SERIES DFPLUS
OPERATION MANUAL

Directional Control Valve with freely configurable supervising Control Circuit
Design > 50

WARNING — USER RESPONSIBILITY

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Introduction

The direct operated control valves D1FP with freely vconfigurable control circuit of the nominal size NG06 (CETOP 03) and D3FP/D30FP of the nominal size NG10 (CETOP 05) shows extremly high dynamics combined with maximum flow. It is the preferred choice for highest accuracy in positioning of hydraulic axis and controlling of pressure and velocity. Driven by the VCD actuator the D*FP reaches the frequency response of real servovalves. At powerdown the spool moves in a defined position. All common input signals and IO-Link Class B are available.

Scope of installation manual

Valve series
- D1FP*D
- D3FD*D
- D30FP*D

Related documents

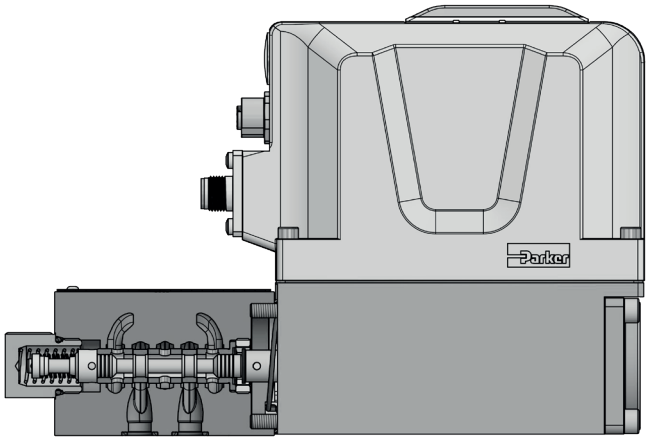
- Catalogue D1FP
- Catalogue D3FP
- Catalogue D30FP

Characteristics of valve electronics

The integral electronic driver combines all functions for optimal operation of the valve. Thanks to its excellent dynamic the valve is deployable within closed loop control applications. The most important features are:

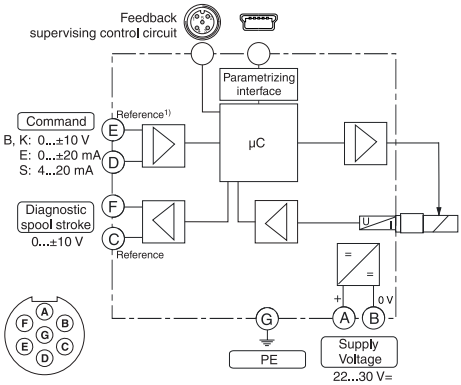
- high dynamic actuator with specially designed
- electronic driver
- closed loop controlled spool position
- constant current actuator control with overcurrent shutoff
- excellent properties for response sensitivity and temperature drift
- differential input stage with various command signal options
- diagnostic output for spool stroke
- meets relevant European EMC-standards
- IO-Link Class B version available
- Pressure or position control
- Optional PQ function with operation mode switching

D1FP*D

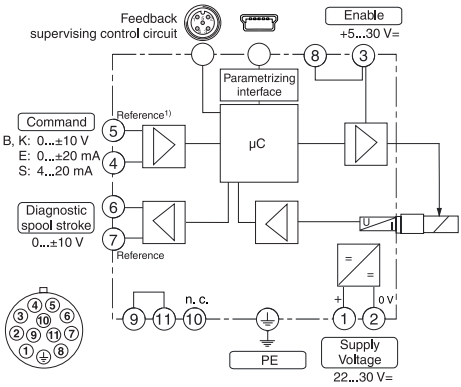


Block diagram of onboard electronics

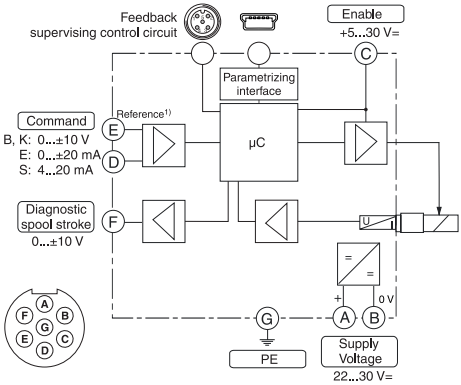
Code 0 (6+PE)



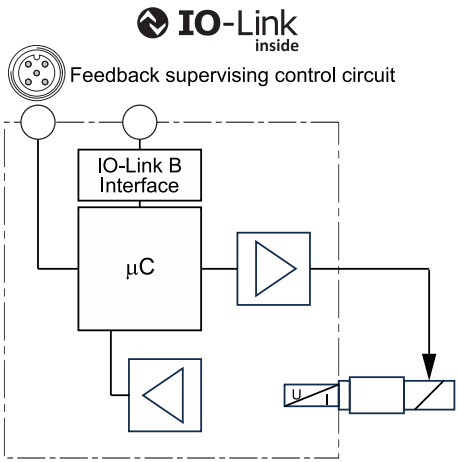
Code 5 (11+PE)



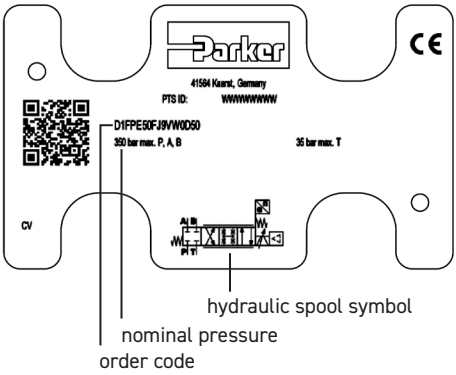
Code 7 (6+PE with enable)



IO-Link Class B



Name plate



[1] Do not connect with supply voltage zero.

Technical data

General		
Model		Proportional directional control valve
Drive		VCD®-actuator
Size		NG06 (CETOP 03) / NG10 (CETOP 05)
Mounting pattern		DIN 24340 / ISO 4401 / CETOP RP121 / NFPA
Installation position		unrestricted
Ambient temperature	[°C]	-20...+50
$MTTF_D$ value [1]	[Jahre]	150
Weight	[kg]	5,0 (D1FP), 6,5 (D3FP)
Vibration resistance	[G]	10 Sinus 5...2000 Hz acc. IEC 68-2-6 20 (RMS) Random noise 20...2000 Hz acc. IEC 68-2-36 15 Shock acc. IEC 68-2-27
Weight	[kg]	NG06: 3.6 / NG10: 6.5
Hydraulic		
Operating pressure max.	[bar]	350 for ports P, A, B; max. 35 for port T at internal drain, 350 (D1FP), 250 (D3FP) with external pilot oil; port Y max. 35 [1]
Fluid		Hydraulic oil according to DIN 51524 ... 535, other on request
Fluid temperature	[°C]	Seal code: N: -25...+60, H, V: -20...+60
Viscosity permitted recommended	[cSt]/[mm²/s] [cSt]/[mm²/s]	20...400 30...80
Filtration		ISO 4406; 18/16/13
Nominal flow at Δp = 35 bar per control edge [3]	[l/min]	3 / 6 / 12 / 16 / 25 / 40 (D1FP), 50 / 100 (D3FP)
Flow maximum	[l/min]	90 bei Δp = 350 bar over two control edges (D1FP), 150 (D3FP) 80 (D30FP Δp = 5 bar per control edge)
Leakage at 100 bar	[ml/min]	< 400 (zerolap spool); < 50 (D1FP overlap spool); < 100 (D3FP overlap spool), 250 (D30FP); < 1800 (D30FP zerolap spool); < 1000 (D30FP overlap spool)
Opening point	[%]	set to 23 (D1FP), 19 (D3FP) command signal (see flow characteristics)
Static / Dynamic		
Step response at 100 % step [4]	[ms]	<3.5
Frequency response (±5 % signal) [4]	[Hz]	350 (amplitude ratio -3 dB), 350 (phase lag -90°)
Hysteresis	[%]	<0.05
Sensitivity	[%]	<0.03
Temperature drift	[%/K]	<0.025

[1] If valves with onboard electronics are used in safety-related parts of control systems, in case the safety function is requested, the valve electronics voltage supply is to be switched off by a suitable switching element with sufficient reliability.

[2] For applications with p_T>35 bar (max. 350 bar) the Y-port has to be connected and the plug in the Y-port has to be removed.

[3] Flow rate for different Δp per control edge: $Q_x = Q_{Nenn.} \cdot \sqrt{\frac{\Delta p_x}{\Delta p_{Nenn.}}}$

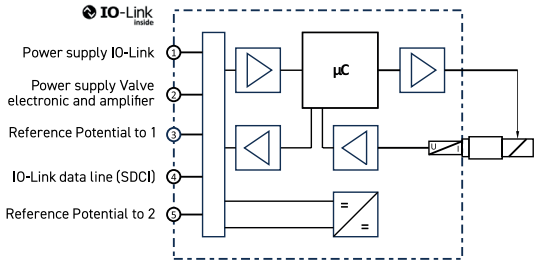
[4] Measured with load (100 bar pressure drop/two control edges).

Interfaces			
IO-Link			IEC 61131-9
NFC			ISO/IEC 15693 - NFC Forum Type 5 tag certified by the NFC Forum Frequency 13.56 MHz; -27.2 dBµA/m at 10 meters distance
Electrical			
Duty ratio		[%]	100
Protection class			IP65 in accordance with EN 60529 (with correctly mounted plug-in connector) 6 = Full protection against contact, dust tight 5 = Protection against water jets (nozzle) from any angle
Supply voltage / ripple		[V]	24 V nom. (tolerance range 22 ... 30V), electric shut-off at < 19, ripple < 5 % eff., surge free
Current consumption max.		[A]	3.5
Pre-fusing		[A]	4.0 A medium lag
Command			Depending on choosen signal type
Voltage	signal	[V]	10...0...-10, ripple <0.01 % eff., surge free
	impedance	[kOhm]	100
Current	signal	[mA]	20...0...-20, ripple <0.01 % eff., surge free
	impedance	[Ohm]	<250
Current	signal	[mA]	4...12...20, ripple <0.01 % eff., surge free <3.6 mA = disable, >3.8 mA = according to NAMUR NE43”
	impedance	[Ohm]	<250
Current	signal	[mA]	10...0...-10, ripple <0.01 % eff., surge free
	impedance	[Ohm]	<250
Current	signal	[mA]	50...0...-50, ripple <0.01 % eff., surge free
	impedance	[Ohm]	<250
Differential input max.			
	Code 0	[V]	30 for terminal D and E against PE (terminal G)
	Code 5	[V]	30 for terminal 4 and 5 against PE (terminal W)
	Code 7	[V]	30 for terminal D and E against PE (terminal G)
Enable signal (only code 5/7)		[V]	acc. EN 61131-2; Type 3 Low -3...+5; High 11...30; input current 3 mA
Diagnostic signal		[V]	+10…0…-10; 4…12…20 (max. 5mA)
EMC			EN 61000-6-2, EN 61000-6-4
Electrical connection			
	Code 0/7		6 + PE acc. EN 175201-804
	Code 5		11 + PE acc. EN 175201-804
Wiring min.	Code 0/7	[mm²]	7 x 1.0 (AWG16) overall braid shield
	Code 5	[mm²]	8 x 1.0 (AWG16) overall braid shield
Wiring length max.		[m]	50

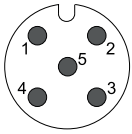
Technical Data IO-Link Class B

Electrical characteristics		
Duty ratio	[%]	100
Protection class		IP65 in accordance with EN 60529 (with correctly mounted plug-in connector) 6 = Full protection against contact, dust tight 5 = Protection against water jets (nozzle) from any angle
Directive		IO-Link Interface and System Specification Version 1.1.2
Valve amplifiers Supply voltage/ripple	[V]	24 V nominal (tolerance range 22 ... 30V), electric shut-off at < 19, ripple < 5 % eff., surge free
Valve amplifiers max. power consumption	[A]	3.5
Valve amplifiers Pre-fusing	[A]	4.0 medium lag
IO-Link Interface Supply voltage/ripple	[V]	24 V nominal (tolerance range 22 ... 30V), electric shut-off at < 19, ripple < 5 % eff., surge free
IO-Link Interface max. power consumption	[A]	1.2
Functional ground and screening		Provide via valve block
Required master port class		Class B
EMC		EN 61000-6-2, EN 61000-6-4
Electrical connection		M12 sensor/actuator connection line, 5-pole; M12 connector/bush, A-coded, without shield
Wiring min.	[mm²]	0.34 mm 2 for a cable length of up to 5 m
Wiring length max.	[m]	20

Block diagram



Pin	Signal	Signal – IO-Link B Class / viewing direction of the valve
1	L+	Voltage Supply IO-Link
2	P24	Voltage supply valve electronics and power part power consumption 4A
3	L-	Reference potential pin 1
4	C/Q	IO-Link data line (SDCI)
5	N24	Reference potential pin 2



Pin 3 and 5 are linked with each other in the valve electronics. The reference potentials L- and N24 of the two supply voltages must also be linked with each other on the power supply unit side.

Safety instructions

Please read the operation manual before installation, start-up, service, repair or stocking! Disregard may result in damaging the valve or incorporated system parts.

Symbols

This manual uses symbols which have to be followed accordingly:

Instructions with regard to the warranty

Instructions with regard to possible damaging of the valve or linked system components

Helpful additional instructions

Service

Workings in the area of installation, commissioning, maintenance and repair of the valve may only be allowed by qualified personnel. These are persons which have, because of education, experience and instruction, sufficient knowledge on relevant directives and approved technical rules.

1. Important details

Intended usage

This operation manual is valid for proportional directional control valves DFplus series. Any different or unintended usage is to be considered as not intended. The manufacturer is not liable for warranty claims resulting from this.

Common instructions

Parker reserves the right for technical modifications of the described product. Illustrations and drawings within this manual are simplified representations. Due to improvement or modification of the product the illustrations might not match precisely with the described valve. The technical specifications and dimensions are not binding. No claims can be derived of it. Copyrights are reserved.

Liability

Parker does not assume liability for damage due to the following failures:

- incorrect mounting / installation
- improper handling
- lack of maintenance
- unintended usage

Do not disassemble the valve! In case of suspicion for a defect please contact Parker.

Storage

In case of temporary storage the valve must be protected against contamination, atmospheric exposure and mechanical damages. Each valve has been factory tested with hydraulic oil, resulting in protection of the internal parts against corrosion. Yet this protection is only ensured under the following conditions:

Storage period	Storage requirements
12 months	constant humidity < 60 % as well as constant temperature < 25 °C
6 months	varying humidity as well as varying temperature < 35 °C

Outdoor storage or within sea and tropical climate will lead to corrosion and might disable the valve!

Mounting / Installation

Scope of supply

Please check immediately after receiving the valve, if the content is matching with the specified scope of supply. The delivery includes:

- valve
- operation manual

The central connector has to be ordered separately and is not included in the delivery.

☞ Please check the delivery immediately after receiving the shipment for apparent damages due to shipping. Report shipment losses at once to the carrier and the supplier!

Mounting

- Compare valve type (located on the name plate) with bill of materials respectively circuit diagram.
- The valve may be mounted fix or movable in any direction.
- Check mounting surface for the valve. Uneveness of 0.01 mm/100 mm, surface finish of 6.3 µm are tolerable values.

☞ Keep valve mounting surface and work environment clean!

- Remove protection plate from the valve mounting surface
- Check the proper position of the valve ports and the O-rings.
- Mounting bolts:
  D1FP: 4 pcs. M5x30
  D3FP: 4 pcs. M6x40
  use property class ISO 4762-12.9
- Bolt kits:
  D1FP: BK375
  D3FP: BK385
- Tighten the bolts crisscross with the following torque values:
  D1FP: 7.6 Nm
  D3FP: 13.2 Nm

⚠ Insufficient condition of the valve mounting surface might create malfunction!
Incorrect mounting resp. bolt torque may result in abrupt leakage of pressure fluid on the valve ports.

Limits of use

The valve may be operated within the determined limits only. Please refer to the "technical data" section as well as to the "characteristic curves" in the Parker catalogue HY11-3500/UK "Hydraulic Valves Industrial Standard".

⚠ Follow the environmental conditions! Unallowable temperatures, shock load, aggresive chemicals exposure, radiation exposure, illegal electromagnetic emissions may result in operating trouble and may lead to failure! Follow the operating limits listed in the catalogue HY11-3500/UK "Hydraulic Valves Industrial Standard", see technical data.

Pressure fluids

The following rules applies for the operation with various pressure fluids:

⚠ This above information serves for orientation and does not substitute user tests among the particular operating conditions. In particular, no liability for media compatibility may be derived out of it.

Mineral oil: usable without restriction.
HFC: choose the right seal option.

For operation with the following pressure fluids please consult Parker:

HFA	oil-in-water emulsion
HFB	water-in-oil emulsion
HFD	unhydrous fluids (Phosphor-Ester)

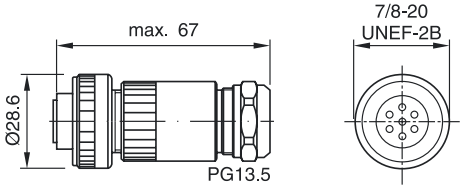
☞ For detailed information concerning pressure fluids note VDMA-document 24317 as well as DIN 51524 & 51502.

Special gaskets may be available depending on the utilized fluid. In case of doubt please contact Parker.

Electrical connection

The valve is connected electrically by one common cable and a central connector.

The connection codes 0 and 7 require a 6 + PE female connector EN 175201-804.



The female connector can be ordered separately under article nr. 5004072.

In case third party connectors are used, accordance to the relevant EMC directives must be ensured.

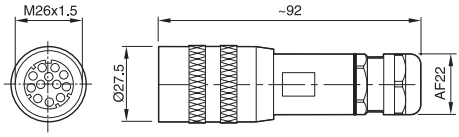
The connecting cable has to comply to the following specification:

Cable type	control cable, flexible, 7 conductors, overall braid shield
Cross section	min. AWG16
Outer dimension	8...12 mm
Cable length	max. 50 m

For cable lengths > 50 m consult Parker.

The connection cable is coupled to the female connector by solder joints.
The shielding has to be assembled according the outline below.
Skinning lengths for the connecting cable:

The connection Code 5 requires a 11 + PE female connector EN 175201-804.



The female connector has to be ordered separately under article nr. 5004711.

In case third party connectors are used, accordance to the relevant EMC directives must be ensured.

The connecting cable has to comply to the following specification:

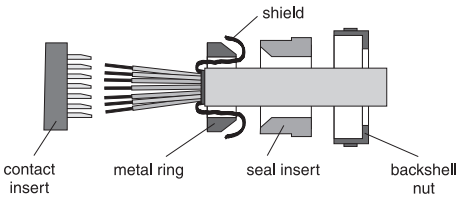
Cable type	control cable, flexible, 8 conductors, overall braid shield
Cross section	min. AWG16
Outer dimension	12...15 mm
Cable length	max. 50 m

For cable lengths > 50 m consult factory.

The connection cable is coupled to the female connector by crimp contacts.
Skinning lengths for the connecting cable:

Do not disconnect cable socket under voltage!

The shielding has to be assembled according the outline below.



The backshell nut of the cable gland has to be tighten with a suitable tool. The target value for the tightening torque is 4 Nm. Tighten the cap nut with a torque of 5 Nm after attaching the female connector on the socket.

Incomplete tightening of backshell nut respectively cap nut may result in undesired release of the connection as well as degradation of the water tightness.

When using female connectors of other manufacturers, the relevant regulations must be observed.

The cable may only be connected to the female connector by authorized and qualified personnel. A short between individual conductors resp. to the connector housing , bad soldering as well as improper shield connection may result in malfunction and breakdown of the valve.

The mounting surface of the valve has to be connected to the earth grounded machine frame. The earth ground wire from the valve connecting cable as well as the cable shield have to be tied to the protective earth terminal within the control unit. It is necessary to use a low ohmic potential connection between control unit and machine frame to prevent earth loops (cross section AWG 6).

Electrical interfacing

Supply voltage

The supply voltage for the valve has to cover the range of 22...30 V. Valve is de-energized below 19 V. The residual ripple may not exceed 5 % eff.

The applied power supply must comply to the relevant regulations (DIN EN 61558) and must carry a CE-mark. The operating voltage for the valve must be free of inductive surges. Do not exceed the max. value of 30V! Higher voltage can lead to failure of the valve.

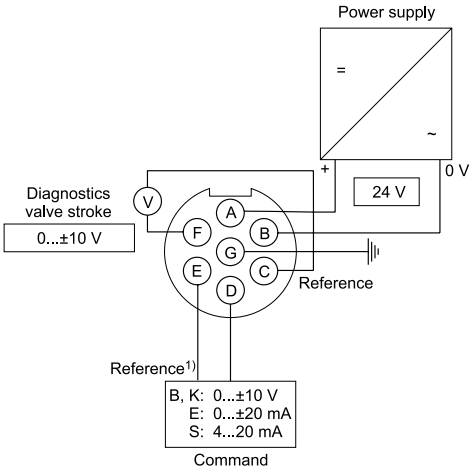
The increased inrush current of the valve should be considered when selecting the power supply. A stabilized power supply with overcurrent limiting feature should not be used. Due to the inrush current of the valve the current limit circuit may respond prematurely and create problems during energizing of the supply voltage.

The operation of the valve is blocked if the supply voltage polarity is interchanged.

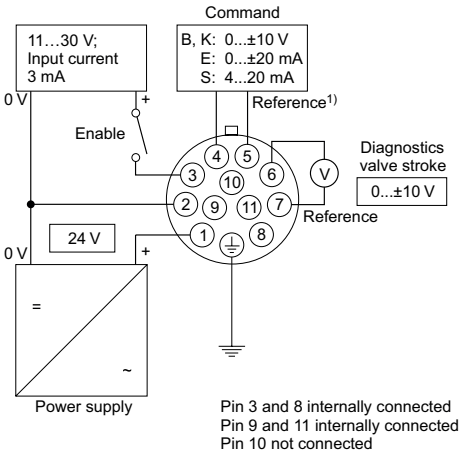
Each valve requires a separate pre-fuse of 4 Amp semi time-lag. Failure to observe this instruction may create irreparable damage of valve respectively incorporated system parts.

Wiring

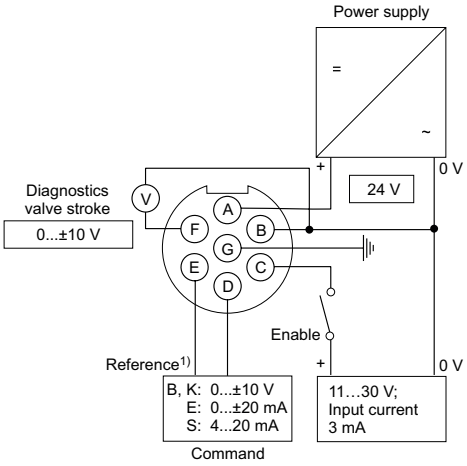
Code 0, 6 + PE acc. EN 175201-804



Code 5, 11 + PE acc. EN 175201-804



Code 7, 6 + PE acc. EN 175201-804 + enable



Pin assignment IO-Link (parametrizing) interface, M12 socket / viewing direction of the valve

PIN assignment acc. IEC 60974-5-2

- Pin 1: 24 VDC
- Pin 3: GND
- Pin 4: IO-Link Communication (C/Q)

[1] Do not connect with supply voltage zero.

A signal voltage enables the actuator drive of the valve. Continuous operation of the valve requires a permanent voltage 11...30 V (e.g. the supply voltage). In case of disabling the signal the valve will reach its power down position spring-actuated independently from the command signal value.

The enable function represents no safety arrangement against unwanted valve operation in terms of accident prevention regulations.

The spool stroke is proportional to the command signal amplitude.

The command input signal needs to be filtered as well as free of inductive surges and modulations. Due to the sensitivity of the valve a high signal quality is recommended. This will prevent malfunction.

The option 4...20 mA uses the "3.6 mA" condition as breakdown-information. If the input signal line is interrupted, an evaluable failure information is available. In this case the actuator drive will be switched off. The drive will switch on when the input signal reaches a value of 3.8 mA, it switches off when the command falls below 3.6 mA. This determination follows the NAMUR-specification NE43.

NAMUR is an association of users of process control technology.
At the diagnostic output, voltage or current information about the operating status of the valve can be measured.

The output may drive a load of max. 5 mA. Exceeding of this limit leads to malfunction

Valves NG06

Code command signal	Command signal	Function	VCD actuator	Diagnostic signal
B	0...+10 V		on	0...+10 V
	0...-10 V		on	0...-10 V
E	0...+20 mA		on	0...+10 V
	0...-20 mA		on	0...-10 V
K	0...+10 V		on	0...-10 V
	0...-10 V		on	0...+10 V
S	4...12 mA		on	0...-10 V
	12...20 mA		on	0...+10 V

Valves NG10

Code command signal	Command signal	Function	VCD actuator	Diagnostic signal
B	0...+10 V		on	0...-10 V
	0...-10 V		on	0...+10 V
E	0...+20 mA		on	0...-10 V
	0...-20 mA		on	0...+10 V
K	0...+10 V		on	0...+10 V
	0...-10 V		on	0...-10 V
S	4...12 mA		on	0...+10 V
	12...20 mA		on	0...-10 V

A valve error can be recognized by the signal color of the 360° LED (page 24). Error and error type can be read out via the ProPXD software or the IO-Link connection. Error Code list > page 23.

5. Operating Instructions
Spool Position at Power Down/Center Position

⚠ For valves with zero lap spools, distinction must be made between hydraulic neutral position and power-down position. Neutral position is taken at neutral input signal, corresponding to zero position of the hydraulic symbol. When the valve is switched off – no supply voltage, no enable, current signal (code S) < 3,8 mA – zero lap valves take the power down position (approximately 10 % opening) according to the ordering code. For valves with overlap spools, neutral position and power down position are the same (zero position).

⚠ Supply pressure must be ensured before valve is energized.

Solenoid Current Monitoring

If the actuator current time interval exceeds 10 seconds, the actuator is switched off to prevent overheating. For normal operating conditions this state will not reached, but it may occur with a contaminated sluggish valve.

⚠ In this case the reason for the contamination should be rectified (hydraulic fluid exchange, filtration review, valve flushing).

The overcurrent shutoff condition may be resetted by the actions below:

Code 0: Temporary disconnection of the supply voltage.

Code 5: Temporary disconnection of the enable signal.

Code 7: Temporary disconnection of the enable signal.

☞ The shutoff of the VCD actuator due the overload will be indicated by LED.

Temperatur monitoring

The prortional directional control valves have internal temperature monitoring of the valve electronics.

☞ When an overtemperature is reached, the valve switches off automatically.
A restart is only possible again when the temperature of the valve electronics is within the operating temperature range.

6. Interface and Parameter
IO-Link Interface

IO-Link communication takes place via the externally accessible M12 interface.

The IO-Link interface allows an external access to the available valve parameters via an IO-Link master or via the ProPxD software.

Parker IO-LINK MASTER USB order no. 40983544 (Parameter overview in the operating instructions)

NFC Interface

The NFC interface allows a wireless access to valve data via the Parker App PDC (available free of charge in the **App Store** or **Google Play Store**).

NFC communication may only be used for maintenance purposes by trained personnel.

⚠ The valve may have hot surfaces. There is a risk of burn injury. Before using NFC radio communication, ensure that the valve has cooled down sufficiently.

ProPxD Parameterizing Software

The ProPxD software allows quick and easy setting of the digital valve electronics. Individual parameters as well as complete settings can be viewed, changed and saved via the comfortable user interface. Parameter sets saved in the non-volatile memory can be loaded to other valves of the same type or saved for documentation purposes.

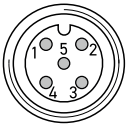
The PC software can be downloaded free of charge at www.parker.com/isde – see page “Support“ or directly at www.parker.com/propxd.

(IO-Link Master USB is required)

IO-Link interface

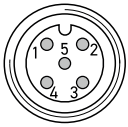
Sensor input connector assignment M12

Voltage sensor



1: U_B Sensor supply 24 V
2: Sensor output ±10 V
3: GND
4: not used
5: not used

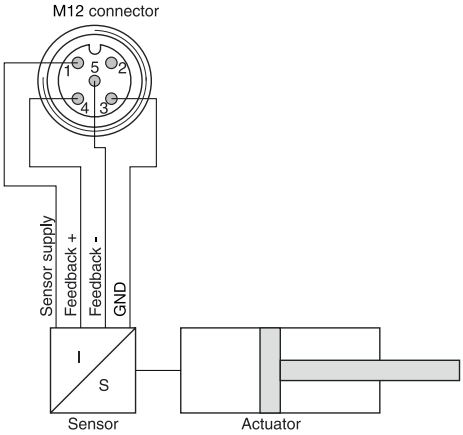
Current sensor



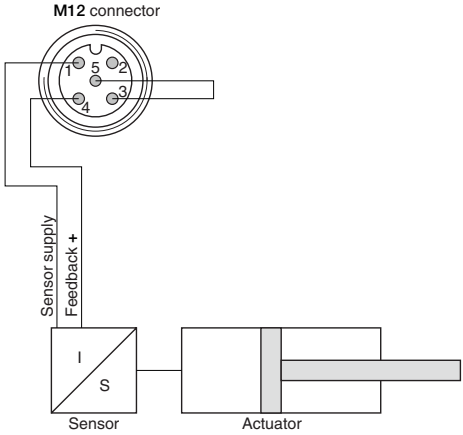
1: U_B Sensor supply 24 V
2: not used
3: GND
4: 4 ... 20 mA +
5: 4 ... 20 mA -

Examples position control
Current 4...12...20 mA contacts at the sensor input

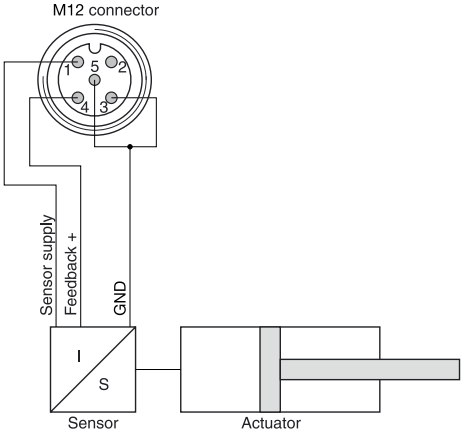
Wiring diagram four-wire



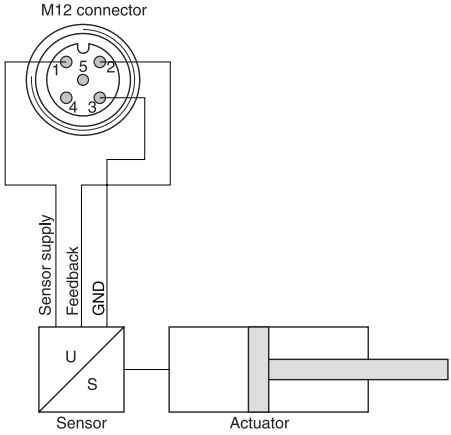
Wiring diagram two-wire



Wiring diagram three-wire



Voltage ±10 V (1...10 V)



The earth connection is achieved via the shilding.

The connection of a unsuitable sensor may create irreparable damage of the electronics.

Valve parameter

Certain combinations of parameters can lead to inappropriate reactions in the application.

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
16	Vendor Name	Vendor Name	Read						
17	Vendor Text	Vendor Text	Read						
18	Product Name	Product Name	Read						
19	Product IOOD	Product IOOD	Read						
20	Product Text	Product Text	Read						
21	Serial Number	Serial Number	Read						
22	Hardware Revision	Hardware Revision	Read						
23	Firmware Revision	Firmware Revision	Read						
24	Application-Specific Tag	Application-Specific Tag	Read						
25	Function Tag	Function Tag	Read						
26	Location Tag	Location Tag	Read						
32	Error Count	Error Count	Read						
36	Device Status	Device Status	Read						
64	Valve Type	Valve family (Parker ident.). If type is unknown update the firmware to the last working version.	Read	uint8				1: Direct CTRLD 2: Pilot CTRLD	2
65	Produktion date code - E-Board		Read	string[2]					
66	Manufacturer Code - E-Board		Read	string[50]					
67	Hardware version - E-Board		Read	string[8]					
85	CRC Calculation	Calculate checksums	Read	uint8					
86	Checksum Active Parameter Setting	Checksum overactive parameters (user changed)	Read	uint32	0				0
87	Checksum Default Parameter Setting	Checksum over default parameters (manufacturing setting)	Read	uint32	0				0
88	Checksum Total Parameter Setting	Checksum overall parameters (supplied setting)	Read	uint32	0				0
96	Device Local	Indicates the source of the control word acting on the device state machine	Read+ Write	uint8				0: Control word via Bus 1: Control word locally	1
97	Device Mode	Device mode (setpoint input)	Read+ Write	uint8				1: Setpoint input via bus 2: Setpoint input locally	2
100	Hold Setpoint	Internal setpoint in device state HOLD	Read+ Write	float32	-100	100			0
101	Enable Behaviour	Determines enable/disable reaction of state machine	Read+ Write	uint8				0: NONE 1: INIT 2: DISABLE 3: HOLD	2
256	Demand Signal Analog Input Type	Selection of the analogue demand signal type	Read+ Write	uint8				0: 0…10V 1: ±10V 2: 4…12…20mA 3: 4…20m A 4: ±10mA 5: ±20mA 6: ±50mA	1
257	Demand Signal Analog Factorisation	Set the demand signal to a range Bsp: I Actual value 0 - 8V Input signal range 0 - 10 V 257 = 125% = Input 5V à 6,25 V	Read+ Write	float32	-200	200	%		100
258	Demand Signal Analog Cable Break	Analog demand signal cable break detection	Read+ Write	boolean				false: Off true: On	false
264	Diagnosis A Output Signal Type	Set the diagnostic output A signal type	Read+ Write	uint8				1: ±10V bi 2: 4…12…20mA bi 3: 4…20mA uni	±10V

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
268	Diagnosis A Measuring Point	Diagnosis A measuring point	Read+ Write	uint8				1: Actual position 2: Setpoint intern 3: Setpoint extern 4: Setpoint bus 5: DMD value 6: CMD pilotstage 7: CMD mainstage 11. Actual pos pilotstage 12: Actual pos mainstage 13: Actual current 14: Actual tep controler 15: Actual temp lvdt 16: Actual voltage supply 23: Actual vel mainstage 24: Actual vel mainstage filtered 31: Actual vel pilotstage 32: Actual vel pilotstage filtered	1
276	Zeropoint adjustment	Adjustment of the zero-point shift. = Offset To compensate for asym-metries.	Read+ Write	float32	-30	30	%		0
277	MIN Overlap Comp On/Off	Activate/Deactivate MIN overlap compensation	Read+ Write	boolean				false: Off true: On	False
278	MIN A-Kanal	Setting of the minimum signal stroke with positive setpoint signal > 0.1%. To adjust the input signal span to the drive working range.	Read+ Write	float32	0	49	%		0
279	MIN B-Kanal	Setting of the minimum signal stroke at negative setpoint signal > -0.1%. To adjust the input signal span to the drive working range.	Read+ Write	float32	0	49	%		0
280	MAX A-Kanal	Setting of the maximum si-gnal stroke when the setpoint signal is positive. To adjust the input signal span to the drive working range.	Read+ Write	float32	51	100	%		100
281	MAX B-Kanal	Setting of the maximum si-gnal stroke when the setpoint signal is positive. To adjust the input signal span to the drive working range.	Read+ Write	float32	51	100	%		100
284	Ramp Type	Selection of the ramp type	Read+ Write	uint8				0: no ramps 3: linear ramps (4 climbs)	0
285	Quadrant I Ramp Time Upwards	Setting the time for the setpoint change / setpoint build-up	Read+ Write	uint16	0	32500	ms		0
286	Quadrant I Ramp Time Down	Setting the time for the setpoint change / setpoint reduction	Read+ Write	uint16	0	32500	ms		0
289	Quadrant III Ramp Time Upwards	Setting the time for the setpoint change / setpoint build-up	Read+ Write	uint16	0	32500	ms		0
290	Quadrant III Ramp Time Down	Setting the time for the setpoint change / setpoint reduction	Read+ Write	uint16	0	32500	ms		0
295	LED Ring ON/OFF	Switching the RGB LED Ring on or off	Read+ Write	boolean				false: OFF true: ON	true

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
512	2nd control circuit Actual value selection	Adjustment of the sensor-type. To match the feedback input to the sensor signal type	Read+ Write	uint8				0: 0… 10V 1: ±10V 2: 4… 20mA 3: 4…12…20mA 4: ±10mA 5: ±20mA	1
513	2nd control circuit Multiplier / Polarity	Adjustment of feedback scaling and its polarity. To adapt the working range to the feedback-input range and the sensor signal polarity of the control system. Example 513 = -120 % and 512 = 1 = > +5 V input is converted to -6 V	Read+ Write	float32	-300	300	%		100
514	2nd control circuit Actual cable break monitoring	Adjustment of the operating mode for feedback cable break detection. To activate or deactivate the cable break detection of the sensor signal.	Read+ Write	boolean				false: OFF true: ON	false
515	2nd control circuit zero point setting actual value	Setting the zero offset. To compensate for unbalances of the sensor signal.	Read+ Write	float32	-50	50	%		0
516	2nd control circuit Max A Setting Actual Signal	Limitation of the Sensor Signal Direction of Movement A	Read+ Write	float32	50	120	%		100
517	2nd control circuit Max B Setting Actual Signal	Limitation of the Sensor Signal Direction of Movement A	Read+ Write	float32	-120	-50	%		-100
518	2nd control circuit Voltage Monitoring Actual Sensor	Setting the operating mode for monitoring the supply voltage of the actual value sensor. To switch on or off the supply voltage monitoring for the actual value sensor.	Read+ Write	boolean				false: OFF true: ON	false
520	2nd control circuit controlled / close loop controlled	Adjustment of the operating mode of the controller. To select the control function.	Read+ Write	uint8				0: controlled 1: closed loop	1
521	2nd control circuit setting sampling rate	Adaptation of the sensor rate's consumption rate to the control function	Read+ Write						
522	2nd control circuit Limitation of the control error	Adjusting the permissible size of the control error	Read+ Write	float32	1	200	%		100
523	2nd control circuit Bypass gain	Setting the bypass portion for the controller. For basic tuning of the controller.	Read+ Write	float32	0	10			0
524	2nd control circuit Bypass gain part limitation	Limitation of the bypass gain part. On the weighting of the Bypass gain part in the control variable.	Read+ Write	float32	0	30	%		10
525	2. Control loop P part	Adjustment of P-part for the controller. Basic configuration of the controller.	Read+ Write	float32	0	100			3
526	2nd control circuit P part Limitation	Limitation of the P-part. To weighten the P-part in the correcting value.	Read+ Write	float32	0	10000	%		1000
527	2nd control circuit I part	Adjustment of I-part for the controller. To reduce the control fault.	Read+ Write	float32	0	10000			0
528	2nd control circuit I-range	Adjustment of the active range for the I-part regarding the control difference. To limit the I-part to a specific range.	Read+ Write	float32	0	100	%		7

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
529	2nd control circuit I-part limited	Limitation of the I-part. To weighten the I-part in the correcting value.	Read+ Write	float32	0	200	%		15
530	2nd control circuit Integrator Hold	Limitation of the I part. Stops the calculation of the I part.	Read+ Write						
531	2nd control circuit Integrator Reset	Limitation of the I part. resets the I-portion to the default setting, 527	Read+ Write						
532	2nd control circuit Proportion Step Size	Limitation of the I part. Limits the increment size of the I-portion	Read+ Write	float32	0	200	%		200
533	2nd control circuit D speed gain	Adjustment of D-part for the controller. To improve the control dynamics.	Read+ Write	float32	0	100			1
534	2nd control circuit D -lead time	Adjustement of the lead time for the DT1-element of the controller. To dampen of the D-part in the controller	Read+ Write	float32	0	10000	%		1000
535	2nd control circuit D-part limitation	Limitation of the D-part. To weighten the D-part in the correcting value.	Read+ Write	float32	0	100	%		100
536	2. Regelkreis Pilot CTRL Ratio to Main Stage Position Controler		Read+ Write		1	20			
537	2nd control circuit Limitation of cycle time	Limiting the cycle time of the controller	Read+ Write		0	100	KHz		
538	2nd control circuit Limitation Acceleration	Limiting the acceleration of the main axis	Read+ Write		0	100			
539	2nd control circuit Limitation Command velocity	Main Controler Cut-Off Frequency Command velocity	Read+ Write		0	100	KHz		
540	2nd control circuit Command Velocity Portion Limit	Main Controler Command Velocity Portion Limit	Read+ Write		0	100	%		
541	4-20 mA Diagnostic Inversion	Adjustment of the polarity of the 4-20mA diagnostic out-put. To adapt to downstream monitoring systems.	Read+ Write	boolean				false: OFF true: ON	false
768	Validate Error Reaction Type	Set reaction type of the chosen error	Read+ Write	uint8				0: NONE 1: LOGGING	0
769	Validate Error Code	Chosen error to validate	Read+ Write	uint16	1	127			1
770	Validate Error Counter	Number of occurred errors of the chosen error	Read	uint16	0	65535			0
771	Validate Auto Acknowledge	Auto acknowledge of each error	Read+ Write	uint8				0: OFF 1: ON	0
800	Operating Time Days	Daily counter in which the device is in operation	Read	uint16	0	65535	d		0
801	Operating Time Hours	Hour counter in which the device is in operation	Read	uint16	0	24	h		0
802	Operating Time Minutes	Minute counter in which the device is in operation	Read	uint16	0	60	min		0
803	Operating Time Overall Minutes	Total minute counter in which the device is in operation	Read	uint32	0	4294967295	min		0
805	On Off Cycles	Counter how often the device was switched on off	Read	uint32	0	4294967295			0
810	Device Supply Voltage Actual	Actual applied supply voltage of the device	Read	float32	0	50	V		0
811	Device Supply Voltage Max	Maximum applied supply voltage of the device	Read	float32	0	50	V		0
812	Device Supply Voltage Avg	Average supply voltage of the device	Read	float32	0	50	V		24.0

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
813	Device Current Actual	Actual current consumption of the device	Read	float32	0	10	A		0
814	Device Current Max	Maximum current consumption that occurred on the device	Read	float32	-10	10	A		0
815	Device Current Avg	Average current consumption of the device	Read	float32	-10	10	A		0
816	Device Power Actual	Actual consumed power by the device	Read	float32	0	500	W		0
817	Device Power Max	Maximum power consumption that occurred on the device	Read	float32	0	500	W		0
818	Device Power Avg	Average power consumption of the device	Read	float32	0	500	W		1.0
819	Actuator Current Actual	Actual current consumption of the device	Read	float32	0	20	A		0
820	Actuator Current Max	Maximum current consumption that occurred on the actuator	Read	float32	0	20	A		0
821	Actuator Current Avg	Average current consumption of the actuator	Read	float32	0	20	A		0
822	Power stage Voltage Actual	Actual voltage on the Power stage	Read	float32	0	50	V		0
823	Power stage Voltage Max	Maximum voltage that occurred on the Power stage	Read	float32	0	50	V		0
824	Power stage Voltage Avg	Average voltage on the Power stage	Read	float32	0	50	V		24.0
825	Power stage Current Actual	Actual current consumption of the Power stage	Read	float32	0	10	A		0
826	Power stage Current Max	Maximum current that occurred on the Power stage	Read	float32	-10	10	A		0
827	Power stage Current Avg	Average current consumption of the Power stage	Read	float32	-10	10	A		0
828	Power stage Power Actual	Actual consumed power by the Power stage	Read	float32	0	500	W		0
829	Power stage Power Max	Maximum power that occurred on the Power stage	Read	float32	0	500	W		0
830	Power stage Power Avg	Average power consumption of the Power stage	Read	float32	0	500	W		0.5
831	Temperature In Housing Actual	Actual temperature in housing	Read	int16	-50	200	°C		0
832	Temperature In Housing Min	Minimum temperature that occurred in housing	Read	int16	-50	200	°C		100
833	Temperature In Housing Max	Maximum temperature that occurred in housing	Read	int16	-50	200	°C		0
834	Temperature In Housing Avg	Average temperature that occurred in housing	Read	int16	-50	200	°C		40
835	Temperature MCU Actual	Actual temperature of the MCU	Read	int16	-50	200	°C		0
836	Temperature MCU Min	Minimum temperature that occurred at the MCU	Read	int16	-50	200	°C		100
837	Temperature MCU Max	Maximum temperature that occurred at the MCU	Read	int16	-50	200	°C		0
838	Temperature MCU Avg	Average temperature that occurred at the MCU	Read	int16	-50	200	°C		40
839	Temperature Amplifier Actual	Actual temperature at the power amplifier	Read	int16	-50	200	°C		0
840	Temperature Amplifier Min	Minimum temperature that occurred at the amplifier	Read	int16	-50	200	°C		100
841	Temperature Amplifier Max	Maximum temperature that occurred at the amplifier	Read	int16	-50	200	°C		0
842	Temperature Amplifier Avg	Average temperature that occurred at the amplifier	Read	int16	-50	200	°C		40
843	Temperature Power Supply Actual	Actual temperature at the power supply	Read	int16	-50	200	°C		0

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
844	Temperature Power Supply Min	Minimum temperature that occurred at the power supply	Read	int16	-50	200	°C		100
845	Temperature Power Supply Max	Maximum temperature that occurred at the power supply	Read	int16	-50	200	°C		0
846	Temperature Power Supply Avg	Average temperature that occurred at the power supply	Read	int16	-50	200	°C		40
847	Pilot Position Min	Minimum pilot position that occurred	Read	float32	-200	200	%		0
848	Pilot Position Max	Maximum pilot position that occurred	Read	float32	-200	200	%		0
849	Pilot Position Avg	Average pilot position during operation	Read	float32	-200	200	%		0
850	Main Spool Position Min	Minimum main spool position that occurred	Read	float32	-200	200	%		0
851	Main Spool Pilot Position Max	Maximum main spool position that occurred	Read	float32	-200	200	%		0
852	Main Spool Pilot Position Avg	Average main spool position during operation	Read	float32	-200	200	%		0
853	Command Min	Minimum command that occurred	Read	float32	-200	200	%		0
854	Command Max	Maximum command that occurred	Read	float32	-200	200	%		0
855	Command Avg	Average command during operation	Read	float32	-200	200	%		0
856	Main Stage Fail Safe Position	Main-stage fail-safe position	Read	float32	-120	120	%		0
857	Pilot Fail Safe Position	Pilot fail-safe position	Read	float32	-120	120	%		0
858	Movement Pilot Mio	Total movement distance of the pilot, 1=1Million 100% stroke	Read	uint32	0	4294967295			0
859	Movement Main Stage Mio	Total movement distance of the main-stage, 1=1Million 100% stroke	Read	uint32	0	4294967295			0
860	Movement Pilot	Total movement distance of the pilot, 1=100% stroke	Read	float32	0	1,00E+06			0
861	Movement Main Stage	Total movement distance of the main-stage, 1=100% stroke	Read	float32	0	1,00E+06			0
1184	Control Word Intern	Internal control word to control the device state machine	Read	uint16	0	65535			
1185	Status Word	Status word of the device state machine	Read	uint16	0	65535			
1186	Setpoint Extern	External setpoint value (analogue)	Read	float32	-120	120	%		
1187	Setpoint Intern	Internal setpoint value (digital)	Read	float32	-120	120	%		
1188	Demand Value	Demand value (processed setpoint value)	Read	float32	-120	120	%		
1189	Command Pilot Stage	Command signal for position of pilot spool	Read	Float32	-120	120	%		
1190	Command Main Stage	Command signal for position of main spool	Read	float32	-120	120	%		
1191	Command Current	Command signal for current control	Read	float32	-120	120	%		
1192	Command PWM	Command signal for PWM output	Read	float32	-100	100	%		
1193	Testsignal	Test signal for device mode Test	Read	float32	-100	100	%		
1194	Actual Pilot Position	Actual position of the pilot stage	Read	float32	-120	120	%		
1195	Actual Main Position	Actual position of the main stage	Read	float32	-120	120	%		
1196	Position Ctrl Main Output		Read	Float32	-120	120	%		

Index	Name	Description	Read+ Write	Data-type	Min	Max	Unit	Value	De-fault
1197	Position Ctrl Main Ub	Output signal of main spool position bypass controller	Read	float32	-30	30	%		
1198	Position Ctrl Main Up	Output signal of main spool position P-controller	Read	float32	-10000	10000	%		
1199	Position Ctrl Main Ui	Output signal of main spool position I-controller	Read	float32	-100	100	%		
1200	Position Ctrl Main Uv	Output signal of main spool position V-controller	Read	float32	-10000	10000	%		
1201	Position Ctrl Main Err	Main spool position control error	Read	float32	-200	200	%		
1202	Actual Velocity Main Stage	Main spool velocity	Read	float32	-200	200	%		
1203	Actual Velocity Main Stage Filtered	Main spool velocity filtered	Read	float32	-200	200	%		
1204	Position Ctrl Pilot Output	Output signal of pilot spool position controller	Read	float32	-100	100	%		
1205	Position Ctrl Pilot Ub	Output signal of pilot spool position bypass controller	Read	float32	-30	30	%		
1206	Position Ctrl Pilot Up	Output signal of pilot spool position P-controller	Read	float32	-10000	10000	%		
1207	Position Ctrl Pilot Ui	Output signal of pilot spool position I-controller	Read	float32	-100	100	%		
1208	Position Ctrl Pilot Uv	Output signal of pilot spool position V-controller	Read	float32	-10000	10000	%		
1209	Position Ctrl Pilot Err	Pilot spool position control error	Read	float32	-200	200	%		
1210	Actual Velocity Pilot Stage	Pilot spool velocity	Read	float32	-200	200	%		
1211	Actual Velocity Pilot Stage Filtered	Pilot spool velocity filtered	Read	float32	-200	200	%		
1212	Current Ctrl Output	Output signal of current controller	Read	float32	-100	100	%		
1213	Current Ctrl Ub	Output signal of current bypass controller	Read	float32	-30	30	%		
1214	Current Ctrl Up	Output signal of current P-controller	Read	float32	-10000	10000	%		
1215	Current Ctrl Ui	Output signal of current I-controller	Read	float32	-100	100	%		
1216	Current Ctrl Err	Current control error	Read	float32	-200	200	%		

Error codes

Error Code	IO Link Description	Short description	Detailed description
5	H BRIDGE UV WARN	Actuator under voltage warning	The supply voltage of the actuator is too low.
6	H BRIDGE OV WARN	Actuator over voltage warning	The supply voltage of the actuator is too high.
7	SIGNAL UV WARN	CPU under voltage warning	The supply voltage of the processor electronics is too low.
8	SIGNAL OV WARN	CPU over voltage warning	The supply voltage of the processor electronics is too high.
9	SIGNAL OV WARN	Temperature in housing too low -20°C	
12	TEMP INHOUSING FALLEN BELOW	Temperature in housing fallen below -30°C	
13	TEMP MCU TOO LOW	Electronics temperature too low (< –20 °C)	
14	TEMP MCU TOO HIGH	Electronics temperature too high (> 110 °C)	
15	TEMP MCU EXCEEDED	Electronics temperature exceeded (> 120 °C)	The unit temperature exceeded dangerously the permissible range.
16	OVERCURRENT ACTUATOR	Actuator over current	The current consumption of the actuator is too high.
19	FAULT_TEMP_MCU_FALLEN_BELOW	Interrupt overflow on CPU1	Interrupt noch nicht abgearbeitet when nächster kommt auf CPU1.
22	FAULT_10V_REF_WARN	10V Reference voltage out of range 4%	The 10V reference voltage is 4% out of range.
23	FAULT_10V_REF_RANGE	10V Reference voltage out of range 10%	The 10V reference voltage is 10% out of range.
24	FAULT_2_5V_REF_WARN	2.5V Reference voltage out of range 4%	The 2.5V reference voltage is 4% out of range.
25	FAULT_2_5V_REF_RANGE	2.5V Reference voltage out of range 40%	The 2.5V reference voltage is 40% out of range.
26	CMD CABLE BREAK	Command signal cable break/short circuit	The wiring of command signal is short-circuited or interrupted.
27	ANALOG INPUT1 BREAK	Analog input 1 supply cable break/short circuit	The wiring at analogue input 1 is short-circuited or interrupted.
28	MAIN STAGE CABLE BREAK	Main stage supply cable break/short circuit	The wiring on analogue input 2 is short-circuited or interrupted.
29	TEMP LVDT TOO LOW	LVDT - oil temperature too low -20°C	LVDT - oil temperature too low -20°C
30	TEMP LVDT TOO HIGH	LVDT - oil temperature too high 75°C	LVDT - oil temperature too high 75°C
36	TEMP H BRIDGE FALLEN BELOW	Temperature amplifier fallen below -30°C	
40	TEMP POWERSUPPLY FALLEN BELOW	Temperature power supply fallen below -30°C	
75	DAC SPI LOOP BACK	DAC SPI Loop back, items received not as expected	The internal communication with DAC is disturbed.
93	FAULT_I2C_POWER_HBRIDGE	No or faulty I2C communication with power monitor of actuator driver	No or faulty I2C communication with power monitor of actuator driver.
94	FAULT_ I2C _POWER_SIGNAL	No or faulty I2C communication with power monitor of CPU electronics	No or faulty I2C communication with power monitor of CPU electronics.
95	FAULT_ I2C _TEMP_H_BRIDGE	No or faulty i2C communication with temperature sensor 0	No or faulty I2C communication with temperature
			sensor 0.
96	FAULT_ I2C _TEMP_POWERSUPPLY	No or faulty I2C communication with temperature sensor 1	No or faulty I2C communication with temperature
			sensor 1.
97	FAULT_ I2C _TEMP_INHOUSING	No or faulty I2C communication with temperature sensor 2	No or faulty I2C communication with temperature
			sensor 2.
118	FAULT_ZERO_DAC	Zero point DAC I2C communication fault	Zero point DAC I2C communication fault
119	FAULT_ I2C _TIMEOUT	I2C general fault	Internal I2C communication is disturbed.

LED flashing signals of the valve electronics

The device status is indicated by an LED with two color fields. Different device states are indicated by the color combinations and the flashing frequency.

Example for position field 1 and 2

Device status	LED field 1		LED field 2		Error
	Colour	Flash code	Colour	Flash code	
Normal					
Active	Green	Permanent	Green	Permanent	
Disabled	Green	1 Hz	Green	1 Hz	Error codes
On Hold	Green	0.5 Hz	Green	0.5 Hz	Error codes
Warning					
Active	Yellow	Permanent	Yellow	Permanent	
Disabled	Yellow	1 Hz	Yellow	1 Hz	Error codes
Error					
Active	Red	Permanent	Red	Permanent	
Disabled	Red	1 Hz	Red	1 Hz	Error codes
Normal + active IO Link communication					
Active	Blue	Permanent	Green	Permanent	
Disabled	Blue	1 Hz	Green	1 Hz	Error codes
On Hold	Blue	0.5 Hz	Green	0.5 Hz	Error codes
Warning + active IO Link communication					
Active	Blue	Permanent	Yellow	Permanent	
Disabled	Blue	1 Hz	Yellow	1 Hz	Error codes

Error codes	
Flash frequency	**Desription**
1x + break	External supply voltage too high or too low
2x + break	Internal power supply fault
3x + break	Analog input error
4x + break	Analog Output Error
5x + break	Control error monitoring – deviation too large
6x + break	Power consumption of the electronics too high
7x + break	Error - external communication
8x + break	Errors – internal communication
9x + break	Internal temperature too high or too low
10x + break	Internal error

Air Bleeding of Hydraulic System

During initial startup, after an oil change as well as after the opening of lines or valves the hydraulic system must be air bleeded.

Filter

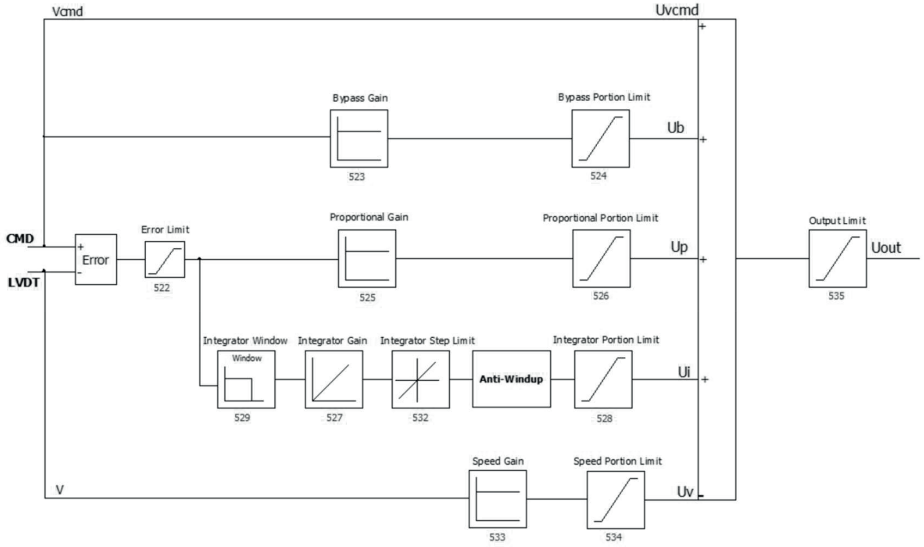
The function and lifetime of the valve are strongly affected by the cleanliness of the fluid.

Purity level class of 18/16/13 acc. ISO4406 is required.

Flushing

It is recommended to flush the pipelines by short circuiting the pressure and return lines. This prevents the installation dirt from entering the valve.

Structure and parameter of the 2nd control loop



Parameter description

Index	Name	Description	Read/ Write	Data type	Min	Max	Unit	Value	Default
520	2nd control circuit controlled / close loop controlled	Adjustment of the operating mode of the controller. To select the control function.	Read+ Write	uint8				0: controlled 1: closed loop	1
521	2nd control circuit setting sampling rate	Adaptation of the sensor rate's consumption rate to the control function	Read+ Write						
522	2nd control circuit Limitation of the control error	Adjusting the permissible size of the control error	Read+ Write	float32	1	200	%		100
523	2nd control circuit Bypass gain	Setting the bypass portion for the controller. For basic tuning of the controller.	Read+ Write	float32	0	10			0
524	2nd control circuit Bypass gain part limitation	Limitation of the bypass gain part. On the weighting of the Bypass gain part in the control variable.	Read+ Write	float32	0	30	%		10
525	2. Control loop P part	Adjustment of P-part for the controller. Basic configuration of the controller.	Read+ Write	float32	0	100			3
526	2nd control circuit P part Limitation	Limitation of the P-part. To weighten the P-part in the correcting value.	Read+ Write	float32	0	10000	%		1000
527	2nd control circuit I part	Adjustment of I-part for the controller. To reduce the control fault.	Read+ Write	float32	0	10000			0
528	2nd control circuit I-range	Adjustment of the active range for the I-part regarding the control difference. To limit the I-part to a specific range.	Read+ Write	float32	0	100	%		7
529	2nd control circuit I-part limited	Limitation of the I-part. To weighten the I-part in the correcting value.	Read+ Write	float32	0	200	%		15
530	2nd control circuit Integrator Hold	Limitation of the I part. Stops the calculation of the I part.	Read+ Write						

531	2nd control circuit Integrator Reset	Limitation of the I part. resets the I-portion to the default setting, 527	Read+ Write						
532	2nd control circuit Proportion Step Size	Limitation of the I part. Limits the increment size of the I-portion	Read+ Write	float32	0	200	%		200
533	2nd control circuit D speed gain	Adjustment of D-part for the controller. To improve the control dynamics.	Read+ Write	float32	0	100			1
534	2nd control circuit D -lead time	Adjustement of the lead time for the DT1-element of the controller. To dampen of the D-part in the controller	Read+ Write	float32	0	10000	%		1000
535	2nd control circuit D-part limitation	Limitation of the D-part. To weighten the D-part in the correcting value.	Read+ Write	float32	0	100	%		100
536	2. Regelkreis Pilot CTRL Ratio to Main Stage Position Controler		Read+ Write		1	20			
537	2nd control circuit Limitation of cycle time	Limiting the cycle time of the controller	Read+ Write		0	100	KHz		
538	2nd control circuit Limitation Acceleration	Limiting the acceleration of the main axis	Read+ Write		0	100			
539	2nd control circuit Limitation Command velocity	Main Controler Cut-Off Frequency Command velocity	Read+ Write		0	100	KHz		
540	2nd control circuit Command Velocity Portion Limit	Main Controler Command Velocity Portion Limit	Read+ Write		0	100	%		
541	4-20 mA Diagnostic Inversion	Adjustment of the polarity of the 4-20mA diagnostic output. To adapt to downstream monitoring systems.	Read+ Write	boolean				false: OFF true: ON	false

Features of the available controllers

Analog setpoints (W) / IO-Link control

The open second control loop can be used for dynamic position or pressure control. Analog position measurement systems or pressure sensors can be connected directly to the valve. The sensors are supplied with 24 VDC via the valve electronics. Active shutdown or setpoint-dependent ON/OFFswitching of the controller is not available.

IO-Link control + Option P

In this configuration, in addition to the basic controller functionality described above, active or value-dependent switching from the “controlled” state to the “regulated” state, or vice versa, is available.

Application: Closed loop systems for position

Introduction

The electronics uses a feedback control loop which automatically adjusts the electrical input to the valve amplifier to move the drive to a commanded position. At the heart of this feedback loop is a digital controller which computes and updates the signal output (set value output) highly dynamic. The controller has adjustable coefficients, which must be set by the user for the application. The controller provides an extended PID control capability plus extra features you can use to improve the performance beyond the limits of PID.

Basic information for the control algorithm

Why tuning?

The controller can be used with valves that vary greatly in flow capacity, frequency response, saturation, and dead band, with different kinds of load, and with cylinders of any area and stroke. The user must adjust the control coefficients for the specific system. There are no fixed sets of values for the controller coefficients that will handle every situation well. The electronics utilizes a "PID" controller for its basic control action. The name PID comes from the fact that the controller output is the sum of three terms, called proportional (P), integral (I) and derivative (D), each with a user adjustable coefficient. The user software provides therefore the parameters Parameter 525 (P), 527 (I) (I) and 533 (D).

P-Share – Parameter 525

This term provides an immediate output signal, proportional to the error between commanded and measured position. If this parameter is set too high, sustained oscillations may occur. If it is set too low, accuracy and speed of response may be poor. By using parameter 526 the setting of the variable.

I-Share – Parameter 527

This term causes the output to change at a rate proportional to the error in measured position over time (integration time), in a direction to drive the steady state error to zero parameter 527 is active within a window, which might be adjustable by parameter 528. Parameter 528 shall be adjusted in the way that the window lies near the final position or in the stationary range of the drive. A too higher value of parameter 527 causes oscillations, in addition to which the selection of a too lower value may result in a slow action. By using parameter 529 the setting of the variable can be limited.

D-Share – Parameter 533

The D-term provides an output proportional to the rate of change of the measured drive position. Depending on the polarity of the parameter prefix, this term causes damping or acceleration. For hydraulic drives this term should be set to a low value. By using parameter 534 lead time the rise can be damped. By using parameter 535 the setting of the variable can be limited.

Simple tuning of a position control loop

Before trying anything complicated, you should adjust the proportional gain, accessible by parameter 525. In many cases this coefficient will be all you need, and you will not have to bother with any of the other control features. If you do need the other features, you cannot adjust them properly without first adjusting the P-gain. Adjusting the P-gain is done by setting all the other control coefficients Parameters 526, 527 - 529 as well as 533 - 535 to zero and increasing parameter 525 to the highest value that does not result in sustained oscillations of the drive position.

Guarantee of control functionality

Before the tuning of the control loop may be commenced, the functionality of the control circuit must be ensured. As previously mentioned, the controller compares command and feedback signal and adjusts the electrical input to the valve amplifier to move the drive to the commanded position. To ensure this functionality, the polarities of command and feedback signal must be equal.

How can the functionality of the control loop be achieved?

At first you should set off the control loop (set parameter 520 to value 0 = open loop and transmit to the electronic) and cause the drive via manual control to the middle of the cylinder stroke. Afterwards adjust at first the control coefficients as described in chapter "Simple tuning of a position control loop" (525 at 10 %) as well as the parameter 520 at 1 = external closed loop and transmit to the electronic. If this results in a rapid movement of the drive to an end position, the polarities are incorrect. Access now the parameter 513 = feedback signal polarity, change the value and transmit the data. The drive should be adjustable and remain in its position when you switch on the closed loop control via parameter 520. Now you should preset position commands and supervise the drive movement. If the drive even tough is running in closed loop mode, but the direction of the movement is not as required, you must change the polarities of both command and feedback signal via the parameters 513 and 541. After that the drive is running as desired, you can continue with tuning of the loop.

Tuning of the closed loop control

1. Create a suitable tuning test profile – otherwise it may be difficult for you to tell how good the system response is. The test profile should program in a way to cause the drive to move from the start position to the required final position with the desired maximum acceleration and velocity. In the final position the drive should be commended to dwell, that will give you enough time to watch the load position to see if it oscillates or remains stationary. This should be followed by returning the drive to the start position, where the dwell in position may also be evaluated.
2. Check once more to be sure that 527 and 533 are set to zero.
3. Adjust 525 to a low value i.e., 10 %, and try the system on the test profile. Observe the result of the test. There are three possible outcomes:
   - The drive oscillates continuously Stop the system quickly. Reduce the 525-value to ½ of the initial guess and try again.
   - The drive overshoots but stops after one or two oscillations. Reduce the 525-value to ¾ of the initial guess and try again.
   - The drive reaches the commanded position with no overshoot. The system is usable with the estimated value of P-gain. You should experiment by increasing the 525-value stepwise to see how high a value the system will tolerate. Accuracy and response are improved by high values, but do not allow permanent oscillation! You have now completed the basic tuning for your control loop. The next step is to test the performance of the system to whether it meets your requirements. If not, the electronic has additional control features you can use to improve performance, as explained below.

The table below gives information which approaches may be embarked if typical problems with position control loops appear.

Issue	Solution
Position error too large when drive is stationary	Use parameter 527 – I-gain increase (only if 528 > 10 %)
Disappointingly low P-gain	Check the frequency response of the valve and position transducer, or possibly the drive resonant frequency (s. item below)
Response too slow	Be sure 525 = P-gain is adjusted high enough (s. also previous items)
Unexplainable problems	Check the setting of all parameters

Improving system performance Using the parameter 527 = I-gain

The integrator gain (abbreviated I) can be adjusted to reduce or eliminate the error between the commanded position and the position measured by the feedback transducer, subject to the command remaining constant. Higher values of I-gain will cause the response to be slower and more prone to oscillation with the combined effect of a reduced stationary error. Lower values will require a reduced time to reach zero steady state error. This parameter is only active if a window (5 – 20 %) is defined via 528.

Elimination of slow, small amplitude oscillation in position

Because of friction and other imperfections, use of the I-gain sometimes causes a slow, small amplitude oscillation in load position. This is an entirely different problem from the vigorous oscillations that occur when the P-gain is set too high. The electronics provides a "Window" feature (sometimes called "in-position-window") to solve this problem. Select the parameter 528. Stepwise increasing of the window size to a large enough value will stop the slow oscillations.

Increasing load stiffness

"Load stiffness" is the term given to the resistance of the servo loop to deflection of the drive by external forces. Adjusting P-gain (parameter 525) to the highest practical value is important.

Disappointing control loop function

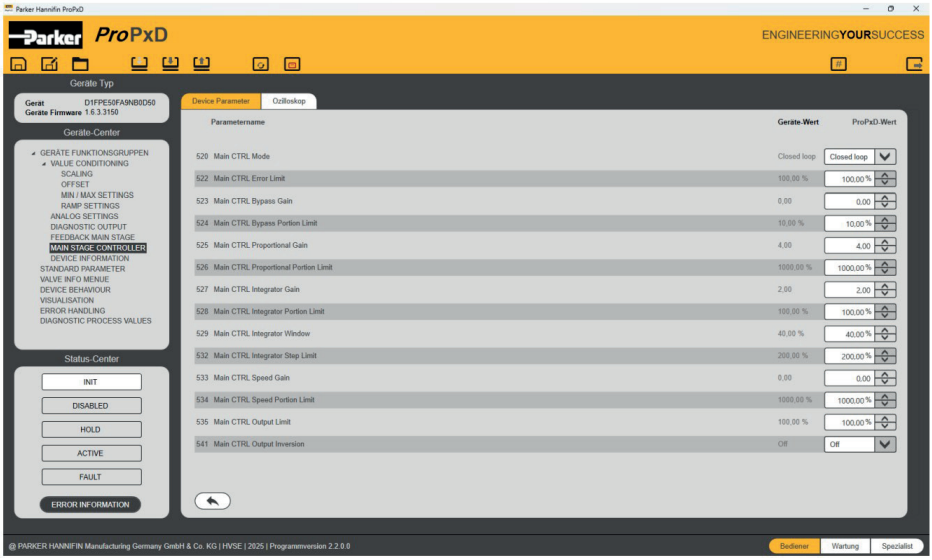
The higher the value of P-gain is adjusted, the better is the static and dynamic performance of the system. You may not have any direct need for fast response but may still need a high value of P to reduce static error, reduce following error or increase load stiffness. High values of P cause faster system response, whether you need it or not. As the system frequency response gets too close to the frequency response of one of your components, the system response becomes oscillatory.

- Valve
  The frequency response of the valve can be obtained from catalogue HY11-3500/UK "Hydraulic Valves Industrial Standard"series D1FP/D3FP. As a first guess, it needs to be at least twice the system frequency response.
- Position transducer
  Some analog output transducers will present problems because of filtering intended to smooth the output. To ensure the best system dynamic, sensors with integrated D/A-converter should operate with a high sampling rate. Magnetostrictive transducers with digital output often have a low sampling rate, because of an interaction with the achievable resolution. Please obtain detailed information from the transducer supplier.
- Drive
  There is a mode of mechanical vibration created by the mass of the load and the compressibility of the hydraulic fluid in the whole system (cylinders, pipe, valve). This frequency is often surprisingly low when using long stroke cylinders.
- Sampling rate of the controller
  The controller updates the electrical output to the valve at >1 kHz. This rate is fast enough to have negligible effect in almost all hydraulic applications, but it does set an absolute limit on the response of the system.

Position transducer accuracy and resolution

A control system cannot be better than its transducer. Here are points to watch for:

- Absolute accuracy
  The controller positions the load as closely as possible to the position measured by the feedback transducer.The absolute accuracy of the measured position is determined by the transducer.
- Resolution
  The electronics cannot position the load more accurately than the resolution of the transducer. Be sure the resolution of your sensor is adequate. When using a true analog transducer (analog measurement principle and analog output), the resolution is limited by the utilized A/D-converter, which is 16 bit (1/4096 = 0.025 %).
- Installation
  The installation of the position transducer plays a most important rule for the proper functionality of the closed loop control. It must be secured, that the mounting of transducer and actuating device provides absolute freedom from vibration and clearance effects. This is most important even for the commonly expected velocities and accelerations. Also, the transducer must be laid out for the dynamic requirements.



Trouble shooting

Basis of troubleshooting is always a systematic approach.

For suspect of a sluggish spool the valve may be flushed with clean pressure fluid.

Troubleshooting in a hydraulic system requires detailed knowledge about function and construction of the system. Therefore the work may exclusively be performed by qualified personnel.

Accessories / Spare parts

Accessories

The following accessories are available for the valve series DFplus:

Bolt kit

D1FP	ordering code BK 375
D3FP	ordering code BK 385

Female connection

Code 0: 6+PE	ordering code 5004072
Code 5: 11-PE	ordering code 5004711
Code 7: 6-PE	ordering code 5004072

Spare Parts

Seal kit NBR

D1FP	ordering code SK-D1FP
D3FP	ordering code SK-D3FP

Seal kit FPM

D1FP	ordering code SK-D1FP-V
D3FP	ordering code SK-D3FP-V

Seal kit HFC

D1FP	ordering code SK-D1FP-H
D3FP	ordering code SK-D3FP-H

malfunction at hydraulic load runtime										
	- generally no function									
		- high frequent oscillation								
			- low frequent oscillation							
				- one way operation only						
					- speed variations at unchanging command					
						- different speeds depending on travel direction				
							- speed too low			
								- drifting without command		
									- poor dynamic	
									possible reasons for malfunction	**corrective actions**
X									hydraulic pump resp. motor defective	replace hydraulic pump resp. motor
X		X	X	X	X	X		X	drive overloaded	reduce pressure resp. speed, increase valve size
X		X	X	X	X	X	X	X	valve contaminated	clean pressure fluid, filter / flush valve
				X		X		X	hydraulic fluid too viscous / too cold	change fluid grade, provide operational temperature
X		X	X						too low oil level within tank	refill pressure fluid
				X	X	X			filter contaminated	replace filter
X		X				X	X		supply voltage too low	keep supply voltage range
	X								supply voltage carries too much ripple	reduce ripple
X			X			X			command signal too low	increase command signal
	X								command signal carries too much ripple	reduce ripple
			X		X				center position adjustment incorrect	check center position adjustment
X	X			X		X	X		contacts of central connector contaminated	clean contacts / replace plug
X									feed cable interrupted	fix feed cable
X	X	X	X	X		X	X		wiring sequence incorrect	correct wiring sequence
	X						X		feed cable without shielding	change cable grade
X									pilot pressure too low or failed	increase pilot pressure to min. 20 bar
		X				X	X		pilot pressure too low	increase pilot pressure to min. 20 bar
								X	pilot pressure too low	increase pilot pressure to min. 50 bar

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