Rexroth
Bosch Group

RE 30027-B/09.06
replaces: 03.04

Closed-loop control system SYDFEC

Projecting guidelines and commissioning instructions

Table of contents

Abbreviations

CAN	**C**ontroller **A**rea **N**etwork
COM	**Com**munication port (serial PC interface)
PT	**P**ressure **T**ransducer
EEPROM	**E**lectrically **e**rasable **p**rogrammable **r**ead **o**nly **m**emory
EMC	**E**lectro**m**agnetic **c**ompatibility
GND	**G**rou**nd** (signal ground)
LP	**L**ow**p**ass
p	Pressure (symbol)
PC	**P**ersonal **C**omputer
p_{diff}	Control deviation between pressure command value and actual pressure value
PE	**P**rotective **E**arth
p_{act}	Actual pressure value
p_{com}	Pressure command value
RS232	**R**ecommended **S**tandard 232
SWA	**S**wivel **A**ngle
SWA_{act}	Actual swivel angle value
SWA_{oom}	Swivel angle command value
SYDFEC	**Sy**stem **D**ruckförderstromregelung **E**lektronisch mit **C**AN-Bus (electronic pressure/flow control with CAN bus)
VT-DFPC	Pilot valve with integral, digital electronics
VT-SWA	VT-SWA swivel angle sensor
WIN-PED®	**Win**dows program for **P**arameterisation, **E**diting, **D**iagnosis

1 Safety regulations

Bosch Rexroth AG is not liable for damage resulting from the non-observance of warning notes in this description.

Read the notes on operation, maintenance and safety prior to commissioning. If the documentation is not clearly understood in the present language, please contact and inform the supplier.

A precondition for the proper and safe operation of this equipment is proper and correct transport, storage, assembly and installation as well as careful operation and maintenance.

WARNING
Improper handling of this equipment and the non-observance of the warning notes given here as well as unauthorised interventions into safety equipment can result in injury, electrical shock or, in extreme cases, to death or damage to property.

Employ trained and qualified personnel for handling and operating hydraulic and electrical equipment: Only trained and qualified personnel should work on or in the vicinity of this equipment. Personnel is qualified, when it is sufficiently familiar with the assembly, installation and operation of the product as well as with all warnings and precautionary measures in accordance with this description. In addition, it must be trained, instructed or authorised to connect or disconnect electrical circuits and devices in accordance with safety regulations, to ground them and to mark them appropriately according to the working requirements. The personnel must be provided with adequate safety equipment and trained with regard to First Aid.

Use only spare parts approved by the manufacturer.

Observe safety instructions and regulations valid in the country of use of the equipment.

The equipment is provided for installation in machines that are employed in an industrial environment.
European countries: EU Directive 89/392/EEC (Machinery Directive).

Commissioning is prohibited until it was demonstrated that the machine, into which the products are to be integrated, comply with national regulations and safety rules valid for the application at hand. Their operation is only allowed when national EMC regulations for the relevant application are adhered to. If required, notes on the installation in line with EMC regulations can be found in the EMC testing documentation published by Bosch Rexroth. The adherence to limit values laid down in national regulations lies within the responsibility of the manufacturer of the plant or machine.

- European countries: EC Directive 89/336/EEC (EMC Directive).
- USA: See National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA) as well as regional construction regulations.

The operator must at any time comply with all aspects mentioned above.

Technical data, connection and installation conditions can be found in the product documentation and wiring plans and must in any case be adhered to.

The incorrect control of connected electrical and hydraulic components (encoders, valves, cylinders,…) can lead to hazardous movements. The causes can be of different nature:

- Improper or faulty wiring or cabling,
- incorrect operation of components,
- errors in transducers and signal encoders,
- defective components,
- errors in the software.

These errors can occur directly after the equipment was switched on or at any time of operation.

Monitors in the drive components can largely rule out malfunction in the connected drives. However, with regard to personal protection, in particular the risk of personal injury and/or damage to property, you must not rely solely on this feature. Until integrated monitors become effective, an incorrect drive movement must in any case be expected, the extent of which depends on the type of control and the operational state.

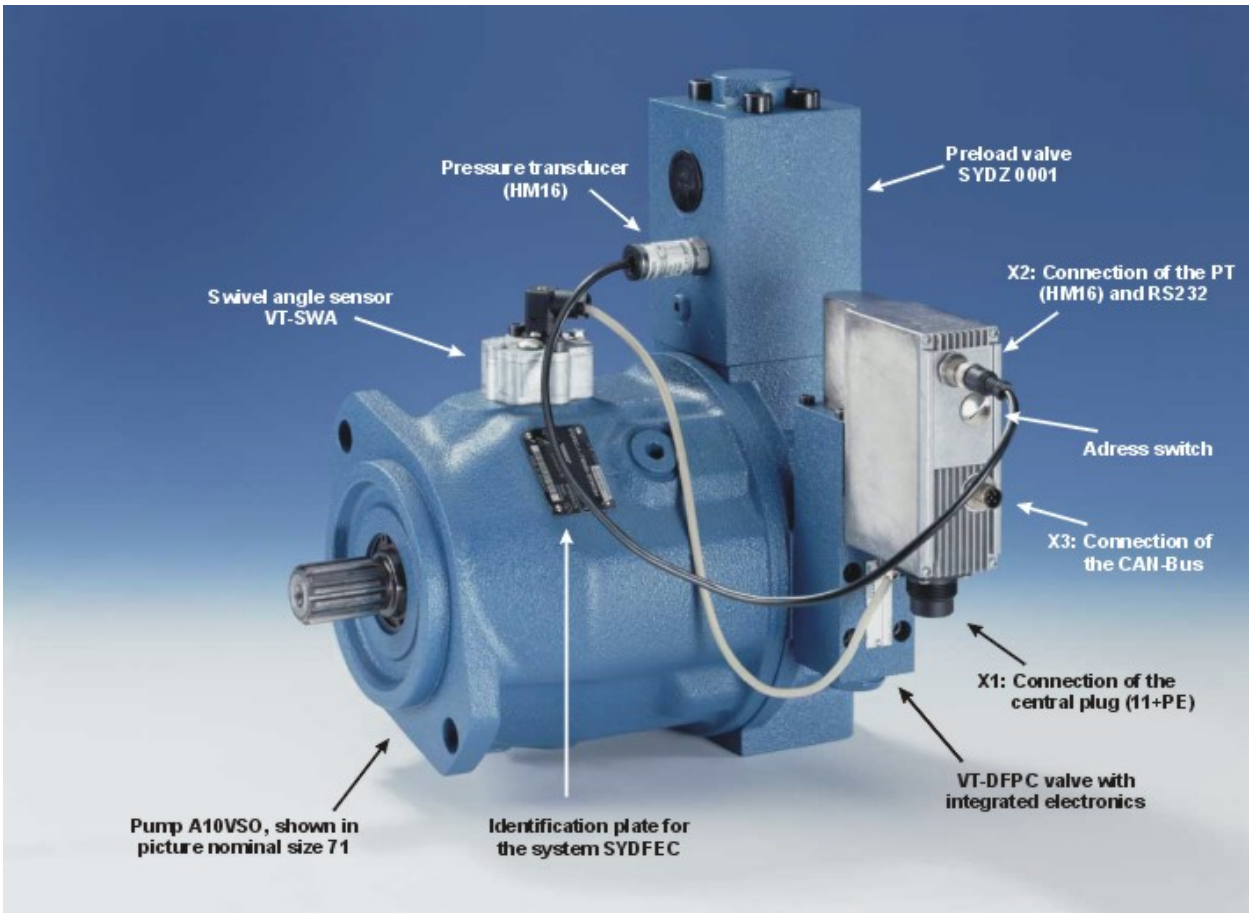
Personal protection must be ensured, among others, for the reasons stated before, by providing monitors or measures of a higher level on the plant side. These have to be provided by the plant manufacturer in accordance with the specific situation of the plant and a risk and fault analysis. In this context, the safety regulations valid for the plant must be observed. The deactivation, bypassing or non-activation of safety equipment can result in uncontrollable movements of the machine or other malfunction. Further regulations for personal protection can be found in general regulations for the prevention of accidents, personal injury and/or damage to property.

2 Structure and connections of the SYDFEC closed-loop control system

2.1 Structure

The SYDFEC control (electronic pressure/flow control system with CAN bus) consists of the following components:

- A10VSO axial piston pump with VT-DFPC high-response valve (proportional valve with integral, digital electronics)
- VT-SWA swivel angle sensor
- HM12, HM13, HM16, HM17 pressure transducers (optional)
- Preload valve of type SYDZ 0001 incl. internal pressure relief function (optional)



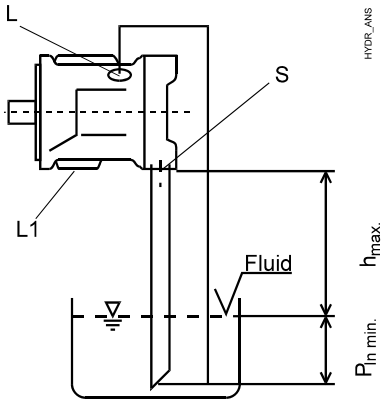
2.2 Hydraulic connection

See also RE 92 711 (A10VSO 28 .. 140) and RE 92 712 (A10VSO 18)

2.2.1 Suction line

Connect S = suction line of the pump to tank. In this context, observe the following points:

- The permissible pressures (0.8 - 30 bar / abs.) must not fall below the lower or exceed the upper limit
- The pipe must be properly installed; the suction pipe must be connected to pump inlet S without any interruption



2.2.2 Pressure line

P = pressure port of the pump

- Piping of the actuators according to SAE, see RE 92711/03.93
- In case that no SYDZ0001 preload valve is used, make sure that a pressure relief valve is installed in the pressure line. The set pressure of this valve must be 20 % higher than the nominal pressure in order to prevent mechanical damage to the pump.

☝ **The electrical pressure control does not assume a pressure relief function!**

2.2.3 Drain line

L1, L = drain line

- Always pipe the highest port position of the drain ports available.
- A reduction in the diameter is not permitted.
- Connect the drain line directly to the oil tank and bring it to an immersed position.

☝ **Mistakes in the installation of the drain line will result in impermissibly high housing pressure peaks, which can result in damage to the pump!**

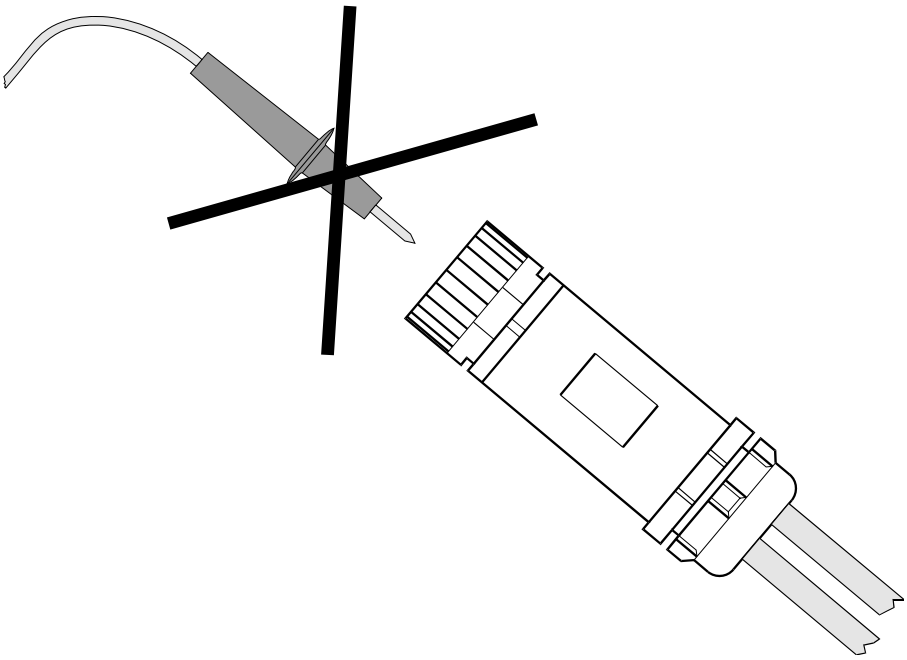
2.2.4 Measuring point for pressure transducers

- To ensure optimum bleeding of the pressure transducer, it must be installed in a **hanging position** (hydraulic connection pointing upwards).
- Apart from the preload valve, no additional valve may be installed in the line between the pump and the pressure transducer.
- In systems without preload valve, the pressure transducer can be mounted directly onto the pump or on the directional valve (if applicable, control block) (see note above).
- The pressure transducer must be connected with a sufficient line diameter (no minimess connections!).

2.3 Electrical connection

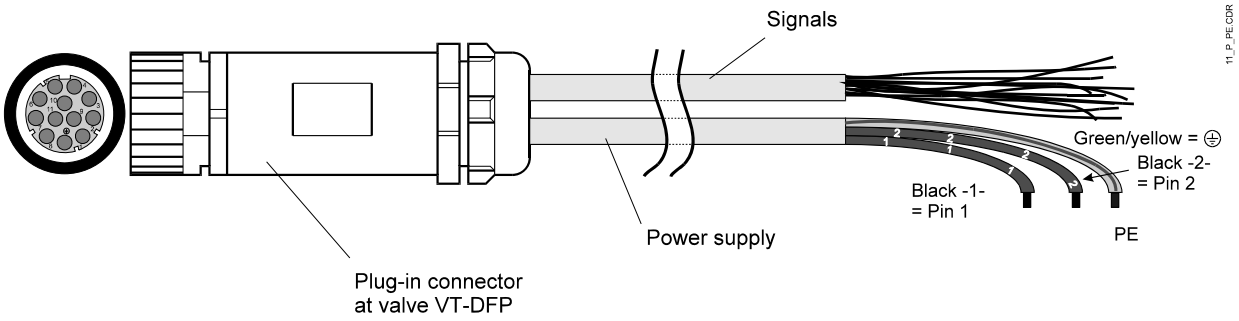
2.3.1 General guidelines

- Electromagnetic sources of interference are not permitted in the direct vicinity of the VT-DFPC high-response valve.
- Do not lay power cables near the VT-DFPC high-response valve.
- Do not lay cables near power cables.
- To comply with EMC regulations, the signal line and bus lines to the VT-DFPC high-response valve must in any case be shielded. Connect one end of the line shield to the ground potential in the control cabinet.
- The contacts of the plug-in connector must not be subjected to mechanical stress. This can result in a faulty connection between the plug-in connector and the component plug.



2.3.2 Voltage power supply

The VT-DFPC high-response valve must be supplied with 24V DC voltage. If this voltage supply cannot be provided by the system, a VT 19 085 power supply unit (NE32) to RE 29 929 can be used. Connect the 24 V output of the power supply unit to connections 1 (+24V) and 2 (L0) of the plug-in connector.
With the connecting cable available this corresponds to the 2 black wires of the 3-pin cable with a cross-section of 1mm². Connect the wire identified by “1“ to +24V and the wire identified by “2“ to L0 (reference potential). Connect the yellow/green wire to ground.



Recommendation: The voltage supply for the VT-DFPC high-response valve should be protected with a 1.6A slow-blowing fuse on the system side.

☝ **The VT-DFPC high-response valve is not provided with an enable input to block the operation of the valve. In the event of a failure, the VT-DFPC high-response valve should be de-energised. Any further, safety-relevant interventions must be made by the higher-level control (e.g. switching off the drive motor, closing the isolator valves, ...).**

2.3.3 Pin assignment of the central plug

The following table shows the pin assignment of the 11 + PE central plug for the VT-DFPC high-response valve. The column on the right refers to the cable set that is available as optional extra.

Type: 11+PE connecting plug 2x5m Mat. no. R900032356
2x20m Mat. no. R900860399

Pin	Meaning	Code
1	UB (+24V)	1
2	L0	2
⏚	Ground	Yellow/green
3	Error	White
4	M0	Yellow
5	$U_{in\ 2}$ (AI2)	Green
6	$U_{out\ 2}$	Purple
7	$U_{in\ 1}$ (AI1)	Pink
8	$U_{out\ 1}$	Red
9	Digital input 1 (DI1)	Brown
10	Actual pressure value High	Black
11	Actual pressure value Low	Blue
n.c.	not used	Grey

2.3.4 Functional description of the signals to the central plug (X1)

Pin	Signal	Description	Signal direction	Signal level
1	+UB	Voltage supply	IN	+24V (-5% +40%)
2	L0	Reference potential for voltage supply	-	-
⏚	Ground	Grounding connection for electronics	-	-
3	Error	Signals errors: - Cable break - Closed-loop control monitoring - Temperature - Voltage monitoring	OUT	0V = error +24V = no error
4	M0	Reference potential for analog signals	-	-
5	$U_{in\ 2}$	Analog input 2 (AI2)	IN	±10V
6	$U_{out\ 2}$	Analog output 2	OUT	±10V
7	$U_{in\ 1}$	Analog input 1 (AI1)	IN	0 to +10V
8	$U_{out\ 1}$	Analog output 1	OUT	±10V
9	Digital IN1	Digital input 1 (DI1)	IN	Logic 0 (low) < 8V Logic 1 (high) > 14V
10	Actual pressure value High	Actual pressure value signal from pressure transducer	IN	0-5V 0.5-5V 0-10V 0-10V 0.1-10V 0-20mA 4-20mA
11	Actual pressure value Low	Reference potential for actual pressure value signal (p_{act} High)	-	-

Note: Connect connections M0 and L0 in the electrical cabinet to prevent potential distribution.

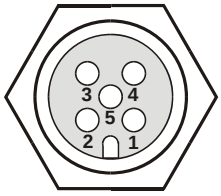
2.3.5 Connection to the swivel angle sensor

The swivel angle of the pump is established by means of the VT-SWA swivel angle sensor and is directly connected to the VT-DFPC high-response valve in the factory. The sensor is supplied by the VT-DFPC high-response valve.

2.3.6 Connection of HM16 and RS232 (M12 connector socket, X2)

The VT-DFPC high-response valve is provided with an M12 connector socket (5 pins) for the connection of the HM16 pressure transducer and the serial interface (RS232).

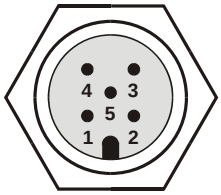
Pin	Pin assignment of HM16	Pin assignment of RS232
1	+ UB	
2		RxD
3	Reference (L0)	
4	Signal	
5		TxD



2.3.7 Connection to CAN bus and digital input 2 (M12 component plug, X3)

The VT-DFPC high-response valve is provided with an M12 component plug (5 pins) for the connection to the CAN bus and digital input 2 (DI2).

Pin	Pin assignment
1	not used
2	Digital input 2 (DI2)
3	reserved
4	CAN High
5	CAN Low



Note: Use a shielded data cable as bus cable.

3 Commissioning

3.1 Preconditions for commissioning

A precondition for commissioning and adjustment of the system is the complete mechanical and electrical installation of all components.

Check that:

- the fluid tank of the hydraulic system is filled correctly,
- the tank and fluid are not contaminated,
- the hydraulic system is correctly piped according to the circuit diagram,
- the A10VSO is filled with fluid,
- the direction of rotation of the drive motor is correct.

3.2 Guidelines to be observed

- RE 07 900 Installation, commissioning and maintenance of oil-hydraulic systems
- RE 92712 Installation notes and further information about the A10VSO pump (size 18)
- RE 92711 Installation notes and further information about the A10VSO pump (sizes 28 … 140)

The VT-DFPC high-response valve monitors internal and system-related operating states, but cannot prevent uncontrolled movements of a hydraulically connected actuator.

☝ **The risk of personal injury must therefore be eliminated by taking appropriate measures in the EMERGENCY OFF CHAIN on the system side!**

The VT-DFPC high-response valve is not provided with an enable input for enabling or blocking the closed-loop control function. In the event of an error, the drive motor of the pump should be switched off. This function should be implemented in the safety chain of the system.

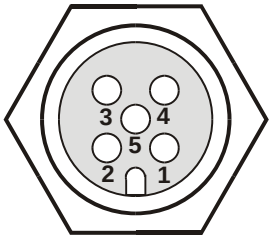
4 Description of the PC program "Win-Ped®"

Two options are available for configuring and parameterising the SYDFEC:

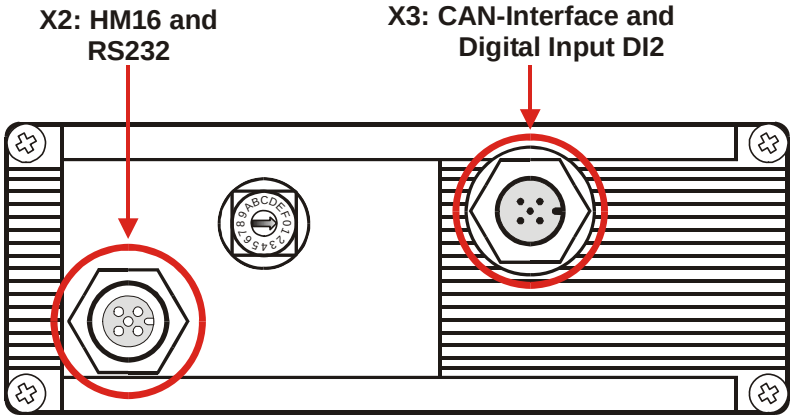
1. Interfacing with the field bus system “CANopen“ (see RE 30027-Z)
2. Use of the Bosch Rexroth software "Win-Ped®"

4.1 Configuration interface

Data are exchanged between the PC program "Win-Ped®" and the SYDFEC via the serial interface (COM interface). The SYDFECs RS232 interface is an M12 connector socket.



1 $+U_B$ (HM16)
2 RxD (RS232)
3 Reference
4 Signal (HM16)
5 TxD (RS232)



4.2 Installation

Install the Bosch Rexroth software Win-Ped® version 5.10 on a PC with operating system Windows 95 or higher. Then, install control type “DFEC“ version “5b27_617“.

Caution: Control type “DFEC“ version “5b27_617“ may be used **exclusively** with PC program Win-Ped® version 5.09 or version 5.10!

4.2.1 Firmware update

A new firmware can be transferred to the control in the view “Bus overview” by selecting menu item ***Communication → Send firmware***. The subsequent initialization of the control can be started by selecting menu item ***Communication → Initialize control***.

Caution: All data in the control are overwritten and a software reset is executed on the control! A software reset corresponds to the switching on and off of the control and may only be carried out when the system is in a safe state, that is, the drive motor must be switched off.

Note: 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 before the firmware is transferred to the SYDFEC the CAN bus connection to other CAN stations (SYDFECs) be interrupted.

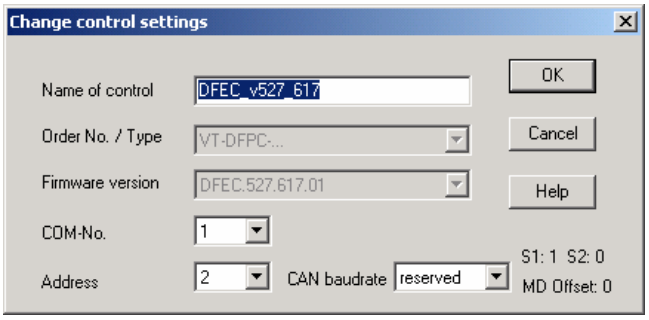
4.3 Setting the address

The VT-DFPC high-response 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.

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

address = switch position + 1

The same address must be entered in the PC program "Win-Ped®" under menu item ***Edit → Configure → Settings*** in order to enable the communication with the SYDFEC.

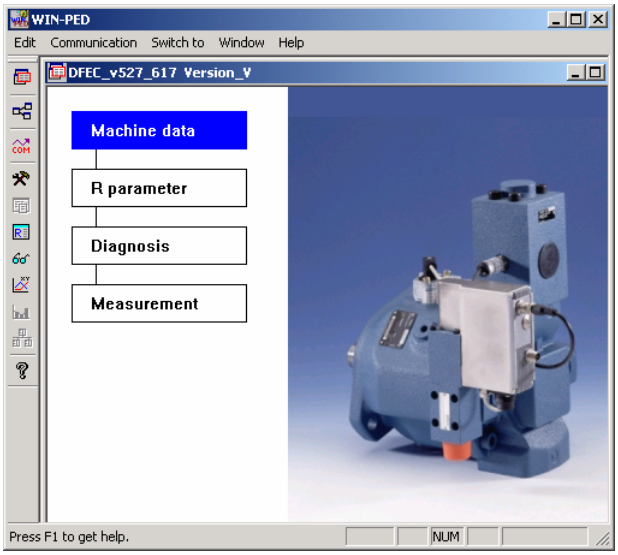


4.4 Program parts of the PC program "Win-Ped®"

The PC program "Win-Ped®" for control type “DFEC“ comprises several program parts as shown below.

Program parts	Description
MACHINE DATA	- Calibration function of SYDFEC - Error memory
R-PARAMETER	Displaying and changing of R parameter values
DIAGNOSIS	Visualization of process data and status messages
MEASUREMENT	Recording of values or states of SYDFEC

The program parts are shown in the view “Active control“.



4.4.1 Program part “MACHINE DATA”

The program part „machine data“ includes the calibration functions of the SYDFEC as well as the fault log with last 10 faults.

Detailed information about the calibration of the SYDFEC can be found in chapter 9 “Calibration of SYDFEC“.

4.4.2 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 via menu item ***Switch to → R-Parameter***.

Changing R parameter

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 you can enter the new value.

Note: Changed values are not automatically transferred to the SYDFEC.

Changed R parameter values can be sent to the SYDFEC control via menu item ***Communication → Send changed parameter values*** in the ONLINE mode. A transfer to the control is only possible, if an ONLINE connection has been established with the SYDFEC control.

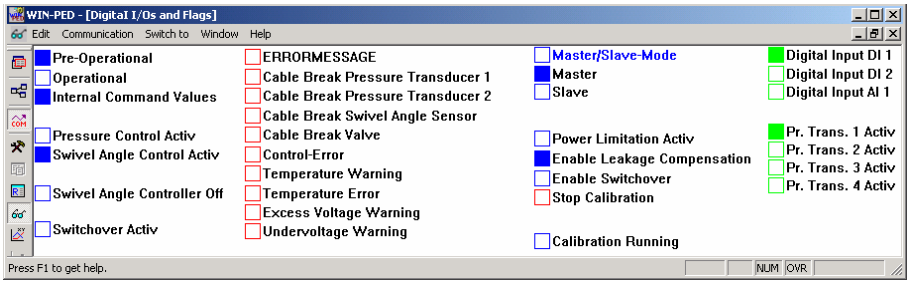
Fetching R parameters

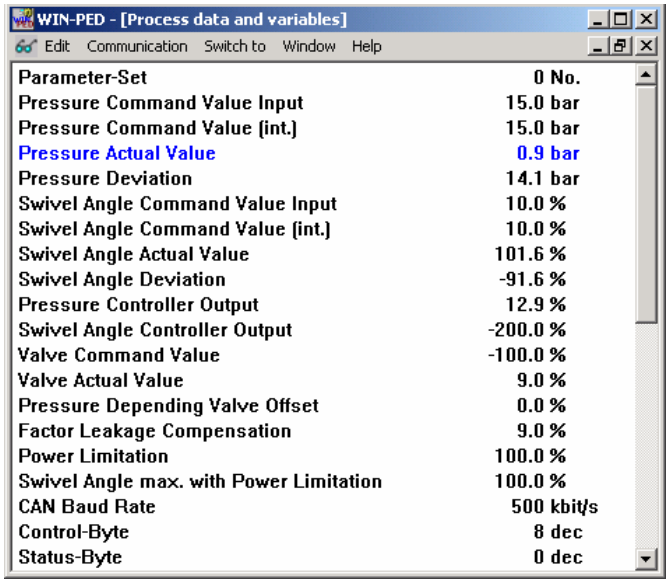
To fetch all R parameter values from the control to the working memory of the PC select menu item ***Communication → Fetch all parameter values*** in the online mode.

Note: This function can only be executed when the operating mode was switched to ONLINE with the help of menu command ***Communication → Online***.

4.4.3 Program part “DIAGNOSIS”

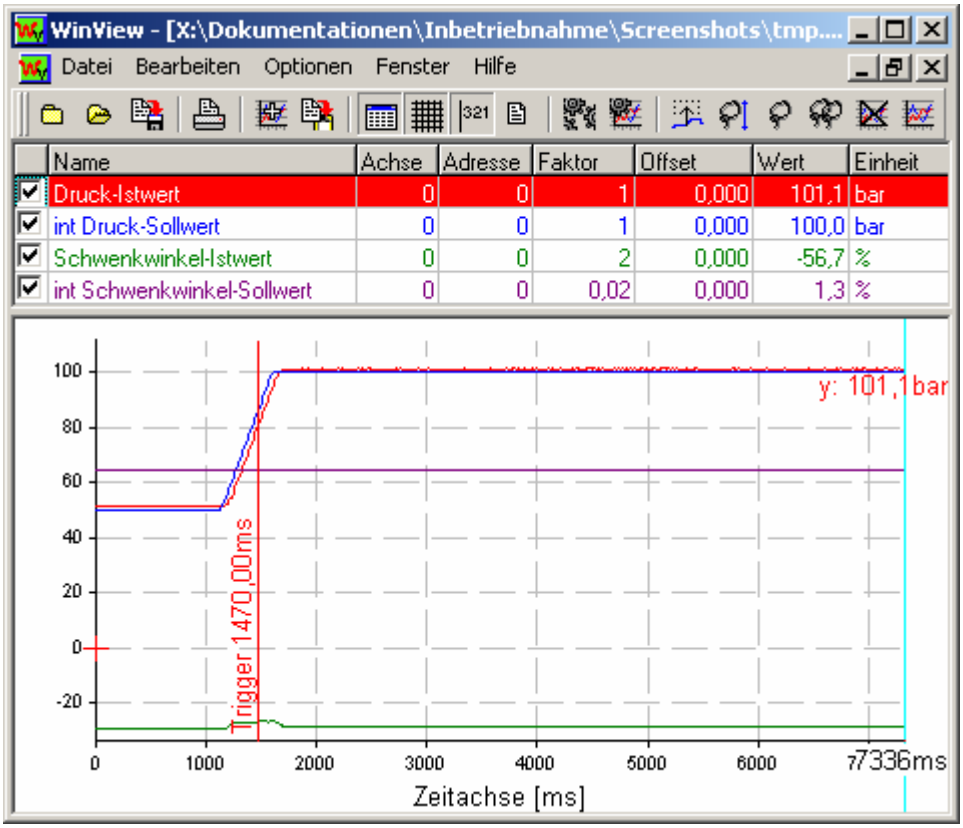
The "diagnosis“ program part shows all current states and values of process data.





4.4.4 Program part “MEASUREMENT”

In the “measurement“ program part, current states and values of process data can be recorded. At present, 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.
The variables to be recorded and the trigger variables can be set under menu item ***Edit***. Recording and the representation are realised with the help of menu item ***Communication***.



4.5 Connection to the control (online mode)

If a SYDFEC is connected via an RS232 interface cable, the connection to the SYDFEC can be established by selecting menu command ***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.

5 Making basic settings on the control electronics

The user must configure the SYDFEC 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)

Note: The configuration of the SYDFEC described in the following is carried out in the program part "R parameters" of the PC program "Win-Ped®".

5.1 Setting of the nominal pressure

Parameter group "command value settings"

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

The setting of the nominal pressure determines 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 +10V) this nominal pressure is obtained.

5.2 Command value source

Parameter group "command value settings"

R parameter	Designation
R602	Command value source

R parameter R602 can be used for the selection of the command value source. The following table lists the different control options for command values.

Meaning
Command values via CAN bus
Command values via the PC program "Win-Ped®"
Analog command value preselection
Call-up command values (DI1/AI1)

5.2.1 Command values via CAN bus

The command values for pressure and swivel angle are fed forward via the CAN bus (see RE 30027-Z).

5.2.2 Command values via the PC program "Win-Ped®"

R parameter	Designation	Range of values
R600	Pressure command value	0 - 450
R601	SWA command-value	-110 - 110

If the command value is fed forward via the PC program "Win-Ped®" the desired values can be set directly.

5.2.3 Analog command value preselection

With analog command value preselection, the command values for pressure or swivel angle are fed forward via analog input AI1 or analog input AI2.

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 0V ... +10V (0 bar ... xx bar) can be selected. A voltage value of +10V corresponds to the nominal pressure set under R parameter R660 (*Nominal Pressure*).
Via analog input AI2 a swivel angle command value can be set within the range of -100% ... +100% (-10V ... +10V).

5.2.4 Call-up command values (DI1/AI1)

For the two digital inputs (DI1/AI1) four pressure and SWA command values each are available. The call-up command values saved for pressure and swivel angle are activated in accordance with the current control state.

Digital input	Connection	Pin	
		Signal	Reference
DI1	Central plug 11 + PE	9	4
AI1	Central plug 11 + PE	7	4

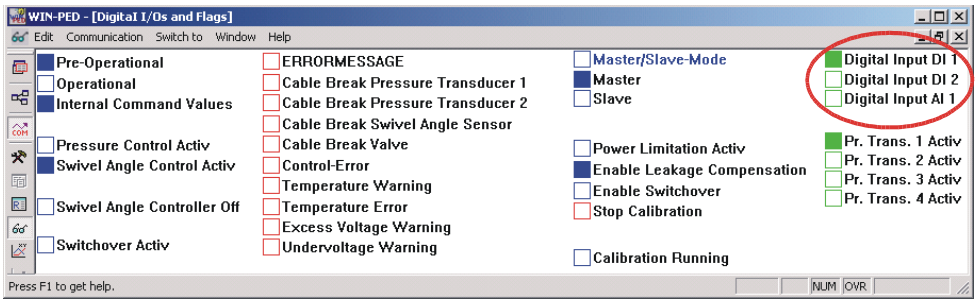
Digital input DI1
Logic 0 (low) < 8V
Logic 1 (high) > 14V

Digital input AI1
Logic 0 (low) < 4V
Logic 1 (high) > 6V

The overview below shows the assignment of R parameters (command values) and the relevant control state.

Control state		Pressure command value	SWA command value
DI1	AI1		
0	0	R600	R601
1	0	R631	R630
0	1	R632	R634
1	1	R633	R635

The logic control state of the digital inputs is shown in the “diagnosis“ program part of the PC program Win-Ped® in the view “digital I/Os and flags“.



5.3 Input selection of the controller parameter sets

Parameter group “Controller parameter set input“

R parameter	Designation
R615	Input selection of controller parameter sets

The digital SYDFEC control is provided with 16 controller parameter sets (0 ... 15) for the optimum adjustment to customer-specific requirements. R parameter R615 can be used for the type of selection of the controller parameter set.
The following table lists the different control options for the controller parameter set selection.

Value	Meaning
0	Controller parameter set input via CAN bus
1	Controller parameter set input via the PC program "Win-Ped®"
2	Controller parameter set input via switching inputs (DI1/DI2)
3	Controller parameter set input via switching inputs (DI1/AI1)

5.3.1 Controller parameter set input via CAN bus

The controller parameter sets are selected via the CAN bus (see RE 30027-Z).

5.3.2 Controller parameter set input via the PC program "Win-Ped®"

In the case of controller parameter set selection via the PC program "Win-Ped®" the required controller parameter set can be set with the help of R parameter R616.

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

5.3.3 Controller parameter set input via switching inputs (DI1/DI2)

This controller parameter set selection is useful, if no CAN bus is used. With the two digital inputs (DI1/DI2) four controller parameter sets (12 ... 15) are available which are activated according to the control state.

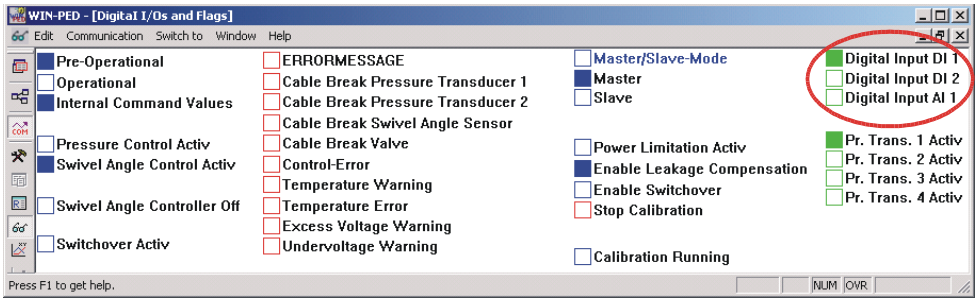
Digital input	Connection	Pin
DI1	Central plug 11 + PE	9
DI2	M12 component plug	2

Digital inputs DI1/DI2
Logic 0 (low) < 8V
Logic 1 (high) > 14V

The overview below shows the assignment of the R parameter set and the relevant control state.

Control state		Controller parameter set
DI1	DI2	
0	0	15
1	0	14
0	1	13
1	1	12

The logic control state of the digital inputs is shown in the “diagnosis“ program part of the PC program Win-Ped® in the view “digital I/Os and flags“.



5.3.4 Controller parameter set input via switching inputs (DI1/AI1)

This controller parameter set selection is useful, if the command values are also be used to switch between controller parameter sets.
With the two digital inputs (DI1/AI1) four controller parameter sets (12 ... 15) are available which are activated according to the control state.

Digital input	Connection	Pin
DI1	Central plug 11 + PE	9
AI1	Central plug 11 + PE	7

Digital input DI1
Logic 0 (low) < 8V
Logic 1 (high) > 14V

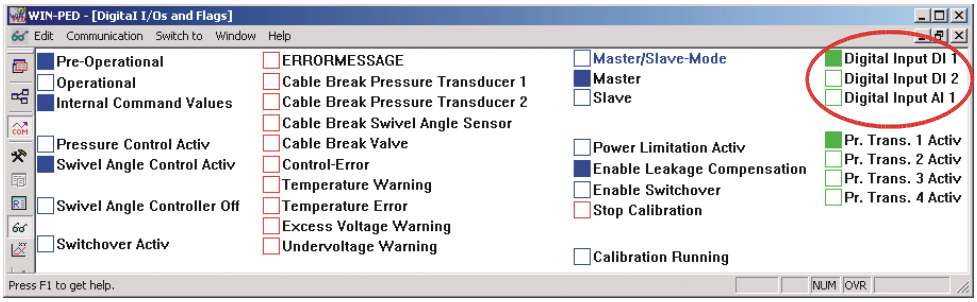
Digital input AI1
Logic 0 (low) < 4V
Logic 1 (high) > 6V

The overview below shows the assignment of the R parameter set and the relevant control state.

Control state		Controller parameter set
DI1	AI1	
0	0	15
1	0	14
0	1	13
1	1	12

Caution: In the case of command value preselection via CAN bus or analog command value preselection only digital input DI1 (controller parameter set 14/15) is available!

The logic control state of the digital inputs is shown in the “diagnosis“ program part of the PC program Win-Ped® in the view “digital I/Os and flags“.



5.4 Setting of the pressure transducers (PT)

For some applications it can be advantageous if it is possible to switch between several pressures transducers. The SYDFEC 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 set is active at that time.

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

1. Selection of the physical PT input
2. Selection of the type of PT (e.g. voltage, current)
3. Setting of the PTs measuring range
4. Selection of the PT input in the controller parameter sets used (chapter 8.3 “Controller parameters”)

5.4.1 PT inputs

The following assignment to the physical inputs is valid.

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

5.4.2 Pressure transducer types

PT input 1 (central plug pin 10/11)

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 SYDFEC.

Type of pressure transducer	Connection
PT - input 2	M12 connector socket
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	

Caution: For reasons of compatibility with older versions, the signal input of the M12 connector socket is to be used in conjunction with PT input 1 and type “PT input 2”. This corresponds to PT input 2 (see PT input 2).

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

A pressure transducer with a signal voltage of (0.5 .... 5) V can be connected to PT input 2 of the SYDFEC.

Caution: For reasons of compatibility with older versions, the signal input of the M12 connector socket is to be used in conjunction with PT input 1 and type “0”. This corresponds to PT input 2.

PT input 1 - type "0" ↔ PT input 2

Note: It is recommended that when the signal input of the M12 connector socket is used, PT input 2 should be selected in the controller parameter sets in order to ensure a clear error diagnosis.

PT input 3 (central pug pin 7/4)
PT input 4 (central pug pin 5/4)

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 SYDFEC.

Type of pressure transducer
0 ... 10 V
0.1 ... 10 V
1 ... 10 V

5.4.3 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.

PT input	R parameter	Designation
1	605	Measuring range PT-Input 1 [bar]
2	654	Measuring range PT-Input 2 [bar]
3	657	Measuring range PT-Input 3 [bar]
4	661	Measuring range PT-Input 4 [bar]]

6 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, and then the drive motor of the pump.

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

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

The following errors are conceivable:

- Voltage supply not available
  - Check voltage supply on the central plug of the electronics
- CAN bus communication not operable
  - Check CAN bus cabling
  - Check configuration of the CAN network
  - Check address
- Control deviation
  - Control deviation between command and actual values too high (SWA_{com} < 95%)
- Error in the pressure measurement branch
  - Read out the actual pressure value (p_{act}); it must be 0 bar. In the case of negative values the cable of the pressure transducer must be broken.
    The output signal of the pressure transducer must match with the type of electronics (current, voltage, zero point).
- Error 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 cable connection of the swivel angle sensor.

Further explanations with regard to error analyses can be found in chapter 11 "Error diagnosis".

- Open directional valve to the oil tank for circulation at zero pressure.
- Before cutting the motor in, feed forward small command values (e.g. p = 15 bar, SWA = 10%).

In this state, the VT-DFPC high-response valve signals an "error“ (excessive control deviation). In the case of proper operation, the error message disappears after the motor was switched on (control deviation now equal to zero).

Switch the drive motor of the pump on!

7 Bleeding of the preload valve

If a pump unit is operated in conjunction with a preload valve, this valve must be bled. Bleed the valve while the system is in operation at low operating pressure. To this end, loosen the screw (see photo below) by **max. 2 turns** and wait until the oil that comes out is bubble-free. Then re-tighten the screw.

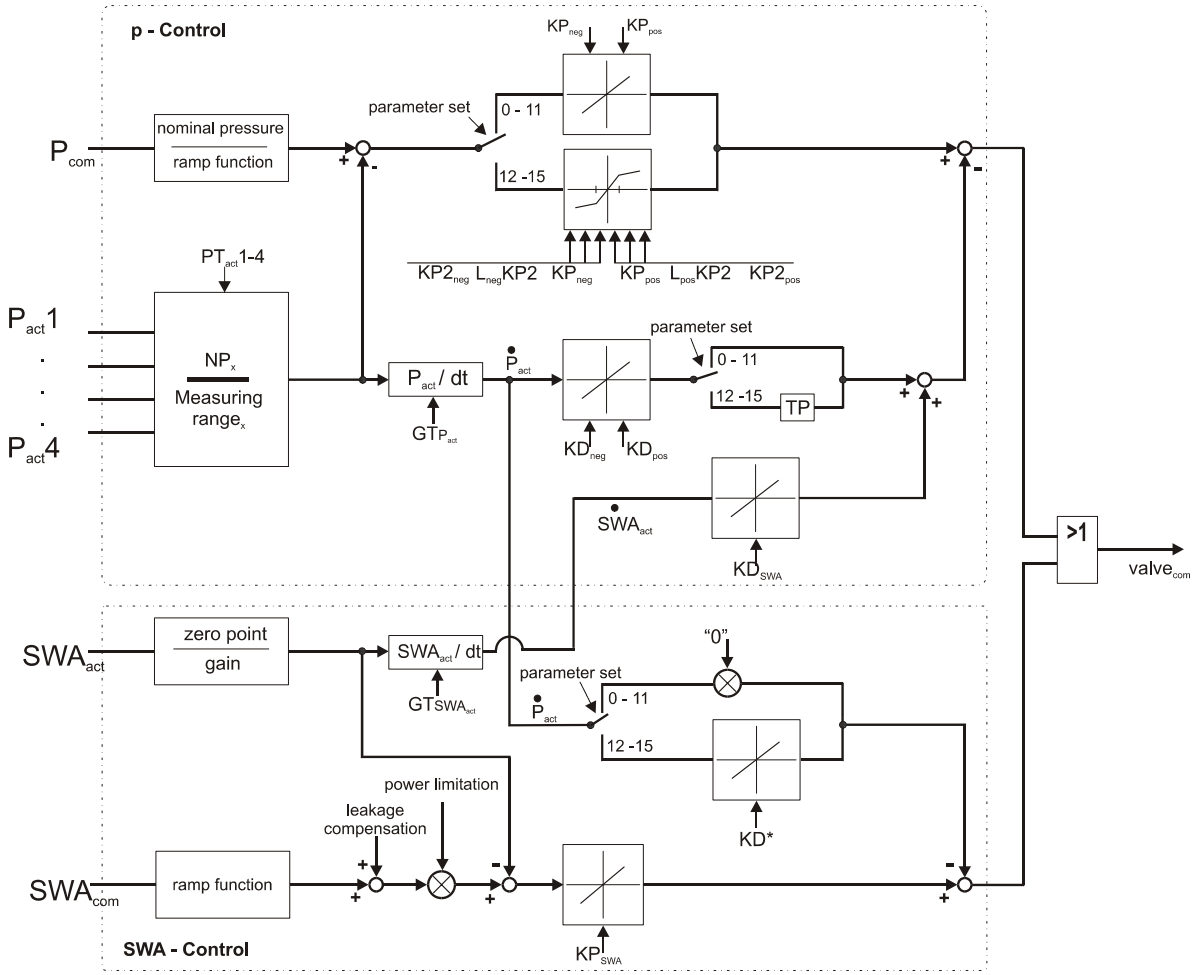
Caution! Risk of injury! Do not screw out the bleed screw too far (max. 2 turns), since the body is under high pressure!

8 Closed-loop controlling of SYDFEC

The transition of a system from a given initial state to a given final state should, in general, take place within the shortest time possible and under stable conditions. To meet this requirement, various control algorithms are used in the field of closed-loop control technology.
The digital SYDFEC control is provided with 16 controller parameter sets (0 ... 15) for optimum adjustment to customer-specific requirements. A controller parameter set includes several, function-related controller parameters. The settings of the individual controller parameters depend on the closed-loop control properties of the system as a whole. Here, the following factors must be taken into account:

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

8.1 Structure of the closed-loop control



8.2 Controller parameter sets

The controller parameter sets are rated for different connected oil volumes as a standard. The controller settings below in the individual controller parameter sets are given as a guideline and can be changed individually by the user at any time. However, it is recommended that only parameter sets 12 to 15 be rewritten with user-specific values. In this way, it is possible to use the default settings of controller parameter sets 0 to 11.

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

You can between the individual controller parameter sets during operation. The values of the controller parameters of the currently selected controller set are active at that time.

8.3 Controller parameters

Each controller parameter set includes the following controller parameters that are use for adjusting the system to the application at hand.

Description of the controller parameter	Abbreviation
P-gain of pressure controller (positive)	$KP_{pos.}$
P-gain of pressure controller (negative)	$KP_{neg.}$
D-component of pressure controller (positive)	$KD_{pos.}$
D-component of pressure controller (negative)	$KD_{neg.}$
SWA-derivation feedback of pressure controller	KD_{SWA}
Gate time of Pressure actual value	GTp_{act}
Gate time of SWA actual value	$GTswa_{act}$
Selection of PT input [PT1-PT4]	
P-gain of SWA controller	KP_{SWA}
Pilot control factor for slave	

In controller parameter sets 12-15 the following controller parameters are additionally available.

Description of the controller parameter	Abbreviation
DT1 pressure feedback of SWA controller	KD*
positive pressure differential threshold [bar]	LposKP2
P-gain above positive threshold	KP2pos
negative pressure differential threshold [bar]	LnegKP2
P-gain under negative threshold	KP2neg
LP filter time of pressure controller (D-component)	TP

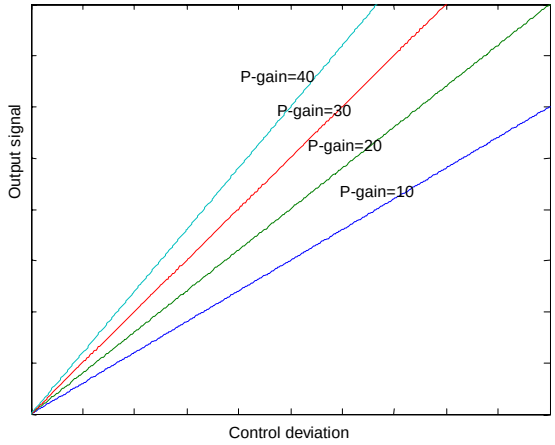
8.4 Meaning of the controller parameters of SYDFEC

The following description is to facilitate the setting of controller parameters. To this end, controller parameter set 15 is **exemplarily** explained in more detail.

8.4.1 P-gain (proportional gain)

R parameter	Designation	Range of values
R550	P-gain of pressure controller (pos.) F15	1 - 1000
R551	P-gain of pressure controller (neg.) F15	1 - 1000
R558	P-Gain of Swivel Angle Controller F15	1 - 1000

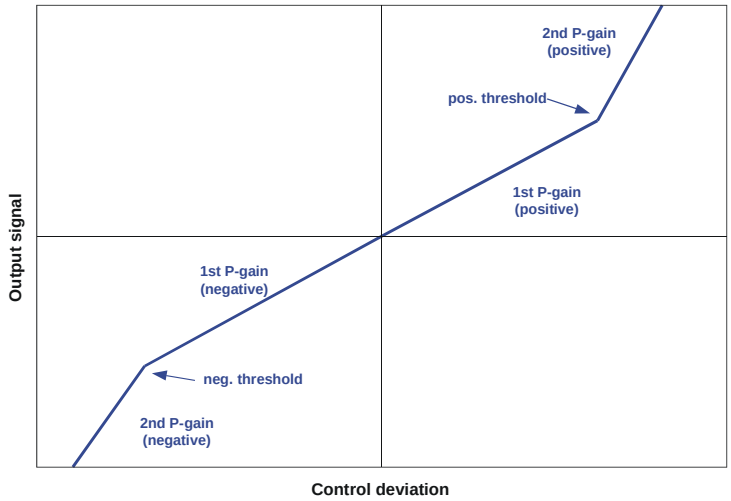
These controller parameters represent a linear gain, i.e. the output signal and the control deviation are proportionally related. It must be noted here that when pressure is being built up, the positive controller parameter (positive control deviation R550) is used, whereas when pressure is being reduced, the negative controller parameter (negative control 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.



8.4.1.1 Second P-gain

R parameter	Designation	Range of values
R591	P differential threshold (pos.) [bar] F15	0 - 450
R592	P-gain above positive threshold F15	1 - 1000
R593	P differential threshold (neg.) [bar] F15	0 - 450
R594	P-gain above positive 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 optimised closed-loop control characteristics. As can be seen in the diagram overleaf, the second P-gain becomes effective only above the adjustable threshold.



The gain above the positive threshold becomes effective when the control deviation is greater than the positive threshold (pos. threshold < control deviation "p_{diff}“, $p_{diff} = p_{com} – p_{act}$).

8.4.2 D-component

R parameter	Designation	Range of values
R552	D-component of pressure contr. (pos) F15	0 - 30000
R553	D-component of pressure contr. (neg) F15	0 - 30000
R554	SWA-der. Feedback for Press.-Contr. F15	0 - 2000

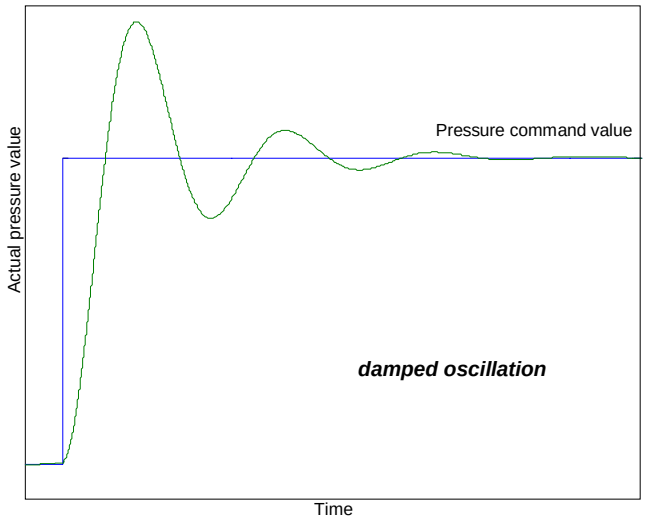
The D-component establishes the change in the actual value signal and ensures a damped transient response of the pressure controller. Due to differentiation the sensitivity is very high, which responds also to undesirable signals such as interference and can result in instability of the system. In the 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.

8.4.3 Setting of the PD gain

The PD gain corresponds to the summation of the P-gain and D-components mentioned before, as described in chapter 8.1 "Structure of the closed-loop control“.
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.

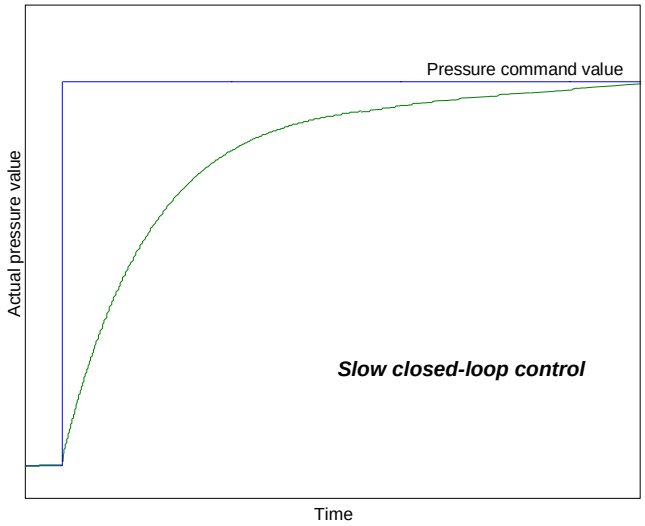
Notes on the setting of the individual parameters are given in the following:

Example 1



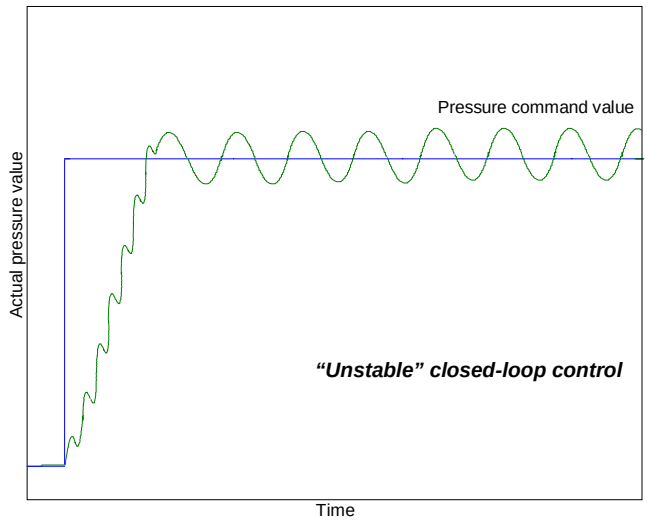
Step	Characteristics / result	Measure
1	Overshooting (damped oscillation)	Increase D-component
2	Actual pressure value still overshooting	Reduce P-gain

Example 2



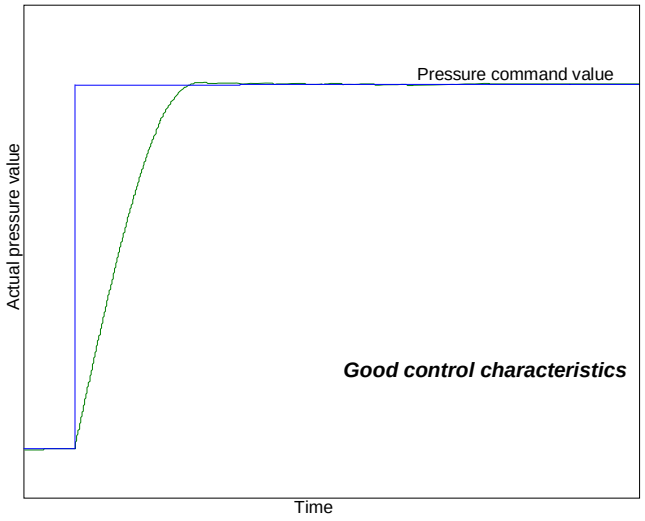
Step	Characteristics / result	Measure
1	Slow reaction	Increase P-gain
2	Reaction still too slow	Reduce D-component

Example 3



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

Example 4



Step	Characteristics / result	Measure
1	Good closed-loop control characteristics	

8.4.4 Gate time

R parameter	Designation	Range of values
R555	Gate Time of Pressure Actual Value F15	1 - 120
R556	Gate Time of SWA Actual Value F15	1 - 120

The gate time has merely influence on the D-component and reduces the sensitivity with regard 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, 1500 min^{-1}), i.e. for

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

8.4.5 Selection of the PT input

R parameter	Designation
R557	Selection of PT-input [1-4] F15

For some applications it can 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.

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

Information about the setting of the pressure transducers can be found in chapter 5.4 "Setting of the pressure transducers (PT)“.

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

Caution: In the case of analog command value preselection, the use of PT inputs 3+4 is impossible.

8.4.6 DT1 pressure feedback of SWA controller

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

In the case of low-frequency systems, e.g. cylinders with long strokes or moved masses, slightly damped vibration may occur in the SWA control. With the help of DT1 pressure feedback, this vibration can be actively damped. 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.
In the factory setting the DT1 pressure feedback is set to the default value of 0, i.e. the function is deactivated.

8.4.7 LP filter time of pressure controller

R parameter	Designation	Range of values
R595	LP filter time of p-contr. (D-comp.) F15	0 - 8

Controller parameter R595 can be used for specifying the filter time constant for a low-pass filter for smoothing the D-component in closed-loop pressure control. The higher the set time constant, the longer is the delay at the controller output in relation to changes in the signal at the controller input. The range of values is 0 … 8, which corresponds to a delay of 0 ... 384ms (2^n * 1.5ms).
In the factory setting the filter time constant is set to the default value of 0, i.e. the function is deactivated.

Note: The use of the filter time constant is recommended when no positive results can be achieved with the adjustment of the gate time.

8.4.8 Pilot control factor for slave

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

The displacement can be increased by coupling several SYDFEx pumps. In order that this SYDFEx system operates approximately synchronous, 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 10.2 "Master/slave applications”.

9 Calibration of SYDFEC

With the help of regular calibration with the calibration functions of the SYDFEC, stable system characteristics can be achieved due to compensation for long-term drifts.
For the calibration of the SYDFEC 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 via the CAN bus (see RE 30027-Z) or from the "machine data“ program part of the PC program Win-Ped®.

Caution: For the calibration of the SYDFEC the hydraulic oil must have reached its operating temperature.

9.1 Calibration of the pressure transducer

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

Determination of the maximum balancing tolerance

Parameter group "Adjustment PT-inputs"

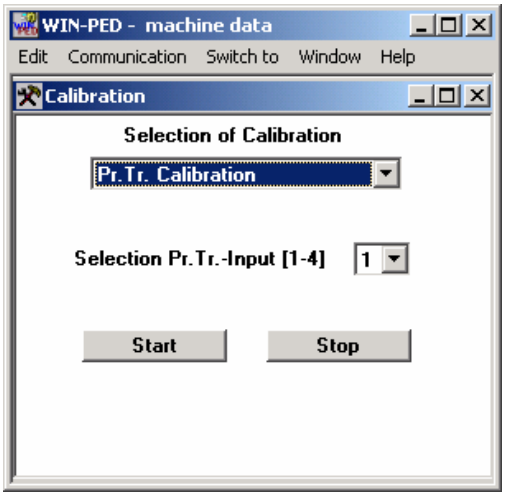
The maximum balancing tolerance of the pressure transducer can be adjusted for the relevant PT input by way of the following R parameters.

PT input	R parameter	Designation
1	609	Maximum balancing tolerance [PT 1]
2	655	Maximum balancing tolerance [PT 2]
3	658	Maximum balancing tolerance [PT 3]
4	662	Maximum balancing tolerance [PT 4]

The range of values of the maximum balancing 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®, menu item “PT calibration“.

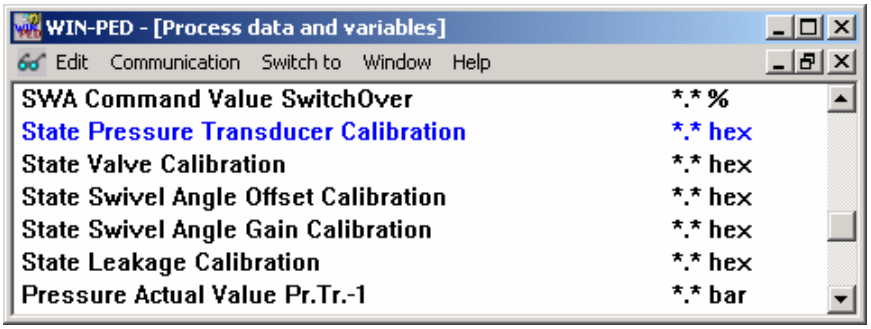


Caution: Before starting the calibration of the relevant pressure transducer, make sure that the drive motor of the pump is switched off and the system is depressurised, i.e. this state is calibrated as 0 bar.

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”.



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

Value	Status of calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process already started
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the PT outside preset balancing 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 via the following R parameters. The established corrective values can be fetched from the control to the working memory of the PC by selecting menu item ***Communication → Fetch all parameter values*** in the online mode.

PT input	R parameter	Designation
1	604	Offset of pressure transducer 1
2	653	Offset of pressure transducer 2
3	656	Offset of pressure transducer 3
4	659	Offset of pressure transducer 4

9.2 Calibration of the valve zero point

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

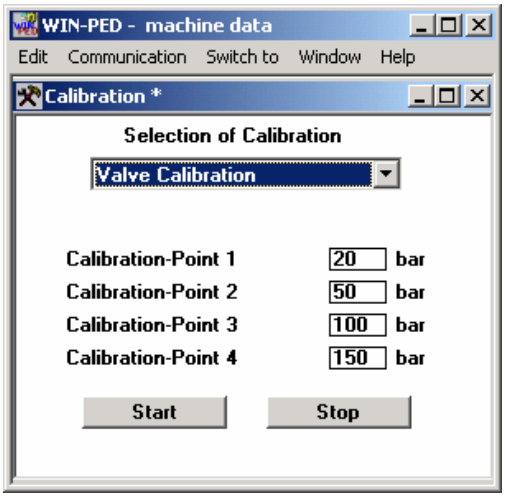
Required preconditions:
- Pump drive motor ON
- All actuators disconnected from the pump

Supporting points for valve calibration

4 given pressure supporting points are used for calibrating the valve. 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 supporting points are 20 bar, 50 bar, 100 bar and 150 bar.

Starting the calibration process

The calibration process of the valve can be started from the machine data of the PC program Win-Ped®, selection of “valve calibration“.

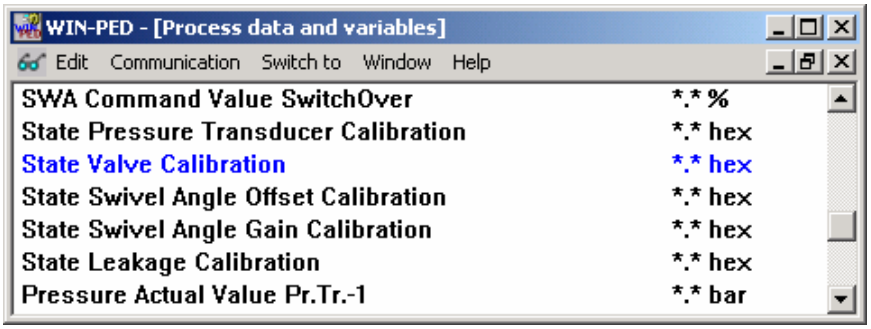


During the calibration process the pump operates in the closed-loop control mode with the given pressure command values. The calibration process takes about 60 seconds.

Caution: During the calibration, the SYDFEC 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 the valve calibration is displayed in the program part “diagnosis” of the PC program Win-Ped® in the view “process data and variables”.



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

Value	Status of calibration
0x0000	Calibration completed and OK
0x0001	Calibration running
0x0002	Other calibration process already started
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)

Offset of valve calibration

Parameter group “Adjustment valve“

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

R parameter	Designation
642	Valve-Offset-Compensation-Point_1 [bar]
643	Valve-Offset-Compensation-Point_2 [bar]
644	Valve-Offset-Compensation-Point_3 [bar]
645	Valve-Offset-Compensation-Point_4 [bar]
646	Valve-Offset-Point_1
647	Valve-Offset-Point_2
648	Valve-Offset-Point_3
649	Valve-Offset-Point_4

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

9.3 Calibration of the swivel angle sensor

The calibration of the swivel angle sensor must be carried out in two steps in the following order:

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

9.3.1 Calibration of the swivel angle sensor offset

Required preconditions:

- Pump drive motor ON
- All actuators disconnected from the pump, there is no oil flow to and from the tank

Caution: The calibration of the swivel angle sensor offset is not possible in the **regenerative mode**!

Starting the calibration process

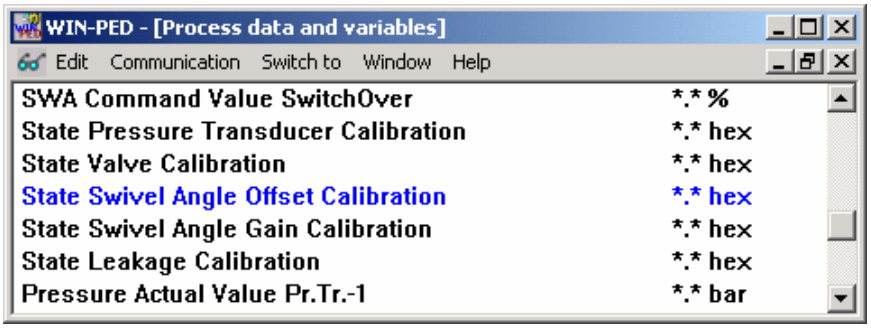
The offset calibration process can be started from the machine data of the PC program Win-Ped®, selection of “SWA offset calibration“.

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.

Caution: During the calibration, the SYDFEC uses internal 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 the SWA offset calibration is displayed in the program part "diagnosis" of the PC program Win-Ped® in the view "process data and variables".



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

Value	Status of 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 (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 12bar ... 28bar)

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 via the following R parameters. The established corrective values can be fetched from the control to the working memory of the PC by selecting menu item ***Communication → Fetch all parameter values*** in the online mode.

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 set to the default value of 0.

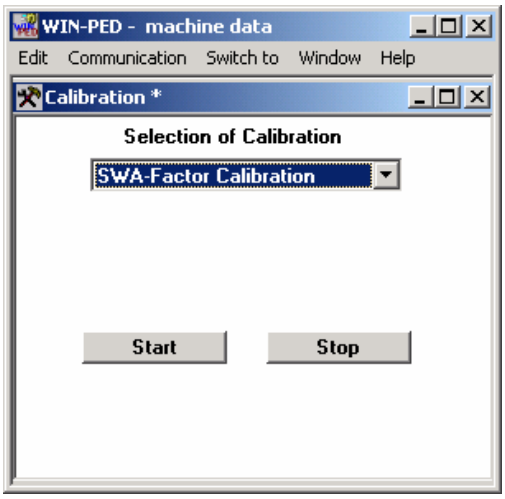
9.3.2 Calibration of the swivel angle sensor gain

Required preconditions:

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

Starting the calibration process

The SWA-factor calibration process can be started from the machine data of the PC program Win-Ped®, selection of “SWA factor calibration“.

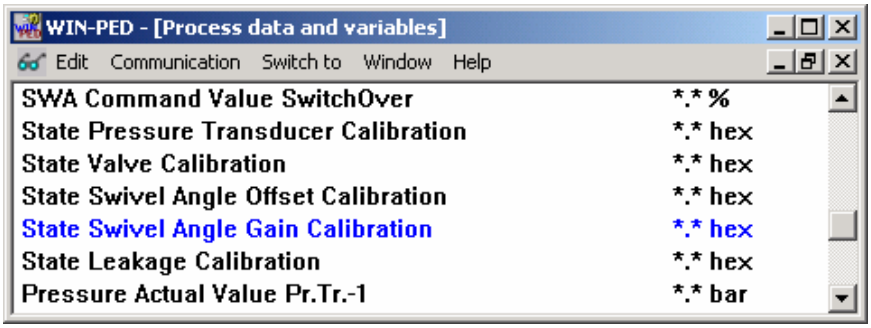


During the calibration process, the pump operates in the closed-loop pressure control mode with a fixed internal pressure command value of 100 bar. The calibration process takes about 20 seconds.

Caution: During the calibration, the SYDFEC uses internal 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 the SWA factor calibration is displayed in the program part “diagnosis” of the PC program Win-Ped® in the view “process data and variables”.



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

Value	Status of 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 (gain 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 has exceeded 80 bar)
0x8000	Calibration error (cable break of swivel angle sensor)

Swivel angle sensor gain

Parameter group " Adjustment swivel angle"

After successful calibration, the gain established (corrective value) for the swivel angle sensor can be read via the following R parameters. The established corrective values can be fetched from the control to the working memory of the PC by selecting menu item ***Communication → Fetch all parameter values*** in the online mode.

R parameter	Designation
R611	Gain Swivel Angle Sensor

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

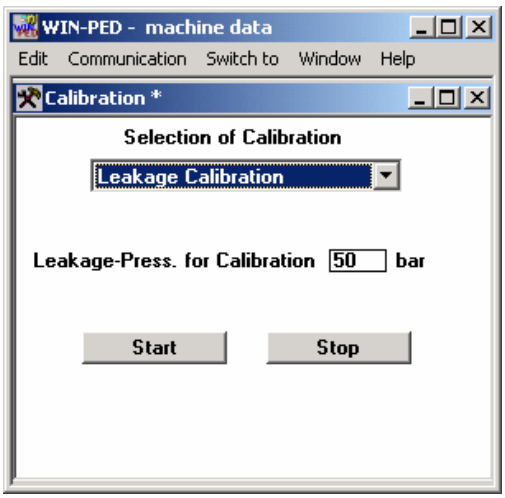
9.4 Calibration of leakage compensation

The closed swivel angle control loop offers an additional function for compensating for pump leakage. For this, a pressure-related offset is added to the swivel angle command value that corresponds to the leakage.

Required preconditions:
- Pump drive motor ON
- All actuators 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 of "leakage calibration".



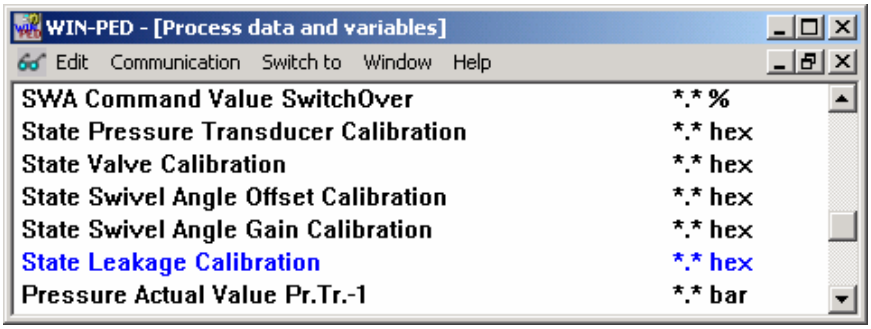
During the calibration process, the pump operates in the closed-loop pressure control mode with the selected pressure command value. The calibration process takes about 60 seconds.

Note: 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 for the calibration.

Caution: During the calibration, the SYDFEC 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”.



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

Value	Status of 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)

Factor of leakage compensation

Parameter group “leakage compensation“

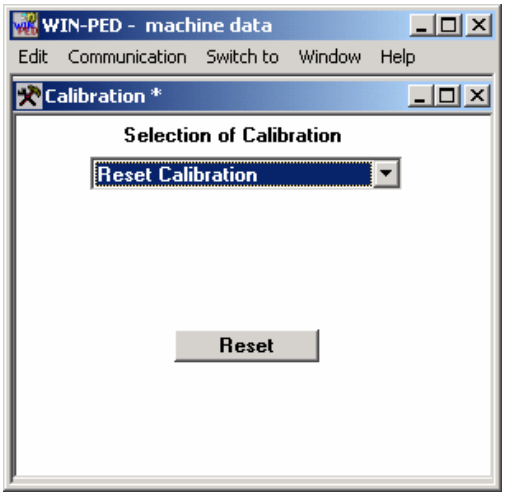
After successful calibration, the factor established (corrective value) for leakage compensation at 315 bar can be read via the following R parameters. The established corrective values can be fetched from the control to the working memory of the PC by selecting menu item ***Communication → Fetch all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

R parameter	Designation
625	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 error is set to the default value of 9 % at 315 bar.

9.5 Resetting the calibration values

To reset the established calibration values to the default values, select “Reset calibration” in the program part “machine data” of the PC program Win-Ped®.



R parameter	Designation	Default value
604	Offset of pressure transducer 1	0
653	Offset of pressure transducer 2	0
656	Offset of pressure transducer 3	0
659	Offset of pressure transducer 4	0
646	Valve_offset_1	0
647	Valve_offset_2	0
648	Valve_offset_3	0
649	Valve_offset_4	0
610	Offset of swivel angle sensor	0
611	Gain of swivel angle sensor	1
625	Leakage compensation	9%

10 Description of special functions

10.1 Power limitation

To protect the drive motor from overloading, the maximum power consumption of the pump can be limited.

Parameter group "Power limitation"

R parameter	Designation
R629	Power limitation

The power limit can be set by means of R parameter R629. The range of values of the power limitation is 0% ... 125%.
The default value entered is 125% → no power limitation.

Example

Calculation of the rated power of the pump (size 100):

Motor power	P_M = 30 kW
Nominal speed	n = 1500 min^{-1}
Pump displacement	V_G = 100 cm^3
System pressure	p = 315 bar
Efficiency	η_{mh} = 1 (theoretical value)

$$P_{100\%} = \frac{V_G \cdot n \cdot p_{\max}}{\eta_{mh}} = \frac{100cm^3 \cdot 1500\frac{1}{\min} \cdot 315bar}{1} = \frac{100cm^3 \cdot 1500\frac{1}{60s} \cdot 31{,}5\frac{J}{cm^3}}{1}$$

$$P_{100\%} = 78750\frac{J}{s} = 78{,}75kW$$

or, simplified:

$$P_{100\%} = \frac{V_G \cdot n \cdot p_{\max}}{600000 \cdot \eta_{mh}} = \frac{100 \cdot 1500 \cdot 315}{600000} = 78{,}75kW$$

Calculation of the power limit $(p \cdot \alpha)_{\max}$:

$$(p \cdot \alpha)_{\max} = \frac{P_M}{P_{100\%}} \cdot 100\% = \frac{30kW}{78{,}75kW} \cdot 100\% = 38\% = \underline{1852_{hex}}$$

10.2 Master/slave applications

The displacement can be increased by coupling several SYDFEx pumps.

The SYDFEC pumps can communicate in 2 ways:
- Communication via the CAN bus
- Communication via analog command value preselection

10.2.1 Master/slave communication via CAN bus

In the case of communication via the CAN bus, the master passes the swivel angle command value on to the slave. Detailed information about the set-up of master/slave operation can be found in the documentation “CANopen interface of SYDFEC pumps“ (RE 30027-Z).

10.2.2 Master/slave communication via analog command value preselection

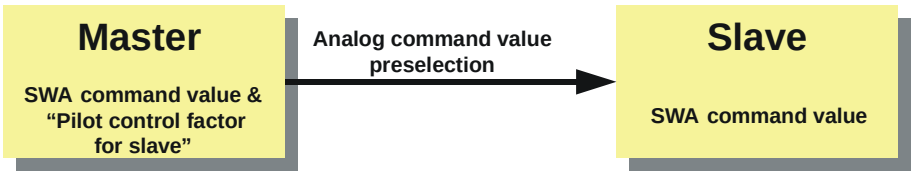
In contrast to the CAN bus communication, the swivel angle command value is passed on to the slave via D/A output 1 or 2 of the master. To this end, the output variable “SWA command value for slave” must be selected for R parameter R607 or R608 in order that the SWA command value for this slave is output via analog output 1 or 2.

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

Parameter group “analog outputs“

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

In order to compensate for the swivel angle difference between the master and slave in dynamic cases, the master adds a pilot control signal to the swivel angle command value. The gain of the pilot control signal is set in the master with the controller parameter “Pilot control factor for Slave“ in the 16 controller parameter sets and passed on to the slave. The values 0 to 16383 correspond to a factor of 0 to 1.



For the configuration of master/slave operation with analog command value preselection, the following proceeding is recommended:

1. Output of the SWA command value at D/A output 1 or 2 of the master (R607/R608 Output variable “SWA command value for slave)
2. Set the controller parameter “pilot control factor for slave” in the controller parameter set used for the master.
3. Determine command value source in the slave (analog command value preselection R602 Command value source “Analog command values”)
4. Switch pressure command value of the slave to maximum (+10V)

10.3 Internal command value ramps

For some applications, it is required to apply the pressure or swivel angle via ramp functions. To meet the requirements of these applications, the SYDFEC is provided 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.

Parameter group “Internal ramps“

R parameter	Designation	Range of values
R638	Delta for p-ramps (pos)	0 – 6500
R639	Delta for p-ramps (neg)	0 - 6500
R640	Delta for SWA-ramps (pos)	0 - 6500
R641	Delta for SWA-ramps (neg)	0 - 6500

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

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

11 Analog outputs

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

Parameter group “analog outputs“

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

The following parameter values can be used for the selection of the variable that is to be output via an analog output. The output variables are normalised to 10V.

Output variable
0V
Pressure command value
Internal pressure command value
Actual pressure value
Pressure differential
SWA command value
Internal SWA command value
Actual SWA value
Swivel angle difference
Pressure controller output
SWA controller output
Valve command value
Actual valve value
SWA command value for slave
Temperature (0 ... 100Grad = 0 ... 10V)
+10V (not suitable for supplying external actuators!)
+10V (not suitable for supplying external actuators!)

With the factory setting, the actual pressure value is output to analog output 1 ($U_{out\ 1}$), and the actual SWA value to analog output 2 ($U_{out\ 2}$).

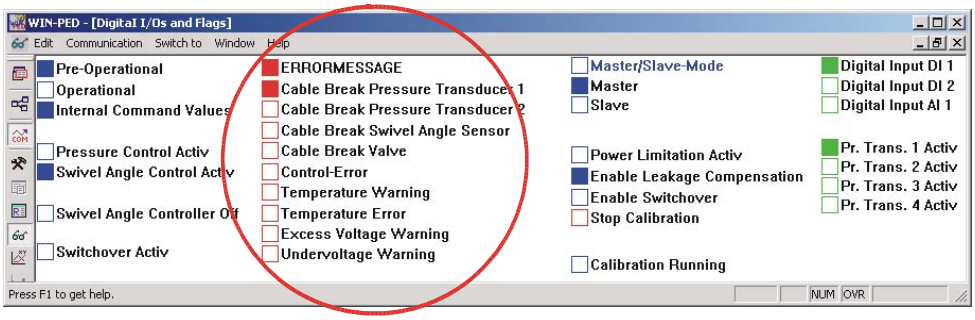
12 Error diagnosis

The “error” signal can be evaluated at pin 3 of the central plug.
The following is valid:

- When no error is detected by the SYDFEC the signal output issues a voltage level that is about 0.2 ... 2V lower than voltage supply U_B. The signal output is overload-protected. From load currents of ca. 100 mA on the output voltage decreases further.
- When the SYDFEC detects an error, a voltage of ca. 0V can be measured at the error signal output. (In this case, the signal output is connected to U_B with a high resistance (in the order of MΩ).

Meaning of the signal	Output signal at pin 3
Electronics OK	24V (U_B – 2V)
Error	0 to 2V

The error signal of the SYDFEC at pin 3 is utilised for all error signals occurring internally (collective error output). The error signal is not saved, i.e. the error signal is applied to pin 3 of the central plug exactly as long as the error is present.
The error messages are shown individually in the “diagnosis“ program part of the PC program Win-Ped® in the view “digital I/Os and flags“.



12.1 Description of errors

The following errors are assigned to the SYDFEC:

Error message
Cable break PT input 1
Cable break PT input 2
Cable break PT input 3
Cable break PT input 4
Cable break swivel angle sensor
Cable break valve
Valve error
Control error
Overvoltage (> 37V)
Undervoltage (< 19V)
Temperature limit value exceeded in housing (approx. 95°C)
Temperature warning (approx. 85°C)

- **Cable break PT**
  The actual pressure value of the relevant pressure transducer is less than or greater than the limit value, i.e. the value is above or below the permissible measuring range of the A/D converter.

- **Cable break swivel angle sensor**
  The actual swivel angle value is less or greater then the limit values for cable break.

  Possible cause:
  - Due to incorrect balancing outside the permissible measuring range of the A/D converter
  - Defective SWA sensor
  - Defective SWA sensor cable
  - Internal electronics error

- **Cable break valve**
  The actual valve value is less or greater than the limit values for cable break

  Possible cause:
  - Due to incorrect balancing outside the permissible measuring range of the A/D converter
  - Valve spool seized due to contamination
  - Internal electronics error

- **Valve error**
  Control error between valve command value and actual valve value over a time interval of >0.5s.

  Possible cause:
  - Valve spool seized due to contamination
  - Internal electronics error

- **Control error**
  Control error between command and actual value in pressure or SWA control over a time interval of >1.5s.

  Possible cause:
  - Valve spool seized due to contamination
  - Backpressure cannot be built up (minimum pressure of the pump 8-10 bar)
  - Drive motor switched off
  - Valve spool does not move as a result of an electronics error

- **Overvoltage warning**
  The supply voltage is higher than 37V.

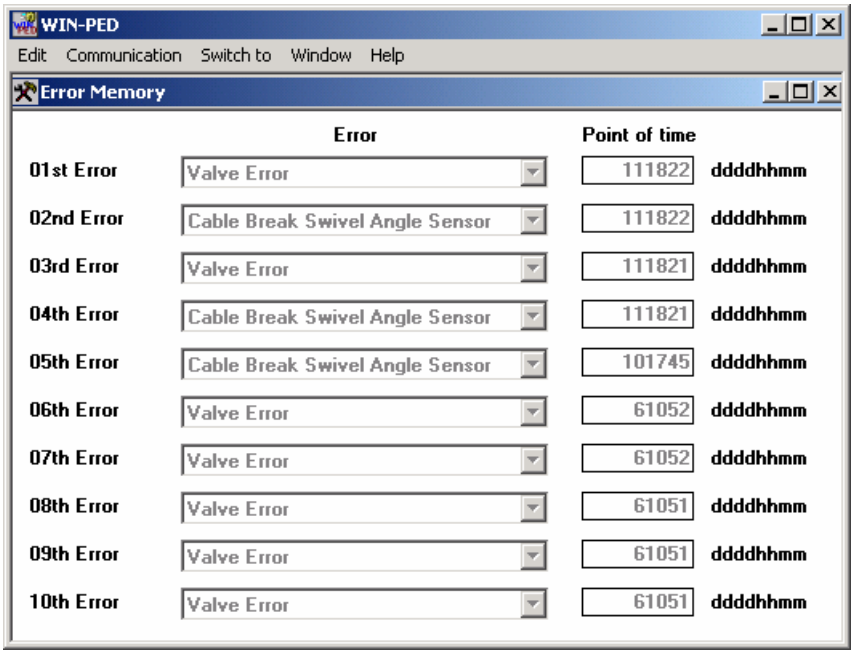
- **Undervoltage warning**
  The supply voltage is lower than 19V.

- **Temperature warning**
  Temperature threshold of approx. 85°C exceeded in the housing. This error message is not output to pin 3 of the central plug (collective fault output).
  IMPORTANT: Shortening of the service life of electronic components!

- **Temperature error**
  Temperature limit value of approx. 95°C exceeded in the housing.
  IMPORTANT: Risk of destruction of the electronics!

12.2 Error memory

For diagnosis purposes, the SYDFEC has an internal error memory that lists the last 10 errors.



Note: The control error is not saved in the internal error memory of the SYDFEC!

13 Further notes

13.1 The SYDFEC control system with external supply of the actuating system

See also notes in RE 30027.

13.1.1 In the case of malfunction

- **In the case of externally supplied actuating systems, the safety function that swivels the pump to zero stroke when the high-response valve is de-energised (in the event of a fault) is ineffective.**
- When the high-response valve is de-energised, the swivel plate of the control pump is pushed by the external pressure to the negative limit stop (displacement of 100 % flow from the system to the tank). An anti-cavitation valve must therefore be installed in order to prevent cavitation.
- When an error message is output, the machine control must react (e.g. by switching the drive motor of the pump off, by interrupting the external supply of the actuating system....).

13.1.2 Applying Command values

- Operating pressures of less than 10 bar in cycle operation only (max. 10 min)
- Command values for pressure and flow must always be greater than zero, since, due to drifts or inaccurate settings, there is no precise “zero” pressure or “zero” swivel angle. A command value preselection of zero or slightly greater than zero can lead to cavitation under unfavourable conditions.

14 Quick start

This quick start offer a short reference of the most important setting options for initial commissioning of the SYDFEC with the default settings (address 2). We refer to the special points for the setting of the SYDFEC.
The described procedure is intended as implementation aid, but is no substitution for the necessity that the user familiarises himself in detail with the operating principle of the SYDFEC.

For initial commissioning of the SYDFEC we recommend the following order:

1. Setting of the nominal pressure
2. Selection of the command value source
3. Selection of the controller parameter sets
4. Setting of the pressure transducer (type, measuring range)
5. Selection of the PT input in the controller parameter sets

1. Setting of the nominal pressure

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

The setting of the nominal pressure determines 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 +10V) this nominal pressure is obtained.

2. Selection of the command value source

R parameter	Designation
R602	Command value source

R parameter R602 can be used for the selection of the command value source. The following table lists the different control options for the command values.

Meaning
Command values via CAN bus
Command values via the PC program "Win-Ped®"
Analog command value preselection
Call-up command values (DI1/AI1)

3. Selection of the controller parameter set

R parameter	Designation
R615	Input selection of contr. parameter sets

R parameter R615 can be used for the type of selection of the controller parameter set.
The following table lists the different control options for the controller parameter set selection.

Meaning
Controller parameter set input via CAN bus
Controller parameter set input via the PC program "Win-Ped®"
Controller parameter set input via switching inputs (DI1/DI2)
Controller parameter set input via switching inputs (DI1/AI1)

4. Setting of the pressure transducers

For some applications it can be advantageous if it possible to switch between several pressures transducers.

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

4.1. Pressure transducer types

PT input 1 (central pug pin 10/11)

R parameter	Designation
R603	Type of pressure transducer 1

Various types of pressure transducers can be connected to PT input 1 of the SYDFEC.

Type of pressure transducer
0 ... 5 V
0,5 ... 5 V
0 ... 10 V
0.1 ... 10 V
1 ... 10 V
0 ... 20 mA
4 ... 20 mA

To take over the changes made for the pressure transducer, a power-on reset must be executed on the SYDFEC.

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

A pressure transducer for a signal voltage of (0.5 .... 5) V can be connected to PT input 2 of the SYDFEC.

PT input 3 (central pug pin 7/4)
PT input 4 (central pug pin 5/4)

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

Various types of pressure transducers can be connected to PT input 3 or 4 of the SYDFEC.

Type of pressure transducer
0 ... 10 V
0.1 ... 10 V
1 ... 10 V

4.2 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.

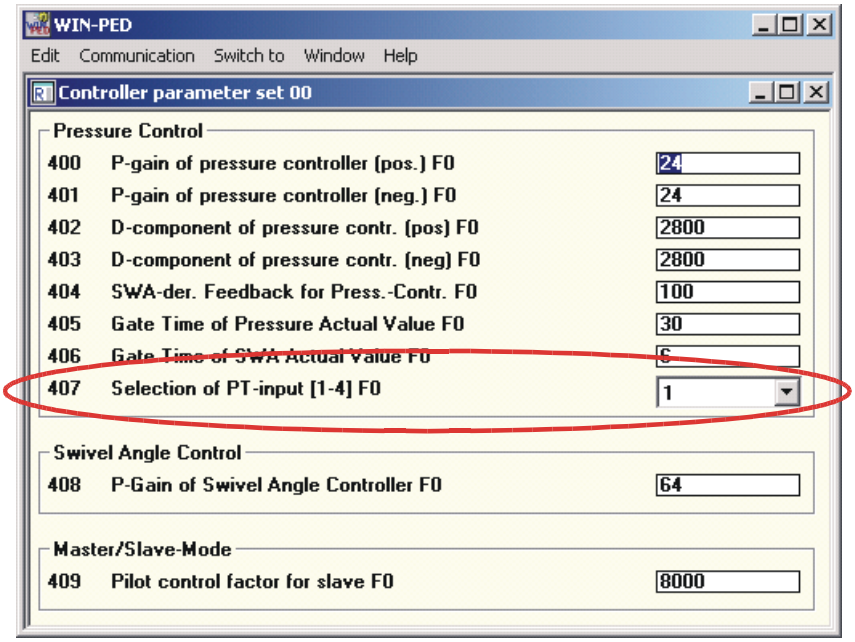
PT input	R parameter	Designation
1	605	Measurement range PT-input 1
2	654	Measurement range PT-input 2
3	657	Measurement range PT-input 3
4	661	Measurement range PT-input 4

5. Selection of the PT input

Designation
Selection of PT-input [1-4]

The PT input is selected through the R parameter “Selection of PT-input [1-4]“ in the controller parameter set currently used.

Note: If several controller parameter sets are used at a time, 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.



15 Notes

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