: “Warring Overvoltage” (greater than 37 V)	Excessive voltage or voltage peaks	Check electrical control
Message in WIN-PED® “Diagnosis”: “Warning Undervoltage” (less than 19 V)	24V supply overloaded, possibly briefly by inductive consumers	Use more powerful supply or reduce the number of consumers connected to the supply
	Cable cross-sections between 24 V supply and pilot valve not sufficient	Use greater cable cross-sections
Message in WIN-PED® “Diagnosis”: “Error CAN communication multiple circuits” or “error master/slave CAN communication”	Error in CAN communication for the multiple-circuit function or in master-slave communication over CAN	For rectifying the error, see RE 30014-02-Z
Humming noise in the pressure control or fluctuations in pressure/flow	Air cushion around the sensor	Completely bleed control system, pre-load valve (see 8.1.8, page 70) and pipes
	Problem with the cable shield	Connect shield to ground
	Incorrect protective earth connection in the control cabinet	Properly connect protective earth connector
	Connection from M0 to L0 missing	Connect M0 (X1, pin 4) and L0 (X1, pin 2) in the control cabinet
	Unfavorable place of installation/mounting technique for the pressure transducer	Change place of installation (e.g. suspended mounting, no minimess line, no throttling point between pump and pressure transducer), see page 58.
	Improperly high gain of the actual pressure value	Reduce P-gain, see Chapter 8.1.9.1 on page 69
Screaming noise	Oil level in the tank too low; pump partly aspires air	Top up oil
	Pump aspires air	Change routing of the suction line
	Suction line leaky	Seal suction line
	Pump cavitates when reducing pressure Diagnosis: Measure, whether the pressure in the pressure line overshoots	Optimize controller, reduce the command value via a ramp or in steps.
	Fluid in the tank mixed with air; cooling and/or filtration circuit leaky	Seal

Table 117: Fault table of SY(H)DFEn control systems

Fault	Possible cause	Remedy
Other unusual noise	Input speed too high	Machine or system manufacturer
	Wrong direction of rotation	Machine or system manufacturer
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line	Check, whether shut-off valves are open
		Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid)
		Completely air-bleed control system, fill suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Improper mounting of the control system	Check mounting of the control system according to the instructions given by the machine or system manufacturer. Observe tightening torques.
	Improper mounting of attachment parts, e.g. coupling and hydraulic lines	Mount attachments in accordance with the instructions of the coupling or fitting manufacturer
	Air in the pump or in the pre-load valve	Bleed pump and pre-load valve
	Wear of/mechanical damage to the control system	Replace control system, contact Rexroth Service
No or insufficient pressure (< 4 bar)	Faulty mechanical drive (e.g. defective coupling)	Machine or system manufacturer
	Hydraulic fluid not within the optimum viscosity range	Use suitable hydraulic fluid (machine or system manufacturer)
	Drive unit defective (e.g. hydraulic motor or cylinder)	Machine or system manufacturer
	Wear/mechanical damage	Replace control system, contact Rexroth Service
Pressure statically at ca. 5...12 bar, cannot be changed	Supply voltage not within the permissible range (23...33.6 V) Diagnosis: Is the actual swivel angle value (X1, pin 6) 0 Volt? If yes, is the supply voltage missing?	Check, whether central plug X1 is connected to the pilot valve
		Check voltage at the last interconnection point (terminal strip) upstream of the pilot valve
	Command value for pressure, swivel angle or power (optional) is 0 bar or 0 %, respectively	If you utilize, for example, only closed-loop pressure control, connect the swivel angle command value (X1, pin 5) to +10 V
		The potentiometer for the (optional) power limitation must not be at the left-hand limit stop
	Swivel angle sensor defective	Inspect swivel angle sensor, see 15.3.1 on page 123
	Spool jams in pilot valve	Contact Rexroth Service

Table 117: Fault table of SY(H)DFEn control systems

Fault	Possible cause	Remedy
Pressure too low (> 12 bar)	PT input improperly set Diagnosis: Pressure command value (X1, pin 7) and actual pressure value normalized (X1, pin 8) are equal and can be regulated	Adjust pressure command value and/or PT input (see 8.1.10.1 on page 76)
		Replace pressure transducer, see page 114
		Change place of installation of the pressure transducer (do not install upstream of the pre-load valve; if possible, close to the consumer)
	Pressure transducer defective/not connected Diagnosis: Measure signal from PT and compare with indication on the pressure gauge	Replace pressure transducer, see page 114
	Control system does not work in closed-loop pressure control Diagnosis: Pressure command value (X1, pin 7) is less than actual pressure value normalized (X1, pin 8).	Increase swivel angle command value
		Raise torque limit
		Check that the hydraulic system is leak-free and that the withdrawal is not excessively high
	Pilot valve defective	Replace pilot valve, see page 113
Pressure too high	PT input improperly set Diagnosis: Pressure command value (X1, pin 7) and actual pressure value normalized (X1, pin 8) are equal and can be regulated	Adjust pressure command value and/or PT input (see 8.1.10.1 on page 77)
		Replace pressure transducer, see page 114
		Replace pilot valve, see page 113
	Pressure transducer defective/not connected Diagnosis: Measure signal from PT and compare with indication on the pressure gauge	Replace pilot valve, see page 113
Insufficient flow	Pressure controller active	Increase pressure command value
	Torque limitation (optional) active	Increase torque command value (optional)
	Actual swivel angle sensing improperly set	Re-adjust swivel angle sensor (see 8.1.10.3 on page 80)
	Drive speed too low (slip, incorrect frequency, wrong motor)	Contact machine or system manufacturer
	Damage to the pump (excessive pump leakage)	Rotary group damaged
	Wear/mechanical damage to the control system	Replace control system, contact Rexroth Service
Drive motor shuts down due to overloading	Excessive power consumption of the pump	Reduce torque limit, see 8.1.12.1 on page 105
		Reduce swivel angle command value
		Check actual pressure value acquisition
	Overcurrent protection of motor does not work properly	Check setting and function
	Spool jams in the pilot valve Diagnosis: Unplug central plug-in connector X1 or disconnect supply voltage from pilot valve and test, whether the motor is still overloaded	Replace pilot valve, see page 104
	Actual swivel angle value acquisition maladjusted or not working properly	Check swivel angle measurement, see below
	Valve electronics defective	Replace pilot valve, see page 113

Table 117: Fault table of SY(H)DFEn control systems

Fault	Possible cause	Remedy
Temperature of hydraulic fluid too high	Too high inlet temperature at control system	Inspect system, e.g. for malfunction of the cooler, insufficient hydraulic fluid in the tank
	Pre-load valve opens Diagnosis: Pipe to the tank warms up	Pressure must be lower than the cracking pressure of the pre-load valve. Keep overshoots and pressure pulsation to a minimum.
	Malfunction of pressure control valves (e.g. high pressure relief valve, pressure cut-off valve, pressure controller).	Contact Rexroth Service
	Control system worn out	Replace control system, contact Rexroth Service

15.3.1 Checking the swivel angle measurement

The settings for swivel angle measurement are made in the factory. The settings described below are only required after a replacement of the swivel angle transducer.

Depending on circumstances, a calibration of swivel angle “100 %“ can be conducted while the drive motor is running or at rest.

15.3.1.1 Checking swivel angle “zero” (while the system is running)

1. Close all directional valves
2. Apply a swivel angle command value of >50 %
3. Apply a pressure command value of 20 bar
4. Check, whether the actual swivel angle value (α_{act}) is 0 % ±1 %
5. In the case of deviations, correct by means of potentiometer (1); the potentiometer is marked with “O“ (=Offset)

15.3.1.2 Checking swivel angle “100%“ (while the system is running)

1. Swivel angle command value greater than 105 % (WIN-PED®), pressure command value ca. 100 bar.
2. Direct the full flow via the actuator, e.g. activate hydraulic motor or set pressure relief valve to ca. 20 bar; in this case, the pilot valve deliberately signals an error (control deviation too great).
3. Adjust potentiometer (2) until the actual swivel angle value is +100.5 %; the potentiometer is marked with “G” (= gain) on the swivel angle transducer (corresponds to maximum stroke).

15.3.1.3 Test swivel angle 100%“ (while drive motor is switched off)

1. Switch the hydraulic system off and wait for ca. 5 minutes until the pump has swiveled out mechanically (wait until pressure has decreased completely).
2. Turn potentiometer (2) until the actual swivel angle value is +100.5 %; the potentiometer is marked with “G” (= gain) on the swivel angle transducer.
3. In some cases, the pump will not swivel out to the positive stop. For this reason, switch the motor on briefly, then switch it off again and wait until the pump has swiveled out. Measure the actual swivel angle value. If a higher voltage is obtained, correct the value.
4. Repeat this process several times!

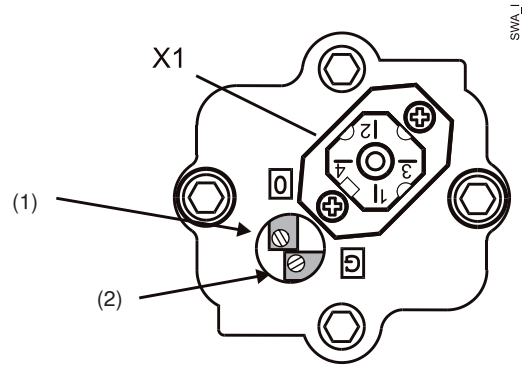


Fig. 62: Swivel angle sensor for SYDFEn

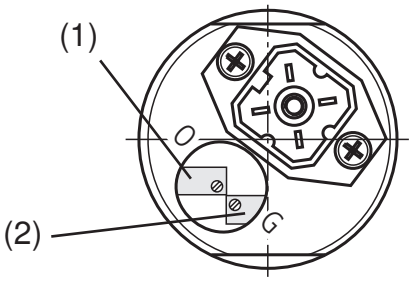


Fig. 63: Swivel angle sensor for SYHDFEn

1 Swivel angle zero point adjustment

2 Adjustment of max. swivel angle

16 Technical data

The technical data of your SY(H)DFEn system are contained in the following data sheets:

SYDFEn series 2X	RE 62240
SYDFEn series 3X	RE 62241
SYHDFEn series 1X	RE 62242

The data sheet can be found on the Internet at

`www.boschrexroth.com/ics`

The preset technical data of your SY(H)DFEn control system can be found in the order confirmation.

The software WIN-PED® can be downloaded free of charge on the Rexroth web site under “Download” in the section “SYDFEn“:

`http://www.boschrexroth.com/sydfe`

17 Annex

17.1 Address directory

For the addresses of our foreign subsidiaries and responsible sales companies, please visit http://www.boschrexroth.com.

Contact for repairs and spare parts

Service Hydraulics - Repair
Bgm.-Dr.-Nebel-Str. 8
97816 Lohr am Main
Tel: +49 (0) 9352 - 18 46 46
Fax: +49 (0) 9352 - 18 34 73
repair.bri@boschrexroth.de
http://www.boschrexroth.com/service

Ordering address for accessories and valves

Headquarters:
Bosch Rexroth AG
Hydraulics
Zum Eisengießer 1
97816 Lohr am Main
Germany
Tel. +49 (93 52) 18-0
or the relevant national sales organization

Addresses can be found on the Internet at:

http://www.boschrexroth.com

For the addresses of foreign subsidiaries, please refer to
www.boschrexroth.com/adressen

17.2 Status table of digital inputs S1, S2

Table 115 describes exemplarily the activation states of digital inputs S1 and S2 as well as of the synchronization bits on the basis of machine states of a plastics injection molding machine.

The table refers only to the teach-in version of the SY(H)DFEn control system for cyclic operation.

Table 118: Status table S1, S2, DI1

No.	Machine function	S1 Variable-speed operation ON	S2 Start teach-in	DI1 Synchronization bit ON/OFF one per cycle, X1 pin 9
1	Operation at constant speed	OFF	OFF	---
2	Variable-speed operation, machine running in automatic operation	ON	ON	ON → OFF > 0.5 sec.
3	Variable-speed operation, after change of position, velocity, pressure, time control in the machine control	ON	ON → OFF → ON (OFF for longer than 1 sec.)	ON → OFF > 0.5 sec.
4	Variable-speed operation, machine running in automatic operation, but automatic operation is interrupted as a result of a fault, e.g. mold protection, door open, manual stop, ...	OFF	AN	..-
5	Variable-speed operation, machine running in automatic operation after fault was corrected	ON	ON	ON → OFF > 0.5 sec.
6	Fixed speed; machine is in manual operating mode	OFF	ON	---
7	Fixed speed; machine is in set-up operating mode	OFF	OFF	---

For S1, S2 and DI1 independent time control is possible.

18 Alphabetical index

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Z

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